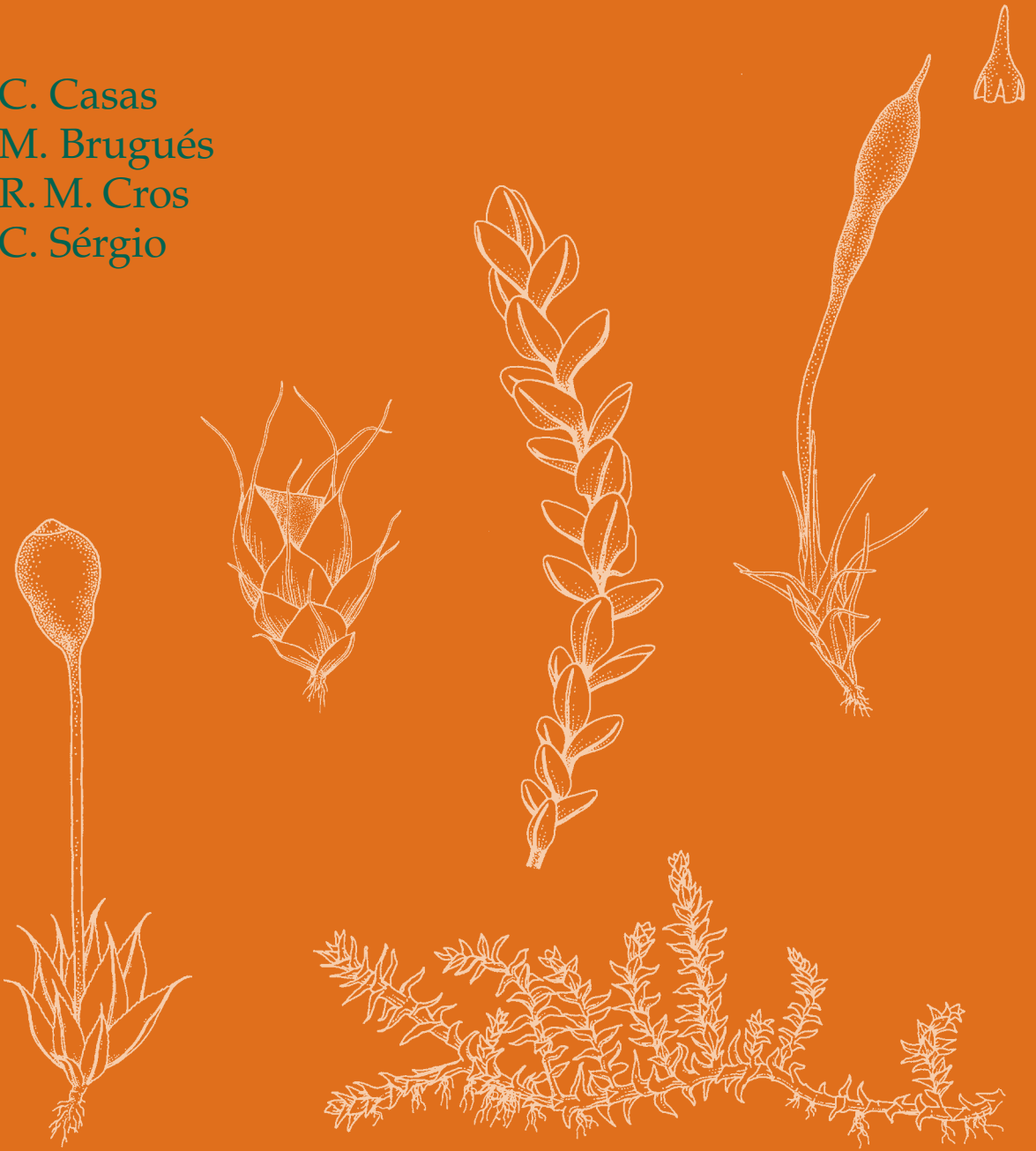


INSTITUT D'ESTUDIS CATALANS

# HANDBOOK OF MOSSES OF THE IBERIAN PENINSULA AND THE BALEARIC ISLANDS

C. Casas  
M. Brugués  
R. M. Cros  
C. Sérgio





HANDBOOK OF MOSSES  
OF THE IBERIAN PENINSULA  
AND THE BALEARIC ISLANDS

ILLUSTRATED KEYS TO GENERA AND SPECIES



INSTITUT D'ESTUDIS CATALANS

SECCIÓ DE CIÈNCIES BIOLÒGIQUES

CREU CASAS  
MONTSERRAT BRUGUÉS  
ROSA M. CROS  
CECÍLIA SÉRGIO

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ILLUSTRATED KEYS TO GENERA AND SPECIES

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BARCELONA  
2006

**Handbook** of mosses of the Iberian Peninsula and the Balearic Islands : illustrated keys  
to genera and species  
Index. Glossari  
ISBN 84-7283-865-X  
I. Casas, Creu II. Ruiz, Elena, trad. III. Institut d'Estudis Catalans. Secció de Ciències  
Biològiques  
1. Molses — Península Ibèrica 2. Molses — Balears  
582.34(46)

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© Institut d'Estudis Catalans 2006  
Carrer del Carme, 47. 08001 Barcelona

First published: October 2006  
Print run: 600 copies

Typesetting by Víctor Igual, SL  
Carrer del Peu de la Creu, 5. 08001 Barcelona

Printed at Limpegraf SL,  
Polígon industrial Can Salvatella. Carrer de Mogoda, 29-31. 08210 Barberà del Vallès

ISBN: 84-7283-865-X  
Legal Deposit: B. 43990-2006

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## FOREWORD

This book, a floristic study of the mosses of the Iberian Peninsula and the Balearic Islands, is the first part of a work addressing the whole group of Bryophytes, and will of course be completed by a second volume devoted to liverworts. The genesis and the approach of the work are to be found in *Flora dels briòfits dels Països Catalans*, published in two volumes by the same institution.

The *Institut d'Estudis Catalans* (Institute of Catalan Studies, IEC) is the national academy of sciences and humanities of Catalonia, a centenary institution engaged in scientific research and knowledge promotion. Within its different lines of research, priority is given, on the one hand, to interdisciplinary projects — often somewhat neglected by conventional scientific centres —, and to studies pertaining to Catalan culture and language — its mandate is to codify and standardise Catalan language— and those dealing with the Catalan Countries (Catalonia, the Valencian Country and the adjacent area of Aragon, Andorra, Northern Catalonia and the Balearic Islands). It normally publishes in the language of the country, although it also publishes the journal *Contributions to Science* in English, aiming to promote the international dissemination of scientific research conducted in Catalonia. In exceptional cases, as in the case of this work, prepared in collaboration with investigators of other nationalities, it accepts English as a language of communication.

The first three signatories of this flora form the core of a research team with longstanding experience in the field of Bryology and which enjoys well deserved international prestige. Its director, Creu Casas, is a member of the Institute of Catalan Studies and for many years was a lecturer at the University of Barcelona, and later of the Autonomous University of Barcelona. The IEC was greatly interested in having this team lead the aforementioned flora of bryophytes of the Catalan Countries and is pleased with the result and its impact in a large part of Europe. It should be said that not only has C. Casas led Catalan bryology, setting it on the right road, but she has also had a notable influence throughout Spain and is regarded as a major authority on the topic. Thus, once the flora of the Catalan Countries had been undertaken, and leveraging the effort made, it was only logical that the team extend it to the Iberian Peninsula territory; and even more so taking into account the fact that this extension did not entail the addition of a major proportion of taxa. The collaboration between the Catalan team and the Portuguese team led by the investigator Cecília Sérgio made things even easier and was a sound guarantee of success.

This volume presents a comprehensive and well-structured synthesis of the current knowledge available on the mosses in the peninsular and Balearic territory; and the volume on liverworts will follow a similar pattern. Like the work that preceded it, this one provides information on the morphology, systematic, ecology and the distribution of the taxa addressed. It contains determination keys and includes numerous illustrations, led by Anna Barrón and Iolanda Filella on the basis of a rigorous scientific analysis and, as you will see, with outstanding mastery.

The author of this foreword, as well as the institution publishing the work, is convinced that this new flora will be well-received, not just by professional bryologists, but also by all nature scholars, and that it will be just as useful — which would be enough in itself — as the preceding one.

JOSEP VIGO BONADA  
Biological Sciences Section, IEC

## ACKNOWLEDGEMENTS

Many people have contributed to the elaboration of this book. We would like to thank J. Vigo very much for the interest he has shown in the development and improvement of the work, and for agreeing to write the Foreword.

We thank A.R. Perry for his helpful comments on the manuscript, as well as the accurate revision of the English text.

Some specimens in the BCB Herbarium have been revised by specialist bryologists, and for their valuable help we express our gratitude to I. Álvaro, H.H. Blom, M.A. Bruggeman-Nannenga, M.J. Cano, A. Ederra, J.-P. Frahm, M. T. Gallego, R. Gauthier, J. Guerra, L. Hedenäs, D.T. Holyoak, F. Lara, B.M. Murray, J. Muñoz, R. Ochyra, R.B. Pierrot, F. Puche and R.M. Ros, among others. The Keepers and Curators of the following herbaria are thanked: BC, BCC, BM, G, MA, MUB, PC, VAB, VIT, in particular the collections of P. Balaguer, J.P. Hébrard, J.A. Rosselló, Ll. Sáez and F. Koppe. We also thank P. Heras and M. Infante for the loan of *Ephemerum*, *Brachydontium*, *Micromitrium*, and *Tetradontium* species, and F. Rumsey for *Tetrastichium virens*, which were all used for the illustrations.

This work is part of the project “Flora i Cartografia de les Plantes i la Vegetació” of the Institut d’Estudis Catalans and has been carried out entirely in the Laboratory of Bryology in the Department of Animal Biology, Plant Biology and Ecology, Autonomous University of Barcelona.



# INTRODUCTION

The present book owes its origins to volume I of *Flora dels Briófits dels Països Catalans* (2001) devoted to mosses. By adding about 15% more species we were able to cover all the moss flora of the Iberian Peninsula and Balearic Islands. We were thus encouraged to prepare this work, for which we had the collaboration of C. Sérgio who contributed the Portuguese species.

This flora comprises identification keys to specific level with corresponding illustrations. Thanks to the numerous specimens deposited in the BCB Herbarium, collected over more than 50 years by the authors and others, and to data provided by colleagues from other universities, we had the basis of this elementary bryophyte flora. The keys are for the use of botanists, students, excursionists and people generally keen on bryology. It is not only of special interest to Spanish and Portuguese 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 and complete flora for moss identification in the Iberian Peninsula and Balearic Islands. “Sinopse das Briófitas de Portugal” (Machado, 1928-1931) published in *Boletim da Sociedade Broteriana*, is an incomplete work, as is *Flora Ibérica, Briófitas* (2ª parte) *Musgos* (Casares, 1932) published by Museo Nacional de Ciencias Naturales.

Botanists interested in detailed descriptions have so far had to turn to floras from other European countries which, however, may lack many of our southern-occidental taxa. For this reason, the Sociedad Española de Briología has started producing *Flora Briofítica Ibérica*, coordinated by J. Guerra and R.M. Cros, and has so far published the fascicles of Sphagnales and Andreaeales and the volume containing Pottiales and Encalyptales. This flora contains very detailed descriptions of each species, its ecology, provincial distribution, notes and observations and, additionally, complete illustrations. It is an essential reference work for anyone interested in bryophyte taxonomy.

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 Euro-Siberian regions (Fig. 1). There is a noteworthy climate variability and a wide range of altitudes from sea levels 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. Recognised taxa number 791, which represent 64% of the European moss flora.

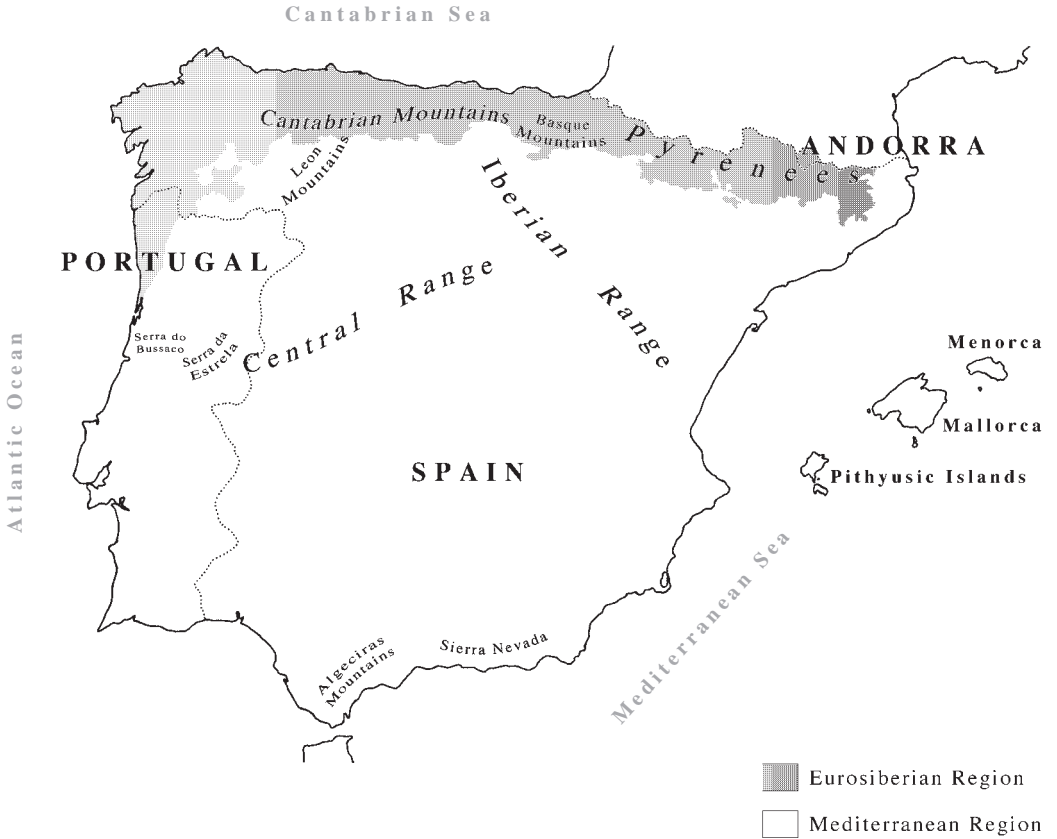


FIGURE 1. Map of the Iberian Peninsula and the Balearic Islands, with the mountains cited in the text.

**Illustrations.** The illustrations are from those in the *Flora dels Briófits dels Països Catalans* Vol. I. *Molses* (2001) with further original drawings for most of the species added. Habitat drawings were made by I. Filella and A. Barrón, the latter also being responsible for the microscopical drawings.



## 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 Hill *et al.* ("An annotated checklist of the mosses of Europe and Macaronesia", in *Journal of Bryology*, 2006). Sphagnales, Andreaeales, Pottiales and Encalyptales are treated according to *Flora Briofítica Ibérica*. 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. The specific name is in bold type, in many cases followed by the most-used synonyms. An \* placed next to a synonym indicates it is the accepted name in Hill *et al.* 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.

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. States in the Iberian Peninsula are abbreviated: Esp (continental Spain), Prt (Portugal), And (Andorra). For the Balearic Islands we specify the different isles: Mallorca (which includes the small isles of Cabrera and Dragonera), Menorca, and Pityusic Islands (including Eivissa and Formentera).

Illustrations were made from moist material. The leaves shown are ventral aspects of stem leaves unless otherwise indicated. When possible, similar details have similar or equal magnifications, although this information is always indicated in the legends.

Semi-fossil material like *Sphagnum austinii* and *Meesia longiseta*, and some doubtful or unconfirmed species such as *Callialaria curvicaulis*, *Discelium nudum*, *Fissidens asplenoides*, *Pohlia crudoides* and *Tetraplodon mniooides*, are not included in this flora.



## ARTIFICIAL KEY TO GENERA

1	Leaf lamina consisting of narrow green cells in a network enclosing large, inflated, hyaline cells; plants with branches in fascicles	<b>Sphagnum</b>	55
1	Plants lacking above combination of characters	<b>2</b>	
2	Plants dark brownish, reddish or blackish, saxicolous; laminal cells thick-walled, reddish to brownish; capsule dehiscing by 4 longitudinal slits	<b>Andreaea</b>	67
2	Plants lacking above combination of characters	<b>3</b>	
3	Basal cells of lamina narrow, elongate, sinuose, nodulose, cells above strongly sinuose	<b>Racomitrium</b>	101
3	Laminal cells lacking above combination of characters	<b>4</b>	
4	Stem leaves arranged in 2 ranks, distichous (occasionally with a third ventral row), or complanate	<b>A</b>	20
4	Stem leaves arranged in 3 or more ranks, not complanate	<b>5</b>	
5	Nerve with filaments or longitudinal lamellae on ventral side	<b>B</b>	21
5	Nerve without filaments or longitudinal lamellae on ventral side	<b>6</b>	
6	At least upper leaves ending in hyaline point or nerve excurrent in hyaline hair-point	<b>C</b>	21
6	Leaves without hyaline point or nerve excurrent in hyaline hair-point	<b>7</b>	
7	Leaves bordered with several rows of narrower cells or leaf margin pluristratose	<b>D</b>	23
7	Leaves unbordered, margin 1-2-stratose	<b>8</b>	
8	Plants acrocarpous	<b>9</b>	
8	Plants pleurocarpous	<b>30</b>	
9	Capsule present	<b>10</b>	
9	Capsule lacking	<b>20</b>	

10	Capsule indehiscent	AA	23
10	Capsule dehiscent	11	
11	Capsule immersed or emergent	AB	24
11	Capsule exserted	12	
12	Capsule larger than plant, ovoid, asymmetrical; seta papillose; leaves minute, ephemeral; perichaetial leaves ciliate	<b>Buxbaumia</b>	78
12	Plants lacking above combination of characters	13	
13	Capsule globose or sub-globose	AC	25
13	Capsule ovoid, oblong, cylindrical, ellipsoid or pyriform	14	
14	Capsule strumose	AD	26
14	Capsule not strumose	15	
15	Peristome rudimentary or lacking	AE	26
15	Peristome well developed	16	
16	Capsule striate or sulcate when dry	AF	27
16	Capsule smooth or only slightly striate when dry	17	
17	Capsule erect or nearly so; seta straight, rarely curved	18	
17	Capsule inclined to pendulous; seta straight or curved	19	
18	Peristome teeth 4 or 16, entire, divided at tips only or slightly and irregularly divided	AG	29
18	Peristome teeth 16, divided to half way or more (32 teeth)	AH	30
19	Peristome single	AI	32
19	Peristome double	AJ	32
20	Propagules present on stem or leaves or in receptacles	AK	33
20	Propagules lacking on stem or leaves or in receptacles	21	
21	Nerve wide, 1/3 or more of leaf base	AL	34
21	Nerve narrow, less than 1/3 of leaf base or without nerve	22	
22	Laminal cells 18 $\mu$ m wide or more	AM	35
22	Laminal cells less than 18 $\mu$ m wide	23	
23	Alar cells differentiated from other basal cells	AN	36
23	Alar cells not differentiated	24	
24	Laminal cells $\pm$ isodiametric	25	
24	Laminal cells longer than wide	29	

25	Leaf margin denticulate or dentate, at least near apex or at base	<b>AO</b>	37
25	Leaf margin entire, crenulate or papillose-crenulate	<b>26</b>	
26	Nerve excurrent	<b>AP</b>	39
26	Nerve not excurrent or lacking	<b>27</b>	
27	Leaf apex rounded or obtuse, apiculate or not	<b>AQ</b>	41
27	Leaf apex acute, sub-acute or acuminate	<b>28</b>	
28	Leaf margin recurved at least on one side	<b>AR</b>	42
28	Leaf margin plane or recurved only at base	<b>AS</b>	43
29	Leaf apex acuminate or subulate, apex consisting largely or entirely of nerve	<b>AT</b>	44
29	Leaf apex obtuse to acuminate, nerve percurrent to excurrent or short or lacking	<b>AU</b>	44
30	Nerve single, extending more than 1/2 way up leaf	<b>31</b>	
30	Nerve single and extending less than 1/2 way up leaf, double, short or long, or lacking	<b>35</b>	
31	Laminal cells short, to twice as long as wide, or median cells elongate and marginal cells short	<b>PA</b>	46
31	Laminal cells elongate, more than twice as long as wide	<b>32</b>	
32	Leaves longitudinally plicate, at least at base	<b>PB</b>	47
32	Leaves plane or only slightly longitudinally plicate	<b>33</b>	
33	Leaves squarrose, falciform or circinate	<b>PC</b>	48
33	Leaves straight or nearly so	<b>34</b>	
34	Leaf apex rounded, obtuse or apiculate	<b>PD</b>	48
34	Leaf apex acute or acuminate	<b>PE</b>	49
35	Laminal cells short, to twice as long as wide, or median cells elongate and marginal cells short	<b>PF</b>	51
35	Laminal cells elongate, more than twice as long as wide	<b>36</b>	
36	Leaf apex rounded, obtuse or apiculate	<b>PG</b>	51
36	Leaf apex acute or acuminate	<b>37</b>	
37	Leaves distinctly falciform or squarrose	<b>PH</b>	52
37	Leaves straight or weakly falciform or squarrose	<b>PI</b>	53

**A. Leaves distichous or complanate**

1	Leaves distichous, arranged on stem in two opposite rows, with or without a third ventral row	2	
1	Leaves complanate, arranged in more than 2 rows on stem but flattened into more or less one plane	5	
2	Plants with a ventral row of leaves different from the lateral leaves	<b>Hypopterygium</b>	245
2	Plants without a ventral row of leaves different from the lateral leaves	3	
3	Lower part of leaf conduplicate	<b>Fissidens</b>	118
3	Leaf not conduplicate	4	
4	Leaves decurrent, without sheathing base, apex acute or acuminate; nerve lacking	<b>Schistostega</b>	138
4	Leaves not decurrent, with sheathing base, narrowed to subulate point; nerve present	<b>Distichium</b>	125
5	Leaves with a border of narrow elongated cells; nerve double	<b>Cyclodictyon</b>	247
5	Leaves unbordered; nerve single, double or lacking	6	
6	Laminal cells 60-100 µm wide	<b>Hookeria</b>	247
6	Laminal cells 4-45 µm wide	7	
7	Nerve single	8	
7	Nerve short and double or lacking	10	
8	Nerve extending to 2/3 way up leaf; leaves lanceolate or ovate-lanceolate	<b>Leptodictyum</b>	256
8	Nerve extending 1/2-4/5 way up leaf; leaves oblong to spatulate	9	
9	Leaves oblong to spatulate, not undulate; leaf apex dentate	<b>Homalia</b>	313
9	Leaves oblong, transversely undulate; leaf apex finely denticulate	<b>Neckera</b>	313
10	Leaves oblong, oblong-lanceolate or oblong-ovate, non-decurrent; stem pinnately or irregularly branched	11	
10	Leaves lanceolate, ovate or ovate-lanceolate, decurrent or not; stem irregularly branched	13	
11	Leaves transversely undulate or not; stem pinnately branched	<b>Neckera</b>	313
11	Leaves not transversely undulate; stem irregularly branched	12	
12	Plants small; median laminal cells 6-10 µm wide	<b>Taxiphyllum</b>	295
12	Plants medium-sized; median laminal cells 20-45 µm wide	<b>Tetrastichium</b>	247

13	Alar cells hyaline, differentiated	14	
13	Alar cells green or yellowish, differentiated or not	15	
14	Leaf margin entire or denticulate at apex	<b>Plagiothecium</b>	304
14	Leaf margin denticulate	<b>Herzogiella</b>	302
15	Plants medium-sized, rare	16	
15	Plants slender or small, common	17	
16	Alar cells not differentiated	<b>Tetrastichium</b>	247
16	Alar cells differentiated	<b>Isopterygium</b>	310
17	Flagelliform propagules in leaf axils, with small primordial leaves	<b>Pseudotaxiphyllum</b>	307
17	Flagelliform propagules lacking	<b>Isopterygiopsis</b>	302

#### B. Nerve with filaments or longitudinal lamellae on ventral side

1	Nerve with branched or unbranched filaments at least in the upper part	2	
1	Nerve with longitudinal lamellae at least in the upper part	3	
2	Leaf margin widely incurved; leaves rigid	<b>Aloina</b>	154
2	Leaf margin recurved or plane; leaves not rigid	<b>Crossidium</b>	159
3	Plants to 0,5 cm tall; nerve with 2-4 lamellae; peristome rudimentary or lacking	<b>Pterygoneurum</b>	180
3	Plants 0,5-6 cm tall; nerve usually with 4 lamellae or more; peristome well developed, of 32 or 64 teeth	4	
4	Nerve narrow, with 3-7 lamellae; leaves with a border of long, narrow cells	<b>Atrichum</b>	71
4	Nerve broad, with more than 7 lamellae; leaves unbordered	5	
5	Nerve with 8-12 sinuose lamellae	<b>Oligotrichum</b>	73
5	Nerve with more than 12 lamellae, not sinuose	6	
6	Capsule not angled, without apophysis; peristome teeth 32; leaves muticous	<b>Pogonatum</b>	73
6	Capsule angled or not, with apophysis; peristome teeth 64; leaves muticous or ending in hair-point	<b>Polytrichum + Polytrichastrum</b>	74

#### C. Leaves with hyaline point or with nerve excurrent in hyaline hair-point

1	Leaves with hyaline point	2	
1	Leaves, at least the upper ones, with nerve excurrent in hyaline hair-point	9	

2	Nerve lacking	<b>Hedwigia</b>	215
2	Nerve present	3	
3	Plants julaceous, silvery when dry	<b>Bryum</b>	221
3	Plants not julaceous, not silvery when dry	4	
4	Median cells of lamina 10-25 $\mu$ m wide	<b>Orthotrichum</b>	201
4	Median cells of lamina 6-12 $\mu$ m wide	5	
5	Leaves longitudinally plicate on both sides of nerve	6	
5	Leaves not longitudinally plicate on both sides of nerve	7	
6	Laminal cells smooth; capsule immersed; calyptra campanulate, plicate	<b>Coscinodon</b>	90
6	Laminal cells usually papillose; capsule exserted; calyptra cucullate, non-plicate	<b>Grimmia</b>	91
7	Leaf basal cells towards nerve longly rectangular, hyaline	<b>Coscinodon</b>	90
7	Leaf basal cells towards nerve quadrate to linear, not hyaline	8	
8	Capsule immersed or emergent; lid coming off attached to columella	<b>Schistidium</b>	105
8	Capsule immersed or exserted; lid not coming off attached to columella	<b>Grimmia</b>	91
9	Nerve wide, 1/3-1/2 of width of leaf base	<b>Campylopus</b>	146
9	Nerve narrow, less than 1/3 of width of leaf base	10	
10	Laminal cells finely papillose or smooth	11	
10	Laminal cells strongly papillose	13	
11	Capsule immersed, indehiscent	<b>Phascum</b>	176
11	Capsule exserted or emergent, dehiscent	12	
12	Capsule exserted; calyptra cucullate	<b>Pottia</b>	177
12	Capsule emergent; calyptra mitriform, with 8 plicae	<b>Goniomitrium</b>	89
13	Basal cells of leaves not forming a distinct ovate group on both sides of nerve	<b>Tortula</b>	190
13	Basal cells of leaves forming a distinct ovate group on both sides of nerve	14	
14	Peristome teeth spirally twisted; calyptra partially covering the capsule	<b>Syntrichia</b>	181
14	Peristome teeth not twisted or lacking; calyptra covering the whole capsule	<b>Encalypta</b>	82



**D. Leaves bordered with narrow cells or margin pluristratose**

1	Marginal cells short, 2-5-stratose		2
1	Marginal cells longer and narrower than the rest of laminal cells, uni- to pluristratose		3
2	Leaf margin recurved; laminal cells strongly papillose; stem with central strand	<b>Dialytrichia</b>	161
2	Leaf margin plane; laminal cells smooth or faintly papillose; stem without central strand	<b>Cinclidotus</b>	159
3	Border unistratose		4
3	Border bi- to pluristratose		10
4	Laminal cells papillose	<b>Tortula</b>	190
4	Laminal cells smooth		5
5	Plants rhizomatous; leaves crowded in terminal rosette	<b>Rhodobryum</b>	233
5	Plants not rhizomatous; leaves crowded in terminal rosette or not		6
6	Nerve ending below apex	<b>Epipterygium</b>	233
6	Nerve percurrent or excurrent		7
7	Marginal cells yellow	<b>Entosthodon</b>	83
7	Marginal cells not yellow		8
8	Sterile shoots creeping; leaf margin dentate	<b>Plagiomnium</b>	241
8	Sterile shoots erect; leaf margin entire, denticulate or dentate		9
9	Leaves ovate to ovate-lanceolate or spatulate; margin $\pm$ denticulate, rarely entire; apex acute	<b>Bryum</b>	221
9	Leaves orbicular, elliptical or obovate; margin entire; apex rounded	<b>Rhizomnium</b>	241
10	Leaf margin entire	<b>Rhizomnium</b>	241
10	Leaf margin dentate		11
11	Leaf margin with simple teeth	<b>Bryum</b>	221
11	Leaf margin with geminate teeth	<b>Mnium</b>	239

**AA. Acrocarpous with indehiscent capsule**

1	Capsule exserted	2
1	Capsule immersed or emergent	5

2	Capsule with perceptible neck, 1/3-1/2 of the capsule length	<b>Bruchia</b>	130
2	Capsule without perceptible neck	<b>3</b>	
3	Capsule globose	<b>Microbryum</b>	173
3	Capsule cylindrical or ellipsoidal	<b>4</b>	
4	Lid differentiated but persistent	<b>Protobryum</b>	178
4	Lid not differentiated	<b>Microbryum</b>	173
5	Plants with persistent protonema	<b>6</b>	
5	Plants without persistent protonema	<b>7</b>	
6	Protonema abundant; capsule apiculate	<b>Ephemerum</b>	167
6	Protonema scarce; capsule without apiculus	<b>Micromitrium</b>	175
7	Laminal cells smooth, more than 25 µm wide	<b>Physcomitrella</b>	89
7	Laminal cells smooth or papillose, less than 15 µm wide	<b>8</b>	
8	Capsule with ± differentiated lid; leaves crisped when dry	<b>Astomum</b>	156
8	Capsule without lid; leaves not crisped when dry	<b>9</b>	
9	Capsule globose, with translucent wall; spores 16-20 in number, 100-200 µm	<b>Archidium</b>	117
9	Capsule globose or ± apiculate, with opaque wall; spores numerous, less than 60 µm	<b>10</b>	
10	Laminal cells rectangular or linear	<b>11</b>	
10	Laminal cells quadrate, rounded, hexagonal, rhomboidal or elliptical	<b>12</b>	
11	Leaves subulate, at least the upper ones; laminal cells 8 µm wide	<b>Pleuridium</b>	128
11	Leaves acuminate; laminal cells 9-13 µm wide	<b>Pseudephemerum</b>	128
12	Plants bulbiform; leaves ovate to elliptic; capsule non apiculate or only minutely apiculate	<b>Acaulon</b>	152
12	Plants not bulbiform; leaves oblong-lanceolate or ovate-lanceolate; capsule apiculate	<b>13</b>	
13	Nerve with dorsal and ventral stereids	<b>Aschisma</b>	155
13	Nerve with only dorsal stereids	<b>Phascum</b>	176

#### AB. Acrocarpous with immersed or emergent capsule

1	Capsule large, ovoid, asymmetrical; perichaetial leaves ciliate	<b>Diphyscium</b>	80
1	Capsule and perichaetial leaves not as above	<b>2</b>	

2	Leaves without nerve	<b>3</b>	
2	Leaves with nerve	<b>4</b>	
3	Plants terricolous; leaves abruptly apiculate; Mediterranean plants	<b>Gigaspermum</b>	90
3	Plants saxicolous; leaves not abruptly apiculate; Eurosiberian plants	<b>Hedwigia</b>	215
4	Lid slightly differentiated	<b>Astomum</b>	156
4	Lid well differentiated	<b>5</b>	
5	Lid coming off attached to columella; capsule smooth	<b>Schistidium</b>	105
5	Lid not coming off attached to columella; capsule smooth or sulcate	<b>6</b>	
6	Seta curved; capsule gibbous at base	<b>Campylostelium</b>	112
6	Seta straight or curved; capsule not gibbous at base	<b>7</b>	
7	Peristome lacking	<b>Amphidium</b>	131
7	Peristome present	<b>8</b>	
8	Peristome double; capsule straight	<b>Orthotrichum</b>	201
8	Peristome single; capsule straight or curved	<b>Grimmia</b>	91

#### AC. Acrocarpous with exserted, globose or sub-globose capsule

1	Capsule blackish, to 1 mm in diameter	<b>Catoscopium</b>	215
1	Capsule green or brownish, more than 1 mm in diameter	<b>2</b>	
2	Peristome lacking	<b>Pyramidula</b>	89
2	Peristome single or double	<b>3</b>	
3	Leaves imbricate, 5-ranked; peristome teeth joined at apex forming a cone	<b>Conostomum</b>	218
3	Leaves erecto-patent to spreading, not 5-ranked; peristome not as above	<b>4</b>	
4	Capsule inclined to pendulous; leaves lanceolate to ovate-lanceolate; peristome double	<b>5</b>	
4	Capsule straight or slightly inclined; leaves narrowly lanceolate to linear-lanceolate; peristome double or single	<b>6</b>	
5	Leaves longitudinally plicate; seta cygneous	<b>Breutelia</b>	217
5	Leaves not longitudinally plicate or weakly so; seta straight	<b>Philonotis</b>	218
6	Capsule asymmetrical; laminal cells finely papillose-striate; peristome double	<b>Plagiopus</b>	221

- |   |   |                  |     |
|---|---|------------------|-----|
| 6 | Capsule symmetrical or asymmetrical; laminal cells mamilllose; peristome double or single | <b>Bartramia</b> | 216 |
|---|---|------------------|-----|

**AD. Acrocarpous with exserted, strumose capsule**

- |   |   |                    |     |
|---|---|--------------------|-----|
| 1 | Neck of capsule as long as urn  | <b>Trematodon</b>  | 131 |
| 1 | Neck of capsule shorter than urn or indistinct  | <b>2</b>           |     |
| 2 | Peristome teeth, divided to base, reddish, usually with a paler border                | <b>Ceratodon</b>   | 125 |
| 2 | Peristome teeth, divided to halfway, reddish, striate in the lower part               | <b>3</b>           |     |
| 3 | Laminal cells longly rectangular  | <b>Dicranella</b>  | 138 |
| 3 | Laminal cells shortly rectangular or $\pm$ quadrate                                   | <b>4</b>           |     |
| 4 | Alar cells not differentiated; laminal cells mamilllose on both sides                 | <b>5</b>           |     |
| 4 | Alar cells differentiated; laminal cells smooth                                       | <b>6</b>           |     |
| 5 | Capsule striate   | <b>Cynodontium</b> | 132 |
| 5 | Capsule smooth  | <b>Oncophorus</b>  | 137 |
| 6 | Alar cells brownish; capsule with the cells of annulus smooth; nerve without stereids | <b>Kiaeria</b>     | 135 |
| 6 | Alar cells hyaline; capsule without annulus; nerve with dorsal and ventral stereids   | <b>Oncophorus</b>  | 137 |

**AE. Acrocarpous with exserted capsule and peristome lacking  
or rudimentary**

- |   |   |                   |     |
|---|---|-------------------|-----|
| 1 | Seta curved   | <b>Funariella</b> | 87  |
| 1 | Seta straight   | <b>2</b>          |     |
| 2 | Calyptra inflated, 4-angled; spores 50-60 $\mu$ m                             | <b>Pyramidula</b> | 89  |
| 2 | Calyptra not inflated or angled; spores smaller                               | <b>3</b>          |     |
| 3 | Capsule striate or sulcate when dry   | <b>4</b>          |     |
| 3 | Capsule smooth when dry   | <b>5</b>          |     |
| 4 | Leaves linear-lanceolate; seta short or long; gemmae lacking                  | <b>Amphidium</b>  | 131 |
| 4 | Leaves oblong-lanceolate to lanceolate; seta long; with ovoid gemmae          | <b>Zygodon</b>    | 212 |
| 5 | Median cells of lamina 20-50 $\mu$ m wide, thin-walled                        | <b>6</b>          |     |
| 5 | Median cells of lamina less than 20 $\mu$ m wide, thin-walled or thick-walled | <b>8</b>          |     |

6	Exothecial cells longer than wide	<b>Entosthodon</b>	83
6	Exothecial cells isodiametric	<b>7</b>	
7	Calyptra mitriform	<b>Physcomitrium</b>	89
7	Calyptra cucullate	<b>Entosthodon</b>	83
8	Plants minute	<b>Seligeria</b>	116
8	Plants small to robust	<b>9</b>	
9	Calyptra cylindrical, covering capsule; basal cells forming a well-delimited group	<b>Encalypta</b>	82
9	Calyptra cucullate not covering capsule; basal cells not forming a well-delimited group	<b>10</b>	
10	Nerve excurrent	<b>11</b>	
10	Nerve not excurrent	<b>14</b>	
11	Leaves linear-lanceolate or lanceolate; margin incurved or plane	<b>Weissia</b>	196
11	Leaves ovate-lanceolate, ovate or obovate; margin plane or recurved	<b>12</b>	
12	Perichaetial leaves wider than stem leaves, sheathing; laminal cells thick-walled	<b>Pottiopsis</b>	178
12	Perichaetial leaves similar to stem leaves, not sheathing; walls of laminal cells thin-walled or only slightly thickened	<b>13</b>	
13	Lid conical	<b>Microbryum</b>	173
13	Lid rostrate	<b>Pottia</b>	177
14	Lid attached to columella after dehiscence	<b>15</b>	
14	Lid not attached to columella after dehiscence	<b>16</b>	
15	Plants 1-4(-10) cm tall; leaves carinate; margin finely crenulate	<b>Hymenostylium</b>	171
15	Plants to 1 cm tall; leaves not carinate; margin dentate at apex	<b>Hennediella</b>	171
16	Leaves carinate	<b>Anoetangium</b>	155
16	Leaves not carinate	<b>17</b>	
17	Annulus of capsule persistent, of large cells	<b>Gyroweisia</b>	170
17	Annulus of capsule persistent or caducous, of small cells	<b>Gymnostomum</b>	170

**AF. Acrocarpous with exserted capsule, striate or sulcate when dry  
and peristome well developed**

1	Plants very small, to 0,3 cm tall, rare	<b>2</b>
1	Plants more than 0,3 cm tall, common	<b>3</b>

2	Nerve ending at or near apex	<b>Campylostelium</b>	112
2	Nerve excurrent	<b>Brachydontium</b>	116
3	Seta curved	4	
3	Seta straight	5	
4	Leaves ovate-lanceolate; laminal cells hexagonal or rectangular, 30-50 $\mu\text{m}$ wide, thin-walled	<b>Funaria</b>	87
4	Leaves lanceolate; laminal cells quadrate or rounded, less than 20 $\mu\text{m}$ wide, thick-walled	<b>Grimmia</b>	91
5	Peristome teeth in pairs or in groups of 4	6	
5	Peristome teeth free, not forming groups	9	
6	Capsule shortly exserted	<b>Orthotrichum</b>	201
6	Capsule longly exserted	7	
7	Calyptra cucullate	<b>Zygodon</b>	212
7	Calyptra campanulate	8	
8	Marginal cells at leaf base rectangular, hyaline, with thickened transverse walls, ascending up margin, basal cells linear	<b>Ulota</b>	211
8	Marginal cells at leaf base elongate, similar to the rest of basal cells	<b>Orthotrichum</b>	201
9	Peristome single	10	
9	Peristome double	17	
10	Peristome teeth spreading	<b>Arctoa</b>	131
10	Peristome teeth erect	11	
11	Peristome teeth 16, entire or slightly and irregularly divided	12	
11	Peristome teeth 16, divided to half way or more	13	
12	Capsule cylindrical, completely covered by the calyptra	<b>Encalypta</b>	82
12	Capsule ovoid, not completely covered by the calyptra	<b>Rhabdoweisia</b>	137
13	Peristome teeth divided to base	14	
13	Peristome teeth divided to half way	15	
14	Plants glaucous	<b>Saelania</b>	130
14	Plants not glaucous	<b>Ceratodon</b>	125
15	Alar cells $\pm$ differentiated, brownish	<b>Dicranum</b>	141
15	Alar cells not differentiated	16	

16	Laminal cells quadrate	<b>Cynodontium</b>	132
16	Laminal cells rectangular	<b>Dicranella</b>	138
17	Median cells of lamina linear, smooth	<b>Orthodontium</b>	245
17	Median cells of lamina rounded, quadrate or hexagonal, mamilllose or papillose	<b>18</b>	
18	Leaves with dentate margins and sheathing base; marginal cells longer and narrower than median cells	<b>Timmia</b>	80
18	Leaves with entire or denticulate margins and the base not sheathing; marginal cells similar to median cells	<b>Aulacomnium</b>	245

**AG. Acrocarpous with exerted, erect capsule, peristome teeth 4 or 16, entire or slightly and irregularly divided and seta straight or curved**

1	Peristome teeth 4	<b>2</b>	
1	Peristome teeth 16	<b>3</b>	
2	Stem to 2 cm high; sterile stems ending in a cup of orbicular bracts containing discoid gemmae; nerve ending below apex	<b>Tetraphis</b>	77
2	Stem to 0,2 cm high; gemmae lacking; nerve short or lacking	<b>Tetradontium</b>	77
3	Seta curved	<b>Campylostelium</b>	112
3	Seta straight	<b>4</b>	
4	Median cells of lamina smooth, more than 20 µm wide	<b>5</b>	
4	Median cells of lamina smooth or strongly papillose, less than 20 µm wide	<b>7</b>	
5	Capsule with apophysis	<b>Splachnum</b>	199
5	Capsule without apophysis	<b>6</b>	
6	Leaf apex acute or obtuse; peristome teeth reflexed when dry	<b>Tayloria</b>	199
6	Leaf apex acute; peristome teeth straight or incurved when dry	<b>Entosthodon</b>	83
7	Leaf apex acuminate or subulate; laminal cells smooth or finely striate	<b>8</b>	
7	Leaf apex acute or obtuse; laminal cells smooth or papillose	<b>12</b>	
8	Alar cells differentiated	<b>9</b>	
8	Alar cells not or only slightly differentiated	<b>10</b>	
9	Alar cells reddish orange	<b>Blindia</b>	114
9	Alar cells brownish	<b>Dicranoweisia</b>	134

10	On calcareous rocks; plants minute	<b>Seligeria</b>	116
10	On acidic or volcanic rocks or tree bases; plants medium-sized	11	
11	Laminal cells papillose-striate	<b>Dicranoweisia</b>	134
11	Laminal cells smooth	<b>Ptychomitrium</b>	114
12	Leaves lingulate or spatulate; calyptra completely covering the capsule	<b>Encalypta</b>	82
12	Leaves not as above; calyptra not completely covering the capsule	13	
13	Nerve excurrent	14	
13	Nerve percurrent	19	
14	Capsule longly cylindrical or ellipsoidal	<b>Trichostomum</b>	195
14	Capsule shortly cylindrical or ovoid	15	
15	Leaf margin with reflexed teeth at base	<b>Eucladium</b>	168
15	Leaf margin without reflexed teeth at base	16	
16	Lamina bistratose or pluristratose in the upper part	<b>Grimmia</b>	91
16	Lamina unistratose	17	
17	Leaves linear-lanceolate or lanceolate	<b>Weissia</b>	196
17	Leaves ovate-lanceolate, ovate, obovate, oblong or lingulate	18	
18	Lid conical	<b>Microbryum</b>	173
18	Lid rostrate	<b>Pottia</b>	177
19	Leaves obovate, very concave, obtuse and apiculate	<b>Stegonia</b>	181
19	Leaves linear-lanceolate, ovate-lanceolate or oblong, abruptly or gradually tapered	20	
20	Capsule striate	<b>Campylostelium</b>	112
20	Capsule smooth	<b>Didymodon</b>	162

**AH. Acrocarpous with exserted, erect capsule, peristome teeth 16, divided to half way or to the base (32 teeth) and seta straight**

1	Peristome teeth slightly or strongly spirally twisted	2	
1	Peristome teeth straight or curved	8	
2	Plants very small, to 0,3 cm tall; capsule ovoid to ellipsoidal, peristome teeth weakly spirally twisted	<b>Leptobarbula</b>	171
2	Plants small to robust; capsule cylindrical to ovoid, peristome teeth strongly spirally twisted	3	



3	Basal cells hyaline, forming a well-delimited group	4	
3	Basal cells hyaline or not, not forming a well-delimited group	5	
4	Hyaline basal cells of leaf ascending up margins in a v-shape	<b>Tortella</b>	187
4	Hyaline basal cells of leaf forming a ovate group, not ascending up margins	<b>Syntrichia</b>	181
5	Peristome with well-developed basal membrane	<b>Tortula</b>	190
5	Peristome without basal membrane	6	
6	Axillary hairs with brown basal cells	<b>Didymodon</b>	162
6	Axillary hairs with hyaline cells throughout	7	
7	Margin plane or recurved; nerve with elongate cells on ventral side	<b>Barbula</b>	156
7	Margin revolute; nerve with quadrate or shortly rectangular cells on ventral side	<b>Pseudocrossidium</b>	178
8	Laminal cells longer than wide	9	
8	Laminal cells $\pm$ quadrate	10	
9	Peristome teeth divided to base	<b>Ditrichum</b>	125
9	Peristome teeth divided to half way	<b>Dicranella</b>	138
10	Peristome teeth irregularly divided to base or nearly so	11	
10	Peristome teeth regularly divided to base or nearly so	13	
11	Laminal cells 15-20 $\mu\text{m}$ wide	<b>Tortula</b>	190
11	Laminal cells to 14 $\mu\text{m}$ wide	12	
12	Nerve excurrent in apiculus; leaf margins unistratose, plane or incurved	<b>Trichostomum</b>	195
12	Nerve ending in or below apex; leaf margins bistratose, recurved in the lower half	<b>Cynodontium</b>	132
13	Leaf lamina bistratose except the lower 1/3	<b>Timmiella</b>	186
13	Leaf lamina unistratose or bistratose at apex	14	
14	Leaves longitudinally plicate at base; laminal cells smooth; calyptra mitriform	<b>Ptychomitrium</b>	114
14	Leaves not longitudinally plicate; laminal cells mamilliose or papillose; calyptra cucullate	15	
15	Leaf margin entire or crenulate or slightly dentate near apex	<b>Bryoerythrophyllum</b>	158
15	Leaf margin strongly dentate in the upper 1/3 or more	16	

16	Laminal cells densely papillose	<b>Leptodontium</b>	172
16	Laminal cells mamilllose	<b>Dichodontium</b>	134

**AI. Acrocarpous with exerted, inclined to pendulous capsule  
and peristome single**

1	Capsule with distinct neck	<b>2</b>	
1	Capsule with indistinct neck	<b>3</b>	
2	Plants dioicous; peristome consisting of exostome with papillose teeth	<b>Mielichhoferia</b>	234
2	Plants synoicous; peristome consisting of endostome with smooth segments	<b>Schizymenium</b>	238
3	Seta curved, at least when moist	<b>Dicranodontium</b>	150
3	Seta straight	<b>4</b>	
4	Alar cells wider than basal cells, usually brownish	<b>Dicranum</b>	141
4	Alar cells not differentiated	<b>5</b>	
5	Median cells of lamina rectangular, long and narrow, smooth	<b>Dicranella</b>	138
5	Median cells of lamina quadrate, mamilllose on both sides	<b>Dichodontium</b>	134

**AJ. Acrocarpous with exerted, inclined to pendulous capsule  
and peristome double**

1	Plants bluish when dry	<b>Mnium</b>	239
1	Plants not bluish when dry	<b>2</b>	
2	Nerve 1/3 or more of leaf base	<b>3</b>	
2	Nerve less than 1/3 of leaf base	<b>5</b>	
3	Leaves lingulate with rounded apex	<b>Meesia</b>	201
3	Leaves not lingulate with acute to acuminate apex	<b>4</b>	
4	Leaves oblong-lanceolate	<b>Amblyodon</b>	199
4	Leaves linear	<b>Leptobryum</b>	201
5	Plants julaceous	<b>6</b>	
5	Plants not julaceous	<b>7</b>	
6	Neck as long as urn; median cells of lamina hexagonal to rhomboidal	<b>Plagiobryum</b>	233
6	Neck half length of urn; median cells of lamina narrowly hexagonal to vermicular	<b>Anomobryum</b>	221

7	Laminal cells hexagonal; peristome teeth sigmoid; capsule asymmetrical	<b>Entosthodon</b>	83
7	Laminal cells hexagonal, isodiametric, rhomboidal or linear; peristome teeth straight; capsule symmetrical, cylindrical to pyriform	<b>8</b>	
8	Laminal cells rhomboidal or hexagonal, to 4 times as long as wide; basal cells quadrate to rectangular	<b>Bryum</b>	221
8	Laminal cells linear to narrowly hexagonal, 5 or more times as long as wide; basal cells not differentiated	<b>Pohlia</b>	234

### AK. Acrocarpous with propagules

1	Plants with axillary bulbils	<b>2</b>	
1	Plants lacking axillary bulbils	<b>3</b>	
2	Laminal cells to 4 times as long as wide; basal cells quadrate to rectangular	<b>Bryum</b>	221
2	Laminal cells 5 or more times as long as wide; basal cells not differentiated	<b>Pohlia</b>	234
3	Plants with foliose propagules in upper leaf axils	<b>Syntrichia</b>	181
3	Plants with gemmae	<b>4</b>	
4	Gemmae crowded at ends of stems	<b>5</b>	
4	Gemmae in leaf axils or on leaves	<b>7</b>	
5	Gemmae globose, ovoid or fusiform, in globose clusters on ends of leafless prolongations of stems	<b>Aulacomnium</b>	245
5	Gemmae lenticular or discoid, in the centre of a rosette of apical leaves	<b>6</b>	
6	Plants growing on soils; nerve excurrent in apiculus	<b>Oedipodiella</b>	90
6	Plants growing on rotting wood; nerve ending below apex		
7	Gemmae unicellular	<b>Bryoerythrophyllum</b>	158
7	Gemmae pluricellular	<b>8</b>	
8	Gemmae globose or ellipsoidal on axillary filaments	<b>9</b>	
8	Gemmae globose or ellipsoidal and sessile, or filamentous	<b>11</b>	
9	Leaves with hyaline point	<b>Grimmia</b>	91
9	Leaves without hyaline point	<b>10</b>	
10	Leaves oblong-lanceolate; ventral surface cells of nerve rectangular	<b>Barbula</b>	156
10	Leaves widely ovate to lanceolate; ventral surface cells of nerve quadrate	<b>Didymodon</b>	162

11	Gemmae at tips of leaves, globose, more than 70 µm	<b>Grimmia</b>	91
11	Gemmae on nerve, on lamina or in leaf axils, if at tips of leaves then not globose or less than 70 µm	12	
12	Gemmae irregularly globose, on nerve	<b>Syntrichia</b>	181
12	Gemmae filamentous, fusiform, ovoid or ellipsoidal on lamina, at tips of leaves or in leaf axils	13	
13	Gemmae filamentous, branched or not	14	
13	Gemmae fusiform, ellipsoidal or ovoid	16	
14	Basal cells of leaves hyaline, forming a well-delimited group	<b>Encalypta</b>	82
14	Basal cells of leaves hyaline or not, not forming a well-delimited group	15	
15	Leaves bordered, with 1-3 rows of elongate cells; laminal cells rectangular-hexagonal, smooth, more than 15 µm wide	<b>Bryum</b>	221
15	Leaves unbordered; laminal cells rounded, papillose, to 14 µm wide	<b>Orthotrichum</b>	201
16	Leaf apex obtuse	<b>Orthotrichum</b>	201
16	Leaf apex acute	17	
17	Gemmae at tips of upper leaves	<b>Ulota</b>	211
17	Gemmae on stems and in leaf axils	<b>Zygodon</b>	212

#### AL. Acrocarpous with nerve 1/3 or more of leaf base

1	Plants whitish to glaucous; alar cells not differentiated	<b>Leucobryum</b>	150
1	Plants green or brownish; alar cells differentiated or not	2	
2	Alar cells inflated, hyaline or coloured	3	
2	Alar cells not differentiated	5	
3	Alar cells hyaline; nerve consisting of small green cells and large hyaline cells	<b>Paraleucobryum</b>	146
3	Alar cells hyaline or coloured; nerve with stereids and guide cells	4	
4	Nerve with stereids on dorsal side only (except <i>C. brevipilus</i> and <i>C. schimperi</i> )	<b>Campylopus</b>	146
4	Nerve with stereids on dorsal and ventral side	<b>Dicranodontium</b>	150
5	Laminal cells papillose	<b>Gymnostomum</b>	170
5	Laminal cells smooth	6	
6	Leaves with channelled point	<b>Ditrichum</b>	125
6	Leaves without channelled point	7	

7	Leaves lingulate, with rounded apex	<b>Meesia</b>	201
7	Leaves not lingulate, with acuminate apex	<b>8</b>	
8	Leaves oblong-lanceolate; laminal cells longly hexagonal	<b>Amblyodon</b>	199
8	Leaves linear to lanceolate; laminal cells rectangular to linear	<b>9</b>	
9	Leaves lanceolate, occasionally secund; laminal cells longly rectangular; capsule ovoid to ellipsoidal; rhizoidal gemmae lacking	<b>Dicranella</b>	138
9	Leaves linear, flexuose; laminal cells linear; capsule pyriform; rhizoidal gemmae abundant	<b>Leptobryum</b>	201

**AM. Acrocarpous with laminal cells 18  $\mu$ m wide or more**

1	Leaves without nerve; capsule immersed	<b>2</b>	
1	Leaves with nerve; capsule immersed or exerted	<b>3</b>	
2	Leaves orbicular, abruptly apiculate; capsule dehiscent	<b>Gigaspermum</b>	90
2	Leaves ovate-lanceolate or ovate, acuminate; capsule indehiscent	<b>Micromitrium</b>	175
3	Laminal cells quadrate, rounded or shortly polygonal	<b>4</b>	
3	Laminal cells longly polygonal or elliptical	<b>9</b>	
4	Nerve ending below apex; plants bluish when dry	<b>Mnium</b>	239
4	Nerve excurrent in apiculus or hair-point; plants not bluish when dry	<b>5</b>	
5	Leaves apiculate, with reflexed, brownish yellow apiculus; margin irregularly denticulate	<b>Leptophascum</b>	173
5	Leaves lacking above combination of characters; margin entire	<b>6</b>	
6	Calyptra small, cucullate; spores less than 40 $\mu$ m	<b>7</b>	
6	Calyptra large, mitriform or cucullate; spores 40-60 $\mu$ m	<b>8</b>	
7	Capsule dehiscent	<b>Pottia</b>	177
7	Capsule indehiscent	<b>Protobryum</b>	178
8	Capsule exerted; calyptra cucullate, distinctly 4-angled	<b>Pyramidula</b>	89
8	Capsule emergent; calyptra mitriform, 8-plicate	<b>Goniomitrium</b>	89
9	Plants bulbiform	<b>Acaulon</b>	152
9	Plants not bulbiform	<b>10</b>	
10	Plants rhizomatous, with erect branches; upper leaves crowded in a conspicuous terminal rosette	<b>Rhodobryum</b>	233
10	Plants not rhizomatous, erect; upper leaves crowded in terminal rosette or evenly arranged along stem	<b>11</b>	

11	Capsule with the apophysis wider than the urn	<b>Splachnum</b>	199
11	Capsule with the apophysis narrower than the urn or lacking	12	
12	Apophysis narrower than the urn	<b>Tayloria</b>	199
12	Apophysis lacking	13	
13	Capsule asymmetrical and curved	14	
13	Capsule symmetrical and straight	17	
14	Capsule sulcate; peristome teeth fused at apices	<b>Funaria</b>	87
14	Capsule smooth; peristome teeth free	15	
15	Capsule with indistinct neck	<b>Entosthodon</b>	83
15	Capsule with distinct neck	16	
16	Capsule inclined to horizontal; nerve 1/3 or more of leaf base	<b>Amblyodon</b>	199
16	Capsule inclined to pendulous; nerve less than 1/3 of leaf base	<b>Plagiobryum</b>	233
17	Capsule pendulous	18	
17	Capsule erect or inclined	19	
18	Laminal cells to 4 times as long as wide; capsule cylindrical	<b>Bryum</b>	221
18	Laminal cells 5 or more times as long as wide; capsule ovoid	<b>Pohlia</b>	234
19	Capsule immersed, indehiscent	<b>Physcomitrella</b>	89
19	Capsule exserted, dehiscent	20	
20	Seta short, curved	<b>Funariella</b>	87
20	Seta long, straight	21	
21	Exothecial cells elongate	<b>Entosthodon</b>	83
21	Exothecial cells isodiametric	22	
22	Calyptra mitriform; lid apiculate or rostellate; spores spinose	<b>Physcomitrium</b>	89
22	Calyptra cucullate or mitriform; lid convex or plane, without apiculus; spores not spinose	<b>Entosthodon</b>	83

#### AN. Acrocarpous with alar cells differentiated

1	Alar cells inflated, hyaline	<b>Oncophorus</b>	137
1	Alar cells inflated or not, coloured	2	

2	Alar cells orange to reddish; laminal cells narrowly rectangular; leaves subulate	<b>Blindia</b>	114
2	Alar cells yellow to brownish; laminal cells quadrate to rectangular; leaves subulate or not	<b>3</b>	
3	Leaves crisped when dry, with entire margin	<b>4</b>	
3	Leaves not or only slightly crisped or if crisped then margin denticulate	<b>5</b>	
4	Laminal cells finely striate; nerve with dorsal and ventral stereids	<b>Dicranoweisia</b>	134
4	Laminal cells not striate; nerve with dorsal and ventral stereids or without stereids	<b>Kiaeria</b>	135
5	Leaves abruptly tapering into subula; nerve without stereids; peristome teeth divergent or spreading	<b>Arctoa</b>	131
5	Leaves acuminate or gradually tapering into subula; nerve with dorsal and ventral stereids or stereids lacking; peristome teeth not spreading	<b>6</b>	
6	Nerve without stereids; capsule strumose	<b>Kiaeria</b>	135
6	Nerve with dorsal and ventral stereids (except <i>Dicranum tauricum</i> ); capsule not strumose	<b>Dicranum</b>	141

**AO. Acrocarpous with laminal cells isodiametric and leaf margin denticulate or dentate, at least near apex or base**

1	Leaf margin denticulate at base, with hyaline, reflexed teeth	<b>Eucladium</b>	168
1	Leaves not as above	<b>2</b>	
2	Plants glaucous	<b>Saelania</b>	130
2	Plants not glaucous	<b>3</b>	
3	Leaves squarrose	<b>4</b>	
3	Leaves not squarrose	<b>5</b>	
4	Basal cells hyaline, ascending up margin; leaf margin dentate above; plants common, growing on dry, open, calcareous soils	<b>Pleurochaete</b>	176
4	Basal cells not as above; leaf margin sharply serrate; plants very rare, growing on peaty soils	<b>Meesia</b>	201
5	Leaves obovate, very concave	<b>Stegonia</b>	181
5	Leaves oblong, ovate or lingulate to lanceolate, flat	<b>6</b>	
6	Stem with dense, brownish tomentum and usually with gemmae in clusters at the tip	<b>Aulacomnium</b>	245
6	Stem not as above	<b>7</b>	

7	Leaves linear-lanceolate, fragile, notched; margin dentate at apex in young leaves	<b>Didymodon</b>	162
7	Leaves not as above	8	
8	Leaves lanceolate to lingulate, with wide, acute or obtuse apex	9	
8	Leaves ovate to linear-lanceolate, with gradually acuminate apex	11	
9	Laminal cells smooth	<b>Rhabdoweisia</b>	137
9	Laminal cells papillose or mamilllose	10	
10	Laminal cells densely papillose	<b>Leptodontium</b>	172
10	Laminal cells mamilllose	<b>Dichodontium</b>	134
11	Leaf margin plane or incurved	12	
11	Leaf margin recurved	17	
12	Marginal cells thick-walled, some longer but not forming distinct border; lid attached to columella after dehiscence	<b>Hennediella</b>	171
12	Marginal cells similar to the rest of laminal cells; lid not attached to columella after dehiscence	13	
13	Laminal cells papillose-striate	<b>Amphidium</b>	131
13	Laminal cells smooth or mamilllose	14	
14	Leaves plicate at base; basal cells with strongly thickened longitudinal walls; margin plane, recurved at base	<b>Ptychomitrium</b>	114
14	Leaves not plicate at base; basal cells with uniformly thickened walls; margin plane or incurved	15	
15	Leaves with channelled subula; plants rare	<b>Rhamphidium</b>	130
15	Leaves not subulate; plants rare or common	16	
16	Lamina bistratose in the upper part	<b>Timmiella</b>	186
16	Lamina unistratose	<b>Timmia</b>	80
17	Leaves crisped when dry	18	
17	Leaves flexuose, slightly twisted or straight when dry	21	
18	Leaves lanceolate, acuminate; margin unistratose	19	
18	Leaves linear-lanceolate or ovate-lanceolate, acute; margin bistratose	20	
19	Plants pale green; median cells of lamina mamilllose; stem circular in cross section	<b>Bartramia</b>	216
19	Plants dark green; median cells of lamina finely papillose-striate; stem triangular in cross section	<b>Plagiopus</b>	221



20	Leaf base sheathing; laminal cells smooth; capsule smooth, strumose		
		<b>Oncophorus</b>	137
20	Leaf base not sheathing; laminal cells smooth or mamilliose; capsule striate, strumose or not or smooth and not strumose	<b>Cynodontium</b>	132
21	Leaf margin dentate, at least in the upper half	<b>Bartramia</b>	216
21	Leaf margin denticulate only at apex	<b>22</b>	
22	Leaf margin crenulate or papillose; apex denticulate, with hyaline teeth; laminal cells papillose; capsule erect, smooth, not strumose		
		<b>Bryoerythrophyllum</b>	158
22	Leaf margin not crenulate or papillose; apex slightly denticulate; laminal cells smooth; capsule inclined, striate, strumose	<b>Ceratodon</b>	125

#### AP. Acrocarpous with isodiametric laminal cells and excurrent nerve

1	Basal cells of leaf hyaline, ascending up margins in a v-shape	<b>Tortella</b>	187
1	Basal cells of leaf hyaline or not, not ascending up margins	<b>2</b>	
2	Basal cells of leaf hyaline, forming a well-delimited group on both sides of nerve, in an arch-shaped area	<b>3</b>	
2	Basal cells of leaf hyaline or not, transition to cells above gradual	<b>4</b>	
3	Peristome teeth spirally twisted; calyptra partially covering the capsule		
		<b>Syntrichia</b>	181
3	Peristome teeth not twisted or lacking; calyptra covering the whole capsule		
		<b>Encalypta</b>	82
4	Leaves bistratose or partially bistratose in the upper part	<b>5</b>	
4	Leaves unistratose or with bistratose margin	<b>6</b>	
5	Lamina partially bistratose; leaf margin bistratose; laminal cells smooth		
		<b>Schistidium</b>	105
5	Lamina bistratose; laminal cells strongly papillose	<b>Cheilothela</b>	125
6	Laminal cells smooth or mamilliose	<b>7</b>	
6	Laminal cells papillose	<b>9</b>	
7	Leaves obovate-lanceolate; plants growing on rotting wood	<b>Zygodon</b>	212
7	Leaves ovate or ovate-lanceolate; plants growing on soil or rocks	<b>8</b>	
8	Nerve excurrent in hyaline or yellowish hair point, rarely in apiculus; capsule indehiscent		
		<b>Phascum</b>	176
8	Nerve ending below apex, percurrent or shortly excurrent; capsule dehiscent		
		<b>Didymodon</b>	162

9	Leaf margin revolute or recurved on one or both sides, at least partially	10	
9	Leaf margin plane or incurved	19	
10	Leaf margin strongly revolute	11	
10	Leaf margin recurved on one or both sides	12	
11	Leaves lanceolate to ovate-lanceolate, triangular or lingulate		
		<b>Pseudocrossidium</b>	178
11	Leaves oblong, ovate, elliptical or obovate	<b>Tortula</b>	190
12	Capsule indehiscent	13	
12	Capsule dehiscent	15	
13	Lid differentiated but persistent	<b>Protobryum</b>	178
13	Lid not differentiated	14	
14	Stereids numerous, in 2-3(4) layers; capsule immersed or slightly emergent		
		<b>Phascum</b>	176
14	Stereids few (2-3), in 1-2 layers; capsule exserted, rarely immersed or emergent		
		<b>Microbryum</b>	173
15	Peristome with straight teeth, rudimentary or lacking	16	
15	Peristome with filiform, spirally twisted teeth	18	
16	Capsule globose	<b>Microbryum</b>	173
16	Capsule ellipsoidal or cylindrical	17	
17	Perichaetial leaves wider and more concave than stem leaves, sheathing; laminal cells thick-walled	<b>Pottiopsis</b>	178
17	Perichaetial leaves similar in shape to stem leaves, not sheathing; laminal cells with thin or with slightly thickened walls	<b>Pottia</b>	177
18	Cells of axillary hairs hyaline	<b>Barbula</b>	156
18	Basal cell of axillary hairs brown	<b>Didymodon</b>	162
19	Capsule immersed	20	
19	Capsule exserted	21	
20	Plants to 0,25 cm tall	<b>Aschisma</b>	155
20	Plants more than 0,5 cm tall	<b>Astomum</b>	155
21	Leaves 0,3-0,5 mm long; margin plane, sinuose, notched	<b>Trichostomum</b>	195
21	Leaves usually to 0,3 mm long; margin plane or incurved, entire	22	
22	Leaf margin plane or cucullate at apex	<b>Trichostomum</b>	195
22	Leaf margin plane or incurved	<b>Weissia</b>	196

**AQ. Acrocarpous with isodiametric laminal cells, rounded or obtuse leaf apex, apiculate or not and nerve not excurrent**

1	Laminal cell walls $\pm$ sinuose or incrassate with stellate lumen	2	
1	Laminal cell walls neither sinuose nor incrassate with stellate lumen	4	
2	Laminal cells thick-walled with stellate lumen	<b>Aulacomnium</b>	245
2	Laminal cells with $\pm$ sinuose walls	3	
3	Leaves lanceolate or narrowly lingulate; lamina unistratose or partially bistratose above; margin plane or recurved; capsule immersed	<b>Schistidium</b>	105
3	Leaves ovate to lanceolate, concave; lamina unistratose; margin plane or incurved in the upper part, recurved at base; capsule exserted	<b>Grimmia</b>	91
4	Laminal cells smooth	5	
4	Laminal cells papillose or mamilllose	7	
5	Leaves ovate, concave	<b>Grimmia</b>	91
5	Leaves lanceolate, usually cucullate	6	
6	Plants aquatic, 1-4 cm tall	<b>Barbula</b>	156
6	Plants saxicolous, to 0,5 cm tall	<b>Ptychomitrium</b>	114
7	Leaves ovate-triangular; margin recurved to apex; laminal cells papillose on both sides, with c-shaped papillae	<b>Bryoerythrophyllum</b>	158
7	Characters not as above	8	
8	Leaf margin plane or incurved	9	
8	Leaf margin recurved	14	
9	Plants epiphytic	<b>Orthotrichum</b>	201
9	Plants not epiphytic	10	
10	Leaves lanceolate to linear	<b>Leptobarbula</b>	171
10	Leaves lingulate	11	
11	Plants growing on heavy metal- or humus-rich substrata	12	
11	Plants growing on calcareous soils or rocks	13	
12	Lamina unistratose; plants growing on heavy metal-rich substrata	<b>Scopelophila</b>	181
12	Lamina bistratose; plants growing on humus-rich substrata	<b>Diphyscium</b>	80
13	Basal cells of lamina narrowly rectangular, finely papillose; capsule with persistent annulus, of large cells	<b>Gyroweisia</b>	170

13	Basal cells of lamina shortly or longly rectangular, slightly differentiated, smooth; capsule with persistent or caducous annulus, of 1-3 rows of small cells	<b>Gymnostomum</b>	170
14	Leaves ovate-lanceolate; laminal cells irregularly hexagonal or rhomboidal	<b>Didymodon</b>	162
14	Leaves obovate, lingulate or elliptical; laminal cells quadrate, rounded or elliptical	<b>15</b>	
15	Plants epiphytic	<b>Orthotrichum</b>	201
15	Plants terricolous	<b>Tortula</b>	190

**AR. Acrocarpous with isodiametric laminal cells, acute, sub-acute or acuminate leaves, margins recurved and nerve not excurrent, or lacking**

1	Nerve lacking	<b>Hedwigia</b>	215
1	Nerve present	<b>2</b>	
2	Basal cells of leaf sinuose	<b>Grimmia</b>	91
2	Basal cells of leaf not sinuose	<b>3</b>	
3	Upper cells of leaf mamilllose on both sides	<b>Cynodontium</b>	132
3	Upper cells of leaf smooth or papillose on one or both sides	<b>4</b>	
4	Laminal cells with high papillae, to 12 µm high	<b>Triquetrella</b>	196
4	Laminal cells smooth or with low papillae	<b>5</b>	
5	Laminal cells rounded	<b>6</b>	
5	Laminal cells hexagonal or quadrate-rounded	<b>7</b>	
6	Leaf base wide and concave; capsule exserted; calyptra hairy	<b>Ulotia</b>	211
6	Leaf base not wide or concave; capsule immersed; calyptra glabrous or with few hairs	<b>Orthotrichum</b>	201
7	Laminal cells ± papillose or mamilllose	<b>8</b>	
7	Laminal cells smooth	<b>9</b>	
8	Leaves ovate, elliptical or oblong	<b>Tortula</b>	190
8	Leaves linear to ovate-lanceolate	<b>Didymodon</b>	162
9	Leaves acute or acuminate; capsule cylindrical, striate, strumose	<b>Ceratodon</b>	125
9	Leaves longly acuminate; capsule ellipsoidal, not striate or strumose	<b>Dicranoweisia</b>	134

**AS. Acrocarpous with isodiametric laminal cells;  
acute, sub-acute or acuminate leaves, margin plane or recurved  
at base and nerve not excurrent**

1	Leaf margin entire		2
1	Leaf margin crenulate or papillose-crenulate		9
2	Laminal cells smooth		3
2	Laminal cells papillose		6
3	Leaves obovate-lanceolate; laminal cells hexagonal, 14-24 µm wide	<b>Zygodon</b>	212
3	Leaves lingulate to lanceolate; laminal cells quadrate or rounded, 6-10 µm wide		4
4	Leaves widest at or above middle	<b>Scopelophila</b>	181
4	Leaves widest at base		5
5	Plants to 1 cm high, on volcanic rocks	<b>Ptychomitrium</b>	114
5	Plants to 0,5 cm high, on basic soils or acidic rocks	<b>Campylostelium</b>	112
6	Plants rusty red; laminal cells with c-shaped papillae	<b>Bryoerythrophyllum</b>	158
6	Characters not as above		7
7	Laminal cells incrassate, with stellate lumen	<b>Aulacomnium</b>	245
7	Laminal cells not as above		8
8	Laminal cells rounded or hexagonal, strongly papillose, basal cells hyaline; gemmae fusiform, pluricellular	<b>Zygodon</b>	212
8	Laminal cells quadrate or rounded, papillose and finely striate, basal cells yellow; gemmae lacking	<b>Amphidium</b>	131
9	Leaf margin irregularly notched	<b>Didymodon</b>	162
9	Leaf margin not notched		10
10	Leaves carinate		11
10	Leaves not carinate		12
11	Stem without central strand; nerve with dorsal and ventral stereids; lid attached to columella after ripening of spores	<b>Hymenostylium</b>	171
11	Stem with central strand; nerve with only dorsal stereids; lid not attached to columella after ripening of spores	<b>Anoetangium</b>	155
12	Plants minute, to 0,3 cm tall	<b>Leptobarbula</b>	171
12	Plants medium-sized, to 8 cm tall		13

13	Leaf margin sinuose and undulate	<b>Trichostomum</b>	195
13	Leaf margin not sinuose or undulate	14	
14	Laminal cells papillose	<b>Amphidium</b>	131
14	Laminal cells smooth or slightly mamilllose	15	
15	Leaf margin bistratose above	<b>Cynodontium</b>	132
15	Leaf margin unistratose	<b>Rhabdoweisia</b>	137

**AT. Acrocarpous with elongate laminal cells; acuminate or subulate leaves  
and apex consisting largely or entirely of nerve**

1	Laminal cells mamilllose	2	
1	Laminal cells smooth	3	
2	Leaves ovate-lanceolate, plicate at base; margin recurved in lower half	<b>Anacolia</b>	216
2	Leaves linear-lanceolate to lanceolate, not plicate at base; margin plane	<b>Bartramia</b>	216
3	Sheathing base of leaves as long as subula	<b>Trematodon</b>	131
3	Sheathing base of leaves lacking or shorter than subula	4	
4	Plants to 0,25 cm tall, terricolous or saxicolous	5	
4	Plants more than 0,25 cm tall, terricolous	6	
5	Capsule indehiscent, neck distinct, 1/3-1/2 of the capsule length; plants terricolous	<b>Bruchia</b>	130
5	Capsule dehiscent, neck indistinct; plants saxicolous	<b>Seligeria</b>	116
6	Capsule indehiscent, immersed	<b>Pleuridium</b>	128
6	Capsule dehiscent, exserted	7	
7	Peristome teeth divided to base	<b>Ditrichum</b>	125
7	Peristome teeth divided to middle	<b>Dicranella</b>	138

**AU. Acrocarpous with elongate laminal cells; obtuse to acuminate leave  
and nerve percurrent to excurrent, short or lacking**

1	Protonema persistent; plants minute	<b>Ephemerum</b>	167
1	Protonema not persistent; plants small to robust	2	
2	Leaves longitudinally plicate	<b>Breutelia</b>	217
2	Leaves not plicate or plicate only near base	3	

3	Laminal cells mamilllose; leaf margin dentate or serrate	4	
3	Laminal cells smooth or mamilllose; leaf margin entire or dentate in the upper part	5	
4	Leaves narrowly lanceolate or linear-lanceolate, with sheathing base; margin with single teeth	<b>Bartramia</b>	216
4	Leaves lanceolate to ovate-lanceolate, without sheathing base; margin with single or geminate teeth	<b>Philonotis</b>	218
5	Laminal cells quadrate to rectangular	6	
5	Laminal cells narrowly hexagonal, rhomboidal or linear	11	
6	Leaf apex obtuse or rounded; leaves squarrose	<b>Dicranella</b>	138
6	Leaf apex acute or acuminate; leaves not squarrose	7	
7	Leaves imbricate, arranged in 5 rows, acuminate; nerve excurrent	<b>Conostomum</b>	218
7	Leaves erect, patent to flexuose, or if imbricate then not arranged in 5 rows, apiculate; nerve percurrent to excurrent	8	
8	Median cells of lamina quadrate to rectangular, thick-walled; capsule globose, less than 1 mm	<b>Catoscopium</b>	215
8	Median cells of lamina rectangular, thin-walled; capsule cylindrical or ovoid, more than 1 mm	9	
9	Leaf margin sharply serrate	<b>Philonotis</b>	218
9	Leaf margin entire	10	
10	Capsule cylindrical, dehiscent	<b>Dicranella</b>	138
10	Capsule ovoid, indehiscent	<b>Pseudephemerum</b>	128
11	Leaves imbricate	12	
11	Leaves erecto-patent to spreading, rarely imbricate	15	
12	Leaves denticulate at apex in the upper part; peristome single	13	
12	Leaves entire or only slightly denticulate at apex; peristome double	14	
13	Laminal cells 7-20 $\mu\text{m}$ wide; exostome teeth papillose, endostome lacking or rudimentary	<b>Mielichhoferia</b>	234
13	Laminal cells 7-8 $\mu\text{m}$ wide; exostome lacking, endostome segments smooth	<b>Schizymenium</b>	238
14	Median cells of lamina hexagonal to rhomboidal, 16-24 $\mu\text{m}$ wide	<b>Plagiobryum</b>	233
14	Median cells of lamina vermicular or rhomboidal, less than 10 $\mu\text{m}$ wide	<b>Anomobryum</b>	221

15	Median cells of lamina hexagonal or rhomboidal-hexagonal; nerve percurrent or excurrent in long or short point	<b>Bryum</b>	221
15	Median cells of lamina hexagonal, narrow to linear; nerve extending to near apex, rarely excurrent	<b>16</b>	
16	Capsule inclined to pendulous; plants common	<b>Pohlia</b>	234
16	Capsule straight; plants rare	<b>Orthodontium</b>	245

**PA. Pleurocarpous with nerve long and short laminal cells,  
at least at margin**

1	Leaf apex rounded	<b>Leptodon</b>	316
1	Leaf apex obtuse, acute or acuminate	<b>2</b>	
2	Branch leaves strongly dentate; plants dendroid	<b>Thamnobryum</b>	316
2	Branch leaves entire or denticulate; plants pinnately or irregularly branched	<b>3</b>	
3	Plants pinnately branched	<b>4</b>	
3	Plants irregularly branched	<b>5</b>	
4	Stem 1-pinnate	<b>Abietinella</b>	267
4	Stem 2-3-pinnate	<b>Thuidium</b>	267
5	Laminal cells papillose, at least above	<b>6</b>	
5	Laminal cells smooth	<b>10</b>	
6	Primary stem stoloniform; laminal cells unipapillose or pluripapillose	<b>7</b>	
6	Primary stem not stoloniform; laminal cells unipapillose	<b>9</b>	
7	Nerve nearly reaching apex	<b>8</b>	
7	Nerve extending to 1/2-2/3 way up leaf	<b>Heterocladium</b>	296
8	Leaf margin strongly dentate from base to apex	<b>Claopodium</b>	320
8	Leaf margin entire or sparsely dentate at apex	<b>Anomodon</b>	319
9	Leaf margin entire or dentate, recurved from base to apex	<b>Pseudoleskea</b>	265
9	Leaf margin entire, recurved at apex	<b>Leskea</b>	263
10	Plants small or slender, with propaguliferous branchlets at tip of ascending branches; capsule exserted	<b>Pseudoleskeella</b>	266
10	Plants medium-sized, without propaguliferous branchlets; capsule immersed	<b>Cryphaea</b>	311



**PB. Pleurocarpous with longitudinally plicate leaves, nerve long  
and laminal cells elongate**

1	Plants dendroid	<b>Climacium</b>	250
1	Plants pinnately or irregularly branched	2	
2	Branch leaves with reflexed teeth at apex	<b>Antitrichia</b>	311
2	Branch leaves without reflexed teeth at apex	3	
3	Stem with paraphyllia	4	
3	Stem without paraphyllia	8	
4	Alar cells large, inflated, well differentiated; plants pinnately or irregularly branched	<b>Palustriella</b>	257
4	Alar cells scarcely differentiated; plants irregularly branched	5	
5	Plants robust; leaf margin dentate; paraphyllia branched	<b>Hylocomiastrum</b>	298
5	Plants small to robust; leaf margin entire or denticulate at apex; paraphyllia entire or shortly branched	6	
6	Stem leaves large, to 0,25 cm long, with long, deep longitudinal plicae	<b>Ptychodium</b>	266
6	Stem leaves less than 0,25 cm long, with 2 short, shallow longitudinal plicae	7	
7	Basal cells of leaves mostly more than twice as long as wide	<b>Lescuraea</b>	263
7	Basal cells of leaves mostly less than twice as long as wide	<b>Pseudoleskea</b>	265
8	Stem leaves straight or only slightly falciform	9	
8	Stem leaves strongly falciform	14	
9	Plants very small and slender	<b>Pseudoleskeella</b>	266
9	Plants medium-sized to large	10	
10	Stem with reddish or brownish tomentum	<b>Tomentypnum</b>	259
10	Stem without tomentum	11	
11	Leaves triangular, gradually tapering into long, fine point	<b>Homalothecium</b>	279
11	Leaves lanceolate to ovate, gradually or abruptly tapering into long or short point	12	
12	Stem leaves ovate-lanceolate, gradually acuminate; nerve not ending in a projection at back of branch leaves; lid conical	<b>Brachythecium</b>	269
12	Stem leaves ovate to lanceolate, sometimes cordate at base, usually abruptly acuminate; nerve ending in a projection at back of branch leaves; lid longly rostrate	13	

13	Nerve extending less than half way up leaf	<b>Eurhynchium</b>	275
13	Nerve extending to half way up leaf or more	<b>Plasteurhynchium</b>	281
14	Stem with hyaloderm; alar cells inflated, hyaline	<b>Sanionia</b>	258
14	Stem without hyaloderm; alar cells not differentiated	<b>Hamatocaulis</b>	259

**PC. Pleurocarpous with squarrose or falciform leaves,  
long nerve and laminal cells elongate**

1	Leaves carinate	<b>Dichelyma</b>	248
1	Leaves not carinate	2	
2	Leaves transversely undulate	<b>Rhytidium</b>	301
2	Leaves not undulate or weakly so	3	
3	Leaf apex acute or obtuse	<b>Hygrohypnum</b>	254
3	Leaf apex acuminate	4	
4	Stem with paraphyllia	5	
4	Stem without paraphyllia	7	
5	Alar cells large, inflated, well differentiated	<b>Cratoneuron</b>	253
5	Alar cells hardly differentiated	6	
6	Basal cells of leaves mostly more than twice as long as wide	<b>Lescuraea</b>	263
6	Basal cells of leaves mostly less than twice as long as wide	<b>Pseudoleskea</b>	265
7	Leaf acumen channelled	<b>Campyliadelphus</b>	251
7	Leaf acumen not channelled	8	
8	Leaf margin denticulate	<b>Warnstorfia</b>	262
8	Leaf margin entire or nearly so	9	
9	Plants epiphytic	<b>Scorpiurium</b>	285
9	Plants aquatic	10	
10	Group of alar cells reaching nerve or nearly so	<b>Drepanocladus</b>	253
10	Group of alar cells small	<b>Scorpidium</b>	260

**PD. Pleurocarpous with long nerve, elongate laminal cells and rounded,  
obtuse or obtuse and apiculate leaf apex**

1	Nerve more than 40 $\mu$ m wide	<b>Hygroamblystegium</b>	254
1	Nerve less than 40 $\mu$ m wide	2	

2	Group of alar cells well differentiated	3	
2	Group of alar cells not or hardly differentiated	6	
3	Alar cells small, opaque	<b>Isothecium</b>	316
3	Alar cells large, inflated, hyaline	4	
4	Leaves ovate-cordate; nerve reaching apex or nearly so	<b>Calliergon</b>	259
4	Leaves oblong or ovate; nerved to 3/4 way up leaf	5	
5	Leaves apiculate; plants usually reddish	<b>Warnstorfia</b>	262
5	Leaves not apiculate; plants never reddish	<b>Straminergon</b>	261
6	Plants aquatic	7	
6	Plants not aquatic	8	
7	Leaf margin entire	<b>Hygrohypnum</b>	254
7	Leaf margin dentate	<b>Platyhypnidium</b>	281
8	Stem and branches not julaceous	<b>Rhynchostegium</b>	283
8	Stem and branches julaceous	9	
9	Plants complanate, pinnately branched	<b>Pseudoscleropodium</b>	282
9	Plants not complanate, irregularly branched	<b>Scleropodium</b>	285

**PE. Pleurocarpous with long nerve, elongate laminal cells  
and acute or acuminate leaf apex**

1	Branch leaves with reflexed teeth at apex	<b>Antitrichia</b>	311
1	Branch leaves without reflexed teeth at apex	2	
2	Median cells 2-6 times as long as wide	3	
2	Median cells more than 6 times as long as wide	11	
3	Alar cells hyaline, inflated, forming a distinct group	<b>Cratoneuron</b>	253
3	Alar cells forming a poorly-differentiated group	4	
4	Median cells of lamina oblong, thick-walled	5	
4	Median cells of lamina rhomboidal, thin-walled	6	
5	Stem with paraphyllia	<b>Pseudoleskea</b>	265
5	Stem without paraphyllia	<b>Pseudoleskeella</b>	266
6	Leaf margin with reflexed teeth at base; plants small	<b>Conardia</b>	253
6	Leaf margin without reflexed teeth at base; plants small to medium-sized	7	

7	Branch leaves different from stem leaves	<b>Scorpiurium</b>	285
7	Branch leaves similar to stem leaves	8	
8	Nerve more than 40 $\mu\text{m}$ wide at base	<b>Hygroamblystegium</b>	254
8	Nerve less than 35 $\mu\text{m}$ wide at base	9	
9	Leaf margin dentate	<b>Scorpiurium</b>	285
9	Leaf margin entire or finely denticulate	10	
10	Nerve ending in a projection at back of branch leaves	<b>Eurhynchium</b>	275
10	Nerve not ending in a projection at back of branch leaves	<b>Amblystegium</b>	250
11	Alar cells inflated, hyaline	12	
11	Alar cells not inflated or hyaline	15	
12	Leaves acute	13	
12	Leaves acuminate	14	
13	Median cells of lamina 6-10 $\mu\text{m}$ wide; leaf margin denticulate; plant large	<b>Brachythecium</b>	269
13	Median cells of lamina 5-6 $\mu\text{m}$ wide; leaf margin entire; plant medium-sized	<b>Hygrohypnum</b>	254
14	Leaf margin entire	<b>Drepanocladus</b>	253
14	Leaf margin denticulate	<b>Warnstorfia</b>	262
15	Alar cells small, opaque, thick-walled; branches usually curved	<b>Isoetecium</b>	316
15	Alar cells not as above; branches straight	16	
16	Leaf acumen channelled	<b>Campyliadelphus</b>	251
16	Leaf acumen not channelled or leaves acute	17	
17	Stem with paraphyllia	18	
17	Stem without paraphyllia	19	
18	Nerve ending in a projection at back of branch leaves	<b>Eurhynchium</b>	275
18	Nerve not ending in a projection at back of branch leaves	<b>Lescurea</b>	263
19	Leaves spreading or sub-complanate	<b>Leptodictyum</b>	256
19	Leaves not spreading or sub-complanate	20	
20	Stem leaves abruptly acuminate in long, fine point	<b>Cirriphyllum</b>	275
20	Stem leaves not as above	21	
21	Leaves linear-lanceolate or oblong-lanceolate; plants small, slender; lid rostrate	<b>Rhynchostegiella</b>	282

21	Leaves lanceolate, ovate or triangular; plants small to robust; lid rostrate or conical		22
22	Nerve ending in a projection at back of branch leaves		23
22	Nerve not ending in a projection at back of branch leaves		24
23	Stem leaves ovate or triangular, usually cordate-triangular; lid rostrate		
		<b>Eurhynchium</b>	275
23	Stem leaves lanceolate to ovate-lanceolate, not cordate at base; lid conical		
		<b>Brachythecium</b>	269
24	Leaves ovate, lanceolate or triangular; alar cells $\pm$ differentiated; lid conical		
		<b>Brachythecium</b>	269
24	Leaves ovate to ovate-lanceolate; alar cells not differentiated; lid rostrate		25
25	Plants robust, aquatic; leaf margin denticulate to serrate from base to apex		
		<b>Platyhypnidium</b>	281
25	Plants medium-sized, not aquatic; leaf margin entire or denticulate above		
		<b>Rhynchostegium</b>	283

**PF. Pleurocarpous with nerve short or lacking, short laminal cells  
at least at margin**

1	Leaves longitudinally plicate	<b>Leucodon</b>	312
1	Leaves not plicate or weakly so		2
2	Laminal cells papillose; plants small to medium-sized		3
2	Laminal cells smooth, occasionally prorate; plants small		5
3	Plants medium-sized; branches secund; leaves imbricate	<b>Pterogonium</b>	313
3	Plants small; branches straight; leaves imbricate or not		4
4	Stem leaves very concave, imbricate; plants julaceous	<b>Myurella</b>	304
4	Stem leaves flat or nearly so, patent to squarrose; plants not julaceous	<b>Heterocladium</b>	296
5	Branch leaves ovate, to twice as long as wide	<b>Pseudoleskeella</b>	266
5	Branch leaves ovate-lanceolate, more than twice as long as wide	<b>Habrodon</b>	295

**PG. Pleurocarpous with nerve short or lacking, elongate laminal cells,  
rounded, obtuse or obtuse and apiculate leaf apex**

1	Laminal cells papillose on dorsal side; plants slender	<b>Pterigynandrum</b>	296
1	Laminal cells smooth on dorsal side; plants robust		2

2	Stem and branches cuspidate	<b>Calliergonella</b>	286
2	Stem and branches not distinctly cuspidate	3	
3	Plants pinnately branched	4	
3	Plants irregularly branched	5	
4	Stem reddish; alar cells orange to brownish	<b>Pleurozium</b>	300
4	Stem green, yellow or light brown; alar cells green or hyaline	<b>Entodon</b>	308
5	Leaves longly decurrent; plants not aquatic	<b>Plagiothecium</b>	304
5	Leaves not decurrent or slightly so; plants aquatic	6	
6	Plant robust, turgid, growing on waterlogged soils	<b>Scorpidium</b>	260
6	Plants small or medium-sized, not turgid, growing on flushed rocks or in waterfalls	<b>Hygrohypnum</b>	254

**PH. Pleurocarpous with falciform or squarrose leaves, nerve short or lacking, elongate laminal cells, acute or acuminate apex**

1	Leaves squarrose; acumen $\pm$ channelled	2	
1	Leaves not squarrose; acumen flat	4	
2	Stem reddish	<b>Rhytidiadelphus</b>	300
2	Stem not as above	3	
3	Plants medium-sized to robust; leaves with long point; margin entire or finely denticulate; alar cells inflated, well differentiated	<b>Campylium</b>	251
3	Plants small; leaves with long or short point; margin dentate; alar cells poorly differentiated	<b>Campylophyllum</b>	288
4	Leaf apex acute; plants aquatic	5	
4	Leaf apex acuminate; plants not aquatic	6	
5	Plants robust, with turgid stem and branches, growing on waterlogged soils	<b>Scorpidium</b>	260
5	Plants small to medium-sized, stem and branches not turgid; growing in waterfalls or on flushed rocks	<b>Hygrohypnum</b>	254
6	Leaves widely and shortly acuminate	<b>Calliergonella</b>	286
6	Leaves narrowly and longly acuminate	7	
7	Stem reddish; plants irregularly branched	<b>Rhytidiadelphus</b>	300
7	Stem not reddish; plants irregularly or pinnately branched	8	
8	Stem leaves longitudinally plicate; plants pinnately branched	<b>Ptilium</b>	294
8	Stem leaves not plicate or weakly so; plants pinnately branched or not	9	

- |   |  |                  |     |
|---|--|------------------|-----|
| 9 | Leaves cordate at base; branch leaves different from stem leaves; plants pinnately branched                | <b>Ctenidium</b> | 288 |
| 9 | Leaves not cordate at base; branch leaves similar to stem leaves; plants irregularly or pinnately branched | <b>Hypnum</b>    | 289 |

**PI. Pleurocarpous with straight or slightly falciform or squarrose leaves, nerve single short, long and double or lacking, elongate laminal cells, acute or acuminate apex**

- |    |  |                        |     |
|----|--|------------------------|-----|
| 1  | Laminal cells papillose on dorsal side   | 2                      |     |
| 1  | Laminal cells smooth   | 4                      |     |
| 2  | Plants slender   | <b>Pterigynandrum</b>  | 296 |
| 2  | Plants robust  | 3                      |     |
| 3  | Stem regularly 2-3-pinnate; nerve double, to 1/2 way up leaf                     | <b>Hylocomium</b>      | 298 |
| 3  | Stem irregularly branched; nerve double, to 3/4 way up leaf                      | <b>Rhytidiadelphus</b> | 300 |
| 4  | Plants aquatic; leaves carinate or not   | <b>Fontinalis</b>      | 248 |
| 4  | Plants not aquatic; leaves not carinate  | 5                      |     |
| 5  | Laminal cells 2-5 times as long as wide; plants very small                       | 6                      |     |
| 5  | Laminal cells more than 5 times as long as wide; plants small to robust          | 8                      |     |
| 6  | Leaf margin entire   | <b>Amblystegium</b>    | 250 |
| 6  | Leaf margin denticulate, dentate or ciliate                                      | 7                      |     |
| 7  | Leaf margin denticulate  | <b>Platydictya</b>     | 307 |
| 7  | Leaf margin dentate or ciliate   | <b>Fabronia</b>        | 286 |
| 8  | Leaves spreading or reflexed   | <b>Campylophyllum</b>  | 288 |
| 8  | Leaves erect to patent   | 9                      |     |
| 9  | Stem with paraphyllia  | 10                     |     |
| 9  | Stem without paraphyllia   | 11                     |     |
| 10 | Stem leaves strongly plicate; branch leaves with single nerve                    | <b>Hylocomiastrum</b>  | 298 |
| 10 | Stem leaves not or weakly plicate; branch leaves with double nerve               | <b>Loeskeobryum</b>    | 299 |
| 11 | Stem leaves cordate-triangular, rapidly narrowed to apex; margin sharply dentate | <b>Hylocomium</b>      | 289 |

11	Stem leaves not cordate-triangular, gradually narrowed to apex; margin entire or denticulate		12
12	Alar cells not differentiated or only slightly so		13
12	Alar cells well differentiated		14
13	Leaves longitudinally plicate or concave	<b>Orthothecium</b>	304
13	Leaves not longitudinally plicate or concave	<b>Isopterygiopsis</b>	301
14	Alar cells inflated		15
14	Alar cells not inflated		19
15	Leaf margin denticulate from base to apex	<b>Herzogiella</b>	302
15	Leaf margin entire or slightly denticulate in the upper part		16
16	Leaves tapering to long acumen	<b>Sematophyllum</b>	310
16	Leaves tapering to acuminate apex		17
17	Plants small and slender	<b>Sematophyllum</b>	310
17	Plants medium-sized to robust		18
18	Stem with hyaloderm; leaves slightly falciform	<b>Calliergonella</b>	286
18	Stem without hyaloderm; leaves straight	<b>Callicladium</b>	286
19	Alar cells small, opaque; branches curved	<b>Isothecium</b>	316
19	Alar cells not as above; branches straight		20
20	Alar group excavate, of thick-walled cells	<b>Hypnum</b>	289
20	Alar group not excavate, of thin-walled cells		21
21	Leaf margin denticulate from base to apex	<b>Herzogiella</b>	302
21	Leaf margin entire or denticulate only at apex		22
22	Basal cells of leaf rectangular; plants corticolous, rarely saxicolous	<b>Pylaisia</b>	295
22	Basal cells of leaf rhomboidal; plants corticolous or saxicolous		23
23	Leaf margin narrowly recurved; plants usually with propaguliferous axillary branchlets; corticolous	<b>Platygyrium</b>	310
23	Leaf margin plane; plants usually without propaguliferous axillary branchlets; usually saxicolous	<b>Homomallium</b>	289



## CL. SPHAGNOPSIDA

Protonema thalloid. Seta absent; capsule globose, exserted and elevated by a pseudopodium at maturity; peristome absent. In dry conditions, capsule walls shrink building up an internal pressure that blows off the lid and ejects the spores into the air.

### **O. Sphagnales** **Fam. Sphagnaceae**

#### **Sphagnum L.**

Plants small to robust, green, yellowish, brownish or reddish, growing in wet areas, by streams, around mountain lakes or in sites where seepage water is available. Stem usually erect and branched, with a cortex of 1 or more layers of large, empty, hyaline cells, the hyaloderm. Rhizoids lacking. Branches differentiated into spreading branches and pendent branches, in fascicles of (1-)2-7 around the stem and crowded at the stem tip forming the capitulum, hyaloderm 1-layered. Leaves nerveless, consisting of elongated, narrow green cells in a network enclosing large, inflated, empty hyaline cells, usually with a border of 1-9 rows of elongated cells, dead at maturity. Hyaline cells may be septate, reinforced by fibrils or perforated by pores (fig. 2, 7). The exposure of green cells on the dorsal or ventral surface and their shape in cross section provide important taxonomic characters. Usually, stem and branch leaves vary in size and shape.

- 1 Cortical cells of stem and branches with spiral fibrils; branch leaves with blunt, cucullate apices, rough at back due to resorption of hyaline cells; plants robust (fig. 2, 1-12) **Sect. Sphagnum**
- 1 Cortical cells of stem and branches without spiral fibrils; branch leaves with acute or truncate apices, never cucullate or rough at back; plants robust or not **2**
- 2 Plants with simple stem or with 1-2 short branches per fascicle; capitula scarcely developed (fig. 2, 13-15) **Sect. Hemitheca**
- 2 Plants with well-developed fascicles, rarely of fewer than 3 branches; capitula well developed, although in some species can be concealed by upper branches **3**

- 3 Green cells of branch leaves triangular or trapezoid in section, exposed exclusively or more broadly on ventral surface (fig. 3, 1-17) **Sect. Acutifolia**
- 3 Green cells of branch leaves various, but if triangular or trapezoid in section then exposed exclusively or more broadly on dorsal surface **4**
- 4 Branch leaves broadly truncate, margin denticulate; green cells of branch leaves enclosed by hyaline cells; branch cortical cells all retort (fig. 4, 1-5) **Sect. Rigida**
- 4 Branch leaves acute or narrowly truncate, margin entire except across the apex; green cells of branch leaves exposed equally on both surfaces or more broadly on dorsal surface; branch cortical cells of 2 kinds, some flat and usually not porose, others retort cells **5**
- 5 Stem leaves large, lingulate, never fibrillose; border not expanded below; pores in middle of branch leaves 12-40  $\mu\text{m}$ , numerous and conspicuous (fig. 4, 6-11) **Sect. Squarrosa**
- 5 Stem leaves various, if lingulate and without fibrils, then with borders expanded below; pores of branch leaves less than 12  $\mu\text{m}$  **6**
- 6 Green cells of branch leaves barrel-shaped in section, exposed equally or almost equally on both surfaces (fig. 4, 12-18) **Sect. Subsecunda**
- 6 Green cells of branch leaves triangular or trapezoid in section, broadly exposed on dorsal surface (fig. 5, 1-14) **Sect. Cuspidata**

## Section Sphagnum

- 1 Inside walls of hyaline cells papillose (fig. 2, 9-10) **S. papillosum** Lindb.  
Plants robust, ochre-brown, with short and blunt branches not tapering. Forms hummocks or dense turfs in open peatlands, wet heath lands and peaty grasslands, in the northern and central part of the Peninsula. Esp, Prt, And.
- 1 Inside walls of hyaline cells smooth **2**
- 2 Green cells of branch leaves elliptical in section, completely enclosed by hyaline cells; plants red or purple (fig. 2, 11) **S. magellanicum** Brid.  
Plants robust, occasionally green under dense shade. Hyaline cells of stem leaves not septate, with fibrils near the leaf apex. Forms hummocks or dense turfs in open sites, oligotrophic mires, by streams, lakes and wet heath lands. Rare in the Central Pyrenees, the Cantabrian Mountains and the Iberian Range. Esp.
- 2 Green cells of branch leaves exposed on one or both surfaces; plants green, yellowish, brownish or orange but never red **3**
- 3 Green cells of branch leaves elliptical in section, exposed on both surfaces and with thickened outer walls (fig. 2, 12) **S. centrale** C.O.E. Jensen  
**S. palustre** L. var. **centrale** (C.O.E. Jensen) A. Eddy

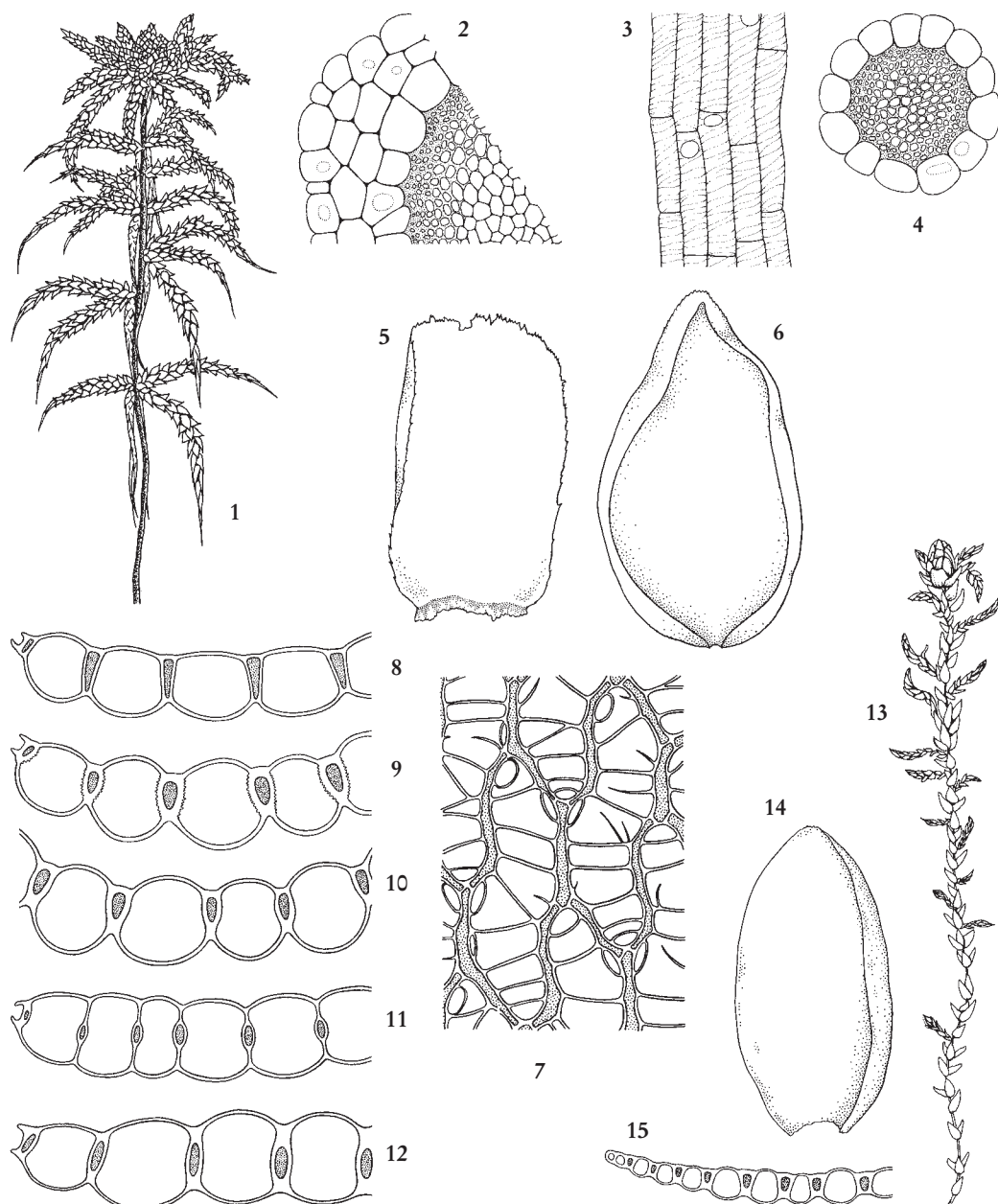


FIGURE 2. 1-12, *Sphagnum*, Sect. *Sphagnum*. 1-8, *S. palustre*: 1, habit; 2, stem section; 3, branch cortex, surface view; 4, branch section; 5, stem leaf; 6, branch leaf; 7, cells of branch leaf, dorsal side; 8, branch leaf section. 9-10, *S. papillosum*, branch leaf sections. 11, *S. magellanicum*, branch leaf section. 12, *S. centrale*, branch leaf section. 13-15, *Sphagnum*, Sect. *Hemitheca*. *S. pylaesii*: 13, habit, 14, stem leaf; 15, branch leaf section. 1, 13 ( $\times 2$ ); 5, 6, 14 ( $\times 20$ ); 2, 3, 4 ( $\times 90$ ); 7, 8, 9, 10, 11, 12, 15 ( $\times 275$ ).

Plants robust, green or brownish. Hyaline cells of stem leaves not septate and lacking fibrils. Forms hummocks or dense turfs by mountain lakes, on peaty and grassy soils and in pinewood glades. Rare in the Central Pyrenees, the Iberian Range and Serra da Estrela. Esp, Prt (Extinct).

- 3 Green cells of branch leaves triangular, oval or trapezoidal in section, exposed exclusively or more broadly on ventral surface 4

- 4 Green cells of branch leaves isosceles-triangular in section, with thin walls, the ventral side  $\pm$  convex and the lateral sides straight (fig. 2, 1-8) **S. palustre** L.

Plants robust, light-green or green yellowish, with branches long tapering. Hyaline cells of stem leaves fibrillose, not septate. Forms lax turfs and low hummocks by streams, mountains lakes, pools and in peaty sites, in woodlands as well as in open places, distributed throughout the northern half of the Peninsula. Esp, Prt, And.

- 4 Green cells of branch leaves oval or trapezoidal in section, with thickened walls, especially on the ventral side, and the lateral sides convex (fig. 2, 9-10)

**S. papillosum** Lindb.

Plants robust, ochre-brown, with short and blunt branches not tapering. This species shows a range of papillosity and, occasionally, plants may be found with papillae indistinct or wholly lacking. Forms hummocks or dense turfs in open peatlands, wet heath lands and peaty grasslands, in the northern and central part of the Peninsula. Esp, Prt, And.

## Section Hemitheca

Plants medium-sized but often much elongated, purple, brown-reddish to almost black. Stem simple or poorly branched, cortical cells well differentiated in 1-3 layers. Stem leaves larger and similar to branch leaves. Green cells of branch leaves trapezoid in section and exposed more broadly on ventral surface or barrel-shaped in section and exposed  $\pm$  equally on both surfaces (fig. 2, 13-15)

**S. pylaesii** Brid.

This species occurs in two habitat forms: Plants prostrate, elongated, poorly branched and brownish-red, which grow on flat granitic rocks that seep throughout the year and plants also prostrate, smaller, almost black, with short branches, which grow in very moist depressions in bogs, in the northwesternmost part of the Peninsula where it is rather locally abundant. Very rare. Esp.

## Section Acutifolia

- 1 Branch leaves erose along margin (fig. 3, 5-6) **S. molle** Sull.

Plants slender to medium-sized, whitish, pale-green or yellowish sometimes with flecks of red or pink. Fascicles closely set, spreading branches pointing upwards. Stem leaves 1,5-2,0 mm long. In low but dense cushions or extensive turfs on seep slopes and acidic rocks in open places, mainly on northwestern coastal areas. Esp, Prt.

- 1 Branch leaves entire, except across the apex 2

- 2 Plants brown, with dark brown stem (fig. 3, 7) **S. fuscum** (Schimp.) H. Klinggr.  
Plants slender. Stem leaves lingulate to slightly spatulate; hyaline cells without fibrils, septa numerous. Forms dense hummocks at the base of mountain pines. Very rare in the Central Pyrenees. Esp. 3
- 2 Plants reddish, green or green variegated with red, orange, yellow or brown, but not the whole plant brown 3
- 3 At least some fascicles with 3 spreading branches; branch leaves strongly 5-ranked (fig. 3, 8) **S. quinquefarium** (Braithw.) Warnst.  
Plants delicate to medium-sized, green variegated with red. Forms loose patches or hummocks in acidic rocky sites under trees and on shady and seeping slopes in wet forests, in the Pyrenees and the Cantabrian Mountains. Esp, And.
- 3 Fascicles with 2 spreading branches; branch leaves 5-ranked or not 4
- 4 Stem leaves fimbriate more than 1/2 across the apex; plants green, never with red coloration 5
- 4 Stem leaves not fimbriate or if fimbriate then less than 1/2 across the apex; plants with red coloration or not 6
- 5 Stem leaves fimbriate around the whole upper part (fig. 3, 9) **S. fimbriatum** Wilson  
Plants medium-sized, tall and thin. Terminal stem bud large. Forms loose patches on acidic substrata by streams and on seeping rocks in wet forests. Scattered in the Cantabrian Mountains, rare in the Pyrenees and in the Iberian Range. Esp, And.
- 5 Stem leaves fimbriate only across the apex (fig. 3, 10) **S. girgensohnii** Russow  
Plants medium-sized to robust. Terminal stem bud large. Stem leaves with a triangular group of expanded hyaline cells at the middle of the base. Forms turfs in wet grasslands, wooded, shady sites, by streams and mountain lakes and on acidic rocks and slopes, in the Pyrenees and in some northern and western localities. Esp, Prt, And.
- 6 Stem leaves with broadly rounded and erose apex, hyaline cells near the apex short and rhomboidal; cells of stem cortex with pores (staining required) (fig. 3, 11) **S. russowii** Warnst.  
Plants delicate to medium-sized, green with red or pink flecks. Terminal stem bud inconspicuous. Hyaline apical cells of branch leaves with 1-3 circular pores per cell, 5-18 µm on ventral side. Forms loose turfs or hummocks in peaty heath lands, wet grasslands, wooded sites and by streams and mountain lakes, in the northern half of the Peninsula. Esp, Prt, And.
- 6 Stem leaves with narrowly rounded to sub-acute apex, not erose, hyaline cells near the apex elongated; cells of stem cortex without pores 7
- 7 Stem leaf apex acute and cuspidate due to inrolled margins; hyaline cells of stem leaves mostly without fibrils; plants shiny when dry (fig. 3, 12-13) **S. subnitens** Russow & Warnst.  
Plants medium-sized to relatively robust, green variegated with yellow, brown or red. Stem leaves triangular to triangular-lingulate, 1,3-2,0 mm long; hyaline cells 1-4 septate. Forms

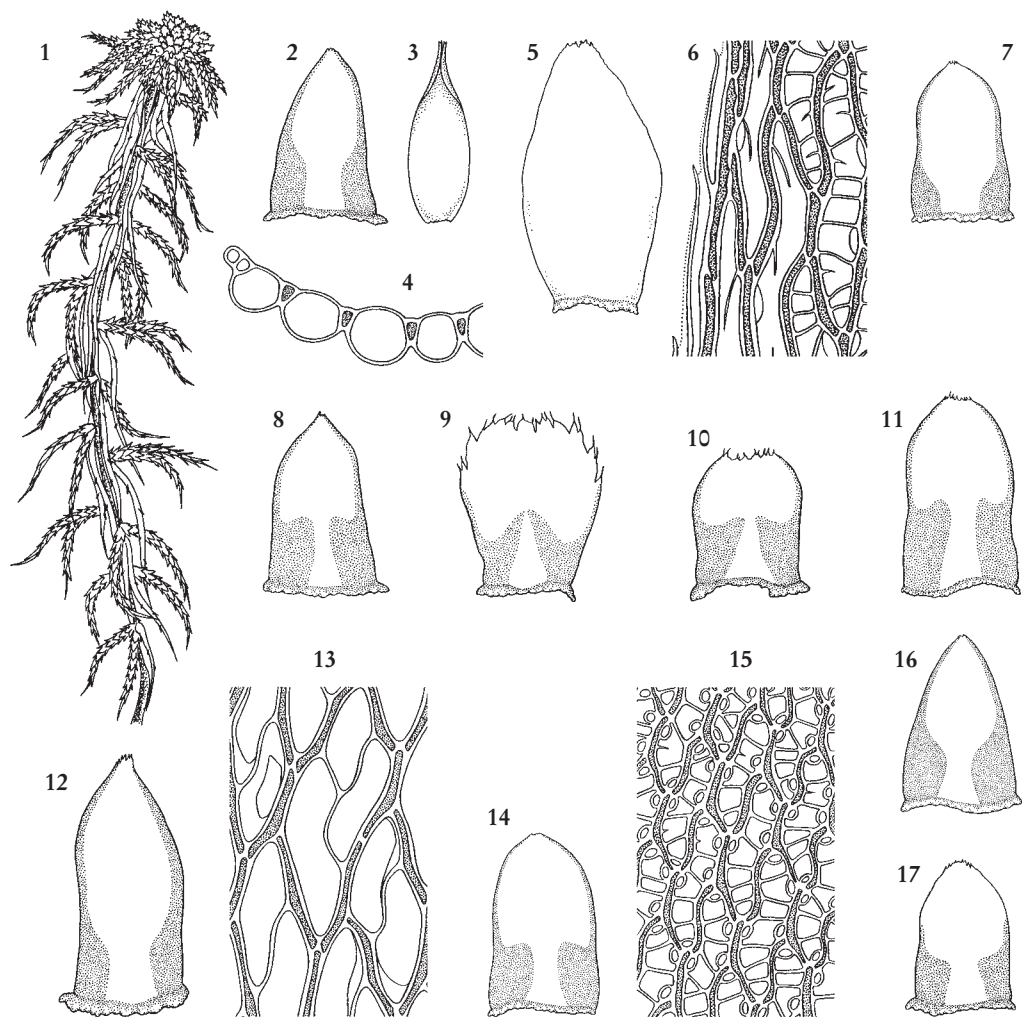


FIGURE 3. 1-17, *Sphagnum*, Sect. *Acutifolia*. 1-4, *S. capillifolium*: 1, habit; 2, stem leaf; 3, branch leaf; 4, branch leaf section. 5-6, *S. molle*: 5, stem leaf; 6, branch leaf margin. 7, *S. fuscum*, stem leaf. 8, *S. quinquefarium*, stem leaf. 9, *S. fimbriatum*, stem leaf. 10, *S. girgensohnii*, stem leaf. 11, *S. russowii*, stem leaf. 12-13, *S. subnitens*: 12, stem leaf; 13, cells of stem leaf, dorsal side. 14-15, *S. warnstorffii*: 14, stem leaf; 15, cells of branch leaf, dorsal side. 16, *S. subtile*, stem leaf. 17, *S. rubellum*, stem leaf. 1 ( $\times 2$ ); 2, 3, 5, 7, 8, 9, 10, 11, 12, 14, 16, 17 ( $\times 20$ ); 4, 6, 13, 15 ( $\times 275$ ).

turfs or hummocks in bogs, peaty heath lands, wet grasslands, by streams and mountain lakes and on damp, acidic soils and slopes. Widespread in suitable localities in the Peninsula. Esp, Prt.

- 7 Stem leaf apex obtuse or acute; hyaline cells of stem leaves mostly fibrillose; plants not particularly shiny when dry

- 8 Pores on dorsal side of branch leaves near apex 3-6  $\mu\text{m}$ , thick-ringed (fig. 3, 14-15)  
**S. warnstorffii** Russow  
 Plants small, green or brownish with red coloration or the whole plant red. Branch leaves 5-ranked, with squarrose apices when dry. Forms patches in wet or waterlogged acidic sites, grasslands and by streams and mountain lakes of the Pyrenees. Esp, And.
- 8 Pores on dorsal side of branch leaves near apex 5-20  $\mu\text{m}$ , not thick-ringed 9
- 9 Stem leaves with a border of 3-7 cells wide above, strongly expanded below to occupy 50-85% of the leaf base (fig. 3, 16) **S. subtile** (Russow) Warnst.  
 Plants delicate, green variegated with red. Forming loose turfs, that can be more compact in dry conditions, in mountain mires. Rare, in the northwestern part of the Peninsula. Esp.
- 9 Stem leaves with a border of 2-5 cells wide above, expanded below to occupy less than 60% of the leaf base 10
- 10 Stem leaves 1,2-1,5 mm long, triangular to lingulate-triangular; stem leaf hyaline cells 75-100  $\mu\text{m}$  long, mostly 0-1 septate; branch leaf hyaline cells with pores 10-20  $\mu\text{m}$  on dorsal surface (fig. 3, 1-4) **S. capillifolium** (Ehrh.) Hedw.  
**S. nemoreum** Scop.  
 Plants delicate to medium-sized, green variegated with red, yellow or brown, sometimes the whole plant red. Capitula  $\pm$  hemispherical, fascicles closely packed. Stem leaves fibrillose in the upper half. Branch leaves not 5-ranked. Forms hummocks and dense turfs in bogs, heath lands, damp grasslands and on wet slopes. Widespread in the northern half of the Peninsula. Esp, Prt, And.
- 10 Stem leaves less than 1,2 mm long, oblong to lingulate; stem leaf hyaline cells 70-80  $\mu\text{m}$  long, 1-3 septate; branch leaf hyaline cells with pores 5-13  $\mu\text{m}$  on dorsal surface (fig. 3, 17) **S. rubellum** Wilson  
 Plants delicate, slender, green variegated with red or the whole plant red. Capitula  $\pm$  flat. Stem leaves weakly fibrillose, sometimes indistinct. Forms dense turfs and hummocks in damp, open peaty sites and in wet heath lands, in the north and west of the Peninsula. Esp, Prt, And.

## Section Rigida

Plants small to occasionally robust, whitish-green, glaucous, ochre or brownish. Stem dark brown to black; branches densely crowded making the capitula hard to discern. Stem leaves very small, up to 0,8 mm long. Branch leaves large, 1,8-3 mm long. Green cells of branch leaves oval in section, completely enclosed by hyaline cells (fig. 4, 1-5)

### **S. compactum** Lam. & DC.

Forms compact and small cushions and turfs in wet heath lands, bogs and wet grasslands by mountain lakes and high mountain streams as well as on seeping rock ledges. Widespread in the northern half of the Peninsula. Esp, Prt, And.



## Sect. Squarrosa

- 1 Plants robust, green or pale green, rarely pale brown; branch leaves over 2,3 mm long, squarrose (fig. 4, 6-8) **S. squarrosus** Crome  
Stem bud visible but not conspicuous. Forms loose and tall patches by streams and pools, in moist forests, rarely in open sites. Scattered in the northern half of the Peninsula. Esp, Prt.
- 1 Plants medium-sized, brown, green, golden yellow or pale yellow; branch leaves less than 2,3 mm long, imbricate or squarrose (fig. 4, 9-11) **S. teres** (Schimp.) Ångstr.  
Stem bud conspicuous. Forms loose turfs along streams and mountain lakes, waterlogged grasslands and damp peaty soils, rarely in natural clearings in forests. Widespread in Pyrenees, southern side of the Cantabrian Mountains, the Spanish Central Range and the Sierra Nevada. Esp, And.

## Sect. Subsecunda

- 1 Hyaloderm 1-layered 2
- 1 Hyaloderm 2-3-layered 3
- 2 Plants medium-sized; stem leaves 0,7-1,1 mm long, fibrillose in the upper 0-25% (fig. 4, 16) **S. subsecundum** Nees  
Plants small to medium-sized, golden yellow, yellow variegated with orange or brown, occasionally green in shade; capitula with short and arcuate branches, the upper very curved. Branch leaves with numerous and minute pores, 2-6 µm, on the dorsal surface in series along the commissures. Forms loose turfs above water level, rarely submerged, in open sites such as heath lands, peaty grasslands and mires, in the northern half of the Peninsula and Sierra Nevada. Esp, Prt, And.
- 2 Plants usually robust; stem leaves 1,2-2,7(-3) mm long, fibrillose in the upper 20-80% (fig. 4, 12-15) **S. denticulatum** Brid.  
**S. auriculatum** Schimp.  
Plants greenish or brownish, very polymorphic. Forms loose turfs, frequently submerged or semi-submerged, in a wide range of open peaty sites. Widespread in northern half of the Peninsula, very rare in the south where it is localized in Algeciras Mountains. Esp, Prt, And. In this species are included the plants named *S. inundatum* Russow.
- 3 Stem leaves 0,8-1 mm long, fibrillose in the upper 10-35% (fig. 4, 17) **S. contortum** Schultz  
Plants medium-sized, green variegated with yellow or brown; upper branches of capitula curved as in *S. subsecundum* but the pores on the dorsal surface of the branch leaves are smaller, 1-3 µm. Fascicles of 6-7 branches. Forms loose turfs in base-rich habitats, along the margins of streams and pools, sometimes semi-submerged. Rare in the Pyrenees and in the Cantabrian Mountains. Esp.
- 3 Stem leaves 1-2 mm long, fibrillose in the upper 80-100% (fig. 4, 18) **S. platyphyllum** (Lindb. ex Braithw.) Warnst.



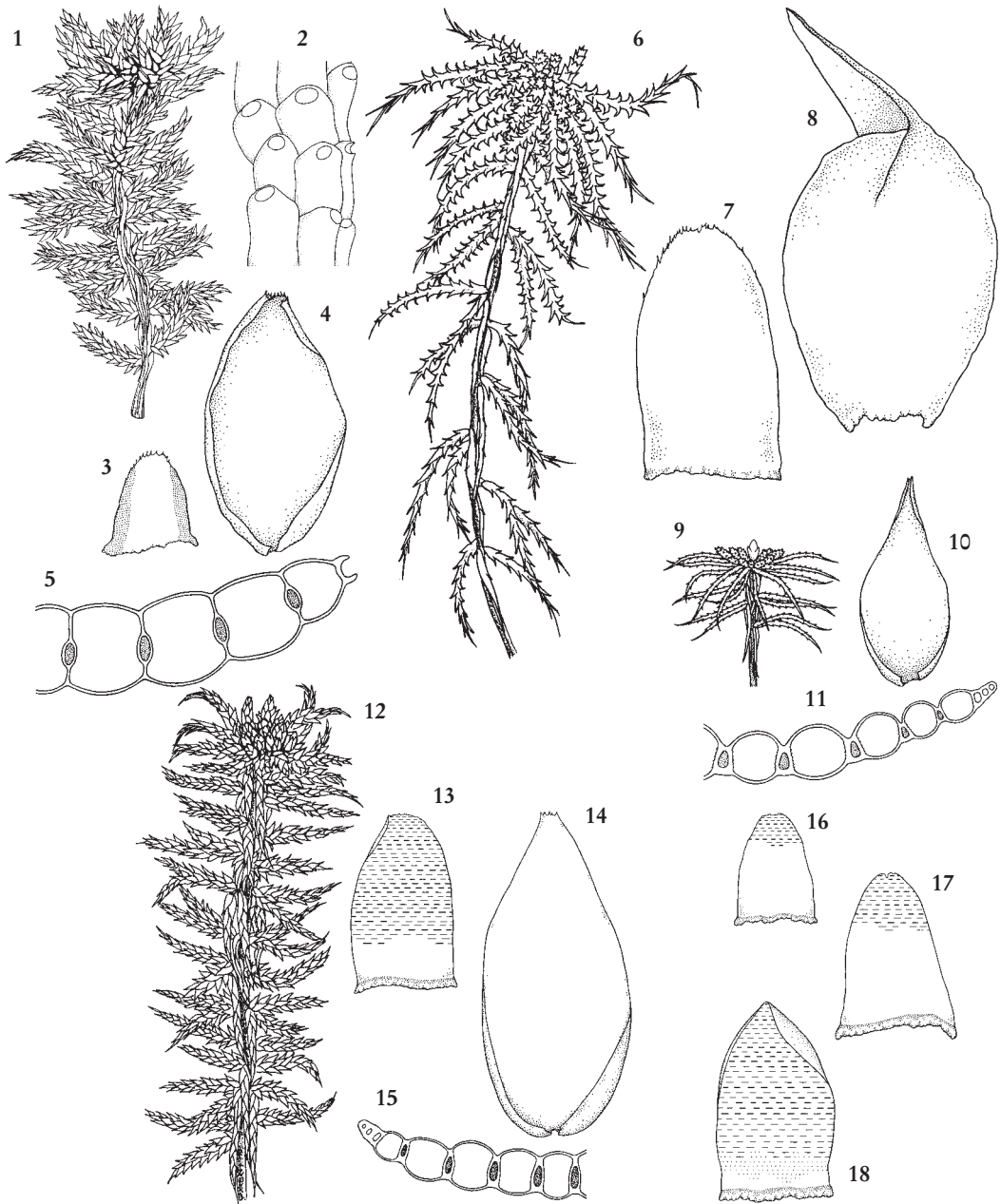


FIGURE 4. 1-5, *Sphagnum*, Sect. *Rigida*. *S. compactum*: 1, habit; 2, branch cortex, surface view; 3, stem leaf; 4, branch leaf; 5, branch leaf section. 6-11, *Sphagnum*, Sect. *Squarrosa*. 6-8, *S. squarrosum*: 6, habit; 7, stem leaf; 8, branch leaf. 9-11, *S. teres*: 9, capitulum with terminal bud; 10, branch leaf; 11, branch leaf section. 12-18, *Sphagnum*, Sect. *Subsecunda*. 12-15, *S. denticulatum*: 12, habit; 13, stem leaf; 14, branch leaf; 15, branch leaf section. 16, *S. subsecundum*, stem leaf. 17, *S. contortum*, stem leaf. 18, *S. platyphyllum*, stem leaf. 1, 6, 9, 12 ( $\times 2$ ); 3, 4, 7, 8, 10, 13, 14, 16, 17, 18 ( $\times 20$ ); 2 ( $\times 90$ ); 5, 11, 15 ( $\times 275$ ).

Plants medium-sized, olive green to brownish; capitula hard to discern but with a conspicuous stem bud. Fascicles rarely with more than 3 branches. Forms loose turfs in waterlogged, open high mountain sites. Rare in the northern part of the Peninsula. Esp, Prt.

## Section Cuspidata

- 1 Branch leaf hyaline cells 20-40  $\mu$ m wide, 1-4 times as long as wide (fig. 5, 6-8)
 

**S. tenellum** (Brid.) Pers. ex Brid.

Plants small and delicate, green or yellow. Pendent branches not different from spreading branches, retort cells very well developed and much larger than the small imperforated cells. Stem leaves ovate-lingulate, 0,9-1,5 x 0,4-0,8 mm, strongly fibrillose in upper half. Branch leaves broadly ovate, concave, like stem leaves in size. Forms loose turfs in open acidic sites by pools, streams, mountain lakes and in peaty heath lands, in the north of the Peninsula. Esp, Prt.
- 1 Branch leaf hyaline cells less than 20  $\mu$ m wide, more than 4 times as long as wide 2
- 2 Branch leaf hyaline cells with numerous pores, 6-15, on dorsal surface (fig. 5, 9-10)
 

**S. majus** (Russow) C.E.O. Jensen

Plants medium-sized, green or brownish, sometimes yellowish. Stem with cortex distinct. Stem leaves triangular to triangular-lingulate, 1-1,4 mm long, with concave and obtuse apices. Branch leaves lanceolate to linear-lanceolate, second, 2,0-2,5 mm long. Forms turfs on open, acidic wetlands, at the wet margins of mountain lakes and by streams, very localized in the Cantabrian Mountains and in the Iberian Range. Esp.
- 2 Branch leaf hyaline cells without pores or very few on dorsal surface 3
- 3 Stem leaves with acute or mucronate apices; cortex distinct 4
- 3 Stem leaves with obtuse or rounded apices; cortex not distinct 5
- 4 Branch leaves lanceolate, 1,3-2,0 mm long; stem leaves with mucronate apices (fig. 5, 11)
 

**S. fallax** (H. Klinggr.) H. Klinggr.

Plants medium-sized, green, yellowish to brownish. Fascicles of 5 dimorphic branches. Stem leaves shortly triangular, 0,8-1,3 mm long, with or without fibrils. Branch leaves 5-ranked; green cells isosceles-triangular in section. Forms turfs on acidic wetlands, peaty heath lands and by streams and mountain lakes, in the north of the Peninsula. Esp, Prt, And.
- 4 Branch leaves lanceolate to linear 1,6-5,0 mm long; stem leaves with acute apices (fig. 5, 12-13)
 

**S. cuspidatum** Ehrh. ex Hoffm.

Plants medium-sized, the aquatic forms plumose, the terricolous ones rather compact, green, pale-green or yellowish. Fascicles of 3-4 not dimorphic branches. Stem leaves triangular to triangular-ovate, 0,9-1,7 mm long. Branch leaves spirally arranged; green cells trapezoid in section. Forms loose turfs, often submerged or semi-submerged, in peaty pools and heath lands, in the north and northwest of the Peninsula, absent in the Pyrenees. Esp, Prt.
- 5 Pendent and spreading branches strongly dimorphic, the pendent branches longer than the spreading; stem leaves 0,7-0,9 mm long (fig. 5, 14)
 

**S. angustifolium** (C.O.E. Jensen ex Russow) C.O.E. Jensen

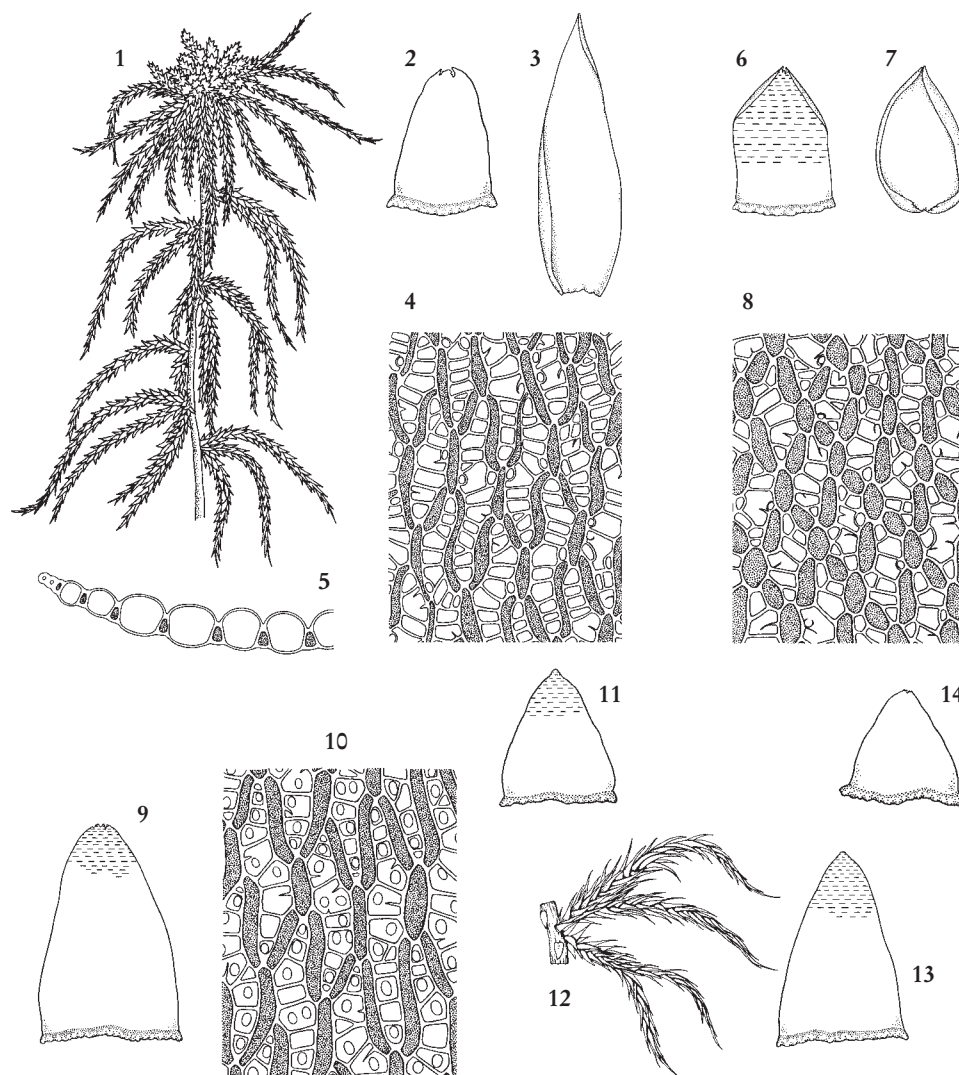


FIGURE 5. 1-14, *Sphagnum*, Sect. *Cuspidata*. 1-5, *S. flexuosum*: 1, habit; 2, stem leaf; 3, branch leaf; 4, cells of branch leaf, dorsal side; 5, branch leaf section. 6-8, *S. tenellum*: 6, stem leaf; 7, branch leaf; 8, cells of branch leaf, dorsal side. 9-10, *S. majus*: 9, stem leaf; 10, cells of branch leaf, dorsal side. 11, *S. fallax*, stem leaf. 12-13, *S. cuspidatum*: 12, fascicle; 13, stem leaf. 14, *S. angustifolium*, stem leaf. 1 ( $\times 2$ ); 12 ( $\times 3$ ); 2, 3, 6, 7, 9, 11, 13, 14 ( $\times 20$ ); 4, 5, 8, 10 ( $\times 275$ ).

Plants medium-sized, green, yellowish to brownish. Green cells of branch leaves triangular in section. Forms loose turfs in mires and peaty heath lands and grasslands. Scattered in the northern half of the Peninsula. Esp, Prt.

- 5 Branches not dimorphic and similar in length; stem leaves 0,8-1,2 mm long (fig. 5, 1-5)  
**S. flexuosum** Dozy & Molk.

Plants medium-sized, green, yellowish to brownish. Green cells of branch leaves trapezoid in section. Forms loose turfs in open acidic wetlands, mires, peaty heath lands and by streams and mountain lakes. Scattered in the northern half of the Peninsula. Esp, Prt.

## CL. ANDREAEOPSIDA

Protonema thalloid. Seta absent; capsule exerted, ellipsoidal, elevated by a pseudopodium, dehiscing by 4 longitudinal, incomplete slits; peristome lacking. In dry conditions the columella contracts and the slits open to release the spores.

### **O. Andreaeales** **Fam. Andreaeaceae**

Andreaea Hedw.

Plants fragile, stem simple or slightly branched. Leaves small, straight or curved, lanceolate to ovate-lanceolate, nerve present or lacking; laminal cells rounded or rectangular, smooth or papillose, thick-walled, strongly porose or sinuously thickened. Perichaetial leaves large, around pseudopodium. Sporophyte terminal. Forms dark brown, reddish or blackish turfs, 0,5-6 cm high, on siliceous rocks, mainly in high mountains.

- |   |  |   |
|---|--|---|
| 1 | Leaves nerveless or with slightly differentiated nerve; when present, nerve dorsally convex  | 2 |
| 1 | Leaves with well differentiated nerve for their entire length; nerve dorsally convex, or also ventrally (in <i>A. frigida</i> )  | 6 |
| 2 | Leaves with slightly differentiated nerve at base or at median and upper part  | 3 |
| 2 | Leaves nerveless   | 4 |
| 3 | Nerve slightly differentiated in the lower third of leaf, sometimes absent at base, more distinct from middle to apex with 3-4(-5) cells layers; leaf lamina 1(2)-stratose in the upper 2/3, unistratose at margin (fig. 6, 1-3) |   |

**A. heinemannii** Hampe & Müll.Hal. subsp. **heinemannii**

Plants to 5 cm tall. Leaves abruptly narrowed, often narrowly subulate, subula 2/3-3/4 length of leaf; nerve (45)50-70(-85) µm wide, with 3-4(-5) cell layers. Perigonia without paraphyses, rarely with some. Perichaetial leaves with nerve in upper part. Spores (20-)24-32(-36) µm.

Forms dense, brownish to blackish turfs on wet, shaded or exposed, granitic rocks, in montane or high mountain areas of the northern half of the Peninsula. Esp, Prt.

- 3 Nerve distinct in the lower third of leaf, with 2-3 cells-layers, nearly imperceptible in the rest; leaf lamina 2-stratose in the upper 2/3, unistratose at margin (fig. 6, 4-5)

**A. heinemannii** Hampe & Müll.Hal. subsp. **crassifolia** (Luisier) Sérgio

**A. crassifolia** Luisier

Plants to 5 cm tall. Leaves gradually tapering, sometimes with obtuse apex; nerve (95-)100-110(-112)  $\mu\text{m}$  wide, with up to 2-3 cell layers. Perigonia with abundant, yellow to brown paraphyses. Perichaetial leaves nerveless. Spores spherical, 23-35(-39)  $\mu\text{m}$ . Forms dense, brown to blackish turfs on dry granitic rocks and walls of exposed, acidic rocks, in montane areas (in lower parts than subsp. *heinemannii*) of the western part of the Peninsula. Esp, Prt.

- 4 Leaf basal cells quadrate or rounded at margins; spores 12-22(-25)  $\mu\text{m}$  (fig. 6, 6-7)

**A. mutabilis** Hook.f. & Wilson

Plants about 1 cm tall. Leaves lanceolate, straight; laminal cells papillose on dorsal side, basal cells rectangular, smooth, thick-walled. Forms reddish to blackish turfs, sometimes glaucous on vertical walls of acidic rocks, in high mountains of the north of the Peninsula, rarely in montane areas. Esp.

- 4 Leaf basal cells shortly rectangular or oblate at margins; spores 22-35  $\mu\text{m}$  5

- 5 Transition between basal and upper cells gradual; upper lamina unistratose or irregularly bistratose at middle of leaf (fig. 6, 8-9) **A. alpestris** (Thed.) Schimp.

**A. rupestris** Hedw. var. **alpestris** (Thed.) Sharp

Laminal cells slightly papillose or papillae lacking on dorsal surface,  $\pm$  regularly thick-walled, lumina rounded, basal cells shortly rectangular, slightly porose or not porose. Capsules uncommon; spores 24-32  $\mu\text{m}$ . Forms short, to 1 cm, brown, blackish or reddish turfs on periodically wet vertical walls of acidic rocks, in high mountains mainly in the north of the Peninsula. Esp.

- 5 Transition between basal and upper cells abrupt; lamina unistratose (fig. 6, 10-16)

**A. rupestris** Hedw.

Laminal cells papillose on dorsal side, irregularly thick-walled, lumina star-shaped, basal cells longly rectangular, strongly porose.

var. **rupestris**: Stem to 1,5 cm high. Leaves to 1 mm long; laminal cells mostly with hyaline papillae on dorsal side, twice as high as wide. Forms reddish brown turfs on wet, acidic rocks or in sheltered rock crevices, in montane areas and high mountains of the northern half of the Peninsula. Esp, Prt, And (fig. 6, 10-14).

var. **papillosa** (Lindb.) Podp.: Stem to 2,5 cm high. Leaves to 2 mm long, lanceolate, abruptly narrowed to long apex; laminal cells with papillae more than twice as high as wide on dorsal side. Forms blackish turfs on shaded, acidic rocks. Very rare, in high mountains of the Pyrenees. Esp (fig. 6, 15-16).

- 6 Leaf margin irregularly crenulate to denticulate; laminal cells papillose on both sides; perichaetial leaves similar to stem leaves; dioicous (fig. 6, 17-20) **A. nivalis** Hook.

Plants 4-6 cm tall, brownish green. Laminal cells and nerve cells papillose. Sporophyte unknown. Grows on rocks and in wet, acidic rock crevices, in high mountains. Scattered in the northern half of the Peninsula. Esp.

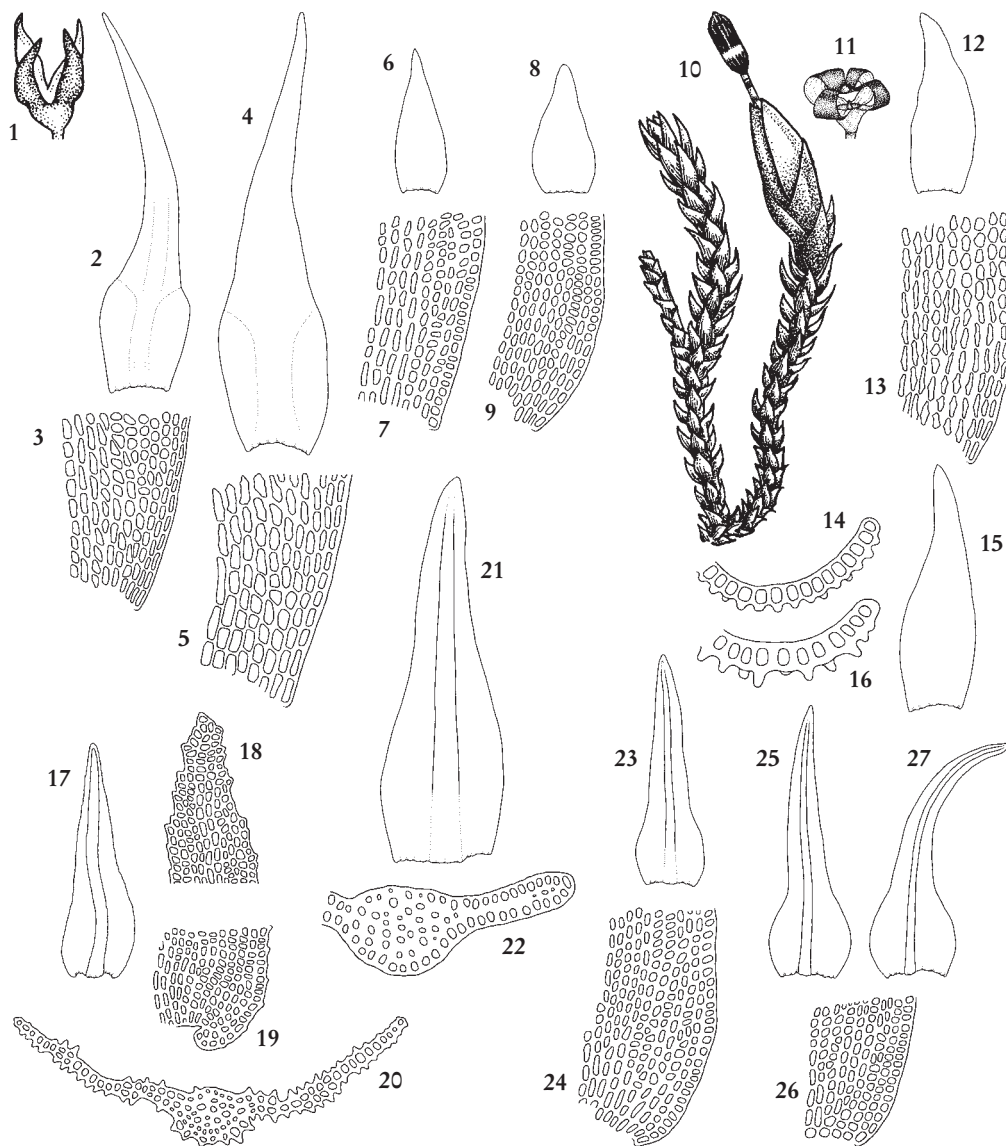


FIGURE 6. 1-3, *Andreaea heinemannii* subsp. *heinemannii*: 1, capsule; 2, leaf; 3, basal cells. 4-5, *A. heinemannii* subsp. *crassifolia*: 4, leaf; 5, basal cells. 6-7, *A. mutabilis*: 6, leaf; 7, basal cells. 8-9, *A. alpestris*: 8, leaf; 9, basal cells. 10-14, *A. rupestris* var. *rupestris*: 10, habit; 11, capsule; 12, leaf; 13, basal cells; 14, leaf section. 15-16, *A. rupestris* var. *papillosa*: 15, leaf; 16, leaf section. 17-20, *A. nivalis*: 17, leaf; 18, leaf apex; 19, basal cells; 20, leaf section. 21-22, *A. frigida*: 21, leaf; 22, leaf section. 23-24, *A. megistospora*: 23, leaf; 24, basal cells. 25-26, *A. rothii* subsp. *rothii*: 25, leaf; 26, basal cells. 27, *A. rothii* subsp. *falcata*, leaf. 10 ( $\times 12$ ); 1, 11 ( $\times 20$ ); 2, 4, 6, 8, 12, 15, 17, 21, 23, 25, 27 ( $\times 30$ ); 3, 5, 7, 9, 13, 14, 16, 18, 19, 20, 22, 24, 26 ( $\times 160$ ).



- 6 Leaf margin entire; laminal cells smooth; perichaetial leaves convolute, broader than stem leaves; cladautoicous 7
- 7 Nerve (75-)100-125(-160)  $\mu\text{m}$  wide at base, with 5-8(-9) layers of cells; spores (18-) 24-32  $\mu\text{m}$  (fig. 6, 21-22) **A. frigida** Huebener  
Plants to 4 cm tall. Leaves lanceolate, margin often incurved; nerve in section biconvex. It is remarkable in the abundant perichaetia and pseudopodia along stem. Forms reddish brown turfs on seeping walls of acidic rocks, in the high mountains of the north and west of the Peninsula. Esp, Prt, And.
- 7 Nerve less than (90-)100  $\mu\text{m}$  wide at base, with up to 5(-6) layers of cells; spores more than 30  $\mu\text{m}$  8
- 8 Spores 50-80(100)  $\mu\text{m}$  (fig. 6, 23-24) **A. megistospora** B.M. Murray  
Plants 5-12(-15) mm tall. Leaves ovate,  $\pm$  abruptly narrowed to acute or slightly rounded apex, margin plane. Forms dense, brownish to blackish turfs on exposed, granitic rocks, in very wet rock crevices and in seeping sites, in montane areas of the northwestern part of the Peninsula. Esp, Prt.
- 8 Spores 30-56  $\mu\text{m}$ , rarely more than 45-50  $\mu\text{m}$  9
- 9 Inner perichaetial leaves smooth or with low papillae in the upper third at back; leaves not falcate or only slightly so, not or slightly fragile (fig. 6, 25-26)  
**A. rothii** F. Weber & D. Mohr subsp. **rothii**  
Forms dark brown to blackish turfs, 0,5-2,5 cm high, on wet, exposed, acidic rocks. Widely distributed in montane areas and high mountains of the Peninsula. Esp, Prt, And.
- 9 Inner perichaetial leaves densely papillose, with high papillae in the upper third at back; leaves strongly falcate, fragile (fig. 6, 27)  
**A. rothii** F. Weber & D. Mohr subsp. **falcata** (Schimp.) Lindb.  
Forms dark brown to blackish turfs, 0,5-2,5 cm high, on damp. acidic rocks and in seeping sites, rarely on slates. Widely distributed from the lowlands to montane areas of the Peninsula. Esp, Prt, And.



## CL. POLYTRICHOPSIDA

Protonema filamentous. Plants acrocarpous, usually large. Leaves with well-developed nerve, bearing green lamellae on the ventral surface. Seta long; capsule operculate; peristome single, with lingulate, non-articulate teeth, directed inwards and attached to an epiphragm.

### **O. Polytrichales** **Fam. Polytrichaceae**

#### **Atrichum** P. Beauv.

Plants to 6 cm tall. Leaves lingulate, ovate-lanceolate or triangular-lanceolate,  $\pm$  undulate, crisped when dry; nerve and lamina toothed at back, margin with unistratose or pluristratose border of narrow cells, strongly dentate; nerve with 3-7 lamellae on ventral surface, 2-9 cells high. Capsule cylindrical, straight or curved, inclined or horizontal; lid rostrate; peristome with 32 teeth, epiphragm present.

- 1 Leaves narrow, 0,4-0,8 mm wide; median cells to 20  $\mu$ m wide; 4-7 lamellae 6-9 cells high; dioicous (fig. 7, 1-2) **A. angustatum** (Brid.) Bruch & Schimp.

**A. angustatum** (Brid.) Bruch & Schimp. var. **rhystophyllum** (Müll.Hal.) Richards & Wallace  
Leaves  $\pm$  undulate, narrow, about 1 mm wide, lingulate or triangular-lanceolate, obtuse or acuminate, lamina toothed at back above, teeth often geminate, margin dentate in the upper half. Seta reddish or yellowish; capsule narrowly cylindrical, curved, straight or slightly inclined; spores 12-14  $\mu$ m. Forms lax turfs, to 3 cm high, on damp, shady, acidic slopes, in montane areas. Distributed in the north and west of the Peninsula. Esp, Prt.

- 1 Leaves more than 0,8 mm wide; median cells more than 20  $\mu$ m wide; 3-6 lamellae 3-7 cells high; monoicous 2

- 2 Seta terminal, 1 (2) per perichaetium, reddish; capsule inclined and curved (fig. 7, 3-6) **A. undulatum** (Hedw.) P. Beauv.

Leaves 1,5-2 mm wide, strongly undulate, lanceolate, lingulate, with acute or acuminate apex, lamina with acute teeth at back above, margin dentate to near base. Capsule cylindrical, curved, inclined to horizontal; spores 16-19  $\mu$ m. Forms lax turfs, to 6 cm high, on damp,

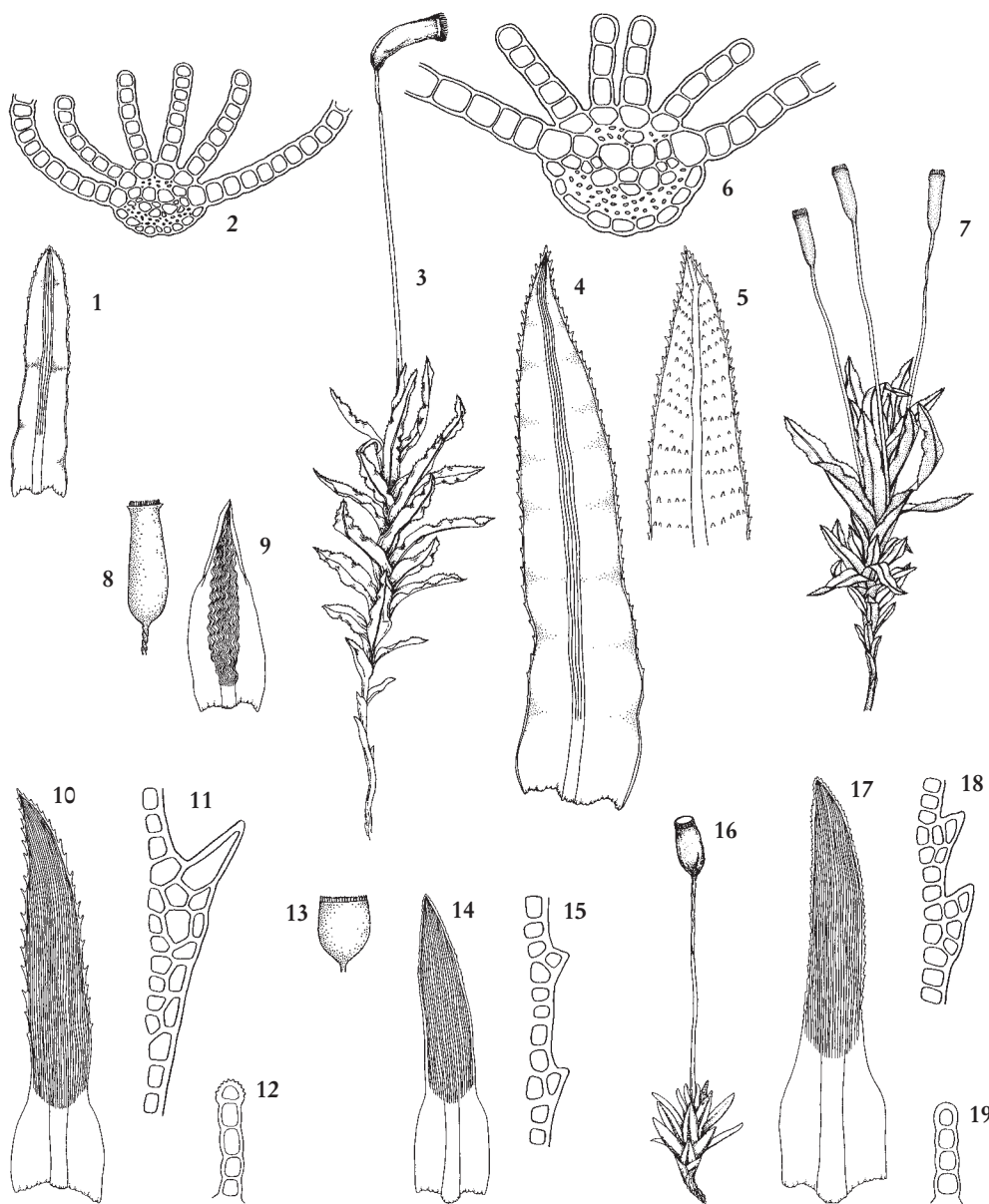


FIGURE 7. 1-2, *Atrichum angustatum*: 1, leaf; 2, nerve section. 3-6, *A. undulatum*: 3, habit; 4, leaf; 5, upper part of leaf, dorsal side; 6, nerve section. 7, *A. flavisetum*, habit. 8-9, *Oligotrichum hercynicum*: 8, capsule; 9, leaf. 10-12, *Pogonatum urnigerum*: 10, leaf; 11, leaf margin; 12, lamella section. 13-15, *P. nanum*: 13, capsule; 14, leaf; 15, leaf margin. 16-19, *P. aloides*: 16, habit; 17, leaf; 18, leaf margin; 19, lamella section. 3 ( $\times 2$ ); 7, 16 ( $\times 2,5$ ); 8, 13 ( $\times 5$ ); 1, 4, 5, 9, 10, 14, 17 ( $\times 10$ ); 2, 6, 11, 12, 15, 18, 19 ( $\times 200$ ).

shady, acidic slopes. Common in the lowlands and in the montane areas of the northern half and western part of the Peninsula. Esp, Prt, And.

- 2 Seta lateral, 2-3 per perichaetium, yellowish; capsule straight (fig. 7, 7)

**A. flavisetum** Mitt.

Plants to 2,5 cm tall. Leaves undulate, oblong linear or ovate, with acute or acuminate apex. Perichaetium persistent, several perichaetia per plant. Capsule very narrow; spores 17-18  $\mu\text{m}$ . Grows on wet, acidic slopes in the lowlands and montane areas. Rare, in the northeastern part of the Peninsula. Esp.

### **Oligotrichum** DC.

Plants to 5 cm high. Leaves erect, lanceolate from broad base, apex obtuse, cucullate, crisped and incurved when dry, margin crenulate; nerve broad, with 8-12 sinuose longitudinal lamellae on ventral side. Capsule ovoid to sub-cylindrical, without apophysis; peristome with 32 teeth, epiphragm present (fig. 7, 8-9)

**O. hercynicum** (Hedw.) Lam. & DC.

Forms dark green turfs or tufts on damp or seeping, acidic rocks and soils, in high mountains, in the Pyrenees and Cantabrian Mountains. Esp, And.

### **Pogonatum** P. Beauv.

Leaves lanceolate, with broad sheathing base, margin dentate; nerve broad, with numerous longitudinal lamellae on ventral surface. Capsule globose to cylindrical, without apophysis; calyptra densely hairy, covering part of the capsule or the whole; peristome with 32 teeth, epiphragm present.

- 1 Stem to 6 cm high, branched; nerve excurrent; lamellae with papillose apical cells (fig. 7, 10-12)

**P. urnigerum** (Hedw.) P. Beauv.

Plants glaucous. Leaf margin with acute teeth. Forms lax turfs on damp, shady, acidic or decalcified slopes, in high mountains and montane areas of the northern half of the Peninsula. Esp, Prt, And.

- 1 Stem to 2 cm high, unbranched; nerve not excurrent; lamellae with smooth apical cells

2

- 2 Leaves dentate in the upper third, with blunt teeth, mostly unicellular; 30-40 lamellae; capsule globose or ovoid, turbinate when empty (fig. 7, 13-15)

**P. nanum** (Hedw.) P. Beauv.

Plants dark green, 0,5-1 cm high. Exothelial cells smooth. When sterile is hard to distinguish from depauperate specimens of *P. aloides*. Forms lax turfs on damp slopes in the lowlands and montane areas, mainly in the north and west of the Peninsula. Esp, Prt.

- 2 Leaves dentate from near sheathing base, with sharp, pluricellular teeth; 40-60 lamellae; capsule oblong-cylindrical (fig. 7, 16-19)

**P. aloides** (Hedw.) P. Beauv.

Plants dark green, to 2 cm high. Exothelial cells mamillate. Protonema persistent. Forms lax turfs on damp, shady, acidic slopes. Common in montane areas of the Peninsula. Esp, Prt, And.

### **Polytrichastrum G.L. Sm.**

Plants medium-sized to robust, to 15 cm tall. Leaves spreading, lanceolate, with broad and sheathing base, lamina narrow, margin entire or dentate; nerve very broad, with numerous longitudinal lamellae on ventral surface. Capsule erect, inclined or horizontal, cylindrical, ovoid or prismatic, apophysis weakly or well differentiated, shallowly delimited from the urn, calyptra hairy covering part of the capsule, peristome with 64 teeth, epiphragm present.

For key to species see under *Polytrichum* below.

### **Polytrichum Hedw.**

Plants medium-sized to robust, to 30 cm tall. Leaves spreading to squarrose or reflexed, lanceolate, with broad and sheathing base and narrow lamina, margin entire or dentate; nerve very broad, with numerous longitudinal lamellae on ventral surface. Capsule inclined or horizontal, prismatic, 4-6 angled, apophysis well defined, sharply delimited from the urn by a basal constriction, calyptra densely hairy, covering the capsule; peristome with 64 teeth, epiphragm present.

### **Key to species of *Polytrichum* and *Polytrichastrum***

- |   |  |   |
|---|--|---|
| 1 | Upper leaf lamina broadly incurved; leaf margin entire   | 2 |
| 1 | Upper leaf lamina plane; leaf margin dentate   | 5 |
| 2 | Leaf apex cucullate; nerve percurrent or excurrent in apiculus (fig. 8, 1-2)   |   |
|   | <b>Polytrichastrum sexangulare</b> (Brid.) G.L. Sm.  |   |
|   | <b>Polytrichum sexangulare</b> Brid.   |   |
|   | Leaves erecto-patent, incurved at tips when dry; apical cells of lamellae ovate to pyriform in cross-section, smooth. Forms lax, dark green turfs, to 5 cm high, on damp soils, frequently on snow-beds, of the Pyrenees. Esp, And.  |   |
| 2 | Leaf apex not cucullate; nerve excurrent in a hyaline hair point or brownish arista  | 3 |
| 3 | Nerve excurrent in long, hyaline hair-point; nerve smooth at back (fig. 8, 3)  |   |
|   | <b>Polytrichum piliferum</b> Hedw.   |   |
|   | Arista dentate; apical cells of lamellae pyriform in cross-section, smooth. Capsule sharply 4-6 angled. Forms lax turfs, to 4 cm high, on sandy ledges and in rock crevices, in dry, exposed, acidic sites, from the lowlands to high mountains. Widespread throughout the Peninsula. Esp, Prt, And. |   |
| 3 | Nerve excurrent in short or long, brownish arista; nerve dentate at back   | 4 |
| 4 | Stem with dense and whitish tomentum <b>Polytrichum strictum</b> Menzies ex Brid.  |   |
|   | Leaves short, erect when dry. Apical cells of lamellae pyriform in cross-section, smooth. Forms compact turfs, to 10 cm high, on peaty soils. Scattered in Pyrenees and Cantabrian Mountains. Esp, And.  |   |

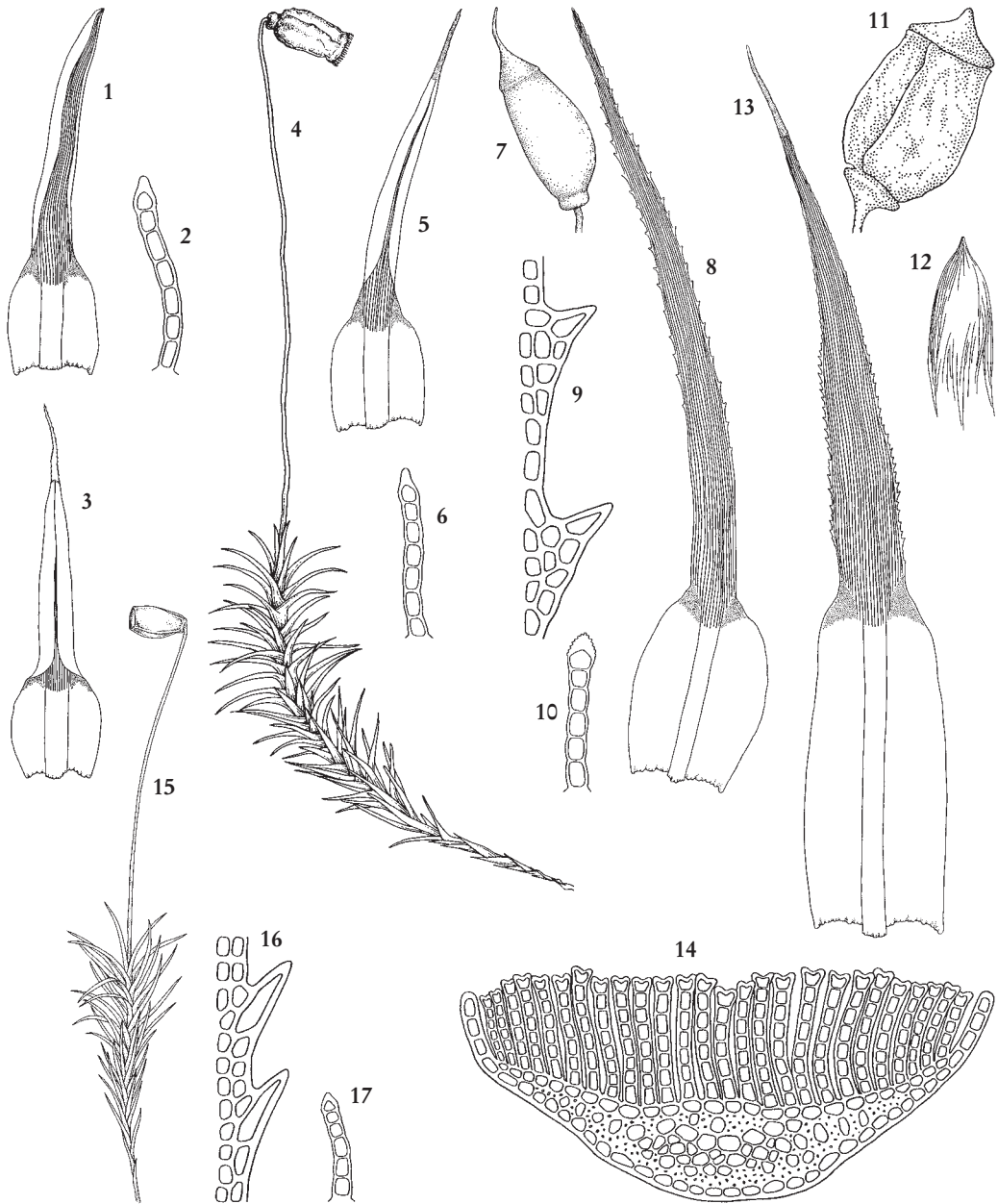


FIGURE 8. 1-2, *Polytrichastrum sexangulare*: 1, leaf; 2, lamella section. 3, *Polytrichum piliferum*, leaf. 4-6, *Polytrichum juniperinum*: 4, habit; 5, leaf; 6, lamella section. 7-10, *Polytrichastrum alpinum*: 7, capsule; 8, leaf; 9, leaf margin; 10, lamella section. 11-14, *Polytrichum commune*: 11, capsule; 12, calyptra; 13, leaf; 14, leaf section. 15-17, *Polytrichastrum formosum*: 15, habit; 16, leaf margin; 17, lamella section. 4, 15 ( $\times 1.8$ ); 7, 11 ( $\times 4$ ); 1, 3, 5, 8, 13 ( $\times 10$ ); 12 ( $\times 20$ ); 2, 6, 9, 10, 14, 16, 17 ( $\times 200$ ).

- 4 Stem not tomentose or with sparse brown tomentum (fig. 8, 4-6)

**Polytrichum juniperinum** Hedw.

Leaves long, spreading when dry. Apical cells of lamellae pyriform in cross-section, smooth. Forms extensive patches, to 8 cm high, on exposed, acidic soils and slopes, from the lowlands to the high mountains. Widespread in the Peninsula, rare in Mallorca. Esp, Prt, And, Bl.

- 5 Capsule cylindrical or ovoid; leaf margin with teeth of 1-3 cells; apical cells of lamellae ovate in cross section, strongly papillose (fig. 8, 7-10)

**Polytrichastrum alpinum** (Hedw.) G.L. Sm.

**Polytrichum alpinum** Hedw.

Stem to 10 cm high. Leaves erecto-patent to reflexed, margin strongly dentate. Capsule erect or inclined, asymmetrical. Calyptra not covering the whole of the capsule. Forms lax turfs on acidic, peaty soils, in rock crevices and on humus-rich slopes, in high mountains of the Peninsula. Esp, Prt, And.

- 5 Capsule prismatic; leaf margin with unicellular teeth; apical cells of lamellae ovate or spherical, flat or emarginate in cross-section, smooth or slightly papillose 6

- 6 Apical cells of lamellae flat or emarginate in cross-section (fig. 8, 11-14)

**Polytrichum commune** Hedw.

Plants to 30 cm tall. Leaves spreading to reflexed; apical cells of lamellae larger than other cells. Capsule sharply 4-6-angled. Forms lax turfs on damp, acidic or peaty soils, in montane areas and high mountains, in the north and west of the Peninsula. Sp, Prt, And.

var. **commune**: Stem to 30 cm high; apical cells of lamellae emarginate; inner perichaetial leaves shorter than stem leaves, toothed at apex.

var. **perigoniale** (Michx.) Hampe (*P. perigoniale* Michx.): Stem to 8 cm high; apical cells of lamellae irregularly emarginate or almost flat; inner perichaetial leaves colorless, longer than stem leaves, entire or slightly denticulate above, gradually subulate.

- 6 Apical cells of lamellae ovate or elliptical in cross-section 7

- 7 Leaf lamina with 5-15 rows of cells, 10-14 µm wide, at each side of nerve; median sheath cells 13-17 µm wide

**Polytrichastrum longisetum** (Sw. ex Brid.) G.L. Sm.

**Polytrichum longisetum** Sw. ex Brid.

Plants to 10-(15) cm tall. Nerve with up to 25-30 lamellae. Capsule erect, obscurely 5-6-angled. Forms dark green turfs, to 8 cm high, on peaty soils in high mountains. Very rare, in the Pyrenees. Esp. And.

- 7 Leaf lamina with 3-6 rows of cells, 9-12 µm wide, at each side of nerve (fig. 8, 15-17); median sheath cells 7-11 µm wide

**Polytrichastrum formosum** (Hedw.) G.L. Sm.

**Polytrichum formosum** Hedw.

Nerve with up to 70 lamellae. Capsule sharply (4)5-6-angled. Forms dark green turfs, 10-12 cm high, on slightly inclined slopes and damp, shady soils, in montane forests in the north and west of the Peninsula, very rare in the south where it is localized in Algeciras Mountains. Esp, Prt, And.

## CL. TETRAPHIDOPSIDA

Protonema filamentous; protonemal leaves persistent or not. Plants acrocarpous, small. Seta long; capsule operculate; peristome single, of 4 erect teeth.

### **O. Tetraphidales** **Fam. Tetraphidaceae**

#### **Tetraphis** Hedw.

Plants small, to 2 cm tall. Sterile stems ending in a cup of orbicular bracts containing numerous discoid gemmae. Leaves orbicular to ovate-lanceolate, acute, margin plane, entire; laminal cells hexagonal, 10-20  $\mu\text{m}$  wide, thick-walled; nerve ending below apex. Capsule exserted, cylindrical and smooth, straight; calyptra mitriform, plicate; peristome single, with 4 triangular teeth wide at base (fig. 9, 1-4)

**T. pellucida** Hedw.

Forms loose turfs on rotting fir and beech stumps, in the northern half of the Peninsula. Esp, And.

#### **Tetrodontium** Schwägr.

Plants minute, to 0,2 cm tall. Protonemal leaves persistent, linear, entire, 2-3-stratose. Stem leaves ovate to lanceolate, acuminate; cells rectangular, thick-walled, smooth; nerve thin and short or absent. Capsule exserted, ellipsoidal and smooth, straight; peristome single, of 4 triangular teeth wide at base; calyptra smooth (fig. 9, 5-6)

**T. brownianum** (Dicks.) Schwägr.

Grows in acidic caves and on damp, shaded, acidic rocks. Very rare, in the Basque Mountains. Esp.

## CL. BRYOPSIDA

Protonema filamentous. Plants acrocarpous or pleurocarpous, small to large. Seta long or short; capsule dehiscent opening by lid or indehiscent; peristome single or double, exostome with 16 simple or  $\pm$  divided, articulate teeth, sometimes peristome reduced or lacking.

### **O. Buxbaumiales**

#### **Fam. Buxbaumiaceae**

##### **Buxbaumia Hedw.**

Plants small. Stem and leaves minute, ciliate, ephemeral, nerveless. Perichaetial leaves ciliate. Seta long, straight, papillose; capsule inclined, ovoid, asymmetrical, larger than the plant. Protonema persistent.

- 1 Capsule shiny, brown, flattened on the upper surface; cuticle not peeling from back of capsule (fig. 9, 7) **B. aphylla** Hedw.  
Plants solitary or gregarious on humus-rich soils or rotting fir and beech stumps, in the Pyrenees. Esp.
- 1 Capsule dull, green or pale brown, scarcely flattened on the upper surface; cuticle splitting and peeling from back of mature capsule (fig. 9, 8) **B. viridis** (Moug. ex Lam. & DC) Brid. ex Moug. & Nestl.  
Plants solitary or gregarious on rotting fir and beech stumps, in the northeast of the Peninsula. Esp.

### **O. Diphysciales**

#### **Fam. Diphysciaceae**

##### **Diphyscium D. Mohr**

Plants small, green to blackish. Leaves lingulate, narrow, crisped when dry, apex obtuse, margin plane; lamina 2-3-stratose, cells isodiametric, mamilllose; nerve ending below apex.



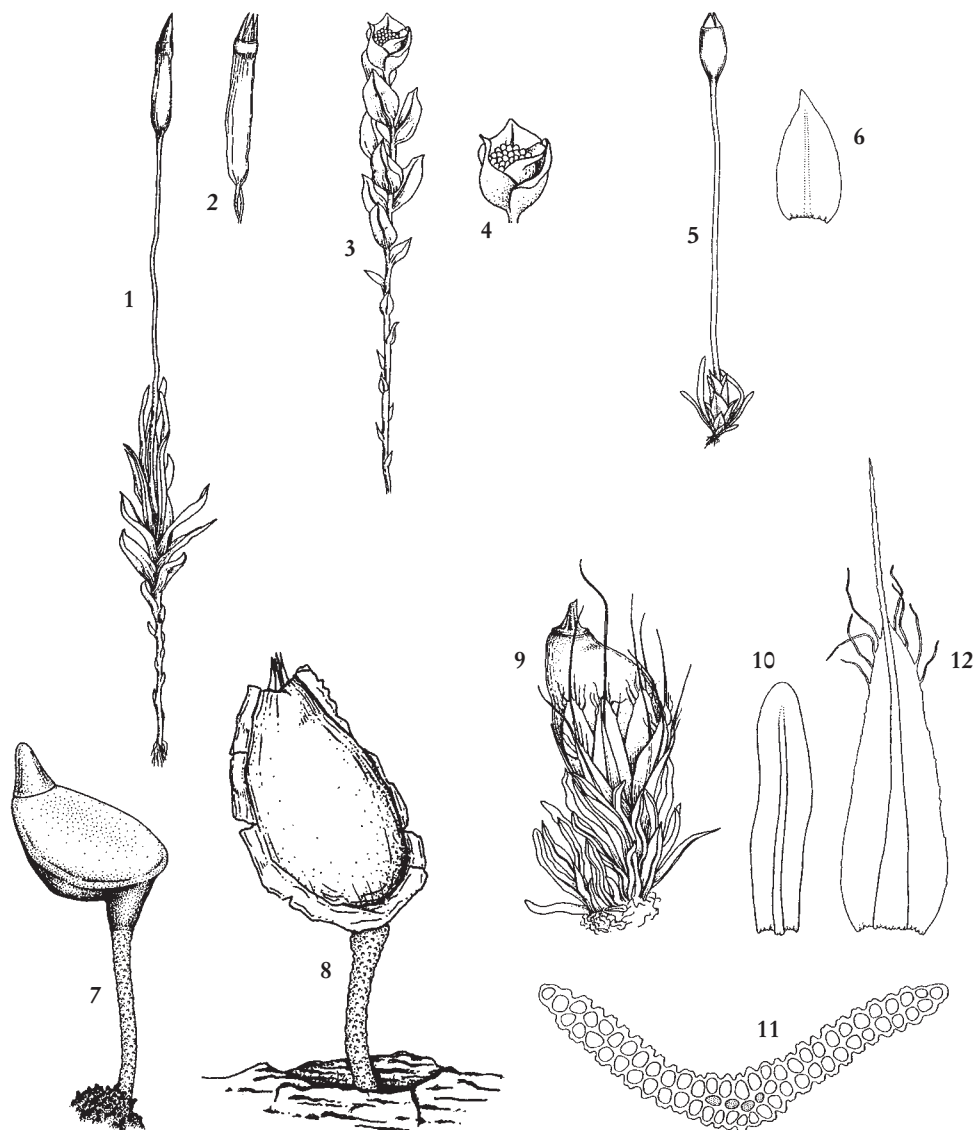


FIGURE 9. 1-4, *Tetraphis pellucida*: 1, habit, plant with sporophyte; 2, capsule; 3, habit, plant with gemmae; 4, gemma cup. 5-6, *Tetrodontium brownianum*: 5, habit; 6, leaf. 7, *Buxbaumia aphylla*, habit. 8, *Buxbaumia viridis*, habit. 9-12, *Diphyscium foliosum*: 9, habit; 10, leaf; 11, leaf section; 12, perichaetial leaf. 7, 8, 9 ( $\times 5$ ); 1, 3, 5 ( $\times 6$ ); 2, 4 ( $\times 10$ ); 6, 10, 12 ( $\times 15$ ); 11 ( $\times 150$ ).

Perichaetial leaves ciliate above; nerve excurrent. Seta smooth, very short; capsule immersed, ovoid, asymmetrical, large (fig. 9, 9-12)

**D. foliosum** (Hedw.) D. Mohr

Forms dense turfs on slopes and damp, shady and humus-rich soils in beechwoods, fir woods and oakwoods, mainly in montane areas. Distributed in northern half of the Peninsula. Esp, Prt.

## O. Timmiales

### Fam. Timmiaceae

#### *Timmia* Hedw.

Plants robust. Leaves lanceolate, widely sheathing at base, margin plane, dentate; median cells of lamina quadrate or hexagonal, mamilllose on ventral side, smooth at back, basal cells rectangular, long and narrow, papillose or smooth, narrower at margin; nerve percurrent, smooth at back, papillose or dentate in the upper part. Capsule ellipsoidal, inclined to pendulous, striate when dry; peristome double; calyptra cucullate.

- 1 Leaf sheath hyaline or light yellow; monoicous (fig. 10, 1) **T. bavarica** Hessel.

**T. megapolitana** Hedw. subsp. **bavarica** (Hessel.) Brassard

Median cells of lamina 7-10 µm wide, upper cells of sheath smooth. Forms lax turfs to 8 cm high, on soils and in calcareous rock crevices, in montane areas of the Peninsula and Mallorca. Esp, Bl.

- 1 Leaf sheath yellow to dark orange; dioicous 2

- 2 Leaves mostly caducous; back of sheath and of upper part of nerve strongly papillose (fig. 10, 2-4) **T. norvegica** J.E. Zetterst.

Plants about 3 cm tall. Forms turfs on wet, calcareous crevices and soil in high mountains. Rare, in the Pyrenees. Esp.

- 2 Leaves not caducous; back of nerve usually dentate (fig. 10, 5-6) **T. austriaca** Hedw.

Forms turfs to 10 cm high on stony soils and in calcareous rock crevices, from the lowlands to high mountains, in the northeastern part of the Peninsula. Esp.

## O. Encalyptales

### Fam. Encalyptaceae

#### *Encalypta* Hedw.

Plants small to medium-size, mainly on rocks or calcareous soils. Leaves lingulate, spatulate or oblong-lanceolate, erecto-patent, crisped when dry, margin plane or slightly recurved, incurved at apex; laminal cells hexagonal or quadrate, strongly papillose, obscure, basal cells rectangular, hyaline, smooth or papillose, with thickened transverse walls which are often reddish, forming an arch-shaped area, marginal cells narrower; nerve strong, percurrent or excurrent in apiculus or in hair-point. Capsule cylindrical, straight, smooth or finely striate; lid rostrate; calyptra cylindrical, campanulate, covering capsule, entire, erose or fringed; peristome single or double of 16 entire teeth, or rudimentary or absent.

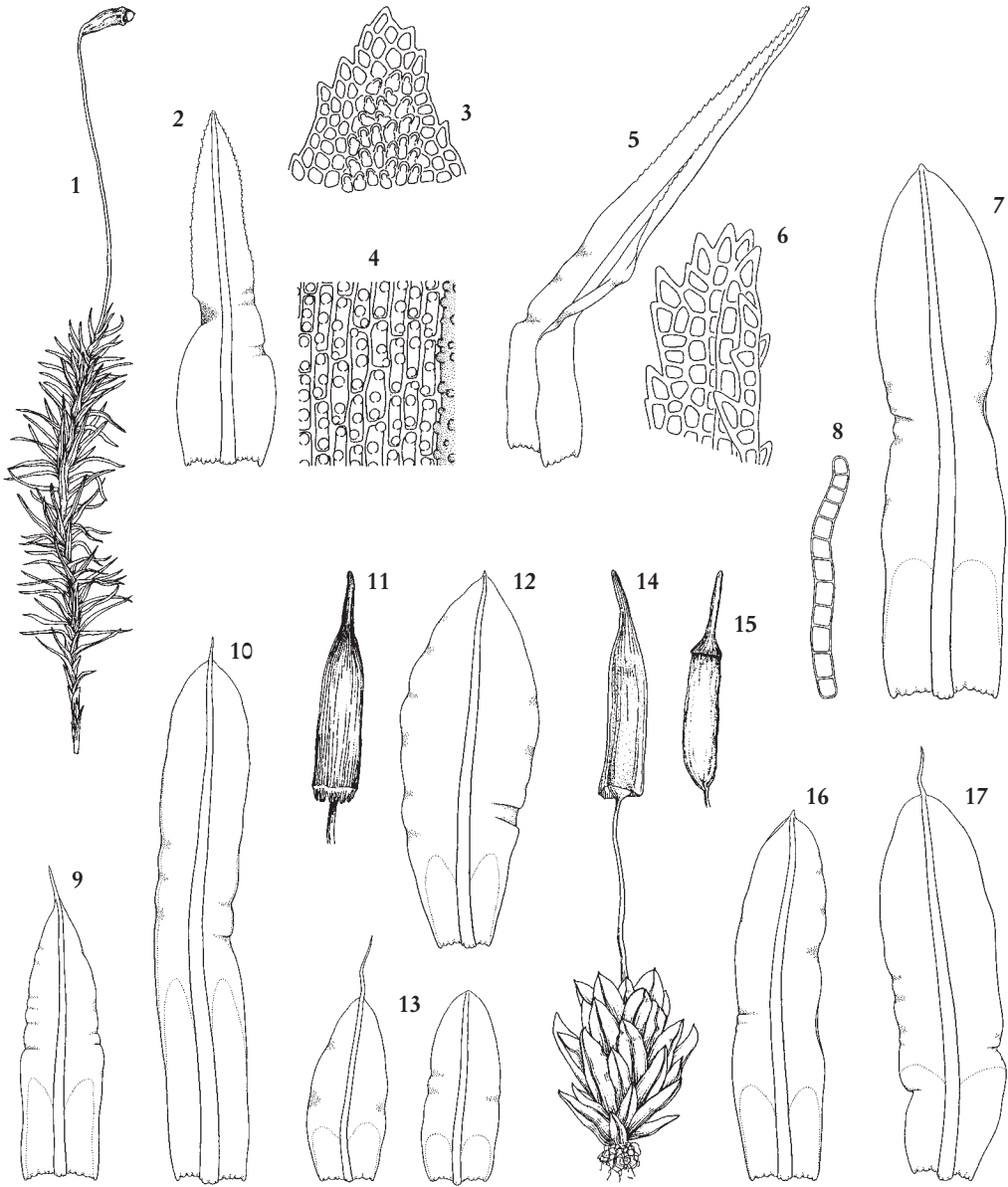


FIGURE 10. 1, *Timmia bavarica*, habit. 2-4, *T. norvegica*: 2, leaf; 3, leaf apex; 4, basal cells. 5-6, *T. austriaca*: 5, leaf; 6, leaf apex. 7-8, *Encalypta streptocarpa*: 7, leaf; 8, gemma. 9, *E. alpina*, leaf. 10, *E. affinis*, leaf. 11-12, *E. ciliata*: 11, calyptra; 12, leaf. 13, *E. rhaptocarpa*, leaves. 14-16, *E. vulgaris*: 14, habit; 15, capsule; 16, leaf. 17, *E. spathulata*, leaf. 1 ( $\times 1,8$ ); 11, 14, 15 ( $\times 6$ ); 2, 5, 7, 9, 10, 12, 13, 16, 17 ( $\times 14$ ); 8 ( $\times 90$ ); 3, 4, 6 ( $\times 200$ ).

- 1 Stem with abundant axillary filamentous gemmae (fig. 10, 7-8) **E. streptocarpa** Hedw.  
Leaves lingulate or spathulate, obtuse; nerve strong, percurrent: Capsule spirally striate; peristome double, spores smooth, 10-14  $\mu\text{m}$ . Rarely with sporophytes. Forms dense turfs, 2-3 cm high, in rock crevices and on damp, calcareous slopes, from the lowlands to high mountains. Widespread in the north and east of the Peninsula, scattered in the south and west and in Mallorca. Esp, Prt, And, Bl.
- 1 Stem without axillary filamentous gemmae 2
- 2 Leaves oblong-lanceolate, gradually tapering to acute apex (fig. 10, 9) **E. alpina** Sm.  
Stem 2 cm high. Leaves with plane and denticulate margin; nerve stout, excurrent. Peristome lacking; spores 28-40  $\mu\text{m}$ . Forms lax turfs in calcareous rock crevices, in montane areas and high mountains in the north of the Peninsula. Esp.
- 2 Leaves lingulate, abruptly tapering to obtuse apex 3
- 3 Basal leaf cells papillose on the dorsal surface (fig. 10, 10) **E. affinis** R. Hedw.  
Nerve excurrent. Peristome double. Forms lax turfs, to 2 cm high, in calcareous rock crevices, in montane areas and high mountains, in the northeastern part of the Peninsula. Esp.
- 3 Basal leaf cells smooth 4
- 4 Calyptra fringed; spores radially ridged 5
- 4 Calyptra entire or erose; spores with large papillae 6
- 5 Capsule contracted below mouth; peristome single, short; leaf margin narrowly recurved in the lower half; nerve excurrent in apiculus or percurrent; calyptra beak more than 1/3 of the calyptra length (fig. 10, 11-12) **E. ciliata** Hedw.  
Leaves spathulate or ovate, apiculate. Peristome single; spores 30-38  $\mu\text{m}$ . Plants solitary or forming lax turfs, to 2 cm high, on soils and rocks in montane areas and high mountains, in the northern half of the Peninsula. Esp, Prt, And.
- 5 Capsule contracted at the mouth; peristome rudimentary or lacking; leaf margin plane; nerve percurrent; calyptra beak 1/4 of the calyptra length **E. microstoma** Bals.-Criv. & De Not.  
Forms lax turfs on dry, calcareous rocks, in montane areas and high mountains. Scattered in the northeastern part of the Peninsula and in Sierra Nevada. Esp.
- 6 Peristome single; capsule longitudinally striate (fig. 10, 13) **E. rhaptocarpa** Schwägr.  
Leaf margin plane or recurved near base, inflexed above; nerve excurrent in hair point or percurrent. Spores 34-50  $\mu\text{m}$ . Forms turfs on earthy ledges in montane areas and high mountains in the north of the Peninsula, sporadic in the southeast. Esp, And.
- 6 Peristome lacking or rudimentary; capsule smooth or  $\pm$  striate 7
- 7 Nerve percurrent or excurrent in apiculus or short hair-point; calyptra entire or  $\pm$  erose; peristome lacking or rudimentary (fig. 10, 14-16) **E. vulgaris** Hedw.

Stem 0,5-1,5 cm high. Leaves lingulate or spatulate, acute or obtuse; nerve very stout at back. Calyptra apex scabrous. Spores papillose, 30-45 µm. Forms turfs on dry, calcareous rocks and soils, from the lowlands to high mountains. Widespread throughout the Peninsula and in Mallorca. Esp, Prt, And, Bl.

- 7 Nerve percurrent, in upper leaves excurrent in long hair-point; calyptra glossy, more or less erose; peristome lacking (fig. 10, 17) **E. spathulata** Müll.Hal.

Leaves lingulate to spatulate. Capsule slightly striate. Grows on rocks and calcareous soils in montane areas and high mountains, in the eastern part of the Peninsula, scattered in the northwest and south of the Peninsula and in Mallorca. Esp, Bl.

## O. Funariales Fam. Funariaceae

### Entosthodon Schwägr.

Plants small, 0,5(-1) cm tall. Leaves mostly concave, upper leaves larger and crowded in rosette at stem apex; laminal cells longly polygonal, more than 20 µm wide, thin-walled, marginal cells narrower, differentiated or not; nerve ending below apex to excurrent. Seta long; capsule pyriform, symmetrical or asymmetrical, often with long neck; peristome lacking, single or double; calyptra mitriform or cucullate.

- 1 Capsule strongly or weakly inclined, asymmetrical, mouth oblique; peristome double, with more or less sigmoid teeth 2
- 1 Capsules straight, symmetrical or nearly so, mouth transverse; peristome double or single, with non-sigmoid teeth, or lacking 5
- 2 Leaves entire or slightly sinuose, longly pointed; lid conical (fig. 11, 5-7)

**E. pulchellus** (H. Philib.) Brugués

**Funaria pulchella** H. Philib.

Plants to 0,5 cm tall. Leaves oblong to obovate, acuminate, gradually tapered to a slender point up to 450 µm long; apical cell to 280 µm long; nerve usually ceasing well below the tip. Neck up to half of the capsule length. Forms small patches or individual yellowish green plants on calcareous soils. Common in montane areas, also occurs in the lowlands of the Peninsula, Mallorca and Menorca. Esp, Prt, Bl.

- 2 Leaves toothed, shortly or longly pointed; lid conical or convex 3
- 3 Leaves shortly pointed; lid convex (fig. 11, 8-10) **E. convexus** (Spruce) Brugués

**Funaria convexus** Spruce

Plants to 0,6 cm tall. Leaves obovate with broad apex abruptly contracted to a very short point to 150 µm long, margin dentate above; apical cell to 120 µm long; nerve ceasing well below the tip. Neck nearly half of capsule length. Grows on soil banks, rock ledges and crevices in exposed places on acidic or basic substrata, mainly in the lowlands of the Mediterranean region of the Peninsula, Mallorca and Menorca. Esp, Prt, Bl.

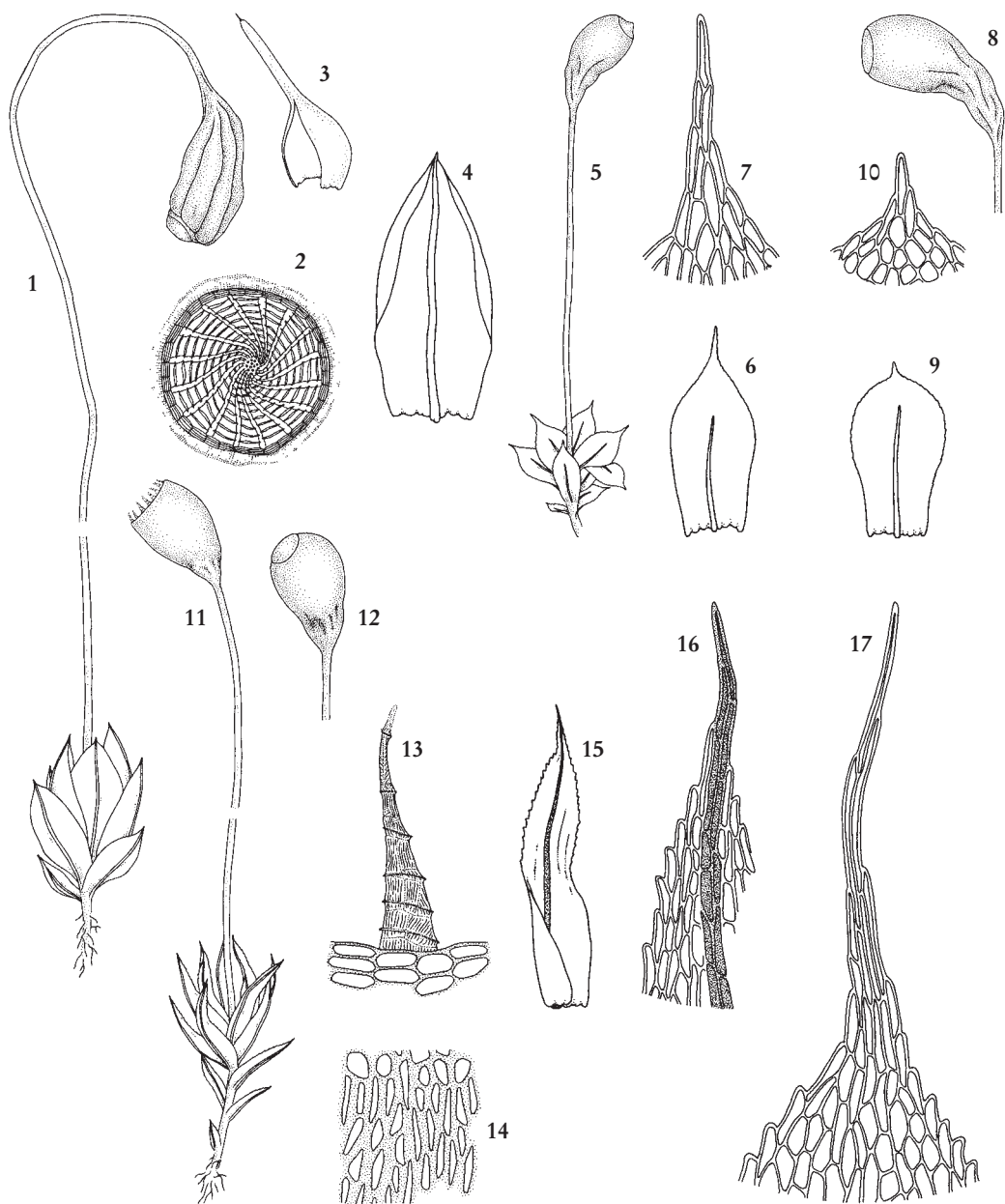


FIGURE 11. 1-4, *Funaria hygrometrica*: 1, habit; 2, capsule mouth and peristome; 3, calyptra; 4, leaf. 5-7, *Entosthodon pulchellus*: 5, habit; 6, leaf; 7, leaf apex. 8-10, *E. convexus*: 8, capsule; 9, leaf; 10, leaf apex. 11-16, *E. schimperi*: 11, habit; 12, capsule; 13, peristome tooth; 14, exothecial cells; 15, leaf; 16, leaf apex. 17, *E. muhlenbergii*, leaf apex. 1, 3, 5, 8, 11, 12 ( $\times 7$ ); 4, 6, 9, 15 ( $\times 14$ ); 2 ( $\times 30$ ); 7, 10, 16, 17 ( $\times 80$ ); 13, 14 ( $\times 120$ ).

- 3 Leaves longly pointed; lid conical or convex 4
- 4 Leaf apices gradually tapering; nerve excurrent; lid convex (fig. 11, 11-16)  
**E. schimperi** Brugués  
**Funaria algieriensis** Lindb., **F. durieui** Schimp.  
 Plants to 0,5 cm tall. Leaves ovate-lanceolate or oblong-lanceolate, strongly toothed in upper 2/3; nerve conspicuous, 80 µm wide near base, excurrent in arista to 450 µm long. Capsule weakly inclined, neck to 1/3 length of capsule; lid convex or occasionally plane. Grows on dry and exposed soils in low calcareous mountains of the south of the Peninsula. Esp, Prt.
- 4 Leaf apices suddenly contracted; nerve ceasing below apex; lid conical (fig. 11, 17)  
**E. muhlenbergii** (Turner) Fife  
 Plants to 0,5 cm tall. Leaves obovate to oblong, fairly slender acuminate, rather suddenly contracted to a long point, up to 700 µm long; apical cell to 400 µm long. Neck nearly half of the total capsule length. Forms yellowish green patches on ledges or crevices of calcareous rocks at high altitudes. Scattered in the north, east and southeast of the Peninsula. Esp.
- 5 Exothelial cells isodiametric to shortly oblong; mouth less than the diameter of the moist capsule 6
- 5 Exothelial cells linear-oblong to oblong; mouth equal the diameter of the moist capsule 7
- 6 Nerve ending in or below apex (fig. 12, 1-4) **E. fascicularis** (Hedw.) Müll.Hal.  
**Funaria fascicularis** (Hedw.) Lindb.  
 Plants to 0,5 cm tall. Leaves oblong-lanceolate, acuminate, toothed; marginal cells narrower forming 1-2 rows. Seta 5-7 mm long; capsule pyriform with short distinct neck, exothelial cells with thickened walls. Small patches or scattered plants usually on damp acidic soils, in arable fields and stream sides in the lowlands, in the north and southwest of the Peninsula. Esp, Prt.
- 6 Nerve excurrent (fig. 12, 5-11) **E. mouretii** (Corb.) Jelenc  
**Funaria mouretii** Corb.  
 Plants to 0,5 cm tall. Leaves oblong-lanceolate or oblong-obovate, acuminate, toothed to middle of leaf with projecting cells; marginal cells scarcely differentiated; nerve excurrent in a long yellow or reddish arista, up to 0,5 mm long. Spores 23-28 µm. Occurs at the margins of periodically waterlogged depressions, on acidic soils in the northeast of the Peninsula. Esp.
- 7 Leaves distinctly bordered, with 2-3 rows of narrow, incrassate, yellowish cells (fig. 12, 12-13)  
**E. obtusus** (Hedw.) Lindb.  
**Funaria obtusa** (Hedw.) Lindb.  
 Plants to 0,4 cm tall. Leaves oblong-lanceolate, acuminate, margin entire or slightly denticulate; nerve ending below apex. Seta to 6 mm long; capsule small, pyriform; lid convex; peristome rudimentary or absent. Forms small loose patches on shady and humid banks within holm oak and beech forest, on peat soils in grasslands or headlands. Fairly common in the north and the west of the Peninsula and in Menorca. Esp, Prt, Bl.
- 7 Leaves not bordered with incrassate cells 8

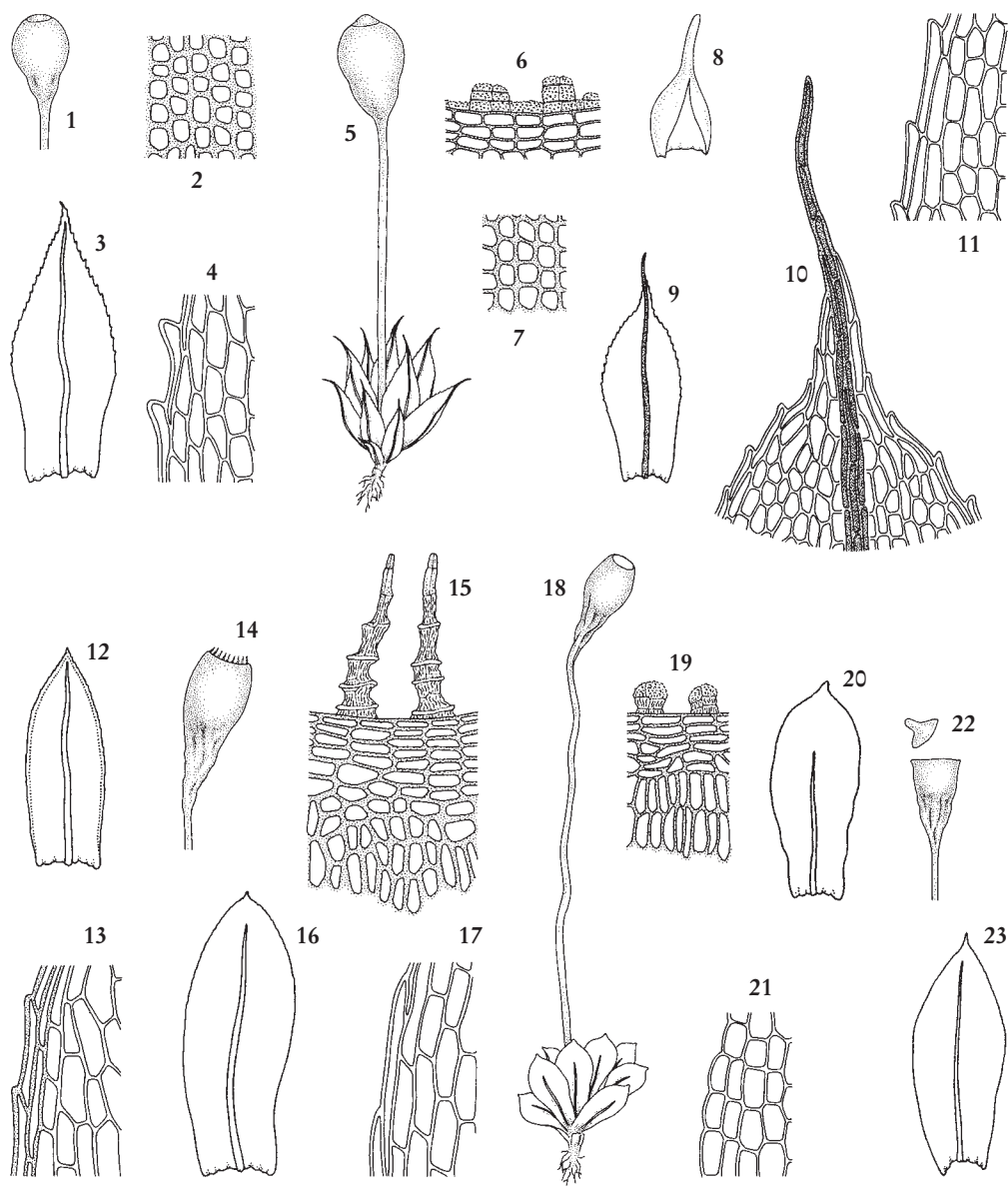


FIGURE 12. 1-4, *Entosthodon fascicularis*: 1, capsule; 2, exothecial cells; 3, leaf; 4, marginal cells. 5-11, *E. mouretii*: 5, habit; 6, peristome; 7, exothecial cells; 8, calyptra; 9, leaf; 10, leaf apex; 11, marginal cells. 12-13, *E. obtusus*: 12, leaf; 13, marginal cells. 14-17, *E. attenuatus*: 14, capsule; 15, peristome; 16, leaf; 17, marginal cells. 18-21, *E. durieui*: 18, habit; 19, peristome; 20, leaf; 21, marginal cells. 22-23, *E. hungaricus*: 22, capsule and lid; 23, leaf. 1, 5, 8, 14, 18, 22 ( $\times 7$ ); 3, 9, 12, 16, 20, 23 ( $\times 14$ ); 10 ( $\times 80$ ); 2, 4, 6, 7, 11, 13, 15, 17, 19, 21 ( $\times 120$ ).



- 8 Peristome present, with well-developed teeth; rhizoids bright to dark purple (fig. 12, 14-17) **E. attenuatus** (Dicks.) Bryhn

**Funaria attenuata** (Dicks.) Lindb.

Plants 0,3-0,5 cm tall. Leaves obovate or oblong, narrowed into short point, margin entire or almost so, with 1-2 rows of narrow elongated cells but not forming a distinct border; nerve ending in or below apex. Capsule narrowly oblong-pyriform with long neck, half of the capsule length; peristome teeth straight, to 180  $\mu$ m high. Scattered or tufted plants on moist acidic soils by streams, in rock crevices and on rock ledges, in the lowlands and montane areas of the north and west of the Peninsula and in Mallorca and Menorca. Esp, Prt, Bl.

- 8 Peristome absent or rudimentary; rhizoids brown 9

- 9 Leaves elliptical to obovate or spatulate, acute to obtuse; mouth equalling the diameter of the dry capsule (fig. 12, 18-21) **E. duriei** Mont.

**E. mustaphae** Trab., **E. physcomitroides** Casares-Gil & Beltrán, **E. pallescens** Jur.

Plants 0,3-0,4 cm tall, light to yellow green, soft. Leaf margin entire. Seta 4-8 mm long; capsule pyriform, neck as long as urn; lid convex; mature calyptra mitriform. Forms small patches on calcareous rocks and artificial walls. Scattered localities in the peninsular Mediterranean region, as well as in Mallorca and Menorca. Esp, Bl.

- 9 Leaves oblong to obovate-lanceolate, acuminate; mouth diameter larger than the dry capsule diameter (fig. 12, 22-23) **E. hungaricus** (Boros) Loeske

**E. maroccanus** (Meyl.) Hébr. & Lo Giudice, **Funaria hungarica** Boros,

**Physcomitrium maroccanum** Meyl.

Plants 0,3-0,4 cm tall. Leaf margin entire or faintly denticulate. Seta 3-4 mm long; capsule pyriform or ovate, with long neck; lid with a short, blunt apiculus; calyptra mitriform. Grows on temporarily wet clayey ledges in calcareous areas or on gypsum and arid soils, in the eastern half of the Peninsula. Esp.

### **Funaria** Hedw.

Plants to 3 cm tall. Leaves widely ovate-lanceolate, concave; laminal cells hexagonal or rectangular, 30-50  $\mu$ m wide, thin-walled, marginal cells a little narrower; nerve ending in or below apex. Seta long, flexuose, cygneous; capsule pyriform, asymmetrical, sulcate, deeply furrowed when dry, annulus of large cells, revoluble, curved outwards after dehiscence; peristome double, exostome teeth strongly sigmoid and fused at apices; calyptra cucullate, rarely mitriform (fig. 11, 1-4) **F. hygrometrica** Hedw.

Forms yellowish green or green patches or scattered plants on disturbed or cultivated soils, can be abundant after fires. Widespread throughout the territory, mainly in the lowlands of the Peninsula, Mallorca, Menorca and Pithyusic Islands. Esp, Prt, And, Bl.

### **Funariella** Sérgio

Plants small, to 0,5 cm tall. Leaves oblong-obovate to spatulate, acuminate, dentate near apex; cells rectangular, 25  $\mu$ m wide or more, thin-walled; nerve ending in the apex. Seta 1,2-2 mm long, curved, as long as the capsule; capsule pyriform, symmetrical, inclined to pendulous before dehiscence, erect when mature, with distinct neck, mouth

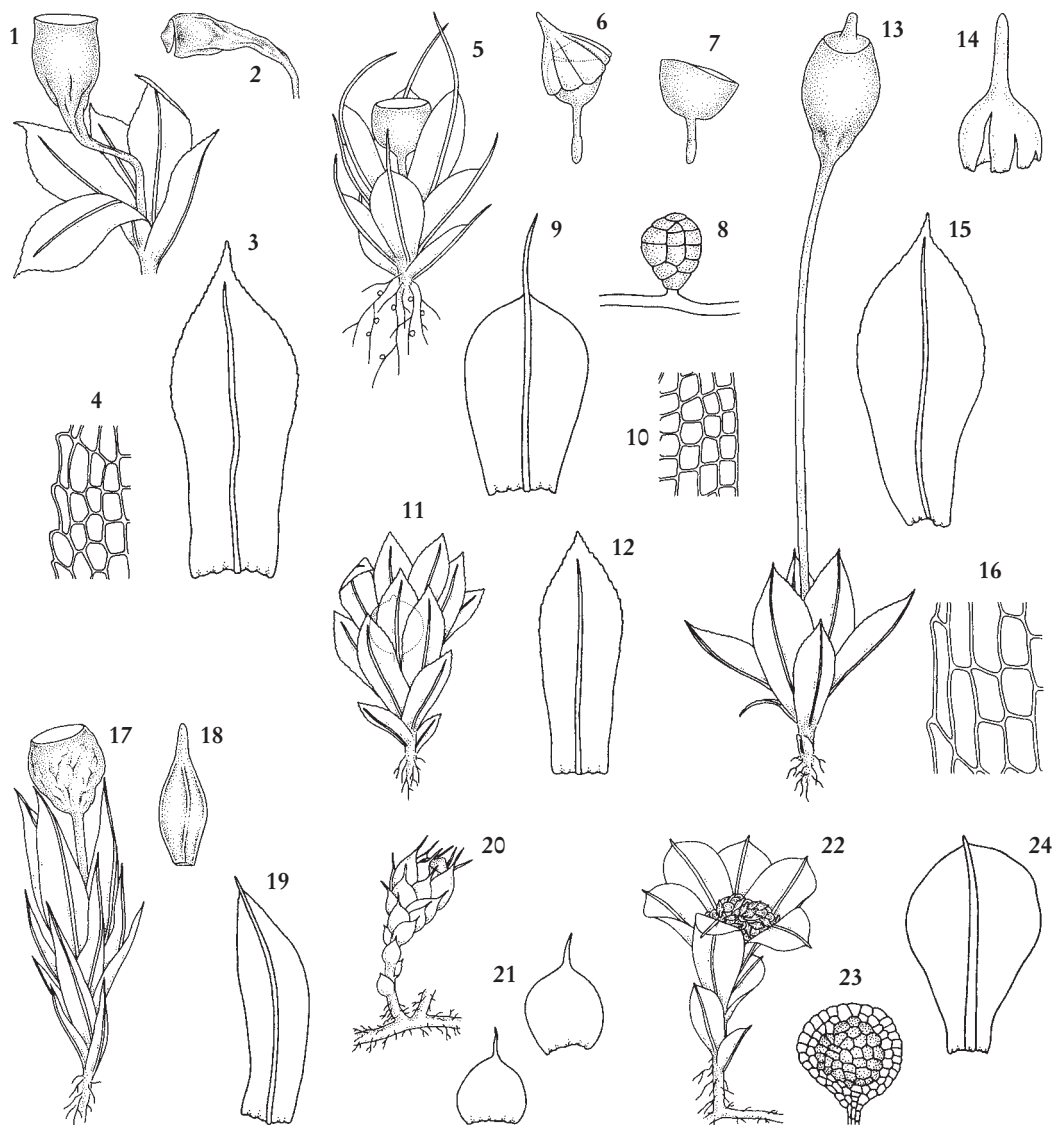


FIGURE 13. 1-4, *Funariella curviseta*: 1, habit; 2, capsule when dry; 3, leaf; 4, marginal cells. 5-10, *Goniomitrium seroi*: 5, habit; 6, capsule with calyptra; 7, mature capsule; 8, rhizoidal gemma; 9, leaf; 10, marginal cells. 11-12, *Physcomitrella patens*: 11, habit; 12, leaf. 13-16, *Physcomitrium pyriforme*: 13, habit; 14, calyptra; 15, leaf; 16, marginal cells. 17-19, *Pyramidula tetragona*: 17, habit; 18, calyptra; 19, leaf. 20-21, *Gigaspermum mouretii*: 20, habit; 21, leaves. 22-24, *Oedipodiella australis*: 22, habit; 23, gemma; 24, leaf. 1, 2, 5, 6, 7, 11, 13, 14, 17, 18, 20, 22 ( $\times 8.5$ ); 3, 9, 12, 15, 19, 21, 24 ( $\times 14$ ); 23 ( $\times 55$ ); 8 ( $\times 85$ ); 4, 10, 16 ( $\times 120$ ).

equalling the diameter of the moist capsule; peristome lacking; spores reticulate (fig. 13, 1-4)

**F. curviseta** (Schwägr.) Sérgio

**Entosthodon curvisetus** (Schwägr.) Müll.Hal., **Funaria curviseta** (Schwägr.) Milde

Occurs in clefts and crevices of calcareous rocks on wet sites with maritime influence. Distributed in the southern half of the Peninsula, being quite frequent in the west, as well as in Mallorca, Menorca and the Pityusic Islands. Esp, Prt, Bl.

### **Goniomitrium** Hook.f. & Wilson

Plants small, to 0,4 cm tall, rhizoidal gemmae present. Leaves crowded, larger above, obovate to spatulate; laminal cells large, 20-25 µm wide, quadrate or rhomboidal, smooth, thin-walled; nerve long-excurrent. Seta 0,3-0,5 mm long; capsule emergent, operculate, turbinate, with broad mouth; peristome absent; calyptra mitriform, bearing 8 radial pleats; spores ovoid to elliptical, 40-55 µm, reddish-brown (fig. 13, 5-10)

**G. seroi** Casas

Forms small patches on soil in brushwood and in sandstone crevices. Very rare, in the east and southeast of the Peninsula. Esp.

### **Physcomitrella** Bruch & Schimp.

Plants light green or yellowish, to 0,3 cm tall. Leaves oblong-lanceolate to obovate, acute, denticulate in the upper half or less; cells 15-20 µm wide, rhomboidal or rectangular, thin-walled, often narrower at margin; nerve ending below apex. Seta short, about 0,2 mm long; capsule cleistocarpous, immersed, globose, bluntly apiculate, with thin-walled exothecial cells, wholly surrounded by perichaetial leaves; calyptra very small, conic-mitriform; spores spinose (fig. 13, 11-12)

**P. patens** (Hedw.) Bruch & Schimp.

**Aphanorrhegma patens** (Hedw.) Lindb.

Solitary to gregarious plants on damp soil in places subject to flooding. Scattered in the north and northeast of the Peninsula. Esp.

### **Physcomitrium** (Brid.) Brid.

Plants to 0,5 cm tall. Leaves ovate-lanceolate, oblong-lanceolate or spatulate, acuminate, margin toothed above; laminal cells 25-28 µm long, rectangular, thin-walled, marginal somewhat narrower; nerve ending near the apex. Seta 5-15 mm; capsule globose to pyriform, narrowed at mouth, with short distinct neck, exothecial cells irregular, quadrate, hexagonal or short rectangular, thin walled; lid apiculate or rostellate; peristome absent; calyptra mitriform; spores spinose (fig. 13, 13-16)

**P. pyriforme** (Hedw.) Hampe

Forms small turfs or scattered stem on moist, usually acidic soils in cultivated fields and on stream banks, in the northern half of the Peninsula. Esp, Prt.

### **Pyramidula** Brid.

Plants pale green, small, about 0,5 cm tall. Leaves ovate or oblong-ovate; nerve excurrent. Seta 1-1,5 mm long; capsule exserted, operculate, ovoid or pyriform, with short

neck, irregularly sulcate when dry and empty; peristome lacking; calyptra cucullate, inflated, 4-angled; spores ovoid to elliptical, 50-60  $\mu\text{m}$  (fig. 13, 17-19)

***P. tetragona*** (Brid.) Brid.

***P. algeriensis*** Chud. & Douin

Solitary plants or forming patches on temporarily moist soil in fields of several southern Spanish localities. Esp.

## Fam. Gigaspermaceae

### *Gigaspermum* Lindb.

Plants small, pale green or glaucous, branches short, 2,5-5(-8) mm high, erect, arising from a leafless, branching, yellowish subterranean rhizome. Leaves distant, concave, orbicular, abruptly apiculate; laminal cells hexagonal, lax, smooth, 20-30  $\mu\text{m}$  wide; nerve lacking. Perichaetial leaves large, concealing sporophyte. Seta very short; capsule immersed, turbinate; peristome lacking; spores reddish brown, to 130  $\mu\text{m}$  (fig. 13, 20-21)

***G. mouretii*** Corb.

Forms loose turfs on dry rocky soils, in the lowlands in the south of the Peninsula, Mallorca and Pithyusic Islands. Esp, Bl.

### *Oedipodiella* Dixon

Plants small, branches erect, 0,3-0,5 cm high, arising from a leafless, branching, yellowish subterranean rhizome. Leaves crowded above, obovate to spatulate, apex rounded, abruptly apiculate, margin entire; laminal cells rounded or hexagonal, smooth, 25-30  $\mu\text{m}$  wide; nerve excurrent. Gemmae lenticular, produced at stem apex and borne in a rosette of upper leaves. Sterile (fig. 13, 22-24)

***O. australis*** (Wager & Dixon) Dixon

***O. australis*** (Wager & Dixon) Dixon var. ***catalaunica*** P. de la Varde

Scattered or loosely caespitose, on small ledges and in rock and wall crevices, in the lowlands and montane areas of the northeast of the Peninsula. Esp.

## *O. Grimmiales*

### Fam. Grimmiaceae

### *Coscinodon* Spreng.

Leaves lanceolate, keeled above, margin plane, entire, longitudinally plicate on both sides of nerve or not, upper leaves with long or short, smooth or slightly denticulate hyaline point, flat at base, decurrent down margin; lamina unistratose or bistratose, partially bistratose at apex, median cells quadrate, smooth, basal cells rectangular. Capsule partially immersed, calyptra enveloping capsule, campanulate, plicate; columella persistent, not attached to lid; peristome with 16 perforated teeth

- 1 Leaves with longitudinal plicae on both sides of nerve; hyaline point usually longer than 0,5 mm (fig. 14, 1-4) **C. cribrus** (Hedw.) Spruce

Leaves ovate-lanceolate, bistratose, partially bistratose at apex; basal cells towards nerve rectangular, slightly differentiated from the rest of basal cells. Forms dense turfs, 0,5-1 cm high, on exposed, granitic or schistose rocks in montane areas and high mountains, mainly in the northeast and southwest of the Peninsula. Esp, Prt, And.

When sterile may be confused with *Grimmia caespiticia* since both species have plicate leaves, but the latter has prominent laminal cells and the peristome teeth not perforated or slightly so.

- 1 Leaves without longitudinal plicae on both sides of nerve; hyaline point shorter than 0,5 mm (fig. 14, 5-6) **C. humilis** Milde

**C. cribrus** (Hedw.) Spruce var. **humilis** (Milde) Roth

Leaves lanceolate to narrowly lanceolate, unistratose or occasionally bistratose at apex; basal cells towards nerve rectangular, longer and narrower than the other basal cells, hyaline. Forms dense turfs to 0,6 cm high at base of acidic rocks. Rare in the central Pyrenees. Esp.

### **Grimmia** Hedw.

Plants small to robust, mostly forming cushions or turfs, whitish above, dark below. Leaves usually with hyaline point, upper lamina 1-3-stratose; upper cells rounded or quadrate, papillose or not, basal cells linear to rectangular, cells towards nerve often sinuose. Seta short or long, straight or curved; capsule immersed to exserted, ovoid, oblong-ovoid or ellipsoidal, symmetrical, rarely gibbous at base, smooth or striate; calyptra mitriform or cucullate; columella persistent; peristome teeth 16, entire or divided, rarely peristome lacking. Species saxicolous, mostly on acidic rocks, rarely on basic substrata.

- 1 Leaves without hyaline point 2
- 1 Leaves, at least perichaetial leaves, with hyaline point (*G. anodon*, *G. elatior*, *G. dissimulata* and *G. longirostris* sometimes have no hyaline points) 5

- 2 Leaves broadly ovate, strongly concave (fig. 14, 7) **G. mollis** Bruch & Schimp.  
**Hydrogrimmia mollis** (Bruch & Schimp.) Loeske

Leaf apex obtuse, margin entire, plane or incurved; laminal cells quadrate, smooth, basal cells shortly rectangular, wider, smooth; nerve long, to near apex. Forms lax, dark green to blackish cushions, 2-3 cm high, on damp, siliceous rocks, in the high mountains of the Pyrenees and Sierra Nevada. Esp, And.

- 2 Leaves lanceolate to ovate-lanceolate, concave or plane 3
- 3 Plants robust, pendulous; nerve on dorsal side with one deep furrow flanked by 2 wings (fig. 14, 8-9) **G. ramondii** (Lam. & DC.) Margad.

**Drytodon patens** (Hedw.) Brid.

Stem 10 cm long or longer, often with curved branches. Leaves dark green, patent, appressed when dry, long, lanceolate, carinate, with broad base, apex acute, denticulate or smooth, rarely with hyaline point, margin bistratose, recurved; lamina unistratose or partially bistratose, laminal cells irregularly quadrate, basal cells linear, sinuose, smooth; nerve stout, prominent, ending below apex. Seta long, curved; capsule elliptical, smooth, striate when old. Forms loose,

dark green turfs, blackish below, on vertical, shady, wet, granitic rocks, in montane areas and high mountains, mainly in the northern half of the Peninsula. Esp, Prt, And.

- 3 Plants small to medium-sized, erect; nerve on dorsal side without one deep furrow flanked by 2 wings 4
- 4 Leaf margin recurved at base, plane in the upper part; leaf apex acute or acuminate (fig. 14, 10-11) **G. atrata** Miel. ex Hornsch.  
Leaves lanceolate, obtuse, carinate at apex, flexuose or upper leaves twisted when dry; median cells 9 µm wide, basal cells beside nerve sinuose, alar group 2-3-stratose, of inflated, reddish cells. Seta curved; capsule exserted, symmetrical. Forms compact, dark green to blackish cushions, to 2,5 cm high, on acidic rocks, in the high mountains in the Pyrenees. Esp, And.
- 4 Leaf margin plane at base, incurved in the upper part; leaf apex obtuse, cucullate (fig. 14, 12-13) **G. unicolor** Hook.  
Leaves ovate-lanceolate, concave, with broad and sheathing base, not carinate, sigmoid in lateral view, erect and rigid when dry; upper half of lamina 2-4-stratose, with very obscure cells, 7 µm wide, basal cells beside nerve with nearly or totally straight walls. Seta long, straight; capsule exserted. Forms compact, fragile, dark brown to blackish cushions, to 2 cm high, on rocks in the high mountains. Very rare, in the Pyrenees. Esp, And.
- 5 Plants with globose, pluricellular gemmae at leaf apex 6
- 5 Plants without globose, pluricellular gemmae at leaf apex 7
- 6 Gemmae light green to orange, 70-80(-100) µm wide; leaf laminal cells finely striate, papillose-like owing to cuticular thickened walls; nerve semicircular in cross section, smooth at back (fig. 14, 14-16) **G. anomala** Schimp.  
Leaves erect, less than 3 mm long, broadly ovate-lanceolate, apex apiculate or rounded, except for some branches with hyaline-pointed leaves; lamina unistratose, partially bistratose in upper part, basal cells with straight walls. Forms loose, dull green turfs, to 3 cm high, on more or less exposed, acidic rocks, in the high mountains. Rare, in the north of the Peninsula. Esp.
- 6 Gemmae reddish, 100-200 µm wide; leaf laminal cells smooth, not striate; nerve reniform in cross section, with prominent cells at back (fig. 14, 17-18) **G. hartmanii** Schimp.  
Plants 3-10(-15) cm tall. Leaves falcate-secund, more than 3 mm long, lanceolate, acute, ending in a short hyaline point; laminal cells with sinuose walls. Forms loose, fragile turfs on shaded, acidic rocks, in montane areas and high mountains, in the northern half of the Peninsula. Esp, Prt.
- 7 Leaves carinate (at least in upper part) 8
- 7 Leaves concave, not carinate 27
- 8 Cross section of nerve in the upper part of leaf with 2 guide cells on ventral side 9
- 8 Cross section of nerve in the upper part of leaf with more than 2 guide cells on ventral side 25

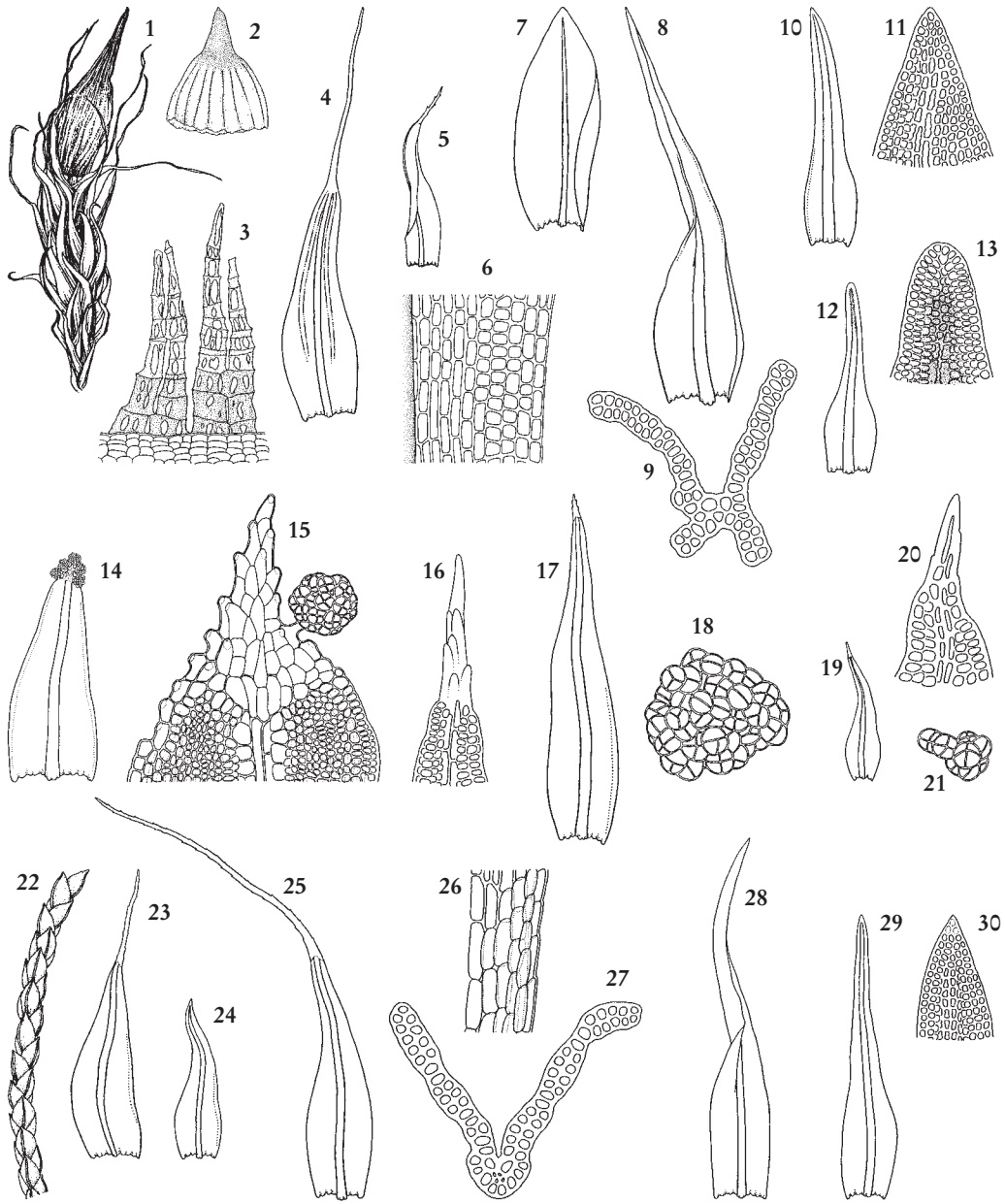


FIGURE 14. 1-4, *Coscinodon cribrosus*: 1, habit when dry; 2, calyptra; 3, peristome; 4, leaf. 5-6, *C. humilis*: 5, leaf; 6, basal cells. 7, *Grimmia mollis*, leaf. 8-9, *G. ramondii*: 8, leaf; 9, leaf section. 10-11, *G. atrata*: 10, leaf; 11, leaf apex. 12-13, *G. unicolor*: 12, leaf; 13, leaf apex. 14-16, *G. anomala*: 14, leaf with gemmae; 15, leaf apex with gemma; 16, leaf apex. 17-18, *G. hartmanii*: 17, leaf; 18, gemma. 19-21, *G. torquata*: 19, leaf; 20, leaf apex; 21, gemma. 22-24, *G. funalis*: 22, innovation; 23, leaf of female plant; 24, leaf of male plant. 25-27, *G. arenaria*: 25, leaf; 26, basal cells; 27, leaf section. 28, *G. incurva*, leaf. 29-30, *G. elongata*: 29, leaf; 30, leaf apex. 1, 2 ( $\times 12$ ); 4, 5, 7, 8, 10, 12, 14, 17, 19, 22, 23, 24, 25, 28, 29 ( $\times 18$ ); 3 ( $\times 100$ ); 15, 16, 18, 21 ( $\times 130$ ); 6, 9, 11, 13, 20, 26, 27, 30 ( $\times 160$ ).



- 9 Leaves strongly crisped when dry (fig. 14, 19-21) **G. torquata** Drumm.  
 Leaves oblong-lanceolate, hyaline point smooth, short or very short, at least present in upper leaves. Gemmae pluricellular, forming pedicellate clusters in the axils of upper leaves. Forms dense, fragile, brownish to orange cushions, dark green to blackish in open sites, grows on acidic rocks and in wet, sheltered rock crevices, in montane areas and high mountains, in the Pyrenees, Spanish Central Range, Cantabrian Mountains and Sierra Nevada. Esp, And.
- 9 Leaves not crisped when dry 10
- 10 Leaves spirally imbricate when dry (fig. 14, 22-24) **G. funalis** (Schwägr.) Bruch & Schimp.  
 Stem with narrow, orange, central strand, with filiform innovations at base. Leaves ovate-lanceolate, asymmetrical, flexuose, hyaline point absent in male plants; basal cells longly rectangular, thick-walled, sinuose; nerve faint below. Seta curved; capsule exserted, striate when dry. Dioicous. Forms dense, fragile, green-olive cushions, blackish below, 1-5 cm high, on vertical, sheltered, wet, acidic rocks in fir woods and pine woods, in montane areas and high mountains in the north of the Peninsula and in Sierra Nevada. Esp, And.
- 10 Leaves not spirally imbricate when dry 11
- 11 Leaf cells at basal margin thin-walled 12
- 11 Leaf cells at basal margin with the transverse walls thickened 14
- 12 Leaf margin plane; autoicous (fig. 14, 25-27) **G. arenaria** Hampe  
 Leaves narrowly ovate, acute, hyaline points to 2 mm long, denticulate or dentate, flexuose and intertwined; laminal cells smooth. Seta to 2 mm long, curved; capsule exserted or emergent; calyptra mitriform. Forms dense, dark green to black cushions to 1,5 cm high, on sheltered rocks, in the montane areas and high mountains. Very rare, in the Pyrenees. Esp, And.
- 12 Leaf margin totally or partially recurved; dioicous 13
- 13 Leaf basal cells towards nerve thick-walled, nodulose; nerve cells on the dorsal upper half longer than adjacent laminal cells; stem leaves muticous, perichaetial leaves with 1 mm long hyaline point (fig. 14, 28) **G. incurva** Schwägr.  
 Leaves linear-lanceolate, base oblong, erect when dry. Seta slightly curved; capsule straight. Forms dense, fragile, dark green cushions, 1-3 cm high, on acidic rocks and in rock crevices, in high mountains. Very rare, in the Pyrenees. Esp
- 13 Leaf basal cells towards nerve thin-walled, non-nodulose; nerve cells and adjacent laminal cells on the dorsal upper half similar in length; stem leaves with short hyaline points to 0,3 mm long, sometimes muticous (fig. 14, 29-30) **G. elongata** Kaulf.  
 Leaves appressed, lanceolate, straight; laminal cells yellowish. Seta straight. Forms dense, fragile brownish red cushions, to 2 cm high, on exposed, acidic rocks, in high mountains. Very rare, in the Pyrenees. Esp, And.
- 14 Leaf margin plane or incurved at apex 15
- 14 Leaf margin recurved, at least partially, on one side 19



- 15 Laminal cells not prominent, rarely prominent on dorsal side 16
- 15 Laminal cells prominent on both sides 17
- 16 Capsule yellowish, with stomata at base; peristome teeth orange; lid conical, obtuse or mamillate; autoicous (fig. 15, 1-2) **G. reflexidens** Müll.Hal.  
**G. sessitana** De Not.
- Leaves patent to spreading, appressed when dry, hyaline point to 0,5 mm long, cylindrical, smooth or with obtuse teeth; upper lamina bistratose, with longitudinal, weak plicae or plicae lacking; basal cells shortly rectangular, with thickened transverse walls. Seta straight or slightly curved; exothecial cells thin-walled. Forms dense, yellowish green to brown cushions to 1 cm high, on humid or periodically wet, acidic rocks, in high mountains, in the Pyrenees, rarer in the Spanish Central Range and Sierra Nevada. Esp, And.
- 16 Capsule and peristome teeth dark brown, without stomata; lid obliquely rostrate; dioicous (fig. 15, 3-4) **G. montana** Bruch & Schimp.
- Leaves erect, sigmoid in lateral view, appressed, flexuose when dry, acuminate, margin plane at base, incurved at apex, hyaline point 1,5 mm long, cylindrical, with obtuse or acute teeth. Seta 2-4 mm long; peristome teeth 50-90 µm wide at base. Forms dense, olive green cushions on dry, acidic rocks, in montane areas and high mountains. Mainly in the northern half of the Peninsula, very rare in the southeast. Esp, Prt, And.
- 17 Leaves with strong, longitudinal plicae on both sides of nerve (w-shape in cross section) (fig. 15, 5-6) **G. caespiticia** (Brid.) Jur.
- Leaves appressed, cucullate, margin plane and entire in the lower half, upper part strongly incurved, apex incurved when dry, ending in short, to 0,4 mm, hyaline point. Seta straight; capsule exserted, ovoid, symmetrical, brownish, with stomata at base; calyptra cucullate. Forms dense, readily disintegrating, glaucous cushions, to 1 cm high, on dry, acidic rocks, in montane areas and high mountains. Scattered in the north of the Peninsula and in Sierra Nevada. Esp, Prt, And.  
When sterile, this species may be confused with *Coscinodon cribrosus*, but the latter has smooth cells.
- 17 Leaves with weak, longitudinal plicae on both sides of nerve 18
- 18 Capsule ovoid, yellowish, with stomata at base; peristome teeth orange; exothecial cells rectangular, thin-walled (fig. 15, 1-2) **G. reflexidens** Müll.Hal.  
**G. sessitana** De Not
- Leaves patent to spreading, ovate to lanceolate, appressed when dry, ending in hyaline point, to 0,5 mm, cylindrical, smooth or with obtuse teeth; upper lamina bistratose, longitudinally plicae weak or lacking, basal cells shortly rectangular, with thickened transverse walls. Seta straight or slightly curved. Forms dense, yellowish green to brown cushions, to 1 cm high, on humid or periodically wet, acidic rocks, in high mountains, in the Pyrenees, rarer in the Spanish Central Range and Sierra Nevada. Esp, And.
- 18 Capsule ellipsoidal, dark brown, without stomata; peristome teeth dark brown; exothecial cells isodiametric, thick-walled (fig. 15, 7-8) **G. alpestris** (F. Weber & D. Mohr) Schleich.
- Leaves patent to spreading, ovate, appressed when dry, apex cucullate, upper margin incurved on one side, plane or recurved at base, hyaline point to 1 mm long, cylindrical, smooth; lamina

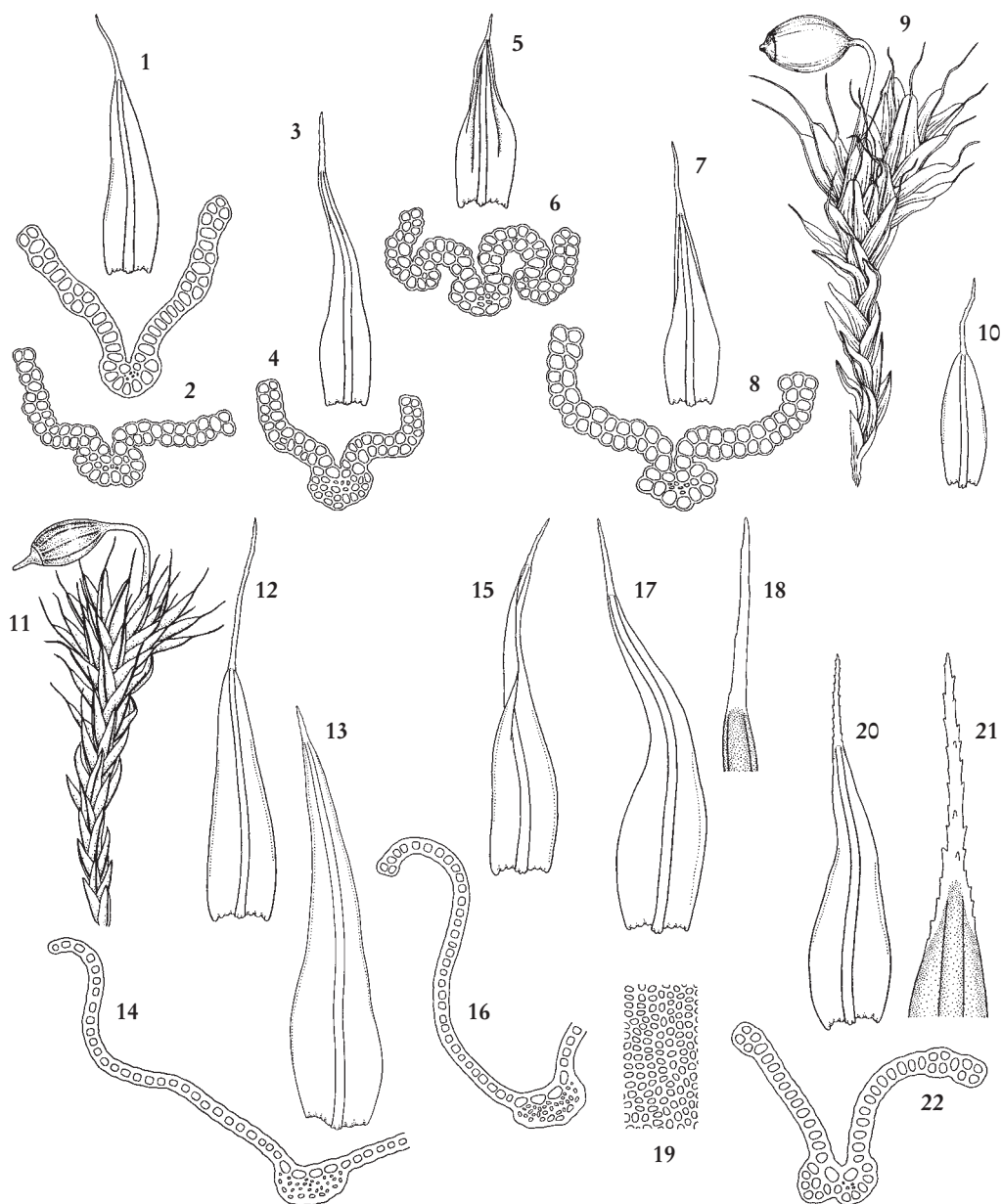


FIGURE 15. 1-2, *Grimmia reflexidens*: 1, leaf; 2, leaf section. 3-4, *G. montana*: 3, leaf; 4, leaf section. 5-6, *G. caespiticia*: 5, leaf; 6, leaf section. 7-8, *G. alpestris*: 7, leaf; 8, leaf section. 9-10, *G. orbicularis*: 9, habit; 10, leaf. 11-12, *G. pulvinata*: 11, habit; 12, leaf. 13-14, *G. dissimulata*: 13, leaf; 14, leaf section. 15-16, *G. trichophylla*: 15, leaf; 16, leaf section. 17-19, *G. elatior*: 17, leaf; 18, leaf apex; 19, upper cells of leaf. 20-22, *G. muehlenbeckii*: 20, leaf; 21, leaf apex; 22, leaf section. 9, 11 ( $\times 8$ ); 1, 3, 5, 7, 10, 12, 13, 15, 17, 20 ( $\times 18$ ); 18, 21 ( $\times 45$ ); 2, 4, 6, 8, 14, 16, 19, 22 ( $\times 160$ ).

2(-3)-stratose, basal cells at margin quadrate. Capsule attenuate at base; lid short, straight, obtuse; calyptra cucullate. Dioicous. Forms compact, glaucous to green cushions on dry, acidic rocks, in montane areas and high mountains. Scattered in the north of the Peninsula and in Sierra Nevada. Esp, And.

- 19 Upper leaf lamina unistratose, with unistratose or bistratose margin 20

- 19 Upper leaf lamina totally or partially bistratose or pluristratose, with bistratose margin 23

- 20 Leaf margin unistratose, recurved on both sides at middle; hyaline point long, denticulate; autoicous; antheridia terminal (fig. 15, 9-10) **G. orbicularis** Bruch ex Wilson

Leaves abruptly narrowed into hyaline point; basal cells towards nerve longly rectangular, thick-walled, nodulose. Seta 2-3 mm long, curved; capsule inclined, exerted, ovoid, smooth; lid mamillate to rostellate; peristome teeth perforated, irregularly divided at apex, orange; calyptra cucullate. Forms whitish green cushions, 1-5 cm high, on calcareous soils and mortar of walls, in the lowlands and montane areas. Widespread throughout the Peninsula and in Mallorca and Pithyusic Islands. Esp, Prt, Bl.

- 20 Leaf margin bistratose, recurved on one or both sides, rarely plane; leaves muticous or with long or short, mostly smooth or nearly smooth hyaline point; autoicous or dioicous; antheridia terminal or located just below archegonia 21

- 21 Leaves abruptly narrowed into long hyaline point, more than 1/2 length of lamina, nearly smooth; autoicous (fig. 15, 11-12) **G. pulvinata** (Hedw.) Sm.

Median cells of lamina 6-11 µm wide, basal cells towards nerve shortly rectangular, with thin and straight walls. Antheridia located just below archegonia; perigonal leaves strongly modified, orange. Capsule striate when dry, yellowish; lid rostrate to rostellate; peristome teeth entire, orange; calyptra mitriform. Forms whitish cushions, 1-5 cm high, on mortar walls and exposed, acidic or basic rocks, in the lowlands and montane areas, rarely in high mountains. Widespread throughout the Peninsula and in Mallorca, Menorca and Pithyusic Islands. Esp, Prt, And, Bl.

- 21 Leaves gradually narrowed into shorter, smooth or nearly so, hyaline point; dioicous 22

- 22 Leaves ovate-lanceolate; muticous or with weakly denticulate hyaline point; basal marginal cells shortly rectangular, nodulose (fig. 15, 13-14) **G. dissimulata** E. Maier

Leaves spreading or erecto-patent, erect or somewhat contorted when dry, with acuminate apex, margin recurved when wet; nerve in leaf base with 4 guide cells arranged in 1 ventral layer. Forms compact yellowish green cushions or extensive tufts on usually calcareous rocks in the lowlands and montane areas, in the south and east of the Peninsula and in Mallorca. Esp, Bl. This species may be confused with *G. lisae*, but that species differs in its nerve in the leaf base having 6 guide cells.

- 22 Leaves lanceolate; hyaline point of variable length, faintly denticulate; basal marginal cells elongate rectangular, non-nodulose (fig. 15, 15-16) **G. trichophylla** Grev.

**G. britannica** A.J.E. Sm.

Hyaline point acute or subulate, straight to flexuose, cylindrical at base; median cells of lamina yellowish green, with thick and sinuose walls, basal cells 2-4 times as long as wide, with thin,

smooth or nodulose walls; nerve in leaf base with guide cells arranged in two layers, 4 cells in ventral side and 1-3 cells on the dorsal side, smaller than the ventral side cells. Sessile gemmae present on back of lamina, seldom on the nerve. Capsule oblong, dull, yellow; peristome teeth orange yellow. Forms loose, easily disintegrating cushions, yellowish above, blackish below, 1-2 cm high, on sheltered, usually siliceous rocks, in the lowlands and montane areas. Widespread throughout the Peninsula and in Mallorca, Menorca and Pithyusic Islands. Esp, Prt, Bl.

Extremely variable species, when sterile is hard to distinguish from *G. muehlenbeckii* and *G. dissimulata*.

- 23 Upper lamina 2-3(-4)-stratose; cells very obscure, papillose (fig. 15, 17-19)

***G. elatior* Bruch ex Bals.-Criv. & De Not.**

Leaves 3-5 mm long, margin recurved on one side, hyaline point less than 1/2 length of lamina, smooth or nearly so, occasionally lacking; median cells 7-9 µm wide, basal cells towards nerve rectangular, strongly sinuose, thick-walled; nerve with prominent cells on back, irregular in cross section. Seta long, curved; capsule pale yellow; peristome reddish. Forms loose, rigid, brownish green to dark green, readily disintegrating turfs, 2-6 cm high, on sheltered, acidic rocks, in high mountains, in the northern half of the Peninsula, mainly in the Pyrenees. Esp, And.

- 23 Upper lamina totally or partially bistratose; cells smooth

24

- 24 Nerve with angulate or winged dorsal projections; capsule smooth (fig. 15, 20-22)

***G. muehlenbeckii* Schimp.**

Leaves to 2 mm long, lanceolate, acute, with partially bistratose apex, margin recurved on both sides at middle, hyaline point short, denticulate, plane, with decurrent base. Gemmae often present, 30-60 µm wide, pluricellular, shortly pedicellate, in the axil of upper leaves. Capsule ovoid, glossy, yellowish or dark brown; peristome teeth purple. Forms dense, yellowish cushions, blackish green inside, 0.5-1.5 cm high, on exposed, acidic rocks, in montane areas and high mountains, in the north of the Peninsula. Esp, And.

- 24 Nerve without dorsal projections; capsule striate (fig. 15, 15-16)

***G. trichophylla* Grev**

***G. britannica* A.J.E. Sm.**

Leaves lanceolate, gradually tapering into acute, subulate, hyaline point, cylindrical at base, straight to flexuose, smooth or nearly smooth; median cells yellowish green, with thick and sinuose walls, basal cells 2-4 times as long as wide, with thin, smooth or nodulose walls. Sessile gemmae present on back of lamina, seldom on the nerve. Capsule oblong, dull, yellow; peristome teeth orange yellow. Forms loose, easily disintegrating cushions, yellowish above, blackish below, 1-2 cm high, on sheltered, usually siliceous rocks, in the lowlands and montane areas. Widespread throughout the Peninsula and in Mallorca, Menorca and Pithyusic Islands. Esp, Prt, Bl.

Extremely variable species, when sterile is hard to distinguish from *G. muehlenbeckii* and *G. dissimulata*.

- 25 Basal cells towards nerve with non-nodulose walls (fig. 16, 1-3) ***G. lisae* De Not.**

Leaves 3-5 mm, apex acute, carinate, bistratose, hyaline point stout, denticulate; median cells quadrate or rounded, thick-walled, not sinuose, cells towards base quadrate to shortly rectangular, 1-3 times as long as wide, with thick and straight walls; nerve with 6(7-8) guide cells

in the base of leaf. Gemmae pluricellular, shortly pedicellate, in the axils of upper leaves. Capsule ovoid, glossy, brown or yellow; peristome teeth reddish. Forms dense or loose, blackish brown cushions, 2-3 cm high, on acidic or basic rocks in very moist sites, in the lowlands and montane areas. Scattered localities in the Peninsula and in Mallorca and Menorca. Esp, Prt, Bl.

- 25 Basal cells towards nerve with nodulose walls 26

- 26 Hyaline point in upper leaves spreading, dentate; seta curved; capsule striate; antheridia just below archegonia (fig. 16, 4-6) **G. decipiens** (Schultz) Lindb.

Leaves 3-3,5 mm long, margin recurved on both sides, hyaline point more than 1/3 length of lamina, cylindrical at base; upper lamina partially bistratose, basal cells near margin short, with thick and nodulose walls. Seta long, flexuose, twisted when dry. Forms loose, whitish, cushions, yellowish below, 2-4 cm high, on exposed, granitic rocks, in montane areas and high mountains. Widespread throughout the Peninsula, mainly in the northern half. Esp, Prt, And.

- 26 Hyaline point in upper leaves erect to erecto-patent, smooth or finely denticulate; seta straight; capsule smooth; antheridia terminal (fig. 16, 7) **G. longirostris** Hook.

**G. affinis** Hornsch.

Leaves ovate-lanceolate, rigid, margin 2-3-bistratose, recurved on one side, hyaline hair point occasionally lacking; basal cells towards margin hyaline, rectangular, with thickened transverse walls. Forms compact, rounded, yellowish green to whitish cushions, 1,5-2 cm high, on dry, exposed, non-calcareous rocks, in montane areas and high mountains. Scattered in the north of the Peninsula. Esp, And.

- 27 Leaves spatulate to obovate; upper lamina unistratose; peristome present 28

- 27 Leaves ovate to lanceolate; upper lamina 1-5-stratose, at least upper margin bistratose; peristome present or lacking 29

- 28 Leaf margin plane; seta sigmoid; capsule immersed, ovoid, gibbous, smooth, glossy brown to reddish (fig. 16, 8-9) **G. crinita** Brid.

Laminal basal cells at margin short and broad, hyaline. Lid conical, shortly rostrate; calyptra cucullate; peristome orange; spores 10-12 µm. Forms dense, whitish cushions, to 0,8 cm high, on exposed calcareous rocks, walls or mortar of walls, in the lowlands, in the north and east of the Peninsula and in Mallorca. Esp, Bl.

When sterile, it is hard to distinguish from *G. capillata*.

- 28 Leaf margin recurved; seta straight; capsule emergent, ovoid, nearly symmetrical, furrowed when dry, dark yellow **G. capillata** De Not.

**G. mesopotamica** Schiffn.

Leaves cucullate, straight and appressed when dry; basal cells at margin rectangular, hyaline. Lid obtuse, mamilliose; calyptra mitriform; peristome teeth reddish; spores about 15 µm. Forms dense, glaucous or slightly white cushions on mortar of walls and banks with gypsiferous soil. Very rare in the east and southeast of the Peninsula, scattered in Mallorca. Esp, Bl.

- 29 Nerve with 2 cells on ventral side; upper lamina unistratose or partially bistratose, margin bistratose; peristome lacking **G. anodon** Bruch & Schimp.

Plants small. Upper leaves oblong-lanceolate, hyaline point long, denticulate, broad at base, decurrent at margin (often lacking in sterile plants). Seta sigmoid; capsule gibbous at base;

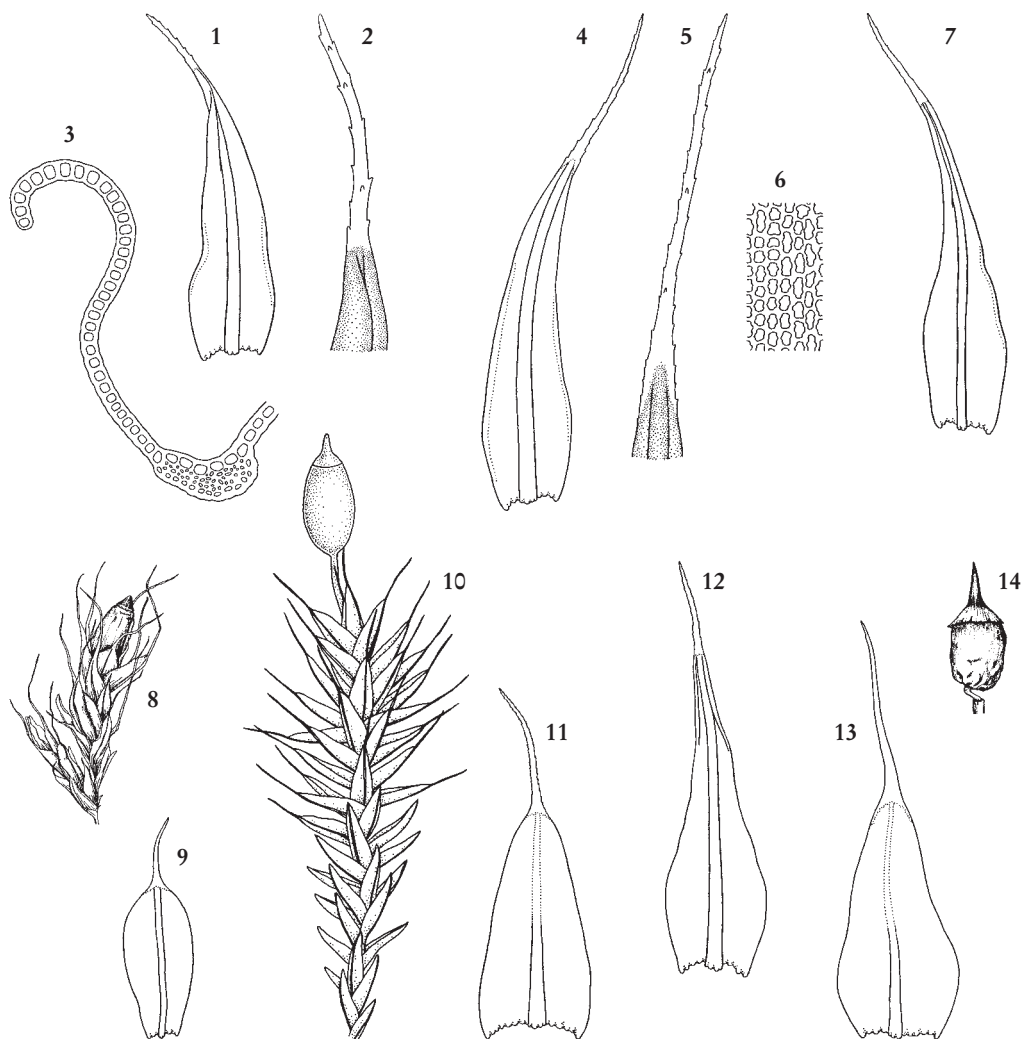


FIGURE 16. 1-3, *Grimmia lisae*: 1, leaf; 2, leaf apex; 3, leaf section. 4-6, *G. decipiens*: 4, leaf; 5, leaf apex; 6, upper cells of leaf. 7, *G. longirostris*, leaf. 8-9, *G. crinita*: 8, habit; 9, leaf. 10-11, *G. laevigata*: 10, habit; 11, leaf. 12, *G. ovalis*, leaf. 13, *G. tergestina*, leaf. 14, *G. poecilostoma*, capsule. 8, 10 ( $\times 8$ ); 14 ( $\times 10$ ); 1, 4, 7, 9, 11, 12, 13 ( $\times 18$ ); 2, 5 ( $\times 45$ ); 3, 6 ( $\times 160$ ).

spores 6-10  $\mu\text{m}$ . Forms dense, soft, whitish cushions, dark green to brownish below, to 0,5 cm high, on dry, calcareous rocks, in montane areas and high mountains. Scattered localities in the northern half of the Peninsula and in Sierra Nevada. Esp.

- 29 Nerve with more than 2 cells on ventral side; upper lamina 2-4(-5)-stratose; peristome present

- 30 Basal cells at margin oblate, 0,4-0,7:1 (fig. 16, 10-11) **G. laevigata** (Brid.) Brid.  
Plants rigid, dull. Leaves triangular, cordate to ovate, apex plane, hyaline point long, denticulate; upper lamina bistratose, basal cells with thickened transverse walls. Seta long, straight; capsule emergent or exserted, ovoid, smooth. Forms dense, fragile cushions, whitish above, dark below, to 1,5 cm high, on dry, exposed, acidic rocks or rock ledges, in the lowlands and montane areas, rarely in high mountains. Widespread throughout the Peninsula and in Menorca. Esp, Prt, And, Bl.
- 30 Basal cells at margin isodiametric to shortly rectangular 31
- 31 Basal cells towards nerve rectangular, 4-8:1, with nodulose walls; perichaetial leaves similar to stem leaves; capsule exserted (fig. 16, 12) **G. ovalis** (Hedw.) Lindb.  
Upper lamina 2-4(-5)-stratose. Capsule straight; calyptra cucullate. Forms loose, dark green to blackish cushions, 1-3 cm high, on exposed rocks, in montane areas and high mountains, in the northern half of the Peninsula, very rare in the southeast. Esp, Prt, And.  
Depauperate specimens may be confused with *G. tergestina*.
- 31 Basal cells towards nerve isodiametric to shortly rectangular, 1-4:1, with non-nodulose walls; perichaetial leaves hyaline, transparent; capsule immersed 32
- 32 Capsule symmetrical; seta straight; spores 8-10 µm (fig. 16, 13)  
**G. tergestina** Tomm. ex Bruch & Schimp.  
Median cells of lamina 6-12 µm wide. Capsule yellow; peristome teeth reddish yellow, strongly perforated. Forms dense, whitish green cushions, 0,5 cm high, on exposed, basic rocks, in montane areas, mainly in the eastern half of the Peninsula and in Mallorca. Esp, And, Bl.
- 32 Capsule gibbous at base; seta sigmoid; spores 10-12 µm (fig. 16, 14)  
**G. poecilostoma** Cardot & Sébille  
**G. tergestina** Tomm. ex Bruch & Schimp. var. **poecilostoma** (Cardot & Sébille) Loeske  
Median cells of lamina 8-10 µm wide. Capsule ovoid, yellow; peristome teeth orange, strongly perforated. Forms readily disintegrating, dark green to blackish cushions, 0,5-0,8 cm high, on wet, acidic rocks, in montane areas and high mountains. Very rare in the Pyrenees and in the northeast of the Peninsula. Esp, And.

### **Racomitrium** Brid.

Plants fairly robust. Stem erect or procumbent, mostly densely, shortly branched. In some species, all or only the upper leaves are elongated in a long, hyaline point; laminal cells sinuose, basal cells sinuose-nodulose. Capsule ovoid or cylindrical, straight, smooth. Mainly growing on siliceous rocks, rarely on calcareous rocks and soils.

- |   |                                 |    |
|---|---------------------------------|----|
| 1 | Leaf apex with hyaline point    | 2  |
| 1 | Leaf apex without hyaline point | 11 |
| 2 | Hyaline point papillose         | 3  |
| 2 | Hyaline point not papillose     | 5  |



- 3 Laminar cells of leaves smooth (fig. 17, 1-2) **R. lanuginosum** (Hedw.) Brid.  
Stem to 5 cm long or more, densely branched. Leaves lanceolate, long, narrow, hyaline point long, decurrent, strongly papillose and with coarse, deep teeth at margin; nerve stout, long. Forms patches or lax cushions on acidic rocks in montane areas, in the northern and western halves of the Peninsula. Esp, Prt.
- 3 Laminar cells of leaves papillose 4
- 4 Leaves non- or slightly carinate; nerve bifurcate, not extending half way up (fig. 17, 3-4) **R. canescens** (Hedw.) Brid.  
Plants robust, brown at base, grey or whitish above. Stem 3-6 cm long or more. Leaves concave, widely ovate to ovate-lanceolate, hyaline point wide, often dentate or spinulose, non- or slightly decurrent; laminar cells with high papillae, marginal cells near base longer than wide, with non-sinuose walls. Forms lax tufts on rock ledges and dry, exposed, sandy, usually acidic soils, in montane areas and high mountains, mainly in the northeastern part of the Peninsula. Esp, And.
- 4 Leaves carinate; nerve reaching apex or nearly so (fig. 17, 5-6) **R. elongatum** Ehrh. ex Frisvoll  
Plants robust, greenish. Stem 3-5 cm long or more. Leaves ovate-lanceolate, hyaline point long, slender, often strongly denticulate, decurrent; laminar cells with low papillae, marginal cells near base wider than long, with sinuose walls. Forms lax tufts on rocks and exposed, sandy soils, usually on acidic substrata, in montane areas and high mountains, in the northern half of the Peninsula. Esp, Prt, And.
- 5 Leaf margin 2-3(4)-stratose of 2-4 rows of cells 6
- 5 Leaf margin 1-2-stratose of 1(2) row of cells 8
- 6 Leaf margin 2-3(4)-stratose; lamina bistratose in the upper part, rarely with unistratose spots; nerve 2-stratose in the upper part, 5-8 cells wide on the ventral side, plane or slightly convex on dorsal side; spores 14-16(-20)  $\mu\text{m}$  (fig. 17, 7) **R. lusitanicum** Ochyra & Sérgio  
Leaves rigid, straight or slightly falcate, hair point to 0,5 mm long, rarely longer, not dentate or nearly so. Capsule cylindrical elongate, 2-3 mm long. Plants green or blackish, forming  $\pm$  loose, prostrate tufts, to 2-3 cm long, on wet or periodically wet, acidic, usually vertical, rocks, in montane areas and high mountains, in the northwestern part of the Peninsula. Prt.
- 6 Leaf margin 2(3)-stratose; lamina unistratose in the upper part; nerve 3-5-stratose in the upper part, to 5 cells wide on the ventral side, strongly convex on dorsal side; spores 12-14  $\mu\text{m}$  7
- 7 Leaves contorted when dry, dull olive green; hyaline point spinulose, straight, short, usually less than 100  $\mu\text{m}$  long **R. macounii** Kindb. subsp. **macounii**  
Forms lax tufts, to 6 cm high, on exposed, acidic rocks, periodically wet by thaw water, in high mountains. Scattered in the northern half of the Peninsula and in Sierra Nevada. Esp, Prt, And.
- 7 Leaves straight when dry, glossy brownish red; hyaline point dentate or spinulose, reflexed, to 200  $\mu\text{m}$  long (fig. 17, 8-9) **R. macounii** Kindb. subsp. **alpinum** (Lawt.) Frisvoll



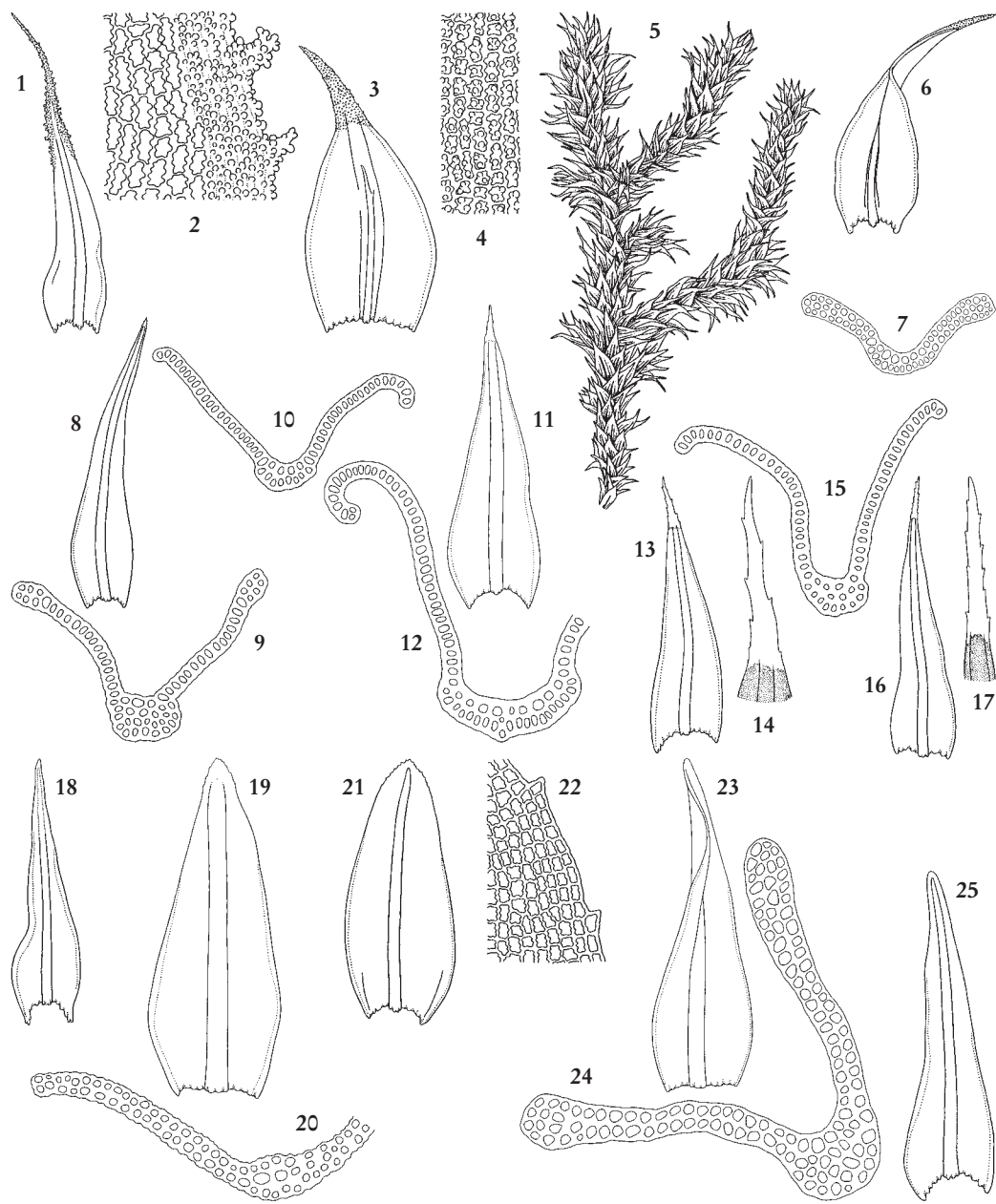


FIGURE 17. 1-2, *Racomitrium lanuginosum*: 1, leaf; 2, upper cells. 3-4, *R. canescens*: 3, leaf; 4, median cells. 5-6, *R. elongatum*: 5, habit; 6, leaf. 7, *R. lusitanicum*, leaf section. 8-9, *R. macounii* subsp. *alpinum*: 8, leaf; 9, leaf section. 10, *R. heterostichum*, leaf section. 11-12, *R. obtusum*: 11, leaf; 12, leaf section. 13-15, *R. affine*: 13, leaf; 14, leaf apex; 15, leaf section. 16-17, *R. sudeticum*: 16, leaf; 17, leaf apex. 18, *R. fasciculare*, leaf. 19-20, *R. hespericum*: 19, leaf; 20, leaf section. 21-22, *R. aciculare*: 21, leaf; 22, upper cells. 23-24, *R. lamprocarpum*: 23, leaf; 24, leaf section. 25, *R. aquaticum*, leaf. 5 ( $\times 1.6$ ); 1, 3, 6, 8, 11, 13, 16, 18, 19, 21, 23, 25 ( $\times 16$ ); 14, 17 ( $\times 60$ ); 7, 9, 10, 12, 15, 20, 24 ( $\times 160$ ); 2, 4, 22 ( $\times 230$ ).

Forms loose cushions, to 5 cm high, on acidic rocks in streams, in montane areas and high mountains, in the northern half of the Peninsula. Esp, Prt, And.

- 8 Nerve in the leaf median part, 2-stratose, rarely partially 3-stratose, 4-10 cells wide on the ventral side 9
- 8 Nerve in the leaf median part, 3-stratose, 2-4 cells wide on the ventral side 10
- 9 Hyaline point usually more than 0,5 mm long, rarely shorter; leaf margin recurved (fig. 17, 10) **R. heterostichum** (Hedw.) Brid.  
Plants fairly robust, procumbent; stem densely branched. Leaf margin recurved to apex or plane in the upper part, unistratose, rarely with 2-stratose spots, hyaline point usually long and flexuose, denticulate; lamina usually totally unistratose. Capsule narrowly cylindrical. Forms dense, yellowish green to greyish tufts on dry, exposed, acidic usually vertical rocks, in montane areas, in the northern half of the Peninsula, although rarer in the northeast and southwest. Esp, Prt.  
Grows in drier and more exposed sites than *R. affine*.
- 9 Hyaline point short, to 0,5(-0,7) mm long, occasionally with some muticous leaves; leaf margin revolute (fig. 17, 11-12) **R. obtusum** (Brid.) Brid.  
Leaves with slightly flexuose hyaline point and leaves muticous on the same plant, margin revolute to apex, unistratose, occasionally with bistratose spots in one or two cell rows; lamina unistratose, with exceptional bistratose spots; nerve very wide. Capsule ellipsoidal or obovoid. Forms dense, olive green and orange tufts on dry, exposed, acidic rocks, in the northwestern part of the Peninsula. Esp, Prt.
- 10 Leaf apex wide, with flexuose hyaline point, flattened at base (fig. 17, 13-15) .  
**R. affine** (F. Weber & D. Mohr) Lindb.  
**R. heterostichum** (Hedw.) Brid. var. **affine** (F. Weber & D. Mohr) Lesq.  
Hyaline point non- or slightly decurrent, 0,5-1 mm long, denticulate; leaf nerve, near base, flattened on ventral side. Perichaetial leaves different from stem leaves. Capsule cylindrical to ovoid. Plants green or blackish, forming prostrate, ± dense tufts, to 15 cm high, on wet or periodically wet vertical rocks, in montane areas and high mountains, in the northern half of the Peninsula. Esp, Prt, And.
- 10 Leaf apex narrow, with non-flexuose, cylindrical hyaline point (fig. 17, 16-17)  
**R. sudeticum** (Funck) Bruch & Schimp.  
**R. heterostichum** (Hedw.) Brid. var. **sudeticum** (Funck) E. Bauer  
Plants green or yellowish green, blackish below, 4-10 cm long, prostrate, slightly branched. Hyaline point of leaves with usually reflexed apex. Perichaetial leaves similar to stem leaves. Capsule sub-globose to cylindrical. Forms dense tufts or cushions on wet, acidic, often inclined rocks, in montane areas and high mountains, in the northern half of the Peninsula. Esp, Prt, And.
- 11 Laminal cells longly rectangular in the upper part of leaf; leaf apex acute to obtuse (fig. 17, 18) **R. fasciculare** (Hedw.) Brid.  
Stem to 10 cm long, procumbent, with numerous fasciculate branches. Leaves lanceolate, with ovate base. Forms dense, dark green or brownish tufts on siliceous rocks by streams, in montane areas and high mountains, in the north of the Peninsula and in Sierra Nevada. Esp.

- 11 Laminal cells quadrate or shortly rectangular in the upper part of leaf; leaf apex rounded 12
- 12 Leaf apex dentate (fig. 35, 16-17) 13
- 12 Leaf apex entire (fig. 35, 18) 14
- 13 Leaf lamina bistratose in the upper part, rarely with unistratose spots; nerve 140-180  $\mu\text{m}$  wide at base, 6-10 cells wide on the ventral side; spores 18-20(-32)  $\mu\text{m}$  (fig. 17, 19-20) **R. hespericum** Sérgio, J. Muñoz & Ochrya  
Plants green or olivaceous, forming  $\pm$  dense, rigid tufts to 5 cm high on wet rocks or granitic rocks in flowing waters, in montane areas and high mountains, in the north, western and central part of the Peninsula. Esp, Prt.
- 13 Leaf lamina unistratose in the upper part; nerve 70-120  $\mu\text{m}$  wide at base, 4-7 cells wide on the ventral side; spores to 20  $\mu\text{m}$  (fig. 17, 21-22) **R. aciculare** (Hedw.) Brid.  
Stem ascending or decumbent, usually 3-4 cm long, occasionally to 10 cm long. Leaves ovate or ovate-lanceolate. Forms cushions or loose tufts on disintegrating granitic rocks in flowing waters, in montane areas and high mountains, in the northern and western halves of the Peninsula and in Sierra Nevada. Esp, Prt, And.
- 14 Leaf margin 2-4-stratose; lamina bistratose in the upper part, rarely with unistratose spots (fig. 17, 23-24) **R. lamprocarpum** (Müll.Hal.) A. Jaeger  
Plants yellowish green to almost black; stem rigid, with ascending tips, 3-10 cm long, branched from base. Leaves straight, falcate, lanceolate, with reflexed apex. Spores 18-28  $\mu\text{m}$ . Grows on wet, usually granitic, rocks in streams, in montane areas, in the northwest of the Peninsula. Esp, Prt.
- 14 Leaf margin unistratose; lamina unistratose in the upper part (fig. 17, 25) **R. aquaticum** (Brid. ex Schrad.) Brid.  
Plants yellowish green; stem procumbent, with ascending tips, to 10 cm long or more, sparsely branched. Leaves straight, lanceolate. Spores 14-20  $\mu\text{m}$ . Grows on wet, mostly granitic, rocks in streams, in montane areas and high mountains, mainly in the northern half of the Peninsula and in Sierra Nevada. Esp, Prt, And.

### **Schistidium** Bruch & Schimp.

Plants brownish green, olive-green to blackish. Stem 0,5 to 12-15 cm high, simple or branched. Leaves ovate-lanceolate to ovate-triangular, straight or falciform, mostly ending in a hyaline point; lamina unistratose, bistratose or with bistratose spots, cells rounded to oblong, smooth or papillose, sometimes with sinuose, thick walls. Capsule globose to cylindrical, immersed among perichaetial leaves and covered totally or partially by them, exothecial cells isodiametric, oblong or irregular, with or without stomata; lid apiculate to rostrate, coming off attached to columella; peristome teeth 16, perforated or not, orange to brownish red, in some species peristome lacking.

- 1 Leaves without hyaline point 2
- 1 At least upper leaves with hyaline point 5

- 2 Leaf lamina unistratose (fig. 18, 1-3) **S. agassizii** Sull. & Lesq.  
Laminal rounded-quadrate, cells thick-walled,  $\pm$  sinuose. Exothelial cells isodiametric, with groups of oblate cells intercalated, stomata lacking. Forms turfs on acidic substrata by streams in montane areas and high mountains, in the northern half of the Peninsula and Sierra Nevada. Esp.
- 2 Leaf lamina totally or partially bistratose 3
- 3 Leaf apex obtuse; capsule orange, yellow or light brown, cyathiform, without stomata; peristome short or rudimentary (fig. 18, 4-6) **S. atrofusum** (Schimp.) Limpr.  
**S. apocarpum** (Hedw.) Bruch & Schimp. var. **atrofusum** (Schimp.) C.E.O. Jensen  
Plants small, jet black. Leaves imbricate, ovate-triangular, slightly keeled, straight, sometimes with smooth or slightly denticulate point; nerve percurrent. Exothelial cells mostly rectangular, usually mixed with isodiametric cells. Grows on dry, calcareous rocks in montane areas of the Peninsula. Esp.
- 3 Leaf apex acute or acuminate; capsule reddish to dark brown, shortly cylindrical to globose, with stomata; peristome well developed 4
- 4 Leaves ovate-triangular to ovate-lanceolate, with acute apex; nerve excurrent in short apiculus (fig. 18, 7-10) **S. rivulare** (Brid.) Podp.  
Plants medium-sized to robust, dull, olive green to blackish. Capsule sub-globose, exothelial cells isodiametric polygonal. Forms tufts on calcareous or siliceous rocks by streams in montane areas and high mountains, rarer in the lowlands, in the northern half of the Peninsula and Sierra Nevada. Esp, Prt, And.
- 4 Leaves lanceolate, with acuminate apex; nerve stout, percurrent, excurrent only in the upper leaves (fig. 18, 11-14) **S. occidentale** (E. Lawton) Churchill  
Plants medium-sized, dull dark green to black. Leaves falcate-secund. Capsule sub-globose to shortly cylindrical. Forms submerged or semi-submerged tufts on siliceous rocks by high mountain streams in Sierra Nevada. Esp.
- 5 Laminal cells papillose, at least on dorsal side; exothelial cells mostly isodiametric 6
- 5 Laminal cells smooth on dorsal side (leaf margin and dorsal side of nerve may be papillose); exothelial cells oblong or isodiametric 8
- 6 Leaf lamina bistratose; upper and median cells rounded or ovate, 6-9  $\mu$ m wide, wall cells slightly sinuose or not; hyaline point rigid; perichaetial leaves elliptical, wider than stem leaves (fig. 18, 15-18) **S. pruinsum** (Wilson ex Schimp.) G. Roth  
Leaves imbricate, oblong to ovate-oblong, straight, hyaline point spinulose at base, more distantly spinulose in the upper part; laminal cells with broad papillae on both sides. Capsule oblong; peristome teeth reddish, perforated with narrow slits in the upper half. Forms olive green turfs on exposed, calcareous or siliceous rocks, in the Pyrenees and Basque Mountains. Esp.
- 6 Leaf lamina unistratose, rarely with bistratose apex; upper and median cells oblong, 8-11  $\mu$ m wide, wall cells sinuose; hyaline point weak, flexuose; perichaetial leaves lanceolate, similar to stem leaves 7

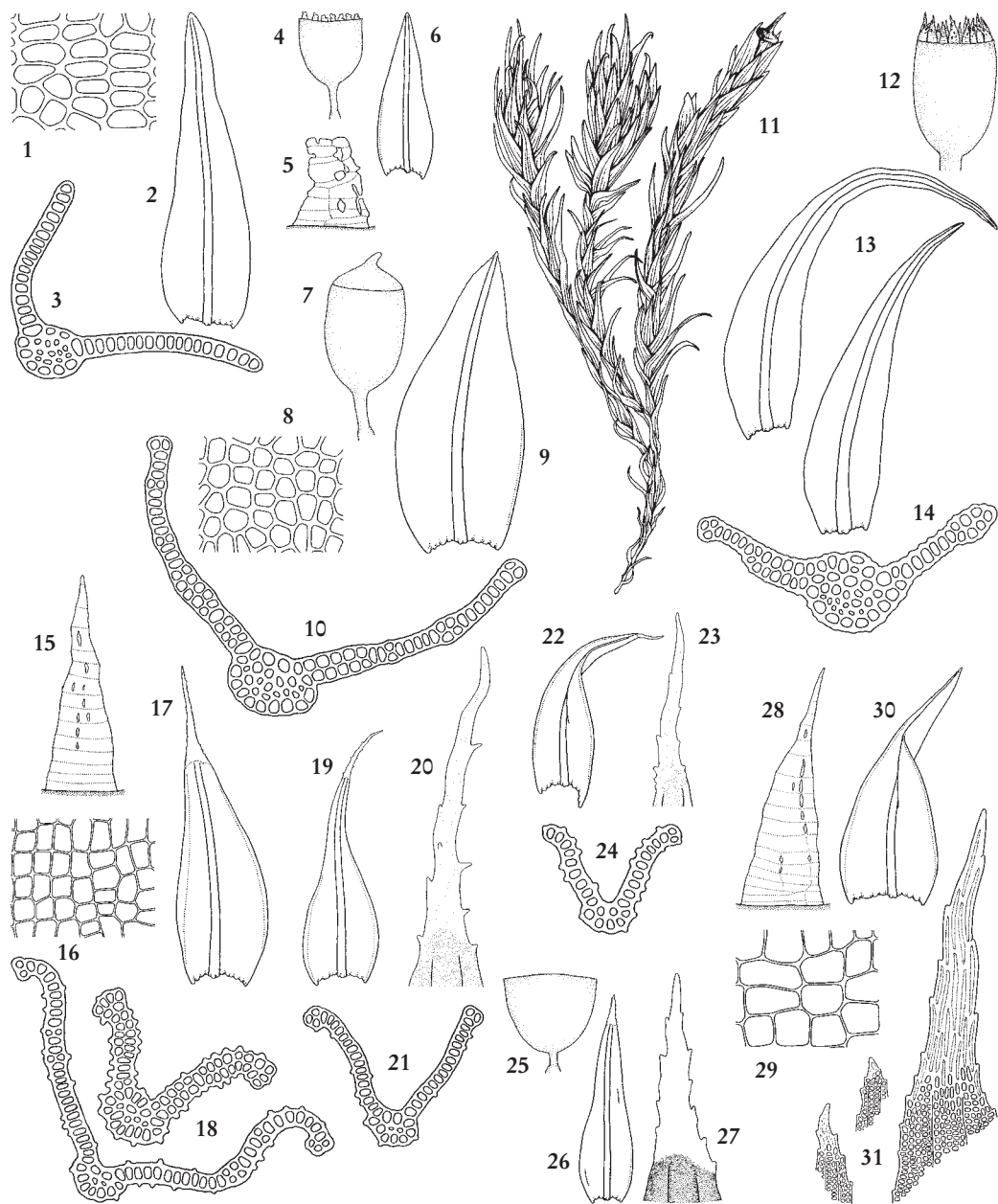


FIGURE 18. 1-3, *Schistidium agassizii*: 1, exothecial cells; 2, leaf; 3, leaf section. 4-6, *S. atrofusum*: 4, capsule; 5, peristome tooth; 6, leaf. 7-10, *S. rivulare*: 7, capsule; 8, exothecial cells; 9, leaf; 10, leaf section. 11-14, *S. occidentale*: 11, habit; 12, capsule; 13, leaves; 14, leaf section. 15-18, *S. pruinsum*: 15, peristome tooth; 16, exothecial cells; 17, leaf; 18, leaf sections. 19-21, *S. strictum*: 19, leaf; 20, leaf apex; 21, leaf section. 22-24, *S. papillosum*: 22, leaf; 23, leaf apex; 24, leaf section. 25-27, *S. flaccidum*: 25, capsule; 26, leaf; 27, leaf apex. 28-31, *S. apocarpum*: 28, peristome tooth; 29, exothecial cells; 30, leaf; 31, leaf apices. 11 ( $\times 4$ ); 4, 7, 12, 25 ( $\times 10$ ); 2, 6, 9, 13, 17, 19, 22, 26, 30 ( $\times 16$ ); 5, 15, 20, 23, 27, 28, 31 ( $\times 100$ ); 1, 3, 8, 10, 14, 16, 18, 21, 24, 29 ( $\times 160$ ).

- 7 Leaves from ovate base abruptly narrowed in long, narrow acumen, arranged in spiral rows (fig. 18, 19-21) **S. strictum** (Turner) Loeske ex Martensson  
 Hyaline point 0-0,6 mm long, thin, narrow,  $\pm$  flexuose, not or shortly decurrent. Capsule subglobose to ovoid, reddish; peristome teeth red, entire or with small perforations in the upper part. Forms tufts on siliceous rocks in wet forests, in high mountains in the eastern Pyrenees. Esp.
- 7 Leaves gradually narrowed from base, not arranged in spiral rows (fig. 18, 22-24) **S. papillosum** Culm.  
**S. apocarpum** (Hedw.) Bruch & Schimp. subsp. **papillosum** (Culm.) Poelt  
 Leaves falcate-secund, hyaline point 0,1-1,25 mm long, thin, flexuose, decurrent spinulose in the lower part, nearly smooth in the upper part. Capsule oblong-cylindrical; peristome teeth reddish, gradually narrowed in fine point, entire or with small perforations. Forms small to large, reddish or olivaceous tufts, blackish brown below, on calcareous or granitic rocks, in montane areas and high mountains, in the north of the Peninsula, common in the Pyrenees. Esp, And.
- 8 Peristome lacking (fig. 18, 25-27) **S. flaccidum** (De Not.) Ochyra  
**S. pulvinatum** (Hedw.) Brid. var. **flaccidum** (De Not.) De Not.  
 Leaves erect, imbricate, ovate-lanceolate, acute, hyaline point flattened, slightly or non-decurrent, with distant, fine, acute or obtuse teeth; lamina usually unistratose. Perichaetial leaves wider than stem leaves. Capsule yellowish to light brown, hemispherical, widely cyathiform to ovoid; lid with short and obtuse beak. Grows on acidic rocks in montane areas of the Peninsula. Esp, Prt.
- 8 Peristome well developed 9
- 9 Exothecial cells mostly isodiametric, sometimes with patches of oblate cells 10
- 9 Exothecial cells mostly oblong 12
- 10 Leaf margin of upper leaves denticulate near apex (fig. 18, 28-31) **S. apocarpum** (Hedw.) Bruch & Schimp.  
 Leaves ovate-lanceolate, sometimes falcate-secund, keeled, with hyaline point short or long, decurrent or not, spinulose, margin recurved and bistratose. Capsule oblong-cylindrical, with wide mouth and 4-8(-12) stomata; peristome teeth reddish, ending in long point, entire at base, in the upper half part with ovate perforations in vertical rows. Forms loose or dense, olivaceous or light brown tufts on siliceous or calcareous rocks and dry or wet walls. Common in montane areas of the Peninsula. Esp, Prt.
- 10 Leaf margin entire 11
- 11 Perichaetial leaves wide; urn smooth; exothecial cells in patches of quadrate, transversely rectangular cells; plants glossy **S. pulchrum** H.H. Blom  
 Upper leaves sub-sheathing, decurrent, margin recurved throughout, point wide, decurrent, white, with geminate spinulae at base; lamina usually unistratose; laminal cells irregular in size and shape, 8-10  $\mu$ m, thick-walled, slightly to strongly sinuose. Perichaetial leaves broad. Capsule not visible laterally, yellow, orange or reddish, with 6-8(-10) stomata; peristome teeth red, gradually narrowed in fine point, with median or sub-marginal, elongated perforations. Forms small, glossy tufts at base of acidic rocks, in the southeast of the Peninsula. Esp.



- 11 Perichaetial leaves narrow; urn finely striate when dry; exothelial cells irregular in shape with trigones; plants dull (fig. 19, 1-4) **S. dupretii** (Thér.) W.A. Weber  
 Leaves ovate-lanceolate, hyaline point erect, rigid, with erecto-patent to squarrose, obtuse spinulae, upper leaves of fertile shoots appressed, sub-sheathing; lamina usually unistratose; median cells of lamina oblong, slightly to strongly sinuose; hyaline point short, fine, denticulate, non- or slightly decurrent. Capsule brownish red, oblong-cylindrical, finely striate in the lower part when empty, exothelial cells irregular in shape and size, with trigones and up to 6 stomata; peristome teeth squarrose, entire or perforated. Plants fine, small, brownish to olivaceous, blackish at base. Grows on exposed, usually dry and calcareous rocks, in montane areas and high mountains. Rare, in the Pyrenees, León Mountains and Basque Mountains. Esp.
- 12 Lamina usually unistratose; laminal cells mostly elongated and sinuose (fig. 19, 5-8) **S. robustum** (Nees & Hornsch.) H.H. Blom  
 Plants medium-sized, olivaceous to light brown. Leaves imbricate, ovate-lanceolate; hyaline point long and spinulose, widely decurrent. Capsule oblong, narrow, light brown, exothelial cells irregular in shape and size, with irregularly thickened longitudinal walls. Forms tufts on dry or periodically wet, exposed calcareous rocks, in montane areas and high mountains in the northern part of the Peninsula. Esp.
- 12 Lamina partially bistratose; laminal cells mostly isodiametric and slightly sinuose 13
- 13 Hyaline point flattened; plants olivaceous (fig. 19, 9-12) **S. confertum** (Funck) Bruch & Schimp.  
**S. apocarpum** (Hedw.) Bruch & Schimp. var. **confertum** (Funck) H. Möller  
 Plants small, with a greasy lustre, olivaceous, grey or light brown. Leaves small, ovate-lanceolate, acute, hyaline point short, not decurrent, with strong, patent to squarrose spinulae. Capsule ovoid, orange yellow, exothelial cells predominantly oblong, with groups of oblate cells, with 3-8 stomata; peristome teeth orange, strongly perforated. Forms dense turfs on dry, exposed, siliceous rocks in montane areas and high mountains, in the north of the Peninsula and in Sierra Nevada. Esp, And.
- 13 Hyaline point circular in cross section; plants olivaceous, brown, jet black or blackish 14
- 14 Plants jet black, glossy; leaves muticous or with very short hyaline point 15
- 14 Plants olivaceous, brown to blackish, ± dull; leaves with ± long hyaline point 16
- 15 Perichaetial leaves widely elliptical, often covering the whole capsule; peristome teeth short, ± rudimentary and truncate (fig. 18, 4-6) **S. atrofusum** (Schimp.) Limpr.  
**S. apocarpum** (Hedw.) Bruch & Schimp. var. **atrofusum** (Schimp.) C.E.O. Jensen  
 Plants small, jet black. Leaves ovate-triangular, slightly keeled, imbricate, straight, sometimes with smooth or slightly denticulate point; lamina partially bistratose; nerve percurrent. Capsule oblong-cylindrical or cyathiform, orange, without stomata, exothelial cells mostly rectangular, usually mixed with isodiametric cells. Grows on dry, exposed, calcareous rocks, in montane areas of the Peninsula. Esp.
- 15 Perichaetial leaves lanceolate, not covering the whole capsule; peristome teeth long, well developed (fig. 19, 13-18) **S. helveticum** (Schkuhr) Deguchi  
**S. singarense** (Schiffn.) Laz.

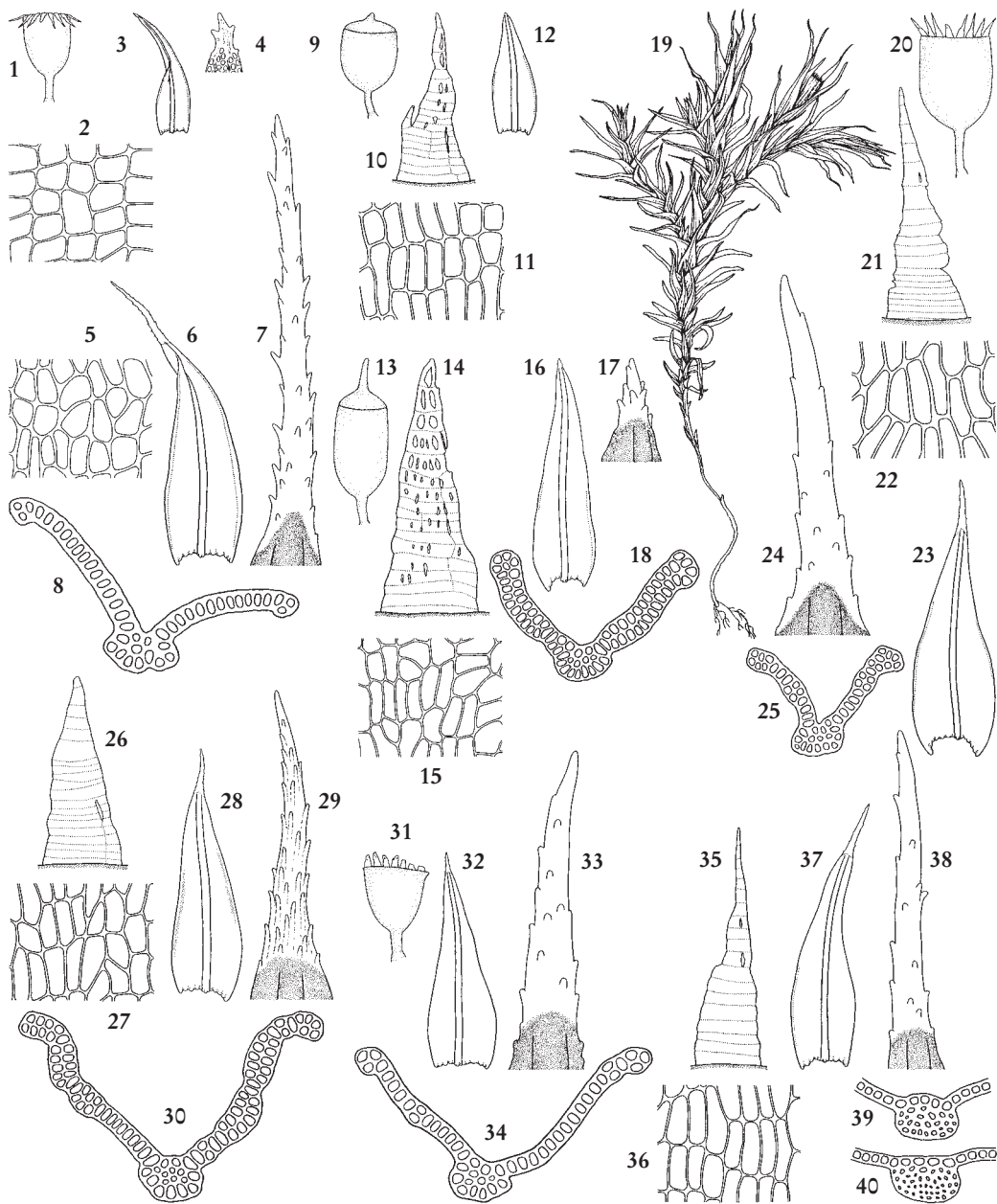


FIGURE 19. 1-4, *Schistidium dupretii*: 1, capsule; 2, exothecial cells; 3, leaf; 4, leaf apex. 5-8, *S. robustum*: 5, exothecial cells; 6, leaf; 7, leaf apex; 8, leaf section. 9-12, *S. confertum*: 9, capsule; 10, peristome tooth; 11, exothecial cells; 12, leaf. 13-18, *S. helveticum*: 13, capsule; 14, peristome tooth; 15, exothecial cells; 16, leaf; 17, leaf apex; 18, leaf section. 19-25, *S. crassipilum*: 19, habit; 20, capsule; 21, peristome tooth; 22, exothecial cells; 23, leaf; 24, leaf apex; 25, leaf section. 26-30, *S. brunnescens* subsp. *griseum*: 26, peristome tooth; 27, exothecial cells; 28, leaf; 29, leaf apex; 30, leaf section. 31-34, *S. brunnescens* subsp. *brunnescens*: 31, capsule; 32, leaf; 33, leaf apex; 34, leaf section. 35-39, *S. elegantulum* subsp. *elegantulum*: 35, peristome tooth; 36, exothecial cells; 37, leaf; 38, leaf apex; 39, nerve section. 40, *S. elegantulum* subsp. *wilsonii*, nerve section. 19 (x4); 1, 9, 13, 20, 31 (x10); 3, 6, 12, 16, 23, 28, 32, 37 (x16); 4, 7, 10, 14, 17, 21, 24, 26, 29, 33, 35, 38 (x100); 2, 5, 8, 11, 15, 18, 22, 25, 27, 30, 34, 36, 39, 40 (x160).



Leaves imbricate, ovate-triangular, lamina irregularly bistratose. Capsule oblong-cylindrical, yellow or orange to brownish, without stomata; peristome teeth reddish orange, strongly perforated to cribose. Grows on dry or wet, calcareous rocks in the lowlands and montane areas. Common in the Peninsula and in Mallorca. Esp, And, Bl.

- 16 Leaf margin of upper leaves denticulate in the upper part (fig. 19, 19-25)

**S. crassipilum** H.H. Blom

Leaves erect to patent, ovate-lanceolate, lamina unistratose or with bistratose spots; upper cells  $\pm$  isodiametric, not or slightly sinuose. Capsule oblong-cylindrical, orange or brownish red, stomata 0-4(-6); peristome teeth gradually tapered in narrow and obtuse apex, reddish. Grows on exposed or shaded rocks, common in montane areas, rarer in the lowlands. Widespread throughout the Peninsula and in Mallorca. Esp, Prt, And, Bl.

- 16 Leaf margin entire 17
- 17 Exothecial cells narrowly oblong with curved walls 18
- 17 Exothecial cells oblong with straight walls, mixed with isodiametric cells 19
- 18 Leaves usually with longitudinal ridge-like striae; nerve 58-90  $\mu$ m wide in the central part; peristome teeth ending in an acute or blunt apex, entire or slightly perforated (fig. 19, 26-30)

**S. brunnescens** Limpr. subsp. **griseum** (Nees & Hornsch.) H.H. Blom

Leaves ovate-lanceolate to ovate-triangular, lamina irregularly bistratose, often bistratose spots, margin plane or recurved in mid-leaf on one or more rarely on both sides, 2-4-stratose. Capsule oblong, orange to brownish red, stomata absent. Grows on calcareous rocks in montane areas and high mountains, in the Pyrenees, Basque Mountains and Cantabrian Mountains. Esp.

- 18 Leaves without longitudinal ridge-like striae; nerve 38-60  $\mu$ m wide in the central part; peristome teeth ending in a blunt apex, strongly perforated (fig. 19, 31-34)

**S. brunnescens** Limpr. subsp. **brunnescens**

**S. apocarpum** (Hedw.) Bruch & Schimp. var. **brunnescens** (Limpr.) Loeske

Leaves oblong, ovate or ovate-triangular, short, lamina unistratose to irregularly bistratose, margin bistratose. Capsule widely ovoid, finely striate, yellow or orange, without stomata. Grows on dry, exposed, calcareous rocks, in montane areas and high mountains, in the Peninsula and in Mallorca. Esp, Prt, Bl.

- 19 Exothecial cells very variable in shape and size; peristome teeth strongly perforated or cribose (fig. 19, 13-18)

**S. helveticum** (Schkuhr) Deguchi

**S. singarense** (Schiffn.) Laz.

Leaves imbricate, ovate-triangular, lamina irregularly bistratose. Leaves and dorsal nerve glossy, hyaline point broad, with obtuse teeth. Capsule oblong-cylindrical, yellow to brownish, without stomata; peristome teeth reddish orange. Grows on dry or wet, calcareous rocks in the lowlands and montane areas. Common in the Peninsula and in Mallorca. Esp, And, Bl.

- 19 Exothecial cells similar in shape and size; peristome teeth entire or slightly perforated

- 20 Hyaline point broad and flattened in the lower part, erecto-patent,  $\pm$  decurrent (fig. 19, 19-25) **S. crassipilum** H.H. Blom  
Leaves erect to patent, ovate-lanceolate, lamina unistratose or with bistratose spots; upper cells  $\pm$  isodiametric, not or slightly sinuose. Capsule oblong-cylindrical, orange or brownish red, stomata 0-4(-6); peristome teeth gradually tapered in narrow and obtuse apex, reddish. Grows on exposed or shaded rocks, common in montane areas, rarer in the lowlands. Widespread throughout the Peninsula and in Mallorca. Esp, Prt, And, Bl.
- 20 Hyaline point circular in cross section, not flattened in the lower part, erect, not decurrent **21**
- 21 Hyaline point narrow, weak, slightly spinulose; peristome teeth orange to reddish, erect to erecto-patent; nerve 55-78  $\mu$ m wide in the lower part, 4-5-stratose (fig. 19, 35-39) **S. elegantulum** H.H. Blom subsp. **elegantulum**  
Leaves ovate lanceolate, acuminate; hair point straight, often yellowish at base. Capsule oblong, orange yellow, with 6-8 stomata; peristome teeth orange, densely papillose in upper part, entire or with narrow slits. Forms tufts on rocks in pinewoods and oakwoods, in the lowlands and montane areas, in the north of the Peninsula and in Mallorca. Esp, Bl.
- 21 Hyaline point stout, finely and densely spinulose; peristome teeth red, erect or patent to squarrose; nerve 75-88  $\mu$ m wide in the lower part, 5-7-stratose (fig. 19, 40) **S. elegantulum** H.H. Blom subsp. **wilsonii** H.H. Blom  
Leaves similar to those to subsp. *elegantulum*. Capsule oblong-cylindrical, orange to light brown, stomata 8-16, often rudimentary. Forms tufts on dry, exposed, calcareous rocks, in the lowlands, in the northeastern part of the Peninsula and in Mallorca, scattered in Portugal. Esp, Prt, Bl.

## Fam. Ptychomitriaceae

### *Campylostelium* Bruch & Schimp.

Plants very small, rarely up to 0,5 cm tall, gregarious. Leaves crisped when dry, linear or linear-lanceolate, apex acute or rounded, margin entire; cells small, quadrate, rectangular at base; nerve percurrent. Seta twisted when dry, curved, cygneous or flexuose when moist; capsule emergent or exerted, ellipsoidal, straight; lid longly rostrate; peristome teeth 16, entire or slightly divided; calyptra mitriform, lobate.

- 1 Capsule emergent, gibbous at base (fig. 20, 1-2) **C. pitardii** (Corb.) E. Maier  
**Grimmia pitardii** Corb.  
Leaves linear, acute, margin plane or recurved on one side; lamina unistratose, basal cells hyaline, longly rectangular, upper cells rounded or quadrate, 6-8  $\mu$ m; nerve percurrent or excurrent. Autoicous. Seta sigmoid; capsule emergent, widely ellipsoidal, smooth, brownish red; peristome teeth perforated, yellow. Forms glossy dark brown cushions, on open, basic soils in the lowlands near coastal areas. Frequent in the eastern half of the Peninsula and in Mallorca and Pithyusic Islands, very rare in the west of the Peninsula. Esp, Prt, Bl.

- 1 Capsule exerted, symmetrical

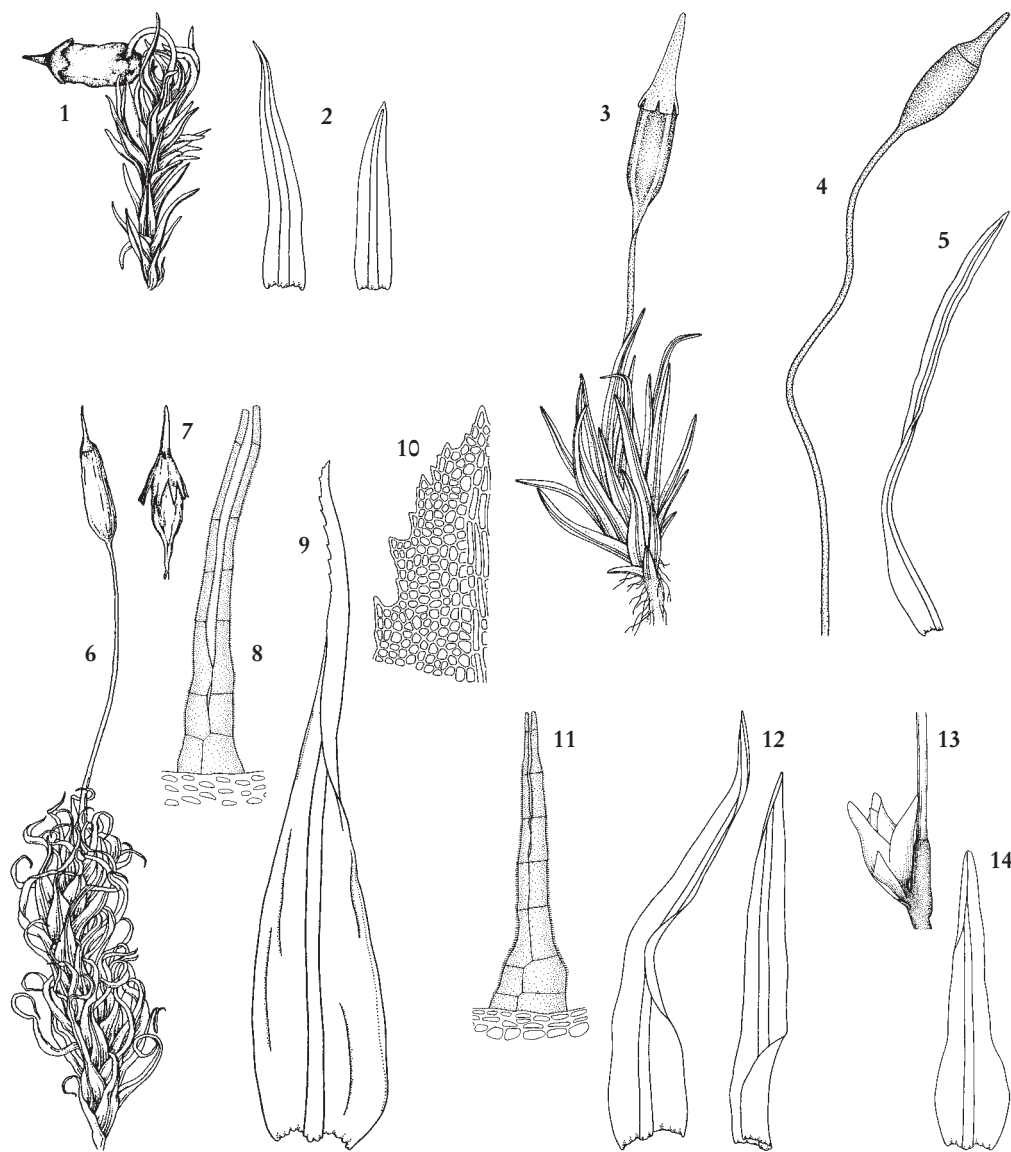


FIGURE 20. 1-2, *Campylostelium pitardii*: 1, habit; 2, leaves. 3, *C. strictum*, habit. 4-5, *C. saxicola*: 4, capsule and seta; 5, leaf. 6-10, *Ptychomitrium polyphyllum*: 6, habit when dry; 7, capsule; 8, peristome tooth; 9, leaf; 10, apical cells. 11-12, *P. nigrescens*: 11, peristome tooth; 12, leaves. 13-14, *P. incurvum*: 13, perigonium; 14, leaf. 6, 7 ( $\times 6$ ); 1, 3, 4 ( $\times 14$ ); 2, 5, 9, 12, 13, 14 ( $\times 18$ ); 10 ( $\times 100$ ); 8, 11 ( $\times 160$ ).

- 2 Seta straight; capsule striate (fig. 20, 3) **C. strictum** Solms  
Grows on shaded, acidic rocks in the lowlands and montane areas. Distributed in the west of the Peninsula. Esp, Prt.
- 2 Seta curved or cygneous; capsule smooth (fig. 20, 4-5) **C. saxicola** (F. Weber & D. Mohr) Bruch & Schimp.  
Capsule narrowly ellipsoidal. Forms patches on shaded, acidic rocks in the lowlands and montane areas. Very rare, only in the north of the Peninsula. Esp.

### **Ptychomitrium** Fürnr.

Plants small to robust. Stem simple or branched. Leaves patent, crisped when dry, lanceolate, flexuose, apex dentate or entire, plicate or not at base, margin plane or recurved at base; lamina bistratose at apex, laminal cells quadrate, smooth, thick-walled, basal cells linear or rectangular; nerve stout, percurrent. Perigonium bud-like, below perichaetium. Capsule exserted, ovoid to cylindrical, slightly striate, rugose when dry; peristome teeth papillose, usually cleft; calyptra mitriform, plicate.

- 1 Plants robust; leaves with dentate apex, plicate at base (fig. 20, 6-10) **P. polyphyllum** (Dicks. ex Sw.) Bruch & Schimp.  
Plants to 4 cm tall. Stem densely branched. Leaves strongly crisped, lanceolate, acuminate; basal cells with strongly thickened longitudinal walls. Peristome teeth deeply bifid. Forms dark green to blackish cushions on exposed, siliceous rocks in montane areas, in the north and northwestern part of the Peninsula, rare in the southwest. Esp, Prt, And.
- 1 Plants small; leaves with entire margin, not plicate at base **2**
- 2 Plants to 1 cm tall; leaf apex acute (fig. 20, 11-12) **P. nigrescens** (Kunze) Wijk & Margad.  
**P. nigricans** Schimp.  
Stem branched. Leaves patent, crisped when dry, linear-lanceolate. Capsule elliptical; peristome teeth with medial, narrow perforations. Forms dense, green turfs, blackish below, on eruptive rocks, in the southwest of the Peninsula. Prt.
- 2 Plants to 0,5 cm tall; leaf apex obtuse (fig. 20, 13-14) **P. incurvum** (Schwägr.) Spruce  
Stem simple. Leaves erect to patent, with cucullate apex, incurved toward stem. Capsule ovoid. Forms brownish green to blackish turfs on siliceous rocks, in montane areas, in the western Pyrenees. Figures are from a Basse Pyrénées (France) specimen. Esp (Extinct).

### **Fam. Seligeriaceae**

#### **Blindia** Bruch & Schimp.

Leaves spreading, sometimes secund, concave, lanceolate, straight, wide at base and gradually narrowed into long subula; laminal cells narrowly rectangular, smooth, alar cells

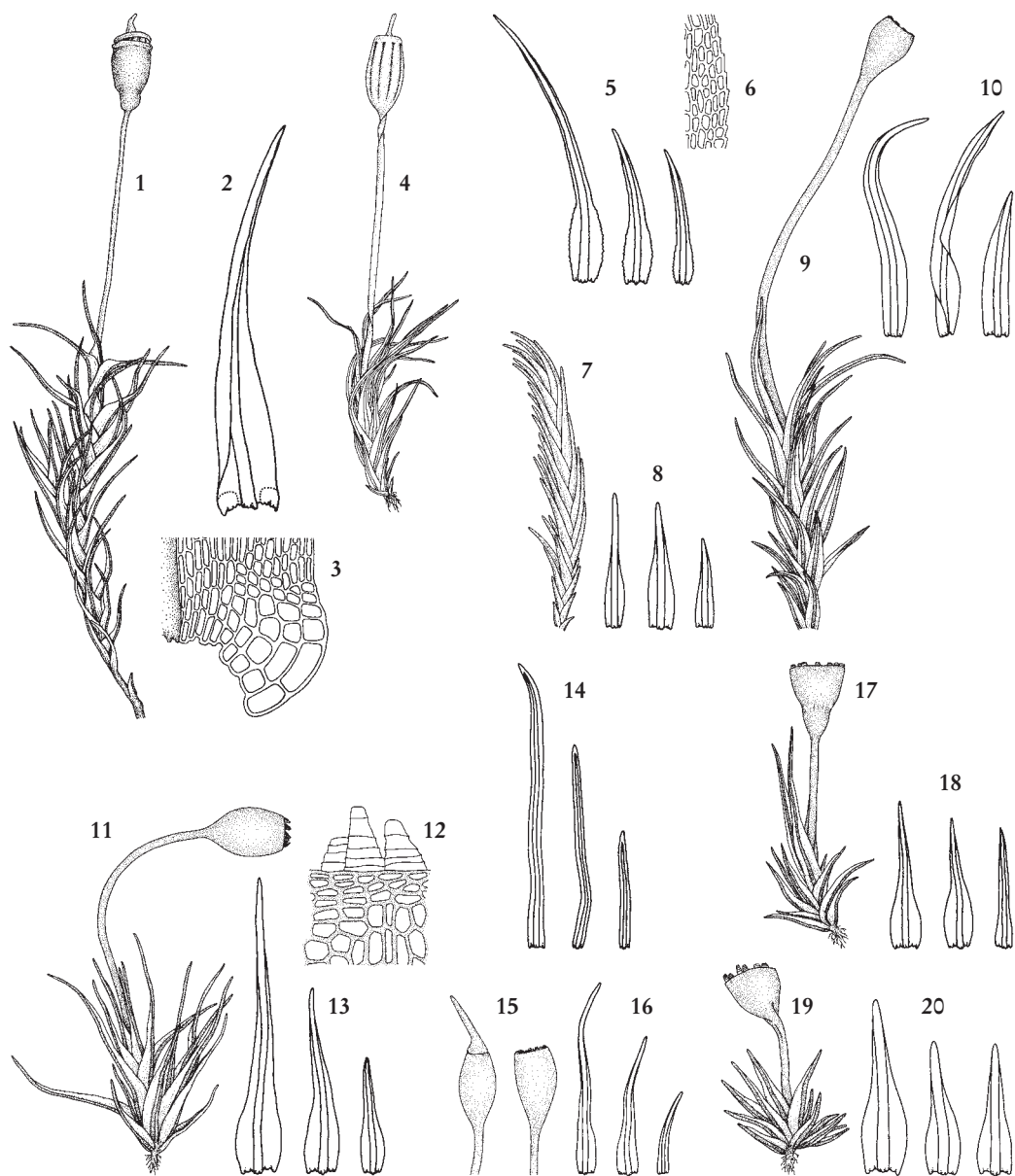


FIGURE 21. 1-3, *Blindia acuta*: 1, habit; 2, leaf; 3, alar cells. 4, *Brachydontium trichodes*, habit. 5-6, *Seligeria donniana*: 5, leaves; 6, marginal cells. 7-8, *S. patula*: 7, habit; 8, leaves. 9-10, *S. trifaria*: 9, habit; 10, leaves. 11-13, *S. recurvata*: 11, habit; 12, peristome; 13, leaves. 14, *S. pusilla*, leaves. 15-16, *S. calycina*: 15, capsules; 16, leaves. 17-18, *S. acutifolia*: 17, habit; 18, leaves. 19-20, *S. calcarea*: 19, habit; 20, leaves. 1 ( $\times 7.5$ ); 4, 7, 9, 11, 15, 17, 19 ( $\times 15$ ); 2, 5, 8, 10, 13, 14, 16, 18, 20 ( $\times 25$ ); 3, 6, 12 ( $\times 150$ ).

differentiated, orange to reddish; nerve excurrent. Capsule pyriform; lid rostrate; peristome teeth 16, usually perforated (fig. 21, 1-3)

**B. acuta** (Hedw.) Bruch & Schimp.

Forms glossy, dark green to blackish, dense or compact turfs, to 4 cm tall, on seeping acidic rocks or by springs and streams, in montane areas and high mountains of the northern half of the Peninsula and in Sierra Nevada. Esp, Prt, And.

### **Brachydontium Fürnr.**

Plants very small, 1-2 mm tall. Leaves ovate-lanceolate, longly tapering to subula; margin entire; nerve excurrent; upper cells quadrate, basal cells rectangular. Seta flexuose when dry; capsule ovoid or ellipsoidal, striate; peristome of 16 short, hyaline, finely papillose teeth; calyptra mitriform (fig. 21, 4)

**B. trichodes** (F. Weber) Milde

Forms small patches dull green or yellow brown on damp, shaded acidic or basic rocks. Very rare in north and northeast of the Peninsula, from the lowlands to the montane areas. Esp, Prt (Extinct).

### **Seligeria Bruch & Schimp.**

Plants very small, usually of a few millimetres, mostly growing on damp, shaded, basic rocks, common on ceilings of caves. Leaves linear to lanceolate; laminal cells quadrate, rhomboidal or rectangular to ovoid. Seta straight or curved; capsule exserted, straight, ellipsoidal or pyriform, often turbinate when mature; peristome present or lacking, when present with 16, sometimes truncate teeth; calyptra cucullate.

- 1 Peristome lacking; leaf margin denticulate at base (fig. 21, 5-6)

**S. donniana** (Sm.) Müll.Hal.

Plants light green or yellowish. Leaf lamina reduced; nerve stout, excurrent. Perichaetial leaves much shorter than seta. Seta straight. Solitary or forming loose turfs on shaded, calcareous rocks, in northern montane areas. Esp.

- 1 Peristome present; leaf margin entire or nearly so 2

- 2 Leaves arranged in three rows; nerve bistratose 3

- 2 Leaves arranged in more than three rows; nerve tristratose or pluristratose 4

- 3 Spores 16-21  $\mu\text{m}$ , finely papillose; nerve cells on ventral side 6-9  $\mu\text{m}$  wide, 4-6  $\mu\text{m}$  wide on dorsal side (fig. 21, 7-8)

**S. patula** (Lindb.) I. Hagen

**S. alpestris** T. Schauer

Plants dark green or brownish. Leaves lanceolate-subulate. Capsule turbinate. Grows on wet, calcareous rocks in caves. Very localized in the Basque Mountains and in the Iberian Range. Esp.

- 3 Spores 24-32  $\mu\text{m}$ , strongly papillose; nerve cells on ventral side 8-11  $\mu\text{m}$  wide, 6-8  $\mu\text{m}$  wide on dorsal side (fig. 21, 9-10)

**S. trifaria** (Brid.) Lindb.

Grows on wet, calcareous rocks. Very localized in the Basque Mountains and in the Iberian Range. Esp.

- 4 Seta curved, straight when dry (fig. 21, 11-13) **S. recurvata** (Hedw.) Bruch & Schimp.  
Nerve longly excurrent. Perichaetial leaves sheathing, longer than stem leaves. Capsule ellipsoidal, turbinate when dry. Forms small, dense, yellowish green or dark green turfs on carbonate-poor rocks, in northern and northeastern montane areas. Esp.
- 4 Seta always straight 5
- 5 Leaves linear, acuminate; nerve not excurrent (fig. 21, 14) **S. pusilla** (Hedw.) Bruch & Schimp.  
Plants light green. Lamina visible to apex; upper cells rectangular. Perichaetial leaves similar to vegetative leaves, shorter than seta. Forms loose or dense turfs on shaded, calcareous rocks, in montane areas of the north and east of the Peninsula and Mallorca. Esp, Bl.
- 5 Leaves lanceolate, subulate; nerve excurrent 6
- 6 Capsule ellipsoidal, longly attenuate at base, narrowed at mouth when empty (fig. 21, 15-16) **S. calycina** Mitt. ex. Lindb.  
Leaves linear-lanceolate, gradually tapered, subulate. Perichaetial leaves similar to vegetative leaves. Grows on shaded rocks. Very rare, in the west of the Peninsula. Prt.
- 6 Capsule globose or ovoid, shortly attenuate at base, with wide mouth when empty 7
- 7 Apical cells of nerve rectangular on ventral side, 3 or more times as long as wide (fig. 21, 17-18) **S. acutifolia** Lindb.  
Plants light green. Laminal cells rectangular. Perichaetial leaves much longer than stem leaves, lanceolate, acute to subulate, with ovate, sheathing base, more than half length of seta, sometimes reaching the capsule base. Spores 10-11  $\mu\text{m}$ . Grows on wet, shaded, calcareous rocks. Forms dense, light green turfs in northern and eastern montane areas. Esp.
- 7 Apical cells of nerve oblong on ventral side, to 3 times as long as wide (fig. 21, 19-20) **S. calcarea** (Hedw.) Bruch & Schimp.  
Plants rigid, dark green. Leaves abruptly tapered; laminal cells ovate. Perichaetial leaves similar to vegetative leaves, much shorter than seta. Spores 12-17  $\mu\text{m}$ . Grows on wet, shaded, calcareous rocks, in the east and north of the Peninsula. Esp.

## O. Archidiales

### Fam. Archidiaceae

#### Archidium Brid.

Plants 1-1,5 cm high, mostly perennial, stem innovating from below perichaetia. Leaves lanceolate, apex finely denticulate; median cells rhomboidal or linear, basal cells rectangular, alar cells quadrate; nerve percurrent to excurrent. Perichaetial leaves larger than stem leaves, with sheathing base. Capsule immersed, globose, indehiscent, pellucid; spores 16-20, angulate, 100-200  $\mu\text{m}$  (fig. 22, 1) **A. alternifolium** (Hedw.) Mitt.

Forms lax or dense turfs on very moist, temporarily waterlogged soils, by lakes, streams or in hollows. Scattered in the Peninsula and Menorca. Esp, Prt, Bl.

## O. Dicranales Fam. Fissidentaceae

### Fissidens Hedw.

Plants a few millimetres to 12 cm long. Stem simple or slightly branched. Leaves distichous, consisting of 3 parts: conduplicate part or sheathing lamina, apical lamina and dorsal lamina (fig. 15, 6), with unistratose or pluristratose margin; laminal cells  $\pm$  hexagonal in upper part, border of narrow, elongated cells in some species; nerve ending below apex to excurrent in short apiculus. Sporophyte lateral or terminal. Capsule straight or inclined, symmetrical or asymmetrical; peristome single, reddish to brownish, teeth divided to middle or with short and truncate teeth.

Due to the high number of sterile specimens in our territory, it is sometimes really difficult to separate the different species, especially when the gametophytic characters are very variable as in *F. viridulus* and *F. pusillus*.

- 1 Leaves with the conduplicate part 1/4-1/3 of leaf length (fig. 22, 2-3)

**F. fontanus** (Bach.Pyl.) Steud.

**Octodiceras fontanum** (Bach.Pyl.) Lindb.

Plants large, soft, 6-12 cm length, mostly branched. Leaves distant, linear, with obtuse and fragile apex, margin entire; marginal cells 8  $\mu$ m wide, smaller than median cells, cells towards nerve 15-20  $\mu$ m wide; nerve ending below apex. Sporophyte lateral, on axillary branches. Seta short and fragile; capsule ovoid; peristome imperfect, with short and truncate teeth. Forms dark patches on submerged rocks in quiet or slow-flowing waters, in the lowlands and montane areas. Scattered localities in the Peninsula and in Mallorca and Menorca. Esp, Prt, Bl.

- 1 Leaves with the conduplicate part 1/2 of leaf length 2
- 2 Leaves with border of narrow, elongated cells, at least in some lamina part 3
- 2 Leaves without border of narrow, elongated cells 16
- 3 Leaf border 4-10  $\mu$ m wide, of 1-2 rows of cells, incomplete in depauperate specimens, often not reaching the leaf base (fig. 22, 4-7) 
**F. crispus** Mont.  
**F. limbatus** Sull.

Plants 0,3-1 cm long, with 5-7(-15) leaf pairs. Leaves oblong, 0,5-2 x 0,15-0,6 mm, apex obtuse, mucronate, border hyaline, confluent with nerve at leaf apex (in small or depauperate plants, border only present, and sometimes even incomplete, in the conduplicate part); conduplicate part with intralaminar border at base; laminal cells 6-9 x 4-6  $\mu$ m. Capsule curved; spores 7-18  $\mu$ m. Species very variable. Grows on shaded, wet rocks and sandy or loamy, rarely damp soils. Widespread in the Peninsula, Mallorca and Menorca. Esp, Prt, Bl.

- 3 Leaf border more than 10  $\mu$ m wide, of more than 2 rows of cells, often reaching the leaf base 4
- 4 Dorsal lamina not reaching the base, border reaching the leaf base (fig. 22, 8) 
**F. ovatifolius** R. Ruthe



Plants 0,3-0,5 cm long, with up to 9 leaf pairs. Leaves widely elliptical to oblong, apex obtuse to broadly acute, often apiculate, border 12-24  $\mu\text{m}$  wide, nearly reaching apex, of 3-4 rows of linear cells; lamina occasionally pluristratose towards nerve, cells 4-7 x 3-6  $\mu\text{m}$ , often mamilllose on both sides; nerve ending near apex. Capsule inclined or oblique; spores 12-13  $\mu\text{m}$ . Grows on soils and in wet rock crevices, rarely on rocks, in the lowlands. Rare, in the northeast and the west of the Peninsula and in Mallorca and Menorca. Esp, Prt, Bl.

- 4 Dorsal lamina reaching the base (except occasionally in *F. crassipes*), border reaching the leaf base 5

- 5 Leaves gradually narrowed into acuminate apex; cells twice as long as wide (fig. 22, 9) **F. curvatus** Hornsch.

**F. algarvicus** Solms

Plants small, 0,2-0,3 cm long. Leaves narrowly lanceolate, acuminate. Grows on wet slopes and rocks in the lowlands. Scattered localities mainly in the northeastern and southwestern part of the Peninsula. Esp, Prt.

- 5 Leaves abruptly narrowed into acute, obtuse or apiculate apex; cells as long as wide 6

- 6 Leaf border not reaching the apex 7

- 6 Leaf border reaching the apex 11

- 7 Margin of conduplicate part bistratose or pluristratose 8

- 7 Margin of conduplicate part unistratose 9

- 8 Conduplicate part narrow at base, with intralaminar margin (row of quadrate chlorophyllose cells outside border of linear cells); border brown or reddish, 10-23  $\mu\text{m}$  wide (fig. 22, 10-12) **F. crassipes** Wilson ex Bruch & Schimp.

Forms turfs on wet or  $\pm$  submerged rocks and by streams, in the lowlands and montane areas. Widespread throughout the Peninsula and in Mallorca and Menorca. Esp, Prt, Bl.

subsp. **crassipes** (*F. crassipes* Wilson ex Bruch & Schimp. var. *rufipes* Schimp.): Plants up to 3 cm. Leaves usually elliptical, apex acute; cells 9-23(26) x 6-12  $\mu\text{m}$ . Peristome teeth width 51-86  $\mu\text{m}$  at base. Archegonia length 420-660  $\mu\text{m}$ . Frequent in the western part of the Peninsula.

subsp. **warnstorffii** (M. Fleisch.) Brugg.-Nann.: Plants 0.5-4 cm long. Leaves usually oblong, less often elliptical, dorsal lamina occasionally not reaching the base, apex obtuse to broadly acute often with a weak apiculus, sometimes more narrowly acute; cells (7-)9-18 x 6-11  $\mu\text{m}$ . Peristome teeth width 37-49 (60)  $\mu\text{m}$  at base. Archegonia length 280-420  $\mu\text{m}$ . Frequent in the eastern part of the Peninsula, also recorded from Mallorca and Menorca. (fig. 22, 10-12).

- 8 Conduplicate part wide at base, without intralaminar margin; border orange to reddish, conspicuous, 12-24  $\mu\text{m}$  wide (fig. 22, 13-14) **F. rufulus** Bruch & Schimp.

Plants 0,5-2 cm long, branched; rhizoids reddish brown, in the leaf axils. Leaves making an angle with the stem of 60°, short and wide, oblong-lanceolate to lingulate, apex broad and obtuse; median cells of dorsal lamina 7-8 x 10(-13)  $\mu\text{m}$ ; nerve orange to reddish, percurrent; dorsal lamina very narrow at base. Peristome teeth 43-66  $\mu\text{m}$  wide at base; spores 18-26  $\mu\text{m}$ . Forms loose turfs on wet or submerged calcareous rocks. Rare, in the north of the Peninsula. Esp. May be confused with *F. crassipes* and with small forms of *F. pusillus*.

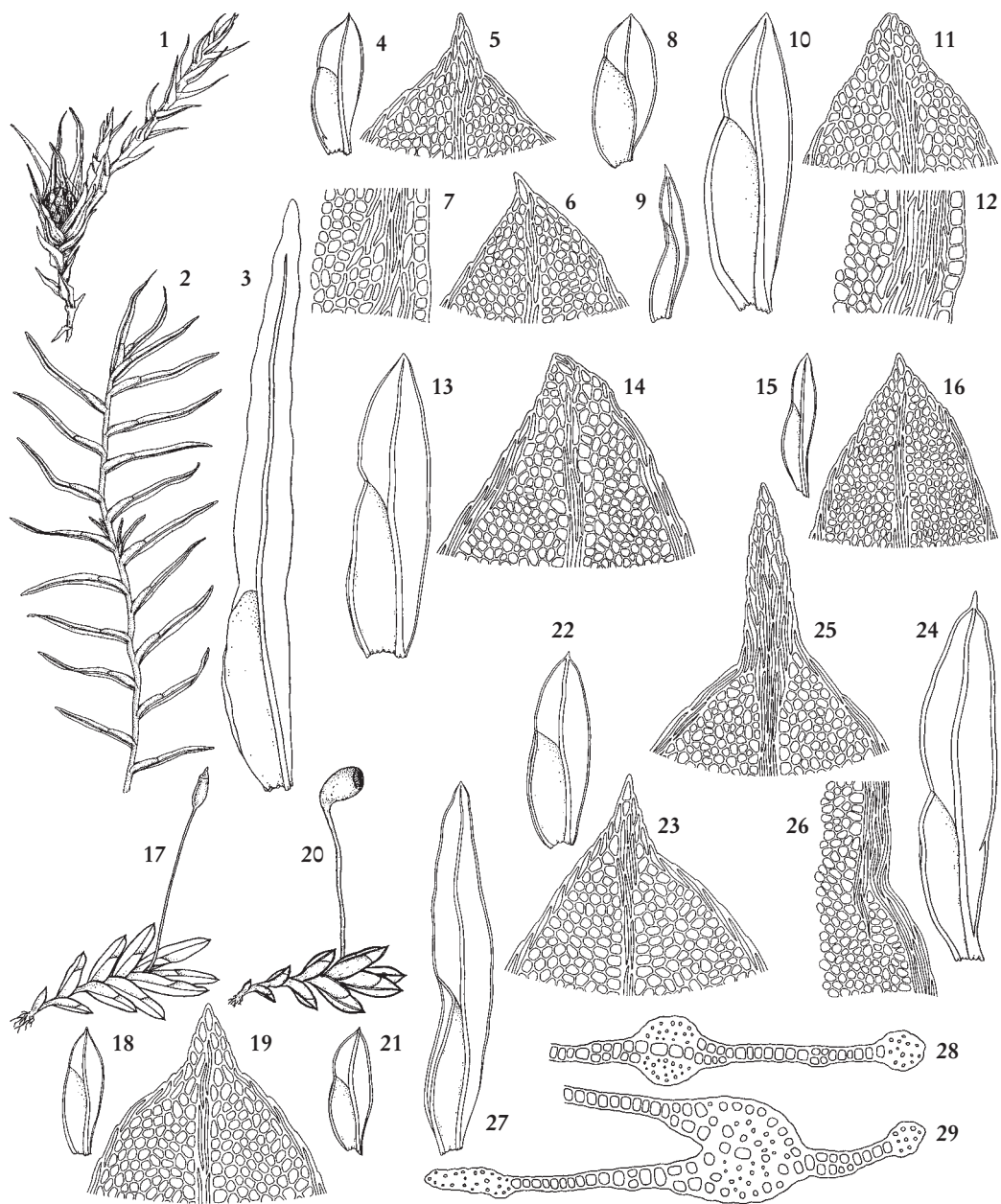


FIGURE 22. 1, *Archidium alternifolium*, habit. 2-3, *Fissidens fontanus*: 2, habit; 3, leaf. 4-7, *F. crispus*: 4, leaf; 5, leaf apex; 6, leaf apex, small plant; 7, basal margin of sheathing lamina. 8, *F. ovatifolius*, leaf. 9, *F. curvatus*, leaf. 10-12, *F. crassipes* subsp. *warnstorffii*: 10, leaf; 11, leaf apex; 12, basal margin of sheathing lamina. 13-14, *F. rufulus*: 13, leaf; 14, leaf apex. 15-16, *F. pusillus*: 15, leaf; 16, leaf apex. 17-19, *F. viridulus* var. *viridulus*: 17, habit; 18, leaf; 19, leaf apex. 20-21, *F. viridulus* var. *incurvus*: 20, habit; 21, leaf. 22-23, *F. bryoides* var. *bryoides*: 22, leaf; 23, leaf apex. 24-26, *F. rivularis*: 24, leaf; 25, leaf apex; 26, margin in the middle of the dorsal lamina. 27-29, *F. jansenii*: 27, leaf; 28, leaf section in the upper part; 29, section in the middle of leaf. 2 ( $\times 3$ ); 17, 20 ( $\times 5$ ); 1 ( $\times 8$ ); 3, 4, 8, 9, 10, 13, 15, 18, 21, 22, 24, 27 ( $\times 16$ ); 5, 6, 7, 11, 12, 14, 16, 19, 23, 25, 26, 28, 29 ( $\times 160$ ).

- 9 Leaves narrowly lanceolate, 6-8 times as long as wide

**F. gracilifolius** Brugg.-Nann. & Nyholm

**F. viridulus** (Sw.) Wahlenb. var. **tenuifolius** (Boulay) A.J.E. Sm.

Plants 0,2-0,4 cm long, with 2-5 leaf pairs. Leaves ending in sharp point; median cells of dorsal lamina 6-14  $\mu\text{m}$ . Seta yellow; capsule erect or slightly inclined; peristome teeth 24-39  $\mu\text{m}$  wide at base. Forms lax turfs on wet or moist basic rocks, mostly non-hydrophilous, in the north of the Peninsula. Esp.

- 9 Leaves lanceolate, 4-6 times as long as wide

10

- 10 Plants saxicolous, with 5-8(-10) leaf pairs (fig. 22, 15-16) **F. pusillus** (Wilson) Milde.

Plants 0,2-0,7(-0,8) cm long. Leaves lanceolate, border often incomplete, not exceeding the middle of dorsal lamina, apex broadly acute or obtuse and apiculate; median cells of dorsal lamina lax, 6-10  $\mu\text{m}$  wide. Antheridia terminal. Seta yellow; capsule nearly straight or oblique; peristome teeth 30-47  $\mu\text{m}$  at base; spores 10-18  $\mu\text{m}$ . Grows on wet or submerged siliceous rocks. Scattered localities, mainly in the north and west of the Peninsula and in Menorca. Esp, Prt, Bl.

- 10 Plants terricolous, with 4-8 leaf pairs (fig. 22, 17-19)

**F. viridulus** (Sw. ex anon.) Wahlenb. var. **viridulus**

**F. bambergi** Milde

Plants to 0,6 cm long. Leaves with obtuse, apiculate apex and border lacking or reduced, or leaves acuminate and border narrow, 4-11  $\mu\text{m}$  wide, hyaline or yellowish, nearly confluent with nerve (in well-developed plants). Monoicous plants with antheridia in basal branches, in dioicous plants antheridia in terminal branches. Capsule symmetrical, straight; spores 8-15  $\mu\text{m}$ . Grows on damp, clayey soils mainly in the lowlands. Widespread throughout the Peninsula and in Mallorca, Menorca and Pithyusic Islands. Esp, Prt, Bl.

- 11 Capsule asymmetrical, incurved (fig. 22, 20-21)

**F. viridulus** (Sw. ex anon.) Wahlenb. var. **incurvus** (Starke ex Röhl) Waldh.

**F. incurvus** Röhl.

Plants 0,3-0,5(-0,9) cm long, with 5-10 leaf pairs. Leaves with short apiculus, dorsal lamina border unistratose, 7-15  $\mu\text{m}$  wide, hyaline, conduplicate part border pluristratose; cells 8-10  $\mu\text{m}$  wide. Antheridia terminal or in basal branches. Spores 10-15(-18). Grows on wet slopes and soils in the lowlands. Widespread throughout the Peninsula and in Mallorca, Menorca and Pithyusic Islands. Esp, Prt, Bl.

- 11 Capsule symmetrical, straight or inclined

12

- 12 Cells in the middle of the dorsal lamina 10-18 (20)  $\mu\text{m}$  wide; border, nerve and cell walls dull reddish brown

**F. monguillonii** Thér.

Plants 0,5-1,5 cm long. Leaves lanceolate, acute, mucronate, with unistratose base, border 10-19  $\mu\text{m}$  wide, 2-3-stratose. Perichaetial leaves very narrow. Antheridia in axillary buds. Forms loose, dark green turfs by streams and in river-beds with slow-flowing waters. Scattered localities in the northern half of the Peninsula. Esp.

- 12 Cells in the middle of the dorsal lamina to 10  $\mu\text{m}$  wide; border, nerve and cell walls green

13

- 13 Border of dorsal lamina up to 19  $\mu\text{m}$  wide at middle, unistratose, colourless 14
- 13 Border of dorsal lamina more than 20  $\mu\text{m}$  wide at middle, pluristratose, yellow or brownish red 15
- 14 Spores 10-14  $\mu\text{m}$ ; capsules erect; rhizoids brown (fig. 22, 22-23)  
**F. bryoides** Hedw. var. **bryoides**  
 Plants 0,3-0,8 cm long, with up to 12 leaf pairs. Leaves green, of similar size, border in mature leaves commonly unistratose, but 2-3-stratose not rare. Antheridia in axillary buds. Seta red. Grows on clayey soils and wet slopes, on acid or basic substrata, in the lowlands and montane areas. Widespread throughout the Peninsula and in Mallorca and Pithyusic Islands. Esp, Prt, Bl.
- 14 Spores 14-19  $\mu\text{m}$ ; capsules inclined; rhizoids red or purplish  
**F. bryoides** Hedw. var. **caespitans** Schimp.  
**F. curnovii** Mitt.  
 Plants 0,5-2 cm long, with up to 25 leaf pairs. Leaves oblong to elliptical, glaucous and shiny, border of mature leaves 2-3-stratose. Fertile plants small with only 3-4 pairs of leaves. Capsules rarely erect. Forms turfs on wet, acidic soils and rocks and by streams, in the north and west of the Peninsula. Esp, Prt.
- 15 Border 20-30(-35)  $\mu\text{m}$  wide; leaf apex mostly longly mucronate or apiculate; antheridia in axillary buds (fig. 22, 24-26) **F. rivularis** (Spruce) Schimp.  
 Plants 0,5-1,5 cm long. Leaves with yellowish border, branched in the middle, not reaching the base of dorsal lamina; laminal cells 6-8 (10)  $\mu\text{m}$  wide. Antheridia terminal, rare. Spores 14-20  $\mu\text{m}$ , dark green. Grows on moist soils and rocks by streams, in the northern half of the Peninsula. Esp, Prt.
- 15 Border 25-62  $\mu\text{m}$  wide; leaf apex bluntly acute to obtuse-mucronate; antheridia terminal (fig. 22, 27-29) **F. jansenii** Sérgio & Pursell  
 Plants rigid, 0,8-1,1 cm long, dark green, blackish in older parts. Border yellow to brown-red, 3-5 (8) cells thick, not reaching the base of dorsal lamina; laminal cells 8-10  $\mu\text{m}$  wide. Spores 23-31  $\mu\text{m}$ . Rheophilous, growing on vertical rocks at the edge of waterfalls or in rock crevices in stream, only in Serra da Estrela. Prt.
- 16 Plants to 0,3 cm long; leaf margin crenulate; nerve ending near apex **F. exilis** Hedw.  
 Plants with 2-4 leaf pairs. Dorsal lamina not reaching the leaf base; laminal cells 8-12  $\mu\text{m}$  wide, smooth; nerve straight. Grows on wet rocks. Scattered localities in the north and east of the Peninsula. Esp, Prt.
- 16 Plants mostly more than 1 cm long; leaf margin entire, denticulate or dentate; nerve ending near apex or excurrent 17
- 17 Leaf margin entire towards apex (fig. 23, 1) **F. grandifrons** Brid.  
 Plants robust, to 10 cm or more. Leaves rigid, oblong-lanceolate, nearly linear, apex obtuse; 2-3-stratose. Grows on basic rocks in waterfalls or submerged, from the lowlands to high mountains. Widespread in the northern half and east of the Peninsula. Esp, Prt.
- 17 Leaf margin denticulate or dentate towards apex 18

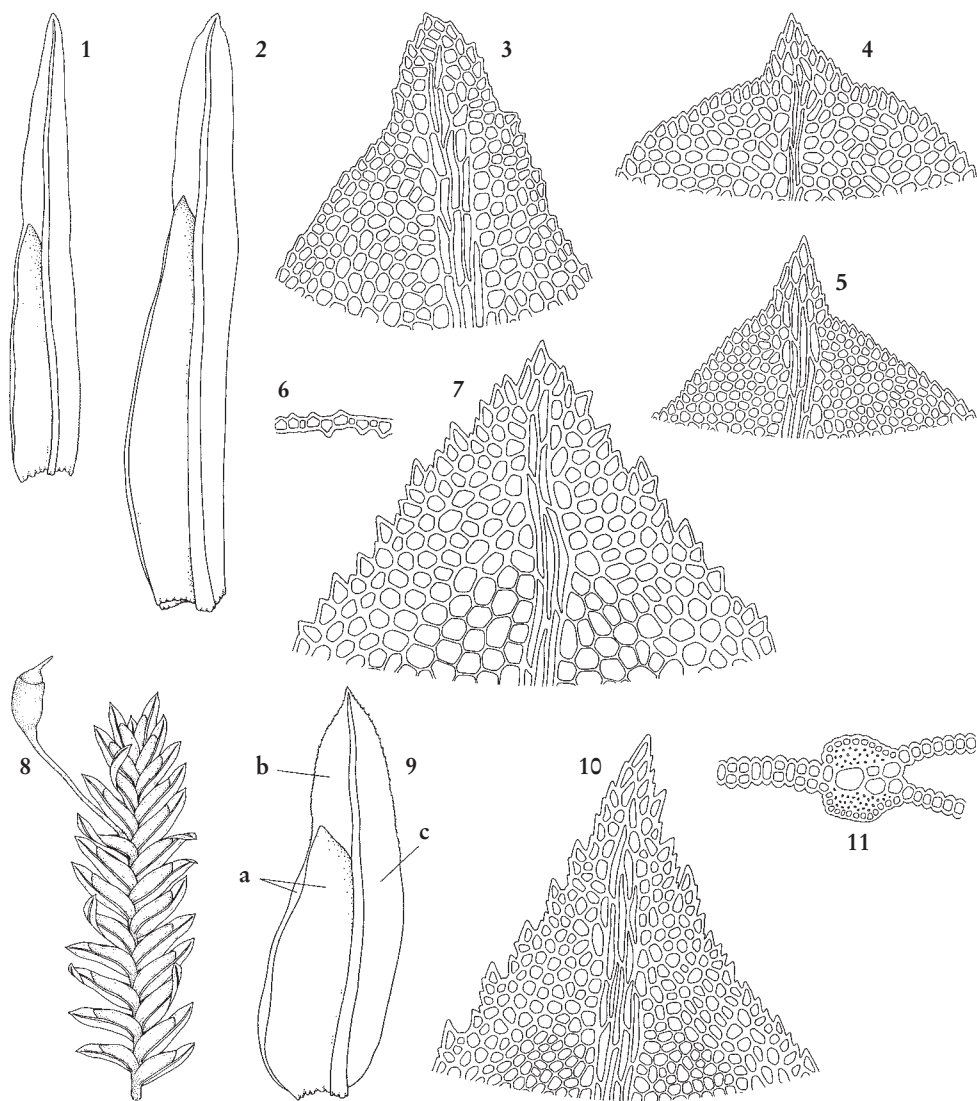


FIGURE 23. 1, *Fissidens grandifrons*, leaf. 2-3, *F. polyphyllus*: 2, leaf; 3, leaf apex. 4, *F. osmundoides*, leaf apex. 5, *F. taxifolius*, leaf apex. 6, *F. serrulatus*, lamina section. 7, *F. adianthoides*, leaf apex. 8-11, *F. dubius*: 8, habit; 9, leaf: (a) sheathing lamina, (b) apical lamina, (c) dorsal lamina; 10, leaf apex; 11, nerve section. 8 ( $\times 3$ ); 1, 2, 9 ( $\times 16$ ); 3, 4, 5, 6, 7, 10, 11 ( $\times 160$ ).

- 18 Leaves with marginal cells not differentiated or with 1 row of paler marginal cells 19
- 18 Leaves with 2-5 rows of paler marginal cells 21
- 19 Plants 5-20 cm long; leaves longly and narrowly lingulate-lanceolate (fig. 23, 2-3)  
**F. polyphyllus** Wilson ex Bruch & Schimp.  
 Plants often branched. Leaves with single marginal row of smaller, but not pale cells, margin entire, finely and obscurely denticulate towards apex with irregular teeth; laminal cells smooth, 8-12  $\mu\text{m}$  wide. Grows on wet or submerged rocks, in the lowlands and montane areas. In the north and northwestern part of the Peninsula. Esp, Prt.
- 19 Plants to 2 cm long; leaves oblong-lingulate or oblong-lanceolate 20
- 20 Leaves short, wide, oblong-lingulate, obtuse or apiculate; nerve percurrent; upper cells 10-14(-18)  $\mu\text{m}$  wide; sporophyte terminal (fig. 23, 4) **F. osmundoides** Hedw.  
 Leaves with a single row of smaller marginal cells, margin regularly and finely serrulate. Seta purplish. Grows on rocks and slopes by streams in montane areas and high mountains. Widespread in the northern part of the Peninsula. Esp, Prt, And.
- 20 Leaves long, oblong-lanceolate, broadly acute; nerve stout, excurrent in mucro; upper cells 6-10  $\mu\text{m}$  wide; sporophyte lateral (fig. 23, 5) **F. taxifolius** Hedw.  
 Leaves sometimes with 1 row of slightly paler marginal cells. Grows on moist slopes in the lowlands and montane areas. Widespread throughout the Peninsula and in Mallorca, Menorca and Pityusic Islands. Esp, Prt, Bl.
- 21 Upper cells of leaf conically mamilllose (fig. 23, 6) **F. serrulatus** Brid.  
 Leaves strongly dentate with irregular teeth in the upper part, finely denticulate below; cells 10-15  $\mu\text{m}$  wide. Sporophyte terminal. Grows on stream margins and damp soils and rocks, in the lowlands and montane areas. Widespread in the north and west of the Peninsula. Esp, Prt.
- 21 Upper cells of leaf bulging but not mamilllose 22
- 22 Upper cells of lamina hexagonal, 12-20  $\mu\text{m}$  wide; dorsal lamina unistratose; 2-4 rows of marginal cells forming a pale, slightly distinct band (fig. 23, 7)  
**F. adianthoides** Hedw.  
 Leaf margin sharply and irregularly dentate in upper part, teeth unicellular. Sporophyte lateral. Grows on seeping rocks and damp soil by streams in montane areas and high mountains, in the northern half of the Peninsula and in Sierra Nevada. Esp, Prt, And.
- 22 Upper cells of lamina rounded, 6-12  $\mu\text{m}$  wide; dorsal lamina irregularly bistratose; 4-5 rows of marginal cells forming a pale, strongly distinct band (fig. 23, 8-11)  
**F. dubius** P. Beauv.  
**F. cristatus** Wilson ex Mitt.  
 Margin irregularly dentate towards apex, teeth sometimes composed of more than one cell. Sporophyte lateral. Grows on calcareous slopes, in calcareous rock crevices and at tree bases, in the lowlands and montane areas. Widespread in the northern part of the Peninsula and in Mallorca and Menorca, rarer in the south of the Peninsula. Esp, Prt, And, Bl.



**Fam. Ditrichaceae****Ceratodon Brid.**

Leaves erecto-patent, ovate-lanceolate, apex slightly denticulate, margin recurved; median cells  $\pm$  quadrate, smooth, basal cells rectangular; nerve stout, percurrent or excurrent. Capsule cylindrical, sulcate when dry,  $\pm$  strumose, annulus of large cells; peristome brownish red, teeth 16, divided to base, papillose and often with a paler border (fig. 24, 1-5)

**C. purpureus** (Hedw.) Brid.

Forms dense, green or reddish turfs to 2 cm high, on exposed soils. Widespread in montane areas and high mountains of the Peninsula. Esp, Prt, And.

subsp. **purpureus**: Capsule inclined or horizontal, strumose, strongly sulcate when dry. (fig. 24, 1-5)

subsp. **stenocarpus** (Bruch & Schimp. ex Müll.Hal.) Dixon (*C. conicus* (Hampe) Lindb.): Capsule straight or nearly so,  $\pm$  strumose, slightly sulcate when dry.

**Cheilothela Broth.**

Plants to 2 cm tall. Leaves erecto-patent, rigid, lanceolate, gradually tapering, appressed when dry, margin plane, crenulate; lamina bistratose, median cells isodiametric, 6-8  $\mu$ m, strongly papillose, basal cells rectangular, smooth; nerve broad, excurrent (fig. 24, 6-7)

**C. chloropus** (Brid.) Broth.

Forms dense, green to glaucous turfs on basic soils in the lowlands, in the southern half of the Peninsula and in Mallorca and Menorca, sporadic in the northwest and northeast. Esp, Prt, Bl.

**Distichium Bruch & Schimp.**

Plants slender, 3-5 cm tall. Leaves distichous, basal part broad and sheathing, abruptly narrowed into long and papillose subula; nerve excurrent. Capsule cylindrical or ovoid, straight or inclined; peristome teeth divided or perforated.

- 1 Capsule cylindrical, straight or slightly inclined; spores 17-22  $\mu$ m; paroicous (fig. 24, 8-9) **D. capillaceum** (Hedw.) Bruch & Schimp.

Leaf subula rigid and reflexed; laminal cells rectangular, basal cells narrower; nerve excurrent. Forms dark green turfs on seeping calcareous rock and schists. Common in montane areas and high mountains of the Peninsula, rarer in Mallorca. Esp, And, Bl.

- 1 Capsule ovoid, inclined; spores 30-40  $\mu$ m; autoicous **D. inclinatum** (Hedw.) Bruch & Schimp.

Leaf subula long, thin, erect and flexuose. Similar to *D. capillaceum*, it is hard to differentiate when the plant has no sporophytes. Grows on calcareous rocks and schists, in the Pyrenees, Basque Mountains and Sierra Nevada. Rare. Esp, And.

**Ditrichum Hampe**

Plants small to medium-sized. Stem unbranched to slightly branched, tomentose or not. Leaves lanceolate from broad base, apex acute to obtuse, gradually or abruptly

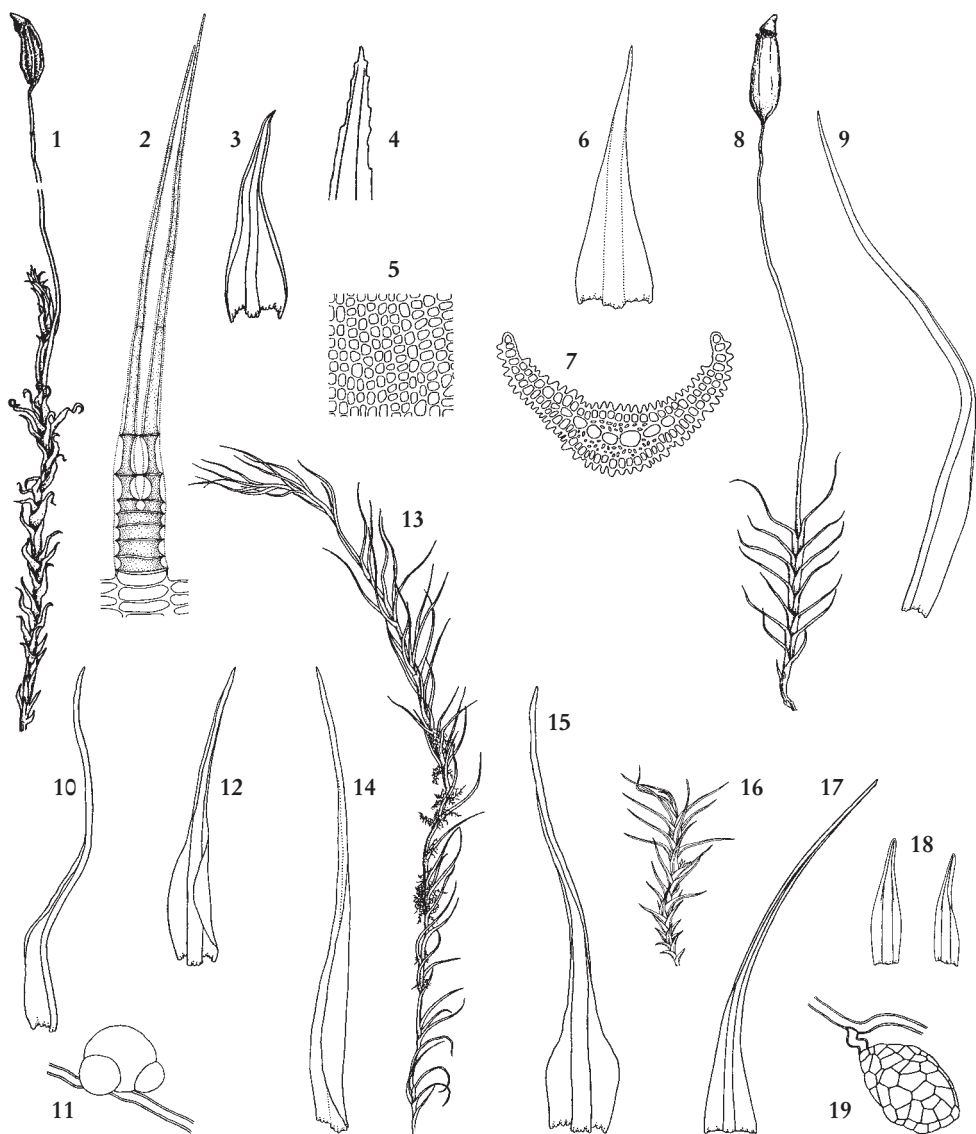


FIGURE 24. 1-5, *Ceratodon purpureus*: 1, habit; 2, peristome tooth; 3, leaf on dorsal side; 4, leaf apex on ventral side; 5, median cells. 6-7, *Cheilothela chloropus*: 6, leaf; 7, leaf section. 8-9, *Distichium capillaceum*: 8, habit; 9, leaf. 10-11, *Ditrichum cylindricum*: 10, leaf; 11, rhizoidal gemma. 12, *D. flexicaule*, leaf. 13-14, *D. gracile*: 13, habit; 14, leaf. 15, *D. subulatum*, leaf. 16, *D. pallidum*, habit. 17, *D. heteromallum*, leaf. 18, *D. lineare*, leaves. 19, *D. pusillum*, rhizoidal gemma. 13 ( $\times 3$ ); 1 ( $\times 4$ ); 8, 16 ( $\times 6$ ); 3, 6, 9, 10, 12, 14, 15, 17, 18 ( $\times 20$ ); 4, 11, 19 ( $\times 100$ ); 2, 5, 7 ( $\times 160$ ).



tapered into long, channelled subula, margin plane or narrowly recurved, entire or denticulate near apex; laminal cells rhomboidal or rectangular, smooth, basal cells rectangular to linear, margin or upper lamina bistratose in some species; nerve broad, percurrent or excurrent. Rhizoidal gemmae frequent. Perichaetial leaves subulate, with broad and sheathing base. Capsule cylindrical, sometimes striate when dry; peristome teeth divided to base.

- 1 Upper leaves squarrose (fig. 24, 10-11) **D. cylindricum** (Hedw.) Grout  
 \* **Trichodon cylindricus** (Hedw.) Schimp.  
 Rhizoids light brown. Leaves with sheathing base, abruptly tapered into long, flexuose, denticulate subula composed of nerve. Rhizoidal gemmae tricellular, brown. Dioicous. Forms turfs to 0,4 cm high by roadsides, in small ditches and on wet, shaded soils. Occasional in the northeast and west of the Peninsula, very localized in the south. Esp, Prt.
- 1 Upper leaves erect to patent 2
- 2 Stem 2-12 cm high 3
- 2 Stem up to 2 cm high 4
- 3 Stem with dense, brown tomentum; leaves ovate-lanceolate, abruptly tapered into subula; nerve distinct, excurrent; cells on dorsal surface of nerve longer than adjacent laminal cells (fig. 24, 12) **D. flexicaule** (Schwägr.) Hampe  
 Basal cells towards nerve short, not sinuose, without pores. Forms dense to compact, dark green turfs, to 3 cm high on rocks and calcareous rocks in montane areas and high mountains in the northeast of the Peninsula and in Mallorca. Esp, And, Bl.
- 3 Stem with scarce tomentum or tomentum absent; leaves ovate-lanceolate, gradually tapered into long subula; nerve faint, excurrent; cells on dorsal surface of nerve shorter than adjacent laminal cells (fig. 24, 13-14) **D. gracile** (Mitt.) Kuntze  
**D. crispatisimum** (Müll.Hal.) Paris  
 Basal cells towards nerve long, sinuose, porose. Forms dense, light green or golden turfs, to 12 cm high, on calcareous rocks and soils in montane areas and high mountains in the northern half of the Peninsula and in Mallorca. Esp, Prt, And, Bl.
- 4 Leaves abruptly tapered into long subula composed of nerve (fig. 24, 15) **D. subulatum** Hampe  
 Upper and perichaetial leaves falciform, margin plane; nerve longly excurrent. Paroicous. Forms very lax, light green turfs, to 0,6 cm high, on rocky slopes. Scattered from the lowlands to montane areas throughout the Peninsula and in Menorca. Esp, Prt, Bl.
- 4 Leaves gradually narrowed into acute or obtuse apex or  $\pm$  long subula, often composed of nerve 5
- 5 Leaves tapering into long, acuminate subula, erecto-patent,  $\pm$  secund 6
- 5 Leaves with tapering into short, acute or obtuse subula, erect to appressed, straight 7

- 6 Plants to 0,5 cm tall; autoicous; rhizoids yellow; seta glossy yellow (fig. 24, 16)  
**D. pallidum** (Hedw.) Hampe  
 Leaves with long, channelled point, margin plane; nerve occupying the channelled subula, excurrent in denticulate point, very broad at base. Androecia bud-like in the axils of upper leaves. Grows on damp, acidic soils in montane areas. Very rare in the Peninsula. Esp.
- 6 Plants to 1 cm tall; dioicous; rhizoids brownish; seta not glossy, red, at least at base (fig. 24, 17)  
**D. heteromallum** (Hedw.) E. Britton  
 Leaves erecto-patent, channelled, often secund, margin plane, entire; nerve occupying the subula, excurrent in dentate point. Forms lax, glossy, yellowish green turfs on damp soils in montane areas in the north and northwest of the Peninsula. Esp, Prt, And.
- 7 Leaves appressed, with obtuse, concave, denticulate apex, margin entire,  $\pm$  recurved (fig. 24, 18)  
**D. lineare** (Sw.) Lindb.  
 Plants to 0,8 cm. Leaves arranged in 3 rows, channelled, margin partially bistratose; nerve broad at base. Grows on damp, rocky soils in montane areas. Rare in the northwest of the Peninsula. Esp.
- 7 Leaves erecto-patent, with acuminate, channelled apex, margin denticulate, recurved (fig. 24, 19)  
**D. pusillum** (Hedw.) Hampe  
 Leaves lanceolate, channelled in upper part; lamina occasionally bistratose; nerve percurrent or slightly excurrent. Often with brown, pyriform, rhizoidal gemmae up to 125  $\mu$ m wide. Dioicous. Grows on wet soils and slopes from montane areas to high mountains in the northern half of the Peninsula. Esp.

### **Pleuridium** Rabenh.

Plants small, to 0,8 cm tall, unbranched. Leaves lanceolate; laminal cells smooth, rectangular or linear; nerve percurrent or excurrent in long subula. Perichaetial leaves broad at base, longer than stem leaves. Capsule indehiscent, ovoid, apiculate, immersed.

- 1 Perichaetial leaves gradually tapering into narrow subula; antheridia axillary, naked; spores 24-28  $\mu$ m, strongly papillose (fig. 25, 1-2)  
**P. acuminatum** Lindb.  
 Plants light green, 0,5 cm tall. Forms small turfs on slopes and wet, exposed ledges, in the lowlands and montane areas. Scattered in the north of the Peninsula, rare in the southern part and in Mallorca. Esp, Prt, Bl.
- 1 Perichaetial leaves abruptly tapering into long, narrow subula; antheridia axillary, covered by perigonal leaves; spores 28-30  $\mu$ m, finely papillose (fig. 25, 3)  
**P. subulatum** (Hedw.) Rabenh.  
 Plants to 0,8 cm tall, green to yellowish green, forming lax turfs. Very similar to *P. acuminatum* and growing in the same habitat but occupying wetter places. Widespread throughout the Peninsula. Esp, Prt.

### **Pseudephemerum** (Lindb.) I. Hagen

Stem straight, simple or branched, innovating from below perichaetia. Rhizoids hyaline or pale brownish, sometimes with bright yellow or pale orange gemmae. Leaves erect,

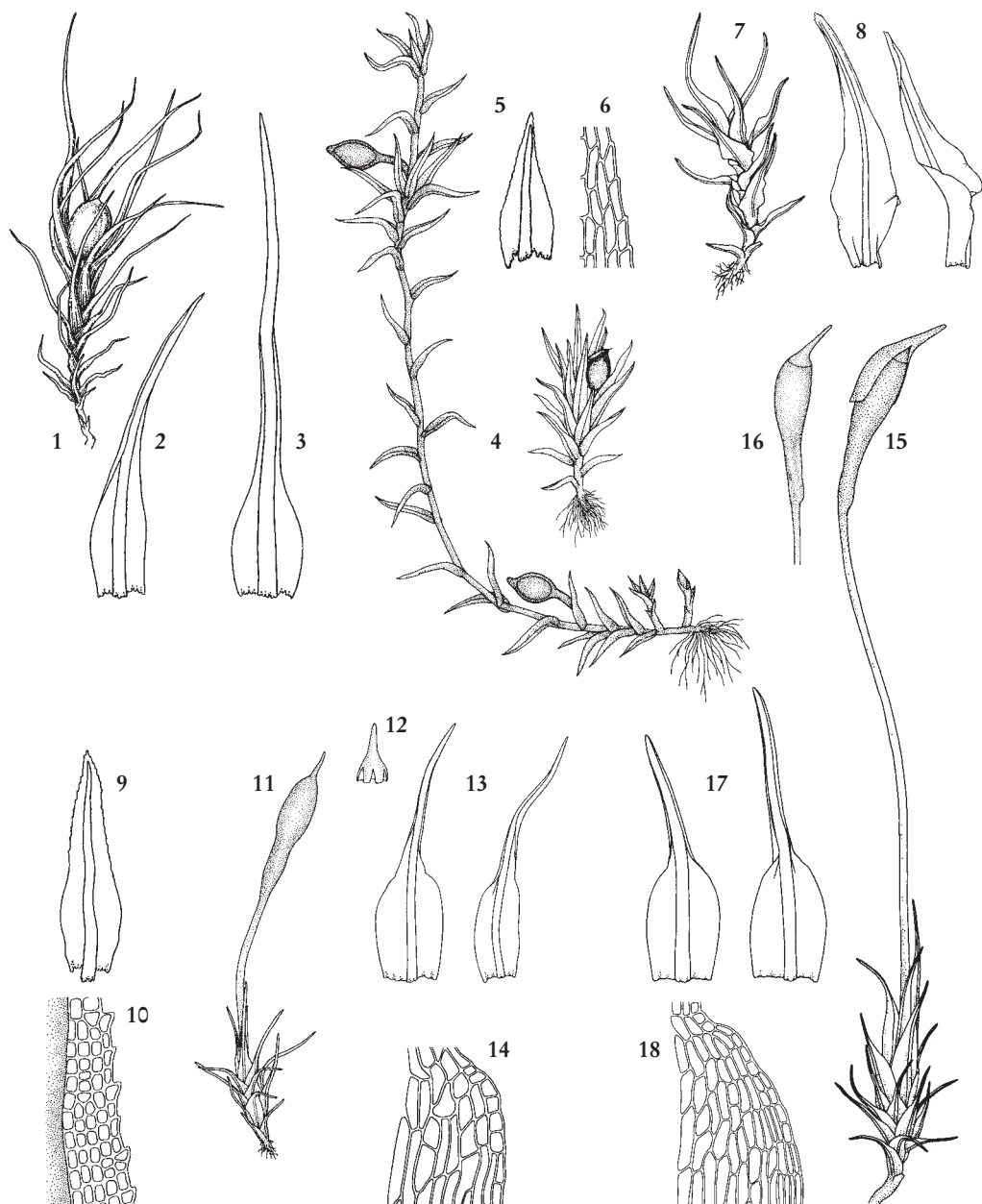


FIGURE 25. 1-2, *Pleuridium acuminatum*: 1, habit; 2, leaf. 3, *P. subulatum*, leaf. 4-6, *Pseudephemerum nitidum*: 4, habits; 5, leaf; 6, marginal cells. 7-8, *Rhamphidium purpuratum*: 7, habit; 8, leaves. 9-10, *Saelania glaucescens*: 9, leaf; 10, median cells. 11-14, *Bruchia vogesiaca*: 11, habit; 12, calyptra; 13, leaves; 14, laminal cells. 15-18, *Trematodon ambiguus*: 15, habit; 16, capsule; 17, leaves; 18, laminal cells. 1, 4, 7, 11, 12, 15, 16 ( $\times 9$ ); 2, 3, 5, 8, 9, 13, 17 ( $\times 25$ ); 6, 10, 14, 18 ( $\times 160$ ).

lanceolate to ovate-lanceolate, gradually tapering, acute, margin plane and denticulate at the apex; laminal cells rectangular, 9-13  $\mu\text{m}$  wide, thin-walled; nerve thin, faint, percurrent. Lower leaves smaller. Seta short, hyaline, terminal but becoming lateral due to later stem growth; capsule immersed, ovoid, shortly pointed and indehiscent (fig. 25, 4-6)

**P. nitidum** (Hedw.) Loeske

Forms loose, glossy pale green turfs about 0,4 cm high or brownish patches to 0,25 cm high, on damp, open, acidic, clayey soils, often beside pools or periodically waterlogged hollows, often with *Isoetes*, mainly in the northeast and southwest of the Peninsula. Esp, Prt.

### **Rhamphidium** Mitt.

Plants small, 0,6-1 cm tall, yellowish green. Leaves erect, distant, lanceolate, sheathing, abruptly or gradually narrowed into channelled subula, squarrose when dry, margin  $\pm$  undulate, entire but often with small teeth at apex; basal cells rectangular, elongated, 60-75  $\times$  8-9  $\mu\text{m}$ , median cells abruptly becoming quadrate, ovate or rounded, smaller, 7-8  $\mu\text{m}$  wide, cells towards nerve gradually smaller; nerve percurrent (fig. 25, 7-8)

**R. purpuratum** Mitt.

Forms loose, green turfs, reddish below, on wet rocks by a waterway, in the west of the Peninsula. Prt (Extinct).

### **Saelania** Lindb.

Plants to 3 cm tall. Leaves linear-lanceolate, pruinose, giving a characteristic glaucous cast to the plant, margin plane and dentate; median cells quadrate, smooth, basal cells rectangular; nerve thin, percurrent or excurrent in upper leaves. Capsule straight, cylindrical, longitudinally striate; peristome teeth papillose, divided to base (fig. 25, 9-10)

**S. glaucescens** (Hedw.) Broth.

Forms turfs in crevices and on basic rock ledges in montane areas, in the northeastern part of the Peninsula. Esp.

## **Fam. Bruchiaceae**

### **Bruchia** Schwägr.

Plants very small. Stem to 0,25 cm high. Basal leaves small, gradually increasing in size above, upper leaves long and flexuose, gradually to abruptly tapering into long subula from an ovate base; cells 3 times as long as wide, smooth. Seta to 4 mm long, straight, flexuose; capsule cylindrical or pyriform, neck slender, 1/3-1/2 of the capsule length, indehiscent; calyptra mitriform. Protonema persistent, producing pluricellular gemmae (fig. 25, 11-14)

**B. vogesiaca** Nestl. ex Schwägr.

Forms small, slightly compact, yellowish green turfs on slopes and in clearings in peaty heath lands, in montane areas, in the western part of the Peninsula. Esp, Prt.

**Trematodon Michx.**

Plants small. Stem to 0,5 cm high. Leaves erecto-patent, abruptly narrowed to subula, apex obtuse and dentate, sheathing base oblong, 1/2 of the leaf length; basal cells rectangular, shorter above; nerve stout, occupying nearly the whole subula. Seta yellow, to 0,7 cm long; capsule exserted, slightly curved, strumose, neck about same length as urn, dehiscent; peristome well developed; calyptra cucullate (fig. 25, 15-18)

**T. ambiguus** (Hedw.) Hornsch.

Grows on very humid soils and on the banks of streams, at high altitudes in the Central Pyrenees. Esp.

**Fam. Rhabdoweisiaceae****Amphidium Schimp.**

Stem branched. Leaves linear-lanceolate, acute or acuminate, flexuose or contorted when dry, margin entire or denticulate, plane or recurved at base; upper laminal cells quadrate or rounded, strongly papillose, basal cells rectangular to linear, finely papillose or smooth; nerve percurrent. Capsule emergent to exserted, pyriform, striate, annulus persistent; peristome lacking; calyptra cucullate, smooth.

- 1 Leaves contorted; upper laminal cells rounded, 8-11  $\mu\text{m}$ , obscure, strongly papillose, with large, rounded papillae, basal cells hyaline, smooth, thin-walled; capsule emergent; autoicous (fig. 26, 1-2) **A. lapponicum** (Hedw.) Schimp.

Plants to 1 cm tall, pale green to dark green. Leaf margin plane or slightly recurved at base. Forms dense turfs in acidic rock crevices, in the high mountains of the Pyrenees and Sierra Nevada. Esp.

- 1 Leaves flexuose or contorted; upper laminal cells irregularly quadrate, 5-9  $\mu\text{m}$ , slightly papillose, basal cells yellowish, thick-walled, finely papillose-striate, with elliptical to linear papillae; capsule exserted; dioicous (fig. 26, 3-5)

**A. mougeotii** (Schimp.) Schimp.

Plants to 6 cm tall, yellowish green, with rhizoids in old parts. Leaf margin recurved at base. Sterile. Forms turfs in wet, siliceous rock crevices in montane areas and high mountains, in the northern half of the Peninsula and in Sierra Nevada. Esp, Prt, And.

**Arctoa Bruch & Schimp.**

Plants 1-4 cm tall. Leaves straight to falciform, often secund, lanceolate with broad base, abruptly tapering into long, plane, entire or slightly denticulate subula; median cells narrowly rectangular, shorter at margin, basal cells narrowly elongated, alar cells few, quadrate; nerve without stereids. Seta short, thick, yellow; capsule exserted, straight and symmetrical, widely ovoid, longitudinally sulcate when dry; peristome teeth reddish, divergent or spreading when dry (fig. 26, 6-8)

**A. fulvella** (Dicks.) Bruch & Schimp.

Plants branched, forming compact, glossy green turfs, dark brown below, on ledges and in wet acidic rock crevices, in high mountains of the Pyrenees. Esp, And.

This species may be confused with *Kiaeria starkei* because it lacks stereids in nerve, but the leaves of the latter are not abruptly tapering and the capsule is curved and slightly strumose.

### **Cynodontium Bruch & Schimp.**

Plants up to 4(-6) cm tall, branched, forming cushions. Leaves linear-lanceolate, margin recurved or plane, bistratose, rarely unistratose, crenulate or irregularly dentate above; upper lamina cells quadrate, obscure, rarely transparent, smooth or mamilllose. Capsule exserted, straight or curved,  $\pm$  striate or smooth, strumose or not, annulus present; lid rostrate; peristome teeth 16, divided to the middle or beyond, sometimes irregularly developed and divided in delicate branches; calyptra cucullate.

- 1 Upper cells of leaf with high mamillae on ventral side or on both sides; annulus of small cells 2

- 1 Upper cells of leaf smooth or some with low mamillae on ventral side; annulus of large cells 4

- 2 Seta curved **C. gracilescens** (F. Weber & D. Mohr) Schimp.

Leaves lanceolate, with wide, blunt apex, margin incurved in upper part, bistratose; lamina unistratose in the upper part, upper cells 9-10  $\mu\text{m}$  wide, oval in cross section, mamilllose on both sides, basal cells pellucid. Capsule striate. Grows in rock crevices, in high mountains. Very rare, in the Pyrenees and Serra da Estrela. Esp, Prt.

- 2 Seta straight 3

- 3 Upper laminal cells mamilllose on ventral side of leaf; capsule striate (fig. 26, 9-10) **C. fallax** Limpr.

Leaf unistratose in the upper part, margin plane, partially recurved in upper part; upper cells of leaf quadrate in cross section. Grows on granitic rocks, in montane areas of the Pyrenees. And.

- 3 Upper laminal cells mamilllose on both sides of leaf; capsule smooth (fig. 26, 11-13) **C. bruntonii** (Sm.) Bruch & Schimp.

**Oreoweisia bruntonii** (Sm.) Milde

Leaves narrowly lanceolate, margin recurved to about 1/2 way up leaf, crenulate above. Lamina partially bistratose above; median cells of lamina 8  $\mu\text{m}$  wide, basal cells rectangular, enlarged towards nerve. Peristome teeth divided in irregularly developed, fragile branches. Grows on rocks, in acidic rock crevices or an epiphyte, in montane areas and high mountains throughout the Peninsula. Esp, Prt.

- 4 Leaf margin narrowly recurved, rarely plane, mostly unistratose; laminal cells smooth **C. jenneri** (Schimp.) E. Britton

Plants to 3-4 cm tall, bright green. Leaf lanceolate-acuminate, coarsely dentate in upper part, entire below; upper cells regularly quadrate and transparent, 12-14  $\mu\text{m}$  wide. Capsule striate,

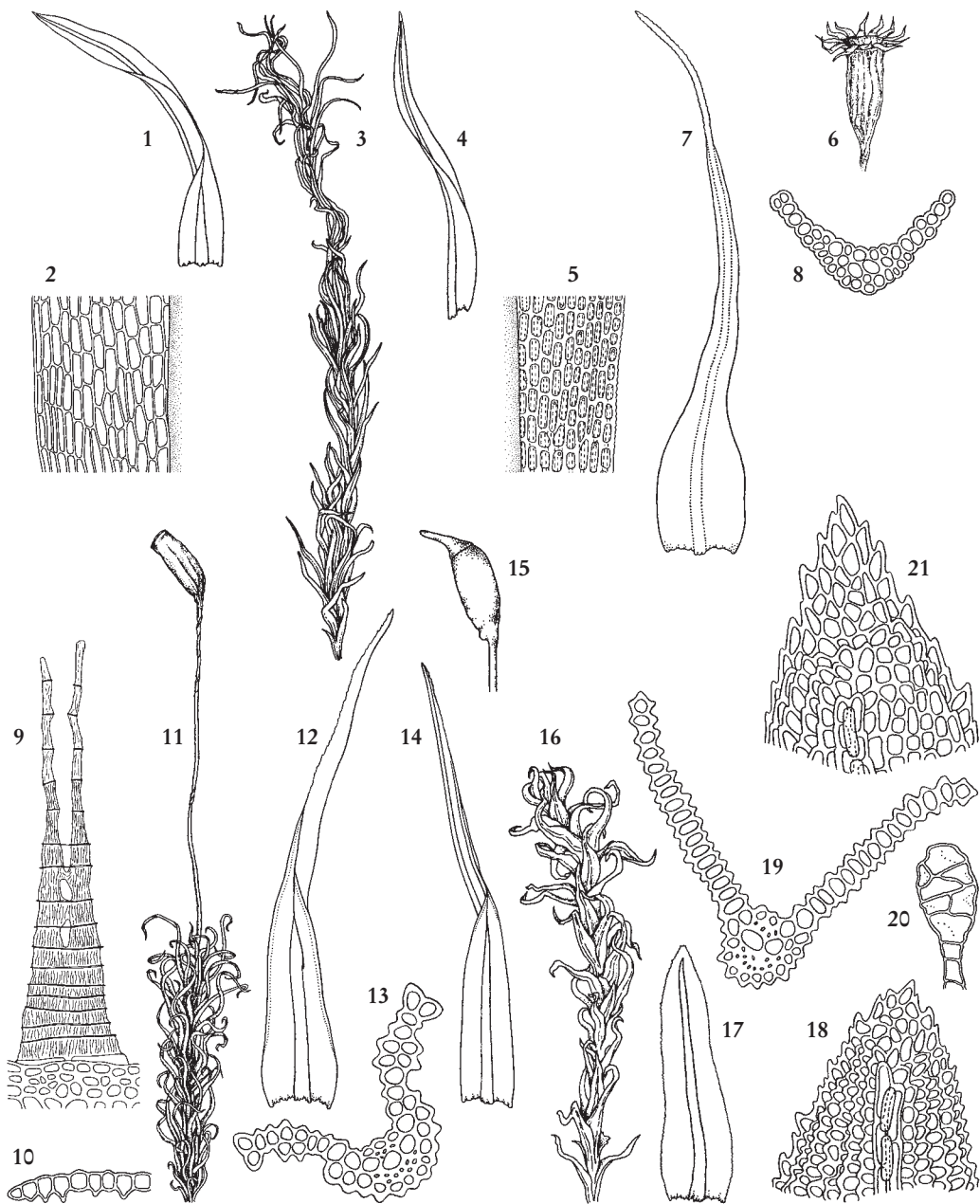


FIGURE 26. 1-2, *Amphidium lapponicum*: 1, leaf; 2, basal cells. 3-5, *A. mougeotii*: 3, habit; 4, leaf; 5, basal cells. 6-8, *Arctoa fulvella*: 6, capsule when dry; 7, leaf; 8, leaf section. 9-10, *Cynodontium fallax*: 9, peristome tooth; 10, leaf margin section. 11-13, *C. bruntonii*: 11, habit when dry; 12, leaf; 13, leaf section. 14, *C. polycarpon*, leaf. 15, *C. strumiferum*, capsule. 16-20, *Dichodontium pellucidum*: 16, habit when dry; 17, leaf; 18, leaf apex; 19, leaf section; 20, gemma. 21, *D. flavescens*, leaf apex. 3, 11, 15, 16 ( $\times 7$ ); 1, 4, 6, 7, 12, 14, 17 ( $\times 20$ ); 2, 5, 8, 9, 10, 13, 18, 19, 20, 21 ( $\times 200$ ).



not or slightly strumose. Grows in rock crevices and on wet slopes, over 1500 m, in Serra da Estrela. Prt.

- 4 Leaf margin plane or nearly so, bistratose; laminal cells mamilllose 5
- 5 Median cells of lamina 10-12  $\mu\text{m}$  wide, mostly mamilllose on dorsal side; capsule symmetrical, straight, not strumose (fig. 26, 14) **C. polycarpon** (Hedw.) Schimp.  
Plants pale green, tomentose. Perigonial leaves acute. Capsule striate when dry. Grows in crevices, on rocks and soils in coniferous forests, in montane areas and high mountains of the northern part of the Peninsula. Esp, Prt (Extinct).
- 5 Median cells of lamina 12  $\mu\text{m}$  wide, mamilllose on both sides; capsule curved, strumose (fig. 26, 15) **C. strumiferum** (Hedw.) Lindb.  
Plants dark green. Perigonial leaves sub-acute. Capsule striate when dry. Grows on rocks, in acidic rock crevices and on rotting trunks in coniferous forests, in the high mountains of the Pyrenees. Esp.

### **Dichodontium Schimp.**

Plants to 6 cm tall, forming lax green or yellowish green turfs. Leaves lanceolate to oblong-lanceolate or almost lingulate, with wide base and acute or obtuse apex, incurved when dry, margin  $\pm$  dentate; median cells quadrate, mamilllose on both sides, basal cells rectangular, smooth; nerve percurrent, narrow, denticulate at back above. Capsule exserted, erect or inclined, ovoid, ellipsoidal or cylindrical, smooth; peristome teeth bifid; calyptra cucullate.

- 1 Leaves oblong-lanceolate to lingulate, with acute or obtuse apex; capsule ovoid, inclined (fig. 26, 16-20) **D. pellucidum** (Hedw.) Schimp.  
Laminal cells pellucid. Sometimes with pluricellular, brown axillary gemmae on branched filaments. Forms dark green turfs on wet rocks and by streams, in montane areas in the northern half of the Peninsula and in Sierra Nevada. Esp, And.
- 1 Leaves lanceolate, with acute apex; capsule ellipsoidal to cylindrical, straight or slightly inclined (fig. 26, 21) **D. flavescens** (Dicks.) Lindb.  
Forms yellowish green turfs on waterlogged or very moist soils, usually in montane areas of the northern part of the Peninsula. Esp.

### **Dicranoweisia Milde**

Plants medium-sized. Stem  $\pm$  branched, radiculose at base. Leaves ovate or lanceolate, acuminate or subulate, channelled, crisped when dry, margin entire, plane or recurved; upper cells quadrate or rectangular, pellucid, smooth or finely striate; nerve narrow, percurrent, with dorsal and ventral stereids. Capsule exserted, straight, smooth, symmetrical; lid obliquely rostrate; calyptra cucullate; peristome teeth 16, short, entire or split at the apex.

- 1 Leaf margin bistratose, recurved; apex bistratose; median cells smooth, 8-14  $\mu\text{m}$ ; alar cells not differentiated (fig. 27, 1) **D. cirrata** (Hedw.) Lindb.



Plants to 1,5 cm tall. Leaves gradually tapering. Pluricellular gemmae on leaf frequent. Capsule ellipsoidal or cylindrical. Forms cushions on acidic rocks, bases of trees and rotting wood, usually in montane areas. Widespread in the Peninsula. Esp, Prt.

- 1 Leaf margin unistratose, plane or slightly incurved; apex unistratose, rarely with bistratose margin; median cells 6-8  $\mu\text{m}$  wide, finely longitudinally striated, giving a papillose appearance in cross section; alar cells rectangular, inflated (fig. 27, 2-4)

**D. crispula** (Hedw.) Milde

Plants to 3 cm tall. Leaves subulate, crisped when dry; alar cells becoming brownish. Capsule ovoid or ellipsoidal. Forms cushions on acidic rocks, occasionally on calcareous rocks or compacted soil, in grasslands and forests, in montane areas. Scattered localities in the northern half of the Peninsula and in Sierra Nevada. Esp, And.

### **Kiaeria** I. Hagen

Plants medium-sized. Leaves lanceolate, falciform or flexuose, frequently secund, gradually tapering into entire or denticulate subula; apical cells of lamina quadrate or rectangular, median cells quadrate, shortly rectangular or rhomboidal, basal cells rectangular, elongated,  $\pm$  porose, alar cells  $\pm$  distinct, brownish; nerve excurrent, without stereids. Seta long; capsule ovoid,  $\pm$  strumose, with annulus; peristome teeth 16, divided to the middle.

- 1 Leaves crisped when dry; perigonia terminal or on separate branches or distant and below the perichaetium (fig. 27, 5) **K. blyttii** (Bruch & Schimp.) Broth.

Leaves erect-spreading, flexuose, subulate point with papillae or mamillae, alar cells quadrate to shortly rectangular, usually rather well differentiated. Capsule slightly strumose, ovate-ellipsoidal, not striate when dry, exothelial cells thin-walled, annulus of 1-3 rows of fugacious cells. Autoicous or polyicous. Forms dull or dark green turfs on rocks or in rock crevices, near streams. Only in Serra da Estrela. Prt.

- 1 Leaves flexuose or falcate-secund, not crisped when dry; perigonia just below the perichaetium 2

- 2 Leaves slightly falciform, flexuose; alar cells sharply distinct, inflated, brownish; basal cells slightly porose (fig. 27, 6-8) **K. starkei** (F. Weber & D. Mohr) I. Hagen

Upper cells of leaf elongated, smooth. Capsule slightly curved, ellipsoidal, strumose, striate when dry, annulus of 2-3 rows of fugacious cells. Forms loose, glossy yellowish green turfs in wet, acidic rock crevices, on stony soils and snow-beds, in montane areas and high mountains in the north and west of the Peninsula. Esp, Prt, And.

- 2 Leaves strongly falcate; alar cells not sharply distinct; basal cells not porose (fig. 27, 9)

**K. falcata** (Hedw.) I. Hagen

Upper cells of leaf quadrate to shortly rectangular, slightly mamilllose. Capsule straight or slightly curved,  $\pm$  strumose, irregularly furrowed but not striate when dry, exothelial cells thick-walled annulus of 3 rows of persistent cells. Forms compact, dull dark green turfs on wet, acidic soils and snow-beds in high mountains. Scattered localities in the northern part of the Peninsula and in Sierra Nevada. Esp, Prt, And.

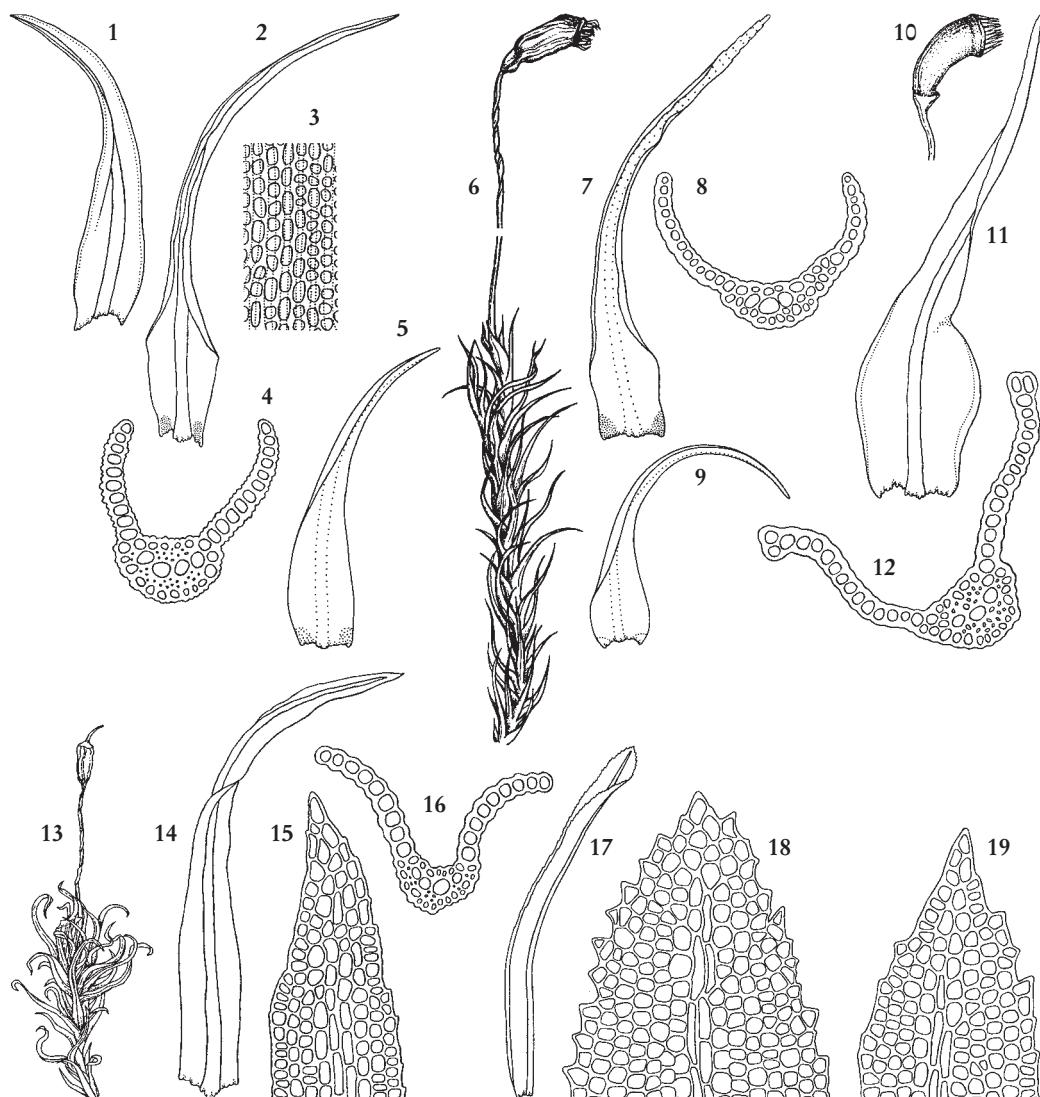


FIGURE 27. 1, *Dicranoweisia cirrata*, leaf. 2-4, *D. crispula*: 2, leaf; 3, laminal cells; 4, leaf section. 5, *Kiaeria blyttii*, leaf. 6-8, *K. starkei*: 6, habit; 7, leaf; 8, leaf section. 9, *K. falcata*, leaf. 10-12, *Oncophorus virens*: 10, capsule; 11, leaf; 12, leaf section. 13-16, *Rhabdoweisia fugax*: 13, habit when dry; 14, leaf; 15, leaf apex; 16, leaf section. 17-18, *R. crenulata*: 17, leaf; 18, leaf apex. 19, *R. crispata*, leaf apex. 6, 13 ( $\times 7$ ); 10 ( $\times 10$ ); 1, 2, 5, 7, 9, 11, 14, 17 ( $\times 20$ ); 3, 4, 8, 12, 15, 16, 18, 19 ( $\times 200$ ).

**Oncophorus (Brid.) Brid.**

Plants medium-sized, forming dense turfs. Leaves lanceolate, with sheathing base, twisted when dry, margin bistratose, entire or dentate, at least in the upper part; median and apical cells of lamina quadrate, 6-8  $\mu\text{m}$ , smooth, thin-walled, alar cells differentiated or not; nerve with 2, dorsal and ventral, stereid bands. Capsule oblong, curved, strumose, smooth or more often sulcate when dry, annulus lacking; peristome teeth reddish, divided to the middle, longitudinally striate.

- 1 Alar cells often inflated and hyaline; leaf margin recurved in the lower half, entire or denticulate in the upper part; capsule 2-3 times as long as wide (fig. 27, 10-12)

**O. virens** (Hedw.) Brid.

Leaves with sheathing base, attenuate into channelled acumen. Grows on very moist, acidic soils by streams in forests and in wet grasslands, in high mountains of the Pyrenees and Sierra Nevada. Esp, And.

- 1 Alar cells not differentiated; leaf margin plane, serrulate, flexuose at base; capsule 1,5 times as long as wide

**O. wahlenbergii** Brid.

Leaves with broad sheathing base, abruptly tapering into elongated, channelled acumen. Grows on very moist, acidic soils, in high mountains. Esp.

**Rhabdoweisia Bruch & Schimp.**

Leaves linear-lanceolate to lingulate, erect-spreading when moist, crisped when dry, apex acute or rounded, margin unistratose, plane or weakly recurved below; median cells rounded, smooth or mamilllose, with thickened walls, basal cells rectangular or elongated hexagonal, hyaline; nerve stout, percurrent, with 4-5(-7) guide cells and 2 stereid bands, the dorsal band well developed and the ventral one weakly so. Seta yellow; capsule exserted, small, ovoid, straight, symmetrical, striate when dry; peristome teeth 16, entire, caducous.

- 1 Leaf margin entire or slightly crenulate near apex; peristome teeth filiform, smooth, with broad base (fig. 27, 13-16)

**R. fugax** (Hedw.) Bruch & Schimp.

Plants 1-1,5 cm tall. Leaves linear-lanceolate, apex narrowly acuminate; upper cells 8-12  $\mu\text{m}$ . Forms compact, yellowish green turfs, discoloured below, on slopes and in wet, acidic rock crevices, in montane areas and high mountains, rarely in the lowlands, mainly in the northern half of the Peninsula. Esp, Prt, And.

- 1 Leaf margin dentate or denticulate above; peristome teeth lanceolate, faintly striate      2

- 2 Leaves lingulate, apex rounded or sharply acute, margin dentate in the upper half (fig. 27, 17-18)

**R. crenulata** (Mitt.) H. Jameson

Plants to 1,5 cm tall. Upper cells of leaf 12-15  $\mu\text{m}$  wide. Forms loose turfs on wet acidic rocks in beechwoods. Rare, in the north of the Peninsula. Esp.

- 2 Leaves lanceolate, apex sharply acute, margin irregularly denticulate at apex (fig. 27, 19)

**R. crispa** (Dicks.) Lindb.

Plants up to 1 cm tall. Laminal cells of leaf with fine cuticular striae, upper cells 10-14  $\mu\text{m}$  wide. Forms dense turfs in wet, acidic rock crevices in montane areas. Scattered in the north of the Peninsula. Esp.

## Fam. Schistostegaceae

### Schistostega D. Mohr

Plants to 1,5 cm tall. Leaves arranged in 2 ranks, confluent at base, lanceolate, acute to acuminate; laminal cells rhomboidal, more than 15  $\mu\text{m}$  wide, thin-walled; nerve lacking. Capsule exserted, erect, ovoid; peristome lacking. Protonema persistent, emerald green, light-refracting (fig. 28, 1)

**S. pennata** (Hedw.) F. Weber & D. Mohr

Grows on sandstone, gneiss or granite, in humid and shady places, in caves or mines. Scattered in the northern part of the Peninsula. Esp, Prt.

## Fam. Dicranaceae

### Dicranella (Müll.Hal.) Schimp.

Plants generally small. Stem simple or slightly branched. Leaves with wide, occasionally sheathing base, abruptly or gradually tapered to apex or to entire or denticulate subula; laminal cells rectangular, elongated, narrow, smooth, alar cells indistinct; nerve with 2 stereid bands, the ventral one with few cells. Some species with rhizoidal gemmae. Seta red or yellow; capsule straight or inclined, symmetrical or asymmetrical, smooth or striate when dry; lid conical or rostrate; peristome single, teeth 16, divided to the middle, commonly with vertical striae and papillose point, basal membrane usually low.

1 Leaves squarrose, with wide, sheathing or semi-sheathing base; seta red 2

1 Leaves erect, straight or falciform, more or less secund; seta reddish or yellow 4

2 Leaves wide, decurrent, apex obtuse; capsule slightly curved, smooth; plants robust (fig. 28, 2)

**D. palustris** (Dicks.) Crundw.

\* **Dichodontium palustre** (Dicks.) M. Stech

Median cells of lamina 9-14  $\mu\text{m}$  wide; nerve 40-50  $\mu\text{m}$  wide near base. Gemmae at stem base, brown, spherical, 200-220  $\mu\text{m}$  wide. Forms loose, green turfs, brown in older parts, on very damp or periodically waterlogged, acidic soils, near springs and streams, in montane areas and high mountains in the north of the Peninsula and in Sierra Nevada. Esp, Prt, And.

2 Leaves narrow, not decurrent, subulate; capsule curved, smooth or striate; plants small 3

3 Leaves  $\pm$  gradually tapered to denticulate subula with obtuse teeth; leaf base semi-sheathing; median cells (8-)10-14  $\mu\text{m}$  wide; nerve (50-)60-70  $\mu\text{m}$  wide; capsule smooth, not strumose (fig. 28, 3)

**D. schreberiana** (Hedw.) Dixon

**Anisothecium schreberianum** (Hedw.) Dixon

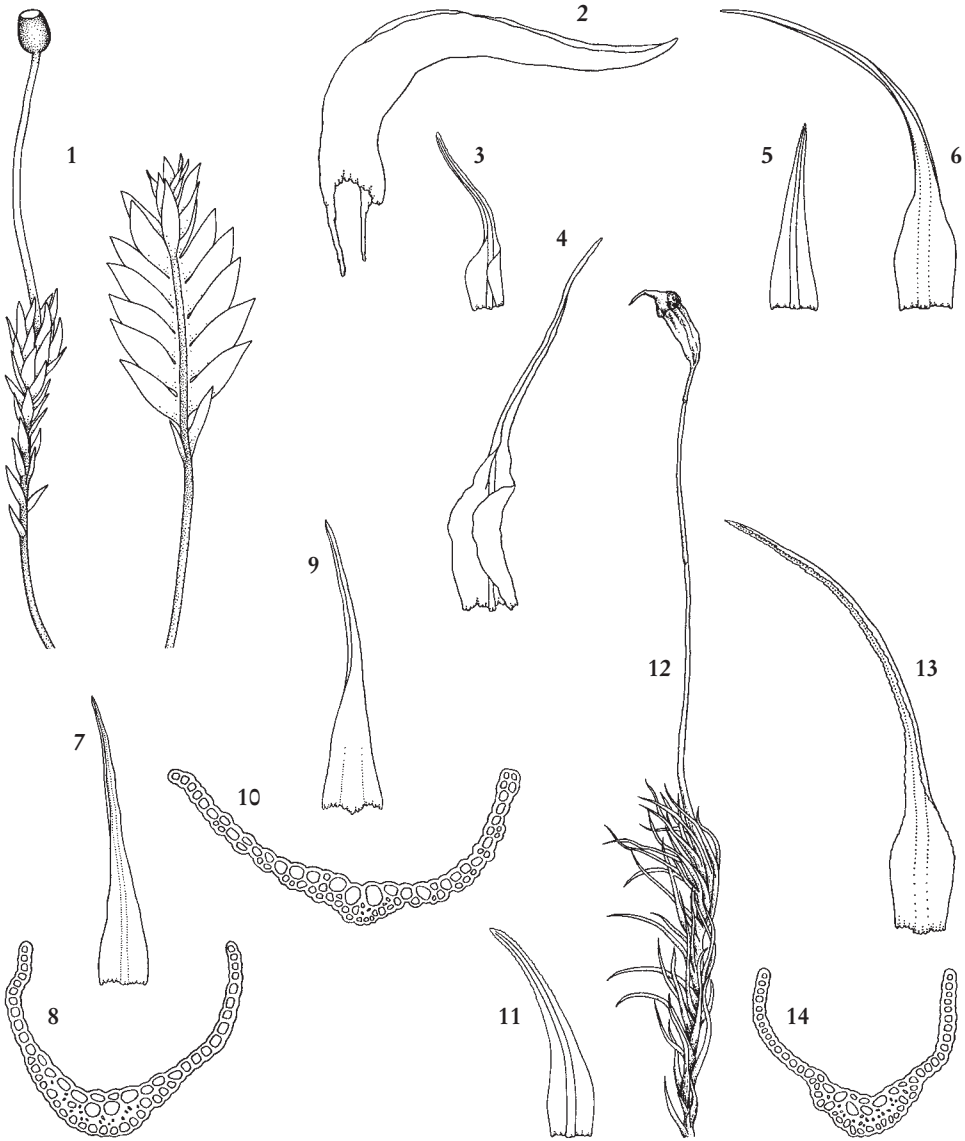


FIGURE 28. 1, *Schistostega pennata*, habit, plants with and without sporophyte. 2, *Dicranella palustris*, leaf. 3, *D. schreberiana*, leaf. 4, *D. grevilleana*, leaf. 5, *D. staphylina*, leaf. 6, *D. subulata*, leaf. 7-8, *D. varia*: 7, leaf; 8, leaf section. 9-10, *D. howei*: 9, leaf; 10, leaf section. 11, *D. rufescens*, leaf. 12-14, *D. heteromalla*: 12, habit; 13, leaf; 14, leaf section. 12 ( $\times 7$ ); 1 ( $\times 15$ ); 2, 3, 4, 5, 6, 7, 9, 11, 13 ( $\times 20$ ); 8, 10, 14 ( $\times 200$ ).

Rhizoidal gemmae occasionally present, spherical, orange brown, (90-)100-130  $\mu\text{m}$ . Forms dense, pale yellowish green turfs, brown below, on wet, clayey soils and rocks by streams, in montane areas. Rare, in the northern part of the Peninsula. Esp.

- 3 Leaves abruptly tapered to flexuose, entire subula; leaf base sheathing; median cells 6(-8)  $\mu\text{m}$  wide; nerve 30-40(-50)  $\mu\text{m}$  wide; capsule striate, strumose (fig. 28, 4)

**D. grevilleana** (Brid.) Schimp.

**Anisothecium grevilleanum** (Brid.) Lindb.

Rhizoids with spherical, brown gemmae. Forms compact, green turfs on wet, clayey soils, in high mountains of the Pyrenees. Esp.

- 4 Leaf margin entire or with a few obtuse teeth towards apex 5

- 4 Leaf margin denticulate 8

- 5 Leaf margin with a few obtuse teeth towards apex; median cells of lamina 10-14  $\mu\text{m}$  wide (fig. 28, 5) **D. staphylina** H. Whitehouse

**Anisothecium staphylinum** (H. Whitehouse) Sipman, Rubers & Riemann

Plants pale green or pale brownish. Leaves erecto-patent to spreading, lanceolate, with acute apex, margin plane or slightly recurved below. Rhizoidal gemmae to 100  $\mu\text{m}$  long, brown. Forms dense turfs on soils near streams. Only one locality in north of the Peninsula. Esp.

- 5 Leaf margin entire; median cells of lamina 3-8  $\mu\text{m}$  wide 6

- 6 Leaves abruptly narrowed to filiform subula, base sheathing, margin plane; basal cells of lamina 5-8  $\mu\text{m}$  wide; capsule striate when dry (fig. 28, 6)

**D. subulata** (Hedw.) Schimp.

Nerve occupying 1/5 of leaf base width. Rhizoidal gemmae more than 110  $\mu\text{m}$  long. Forms loose, glossy green turfs on wet, clayey or sandy soils in oakwoods and fir woods in montane areas and high mountains, in the northern part of the Peninsula. Esp, Prt.

- 6 Leaves gradually narrowed to acumen, base not sheathing, margin recurved, at least on one side; basal cells of lamina 10-12  $\mu\text{m}$  wide; capsule smooth 7

- 7 Leaves unistratose, margin recurved; nerve well defined, occupying 1/5 of leaf base width (55-85  $\mu\text{m}$ ); exothelial cells elongated, with straight walls, longitudinal walls more thickened than transverse walls, especially at convex part of capsule (fig. 28, 7-8)

**D. varia** (Hedw.) Schimp.

**Anisothecium rubrum** Lindb., **A. varium** (Hedw.) Mitt.

Rhizoids pale brown, often with irregular gemmae having prominent cells. Capsule smooth, asymmetrical, curved. Grows on rocks, soils and slopes by wet, calcareous roads in montane areas. Widespread throughout the Peninsula. Esp, Prt.

- 7 Leaves bistratose, rarely unistratose near base, basal margin plane or narrowly recurved on one side; nerve ill-defined, occupying 1/3 of leaf base width (85-100  $\mu\text{m}$ ); exothelial cells elongated, with sinuose walls, longitudinal and transverse walls with similar thickness (fig. 28, 9-10) **D. howei** Renauld & Cardot

Rhizoids brown, often with irregular gemmae having prominent cells. Grows usually on exposed soils and stony slopes in the lowlands. Frequent in the eastern half of the Peninsula and in Mallorca, Menorca and Pithyusic islands. Esp, Prt, Bl.

- 8 Stem and nerve reddish; nerve percurrent, occupying 1/5 of leaf base width; leaves straight or falciform; seta red; capsule reddish, straight or slightly inclined, symmetrical, smooth (fig. 28, 11) **D. rufescens** (Dicks.) Schimp.

**Anisothecium rufescens** (Dicks.) Lindb.

Rhizoids red-brown in old parts, with reddish or brownish gemmae of 1-3 cells. Lid high-conical; peristome basal membrane high, of up to 10 rows of cells. Forms lax, dull reddish to brownish turfs on wet, acidic, clayey or clay-sandy soils, by roadsides or streams in montane areas, in the northern half of the Peninsula. Esp, Prt.

- 8 Stem and nerve green; nerve excurrent, occupying 1/3 of leaf base width; leaves falciform, secund; seta yellow; capsule brown, inclined, asymmetrical, sulcate when dry (fig. 28, 12-14) **D. heteromalla** (Hedw.) Schimp.

Lid rostrate; peristome reddish brown, basal membrane yellow. Forms glossy green turfs on slopes, in wet rock crevices and by streams, on acidic substrata in beechwoods, oakwoods and *Quercus ilex* L. forests. Common in montane areas of the Peninsula. Esp, Prt, And.

### **Dicranum** Hedw.

Plants medium-sized to large, generally forming dense or compact, glossy turfs or tufts. Stem tomentose. Leaves straight or falciform, often secund, lanceolate, plane or undulate, mostly with subulate apex and margin  $\pm$  dentate; upper cells of lamina quadrate, rectangular to elongate, smooth or mamilliose, thick-walled, occasionally porose, alar cells  $\pm$  distinct; nerve percurrent or excurrent or ending below apex, smooth or with longitudinal lamellae at back and 2 stereid bands, rarely without stereids. Capsule erect or inclined, straight or curved, smooth or striate; lid longly rostrate; calyptra cucullate; peristome teeth 16, divided to halfway or to 2/3.

- |   |   |                                  |
|---|---|----------------------------------|
| 1 | Upper cells of leaf elongated, often porose   | 2                                |
| 1 | Upper cells of leaf quadrate or shortly rectangular, not porose   | 7                                |
| 2 | Leaves transversely undulate, mainly in the upper part  | 3                                |
| 2 | Leaves not distinctly undulate  | 4                                |
| 3 | Leaves about 10 mm long, straight to falciform, with long and narrow upper part, margin plane, irregularly dentate, recurved at base; nerve percurrent, with 2(-4) high lamellae at back above (fig. 29, 1-2) | <b>D. polysetum</b> Sw. ex anon. |

**D. undulatum** Ehrh. ex F. Weber & D. Mohr

Stem robust, strongly tomentose. Alar cells brownish yellow. Fertile plants with (1-)5(-7) sporophytes per perichaetium. Forms large turfs on wet, shaded soils in pinewoods, oakwoods and fir woods in the northern part of the Peninsula. Esp, And.



- 3 Leaves about 4-7 mm long, straight, with short and wide upper part, margin plane, denticulate; nerve ending below apex, smooth or with 2 short lamellae at back above (fig. 29, 3-4) **D. bonjeanii** De Not.  
Stem thin, tomentose. Alar cells brownish. Fertile plants with 1(-2) sporophytes per perichaetium. Forms turfs on wet, exposed soils, wet grasslands and peaty soils, in the northern part of the Peninsula. Esp, And.
- 4 Leaves 9-12 mm long, bistratose in the upper part; nerve without lamellae but toothed at back above (fig. 29, 5) **D. majus** Sm.  
Leaves falcate-secund, flexuose. Laminal cells rectangular, with thin longitudinal walls; nerve with 2(-3) rows of central guide cells. Seta yellow. Grows on damp or humid, shaded, stony soils and at base of walls, in the Western Pyrenees and in the Basque Mountains. Esp.
- 4 Leaves to 8 mm long, unistratose or bistratose in the upper part; nerve with (2-)4-6 lamellae at back above or smooth 5
- 5 Nerve without dorsal lamellae **D. leioneuron** Kindb.  
Stem slightly tomentose, with flagelliform branches; leaves straight, ovate-lanceolate, concave, channelled, margin entire. Forms light green turfs in mires and damp sites. Very rare, in the north of the Peninsula. Esp.
- 5 Nerve with lamellae at back above 6
- 6 Lamina unistratose; nerve with (2-)4 dorsal lamellae at back above (fig. 29, 6-10) **D. scoparium** Hedw.  
Stem of young plants covered by dense, whitish tomentum. Leaves often secund, plane, margin dentate; laminal cells rectangular, with thickened longitudinal walls; nerve with a central row of guide cells. Seta yellow, reddish at base. Forms light green, glossy tufts on dry or wet, shaded, stony soils, at base of rotting trees and trunks, usually in montane areas, although it can reach high mountains, in the lowlands in northwest of the Peninsula. Widespread throughout the Peninsula and in Mallorca. Esp, Prt, And, Bl.
- 6 Lamina bistratose or partly bistratose in the upper half; nerve with 4-6 dorsal lamellae at back above (fig. 29, 11-12) **D. crassifolium** Sérgio, Ochrya & Séneca  
Stem with whitish tomentum. Leaves gradually tapering to a channelled subula; lamina with tristratose strands, alar cells yellowish to brownish; dorsal lamellae 1-3(-4) cells high. Forms rather loose, yellowish-green or light to dark green turfs, on soil or humus in open or shaded places, and on rocks and at tree bases. Widespread in the north and west of the Peninsula. Esp, Prt.
- 7 Leaves rugose or transversely undulate, mainly in the upper part 8
- 7 Leaves not rugose or transversely undulate, channelled in the upper part 9
- 8 Leaves ovate-lanceolate, abruptly acuminate, acumen twisted, dentate, fragile; median cells triangular or quadrate, with sinuose walls, basal cells not porose; nerve with high mamillae at back above (fig. 29, 13) **D. spurium** Hedw.  
Stem tomentose, 2-6 cm high. Capsule slightly strumose. Grows in hollows of humus-rich soils in shaded sites, in *Pinus sylvestris* L. forests. Scattered in the north of the Peninsula. Esp.



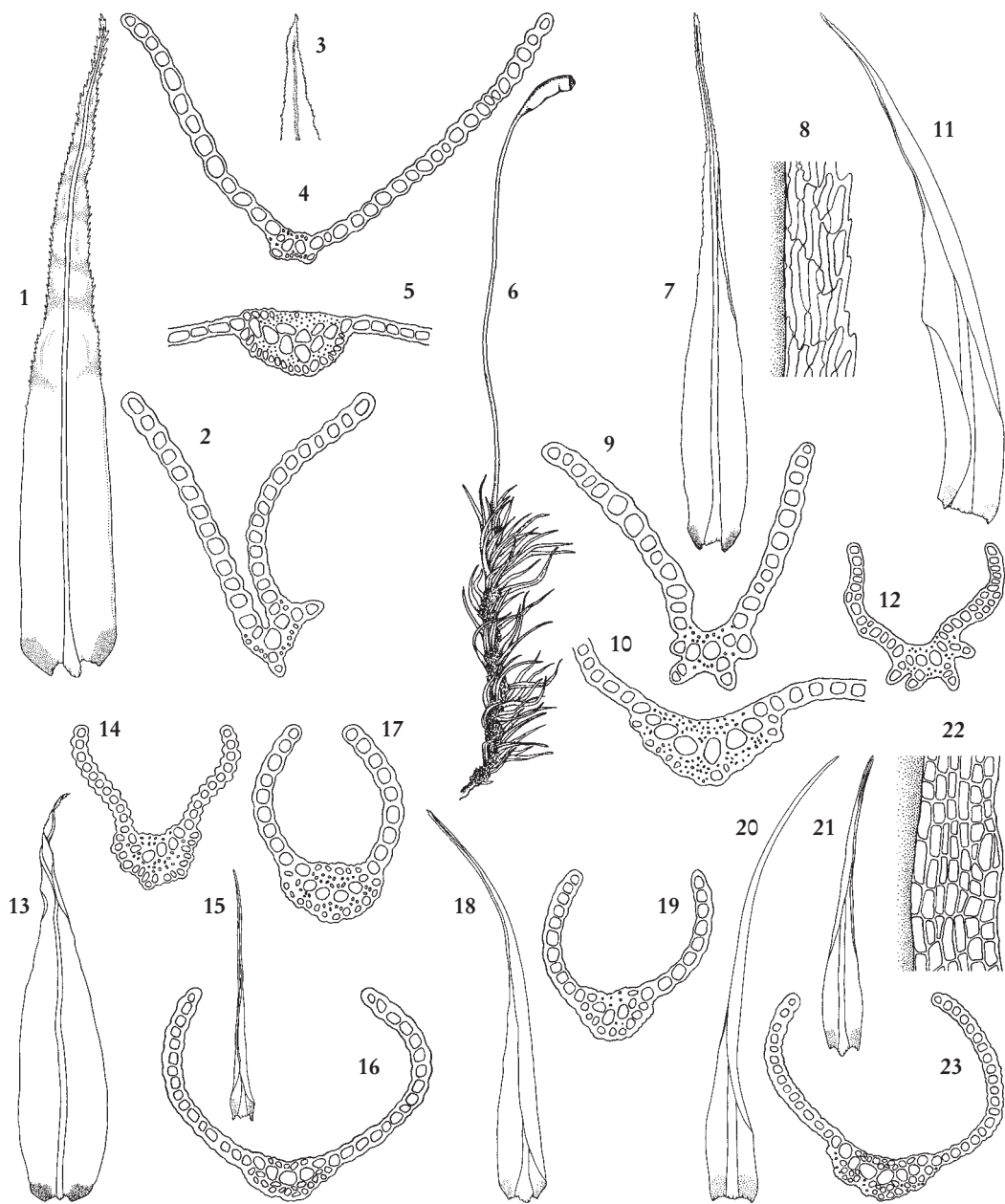


FIGURE 29. 1-2, *Dicranum polysetum*: 1, leaf; 2, leaf section. 3-4, *D. bonjeanii*: 3, leaf apex; 4, leaf section. 5, *D. majus*, nerve section at base. 6-10, *D. scoparium*: 6, habit; 7, leaf; 8, upper cells; 9, section in the middle of leaf; 10, nerve section at base. 11-12, *D. crassifolium*: 11, leaf; 12, leaf section. 13, *D. spurium*, leaf. 14, *D. brevifolium*, leaf section. 15-16, *D. tauricum*: 15, leaf; 16, leaf section. 17, *D. muehlenbeckii*, leaf section. 18-19, *D. fuscescens*: 18, leaf; 19, leaf section. 20, *D. scottianum*, leaf. 21-23, *D. montanum*: 21, leaf; 22, upper cells; 23, leaf section. 6 ( $\times 2$ ); 1, 3, 7, 11, 13, 15, 18, 20, 21 ( $\times 10$ ); 2, 4, 5, 8, 9, 10, 12, 14, 16, 17, 19, 22, 23 ( $\times 170$ ).

- 8 Leaves lanceolate, gradually acuminate, apex obtuse; median cells smooth, basal cells mostly porose; nerve smooth at back above **D. undulatum** Schrad. ex Brid.  
**D. bergeri** Blandow, **D. affine** Funck.  
 Stem to 10-15 cm high, with brown tomentum below. Grows on wet soils and peaty or wet grasslands, in high mountains of the Eastern Pyrenees. Esp.
- 9 Cross section of upper part of leaf like a pair of tongs (fig. 29, 14)  
**D. brevifolium** (Lindb.) Lindb.  
**D. muehlenbeckii** Bruch & Schimp. var. **cirrhatum** (Schimp.) Lindb.  
 Plants 2-10 cm tall, with tomentose stem. Leaves falciform, base ovate-lanceolate, attenuate to a fine, slightly dentate point; upper cells of lamina quadrate or rounded, arranged in rows. Grows on calcareous rocks and soils, in high mountains of the Pyrenees. Esp.
- 9 Cross section of upper part of leaf orbicular 10
- 10 Nerve without stereids (fig. 29, 15-16) **D. tauricum** Sapjegin  
**D. strictum** Schleich. ex D. Mohr, **Orthodicranum tauricum** (Sapjegin) Smirnova  
 Plants small, to 2-3 cm tall. Leaves rigid, apex subulate, very fragile; basal cells of lamina not porose, alar cells yellowish; nerve smooth, longly excurrent. Capsule straight. Grows on rotting stumps, or at tree bases, in montane areas and high mountains, mainly in the northern half of the Peninsula. Esp, Prt, And.
- 10 Nerve with stereids 11
- 11 Leaves with porose basal cells 12
- 11 Leaves with non- or only slightly porose basal cells 13
- 12 Cells more than 12  $\mu\text{m}$  wide in upper part of leaf; margin serrate close to the leaf apex (fig. 29, 17) **D. muehlenbeckii** Bruch & Schimp.  
 Plants robust, to 10 cm tall, dull. Stem with golden brown tomentum below. Leaves slightly contorted, strongly twisted when dry; upper cells of lamina regularly quadrate, 12-18  $\mu\text{m}$  wide, basal cells rectangular. Grows on humus-rich soils. in montane areas and high mountains. Scattered localities mainly in the Pyrenees. Esp.
- 12 Cells to 12  $\mu\text{m}$  wide in upper part of leaf; margin entire to slightly denticulate close to the leaf apex **D. spadiceum** J.E. Zetterst.  
**D. muehlenbeckii** Bruch & Schimp. var. **neglectum** (De Not.) Pfeff.  
 Plants to medium size, dark or pale green. Stem with dark brown tomentum below. Leaves erect-spreading when dry, margin entire or denticulate in upper part; upper cells of lamina irregular, quadrate, triangular or shortly rectangular, 8-12  $\mu\text{m}$  wide, basal cells elongated, strongly porose. Grows on moist soils and in rock crevices in high mountains of the Pyrenees an in the southwestern part of the Peninsula. Esp, Prt.
- 13 Leaves twisted when dry; alar cells distinct, orange yellow; capsule curved (fig. 29, 18-19) **D. fuscescens** Sm.  
 Plants 1-6(-10) cm tall. Leaves falciform, secund, upper margin partially bistratose, dentate; upper cells of lamina regularly quadrate, arranged in rows, mamilllose; nerve mamilllose and

dentate at back above. Capsule striate. Forms dense, yellowish green to olive green turfs on wet, shaded, stony, acidic soils and rotting stumps, in montane areas and high mountains. Distributed in the northern part of the Peninsula. Esp, And.

- 13 Leaves slightly contorted when dry; alar cells  $\pm$  distinct, brownish; capsule erect or nearly so 14
- 14 Leaf margin entire above; nerve broad but not strong (fig. 29, 20)

**D. scottianum** Turner ex R. Scott

**Orthodicranum scottianum** (Turner ex R. Scott) G. Roth ex Casares-Gil

Plants to 5 cm tall. Lamina unistratose, sometimes bistratose or partly bistratose near apex, alar cells brownish. Forms dark green turfs on siliceous, shaded rocks, in the north and northwest of the Peninsula. Esp.

- 14 Leaf margin denticulate above; nerve strong but not broad 15
- 15 Leaves with mamilllose upper cells (fig. 29, 21-23) **D. montanum** Hedw.

**Orthodicranum montanum** (Hedw.) Loeske

Plants to 3 cm tall. Leaves with fragile points, margin denticulate; laminal cells quadrate, mamilllose; nerve with few stereids, mamilllose at back above. Capsule straight. Forms low,

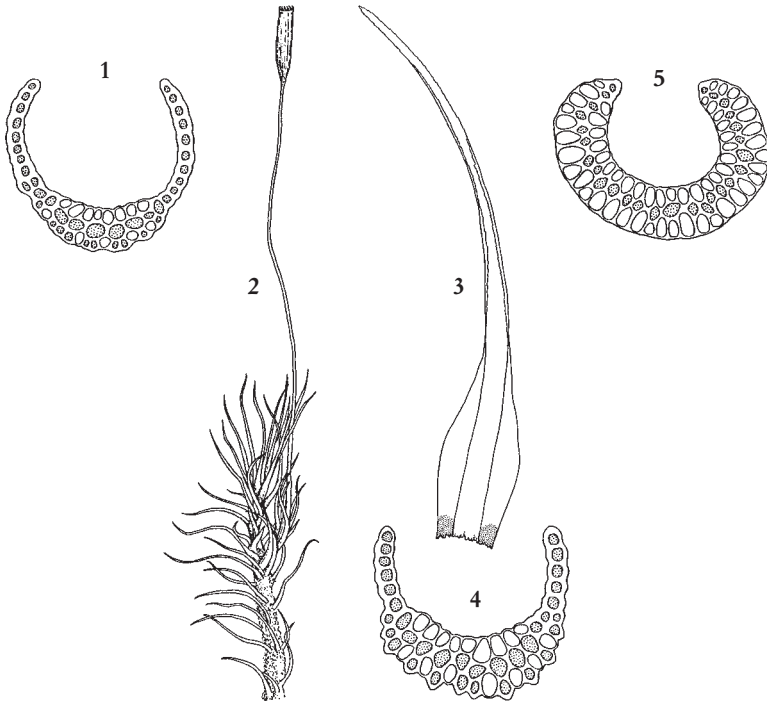


FIGURE 30. 1, *Paraleucobryum sauteri*, leaf section. 2-4, *P. longifolium*: 2, habit; 3, leaf; 4, leaf section. 5, *P. enerve*, leaf section. 2 ( $\times 3,5$ ); 3 ( $\times 15$ ); 1, 4, 5 ( $\times 200$ ).

soft, compact light green to brownish turfs on wet or damp, shaded, humus-rich soils and rotting trunks, in montane areas of the north of the Peninsula. Esp.

15 Leaves with smooth upper cells

**D. flagellare** Hedw.

**Orthodicranum flagellare** (Hedw.) Loeske

Plants to 5 cm tall. Leaf margin entire or denticulate only in the uppermost part. Propaguliferous, flagelliform branches with short, ovate-lanceolate, appressed, leaves from axils of upper stem leaves. Forms green to yellowish green, dense turfs on decaying wood and humus-rich soils, in montane areas, in the north and northwest of the Peninsula. Esp.

**Paraleucobryum** (Limpr.) Loeske

Plants ± robust, glossy, pale green. Leaves lanceolate, subulate, erect or falciform, often secund; upper cells rectangular, elongate and ± porose below, alar cells differentiated; nerve broad, in section with a ventral layer of hyaline cells, a central layer of chlorophyllose cells and a dorsal layer of hyaline cells intermingled or not with chlorophyllose cells. Capsule straight, cylindrical.

1 Nerve less than 1/2 width of leaf base (fig. 30, 1)

**P. sauteri** (Bruch & Schimp.) Loeske

Leaf margin entire; nerve in section with the dorsal layer composed of hyaline and chlorophyllose cells mixed. Forms turfs on acidic rocks and rotten stumps by streams in high mountains pine woods and fir woods of the Pyrenees. Esp.

1 Nerve 1/2 or more width of leaf base

2

2 Nerve 1/2-2/3 of leaf base, dorsally striate, in section dorsal layer composed of hyaline cells with chlorophyllose cells mixed (fig. 30, 2-4)

**P. longifolium** (Hedw.) Loeske

Leaf margin denticulate in the upper part. Forms glossy turfs on wet acidic rocks and at tree bases in fir woods, beechwoods and pine woods, in montane areas and high mountains, in the northern half of the Peninsula and in Sierra Nevada. Esp.

2 Nerve more than 3/4 of leaf base, smooth, in section the dorsal layer composed only of hyaline cells (fig. 30, 5)

**P. enerve** (Thed.) Loeske

Leaf margin entire or with few denticulations in the upper part. Forms glossy dense turfs on wet rocks and soils in high mountains pine woods, in the Pyrenees. Esp, And.

**Fam. Leucobryaceae**

**Campylopus** Brid.

Plants small to robust, forming dense, usually glossy turfs. Stem mostly tomentose. Leaves lanceolate, with ± widened base, abruptly tapered to channelled apex; median cells variable, quadrate to vermicular, alar cells hyaline, coloured or slightly distinct; nerve broad, occupying 1/3-1/2 of leaf base width, excurrent in hyaline hair-point or in green or

brownish arista, smooth or with low ribs at back, often with large guide cells and dorsal stereids, rarely stereids lacking.

- |   |   |  |
|---|---|--|
| 1 | Nerve without stereids  | 2  |
| 1 | Nerve with stereids   | 3  |
| 2 | Plants with reddish-brown tomentum; upper cells irregular, rhomboidal or trapeziform; nerve smooth at back (fig. 31, 1)   | <b>C. schimperi</b> Milde                  |
|   | Stem 2-6 cm high. Leaves appressed, straight, apex channelled, slightly dentate or entire; partially bistratose in upper part, median cells of lamina narrow (3-7:1), basal cells widely rectangular, with some rows of hyaline or colourless marginal cells, alar cells slightly differentiated, hyaline. Forms compact, matted, dull green to yellowish brown turfs on soils by streams or in wet grasslands in high mountains of the Pyrenees. Esp.  |  |
| 2 | Plants not or slightly tomentose; upper cells regular, mainly rectangular and quadrate; nerve with low ribs at back (fig. 31, 2-3)  | <b>C. subulatus</b> Schimp. ex Milde       |
|   | Stem 0,5-3 cm high. Leaves with rather short subula; alar cells hyaline, rarely forming more or less distinct auricles. Forms green or light green loose turfs on siliceous rocks, in the lowlands in the north and northwestern part of the Peninsula. Esp, Prt.   |  |
| 3 | Nerve with dorsal and ventral stereids (fig. 31, 4-5)   | <b>C. brevipilus</b> Bruch & Schimp.       |
|   | Leaves straight, often ending in short, hyaline point; median cells of lamina $\pm$ sinuose. Forms compact, golden turfs on acidic soils and slopes, in the lowlands. Distributed in the north and west of the Peninsula and in Menorca. Esp, Prt, Bl.  |  |
| 3 | Nerve with dorsal stereids only   | 4  |
| 4 | Leaves narrower at base (fig. 31, 6-9)  | <b>C. fragilis</b> (Brid.) Bruch & Schimp. |
|   | Stem 0,5-4 cm high, with reddish tomentum. Leaves subulate, denticulate at apex; median cells of lamina shortly rectangular, thick-walled, basal cells longly rectangular, larger, thin-walled, marginal cells narrower; nerve occupying 2/3 of leaf base width, excurrent, dentate. Plants sterile, often with caducous, propaguliferous leaves at stem tip. Forms dense, glossy light green turfs on rocks and acidic slopes and in rock crevices in montane areas, in the north and west of the Peninsula. Esp, Prt. |  |
| 4 | Leaves not narrower at base   | 5  |
| 5 | Median cells of lamina vermicular; nerve excurrent in hyaline hair-point (fig. 31, 10-12)   | <b>C. atrovirens</b> De Not.               |
|   | Stem 2-10 cm high. Leaves longly subulate, channelled; basal cells of lamina thick-walled, alar cells inflated, hyaline or reddish brown; nerve occupying 1/2 of leaf base width, smooth or with low ribs 1 cell high at back, excurrent in denticulate, hyaline hair-point of variable length, occasionally lacking. Forms loose, glossy dark green turfs on wet, acidic rocks in montane areas and high mountains, in the northern half of the Peninsula. Esp, And.   |  |
| 5 | Median cells of lamina quadrate, rectangular, trapeziform or rhomboidal; nerve percurrent or excurrent in hyaline hair-point  | 6  |

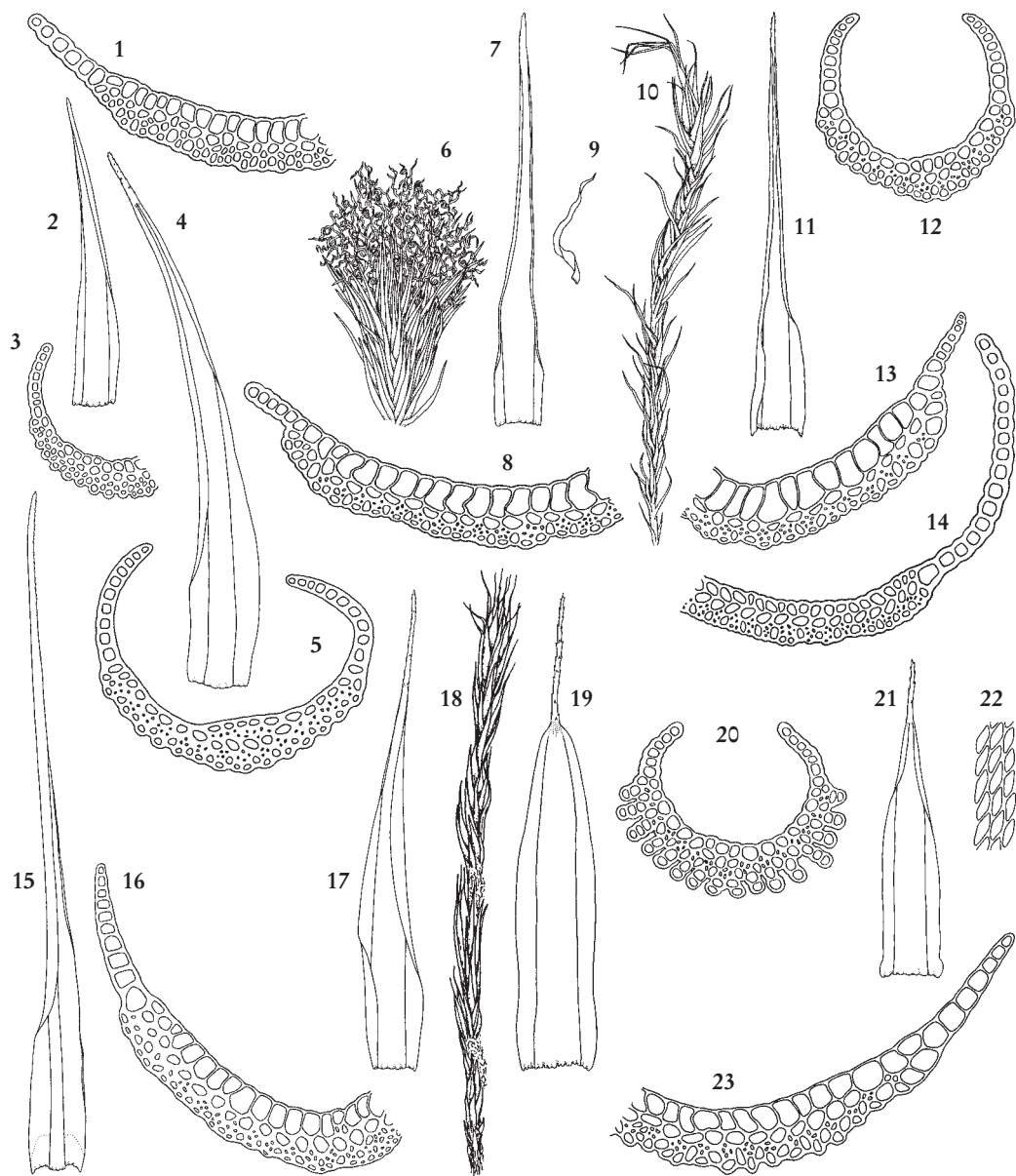


FIGURE 31. 1, *Campylopus schimperi*, leaf section. 2-3, *C. subulatus*: 2, leaf; 3, leaf section. 4-5, *C. brevipilus*: 4, leaf; 5, leaf section. 6-9, *C. fragilis*: 6, stem tip with caducous leaves; 7, leaf; 8, leaf section; 9, caducous leaf. 10-12, *C. atrovirens*: 10, habit; 11, leaf; 12, leaf section. 13, *C. pyriformis*, leaf section. 14, *C. flexuosus*, leaf section. 15-16, *C. setifolius*: 15, leaf; 16, leaf section. 17, *C. introflexus*, leaf. 18-20, *C. pilifer*: 18, habit; 19, leaf; 20, leaf section. 21-23, *C. oerstedianus*: 21, leaf; 22, upper cells; 23, leaf section. 10, 18 ( $\times 4$ ); 6 ( $\times 6$ ); 2, 4, 7, 9, 11, 15, 17, 19, 21 ( $\times 16$ ); 1, 3, 5, 8, 12, 13, 14, 16, 20, 22, 23 ( $\times 200$ ).

- 6 Leaves without hyaline hair-point 7
- 6 At least upper leaves with hyaline hair-point 9
- 7 Alar cells not or slightly differentiated (fig. 31, 13) **C. pyriformis** (Schultz) Brid.  
Stem to 3 cm high, slightly tomentose at base. Leaves longly and finely subulate; alar cells hyaline or pale red; nerve usually occupying more than 2/5 of leaf base width, shortly excurrent in green, denticulate point, with low ribs at back. Forms dense, pale green to yellowish green turfs on damp slopes and peaty soils, in the north and west of the Peninsula. Esp, Prt.
- 7 Alar cells well differentiated 8
- 8 Plants with abundant reddish brown tomentum (fig. 31, 14)  
**C. flexuosus** (Hedw.) Brid.  
Stem 1-6 cm high, branched. Leaves erect, flexuose, longly subulate, apex channelled, dentate; median cells of lamina quadrate to shortly rectangular, in regular rows, alar cells hyaline or reddish brown, inflated, basal cells hyaline, narrowly rectangular; nerve smooth, occupying 1/2 of leaf base width. Forms dense, glossy golden green turfs on humus-rich soils and in shaded, acidic rock crevices, in the lowlands and montane areas. Distributed in the northern part of the Peninsula. Esp, Prt.
- 8 Plants without tomentum or with few pale rhizoids (fig. 31, 15-16)  
**C. setifolius** Wilson  
Stem to 3 cm high. Leaves erecto-patent, flexuose when dry, gradually tapering to long subula, upper 1/4 of leaf with numerous spinose teeth, apex crowned with 1-4 large teeth; median cells irregular, trapeziform or rectangular, in regular rows, alar cells orange red, basal cells rarely hyaline, rectangular; nerve not excurrent, smooth or with low toothed ribs near apex, occupying 2/5-3/5 of leaf base width. Forms loose, dark green turfs in wet, acidic rock crevices, in the lowlands. Rare, in the north of the Peninsula. Esp.
- 9 Hyaline hair-point reflexed when dry (fig. 31, 17) **C. introflexus** (Hedw.) Brid.  
Plants golden, to 4 (-7) cm tall. Leaves erect, oblong, subulate, hyaline hair-point dentate; median cells of lamina short, rhomboidal, irregular, thick-walled, basal cells hyaline, extending up margins, alar cells reddish to brown in old leaves; nerve with ribs 1-2 (-3) cells high at back. Grows on rotting pine wood and peaty soils, in the lowlands and montane areas, in the north and west of the Peninsula, rare in the northeastern part and in Mallorca. Esp, Prt, Bl.
- 9 Hyaline hair-point straight when dry 10
- 10 Nerve with dorsal lamellae (2-)3-4 cells high and numerous stereid groups (fig. 31, 18-20)  
**C. pilifer** Brid.  
**C. polytrichoides** De Not.  
Stem very rigid, 1-3 cm high. Leaves strongly imbricate; median cells of lamina irregularly ovate, basal cells rectangular, narrower, hyaline, extending up margins in a v-shape. Forms dense, golden green turfs on dry or slightly wet, acidic rocks and soils and in rock crevices, in the lowlands and montane areas. Widespread in the Peninsula and in Menorca. Esp, Prt, Bl.
- 10 Nerve smooth or with some slightly prominent cells at back, with 1-2 stereid groups (fig. 31, 21-23) **C. oerstedianus** (Müll.Hal.) Mitt.



Stem 0,5-1,5 cm high. Median cells of lamina trapeziform or shortly rhomboidal, obliquely arranged, basal cells quadrate or rectangular, with transverse thickened walls. Forms dense turfs in acidic rock crevices, in the lowlands. Scattered localities in the north of the Peninsula. Esp.

### **Dicranodontium** Bruch & Schimp.

Plants with tomentose stem, forming loose, brownish yellow turfs. Leaves straight to falciform, subulate, channelled; laminal cells narrow and long, alar cells hyaline to brownish, often inflated, fragile; nerve excurrent, with dorsal and ventral stereids. Seta  $\pm$  curved, straight to sinuose when dry; capsule cylindrical, straight, smooth, without annulus; lid conical, rostrate; peristome teeth 16, divided to near base, obliquely striate at tips; calyptra cucullate. Dioicous.

- 1 Leaf margin denticulate almost throughout (fig. 32, 1) **D. asperulum** (Mitt.) Broth.  
Plants to 5 cm tall. Leaves often caducous, flexuose, erect, sometimes falcate-secund. Leaves with inflated, fragile alar cells; nerve occupying about 1/3 of leaf base width. Forms soft, loose, silky or dull yellowish to dark green turfs on damp or wet siliceous rocks by streams. Very rare in the north of the Peninsula. Esp.
- 1 Leaf margin denticulate only in upper part of leaf 2
- 2 Nerve well defined, occupying 1/5 of leaf base width; basal cells widely rectangular, hyaline (fig. 32, 2) **D. uncinatum** (Harv.) A. Jaeger  
Plants to 10 cm tall. Leaves falciform, with wide base, abruptly narrowed to subula; alar cells fragile. Grows on acidic soils and rock in montane areas and high mountains, in the northern part of the Peninsula. Esp, And.
- 2 Nerve ill-defined, occupying 1/3-1/2 of leaf base width; basal cells narrowly rectangular, not hyaline (fig. 32, 3-5) **D. denudatum** (Brid.) E. Britton  
Plants to 5 cm tall. Leaves straight or falciform, caducous, gradually subulate; alar cells inflated. Grows on acidic rocks and slopes, and humus-rich soils in wet forests in montane areas and high mountains, in the northern part of the Peninsula. Esp, And.

### **Leucobryum** Hampe

Plants robust, forming glaucous to brownish cushions. Leaves lanceolate, with broad and sheathing base, lamina narrow, composed of 1-12 rows of cells; nerve very broad, occupying almost all the leaf, consisting of a central layer of chlorophyllose cells covered on both sides by 1 to several layers of hyaline cells. Vegetative propagation frequent, by means of axillary groups of caducous narrower leaves.

- 1 Upper part of leaf shorter, equalling or slightly longer than the basal sheathing part; lamina with 1-7 rows of cells; leaf base with a central shallow depression in cross section (fig. 32, 6-8) **L. glaucum** (Hedw.) Ångstr.  
Leaves erect. Forms whitish to brownish compact cushions, 3-4 cm high, on very moist, peaty soils, in the north of the Peninsula. Esp, Prt.



- 1 Upper part of leaf longer than the basal sheathing part; lamina with 5-12 rows of cells; leaf base with a central deep depression in cross section (fig. 32, 9-11)

***L. juniperoideum* (Brid.) Müll.Hal.**

Leaves  $\pm$  flexuose. Forms cushions, to 8 cm high, at base of rocks and on wet soils, in the north of the Peninsula and in Algeciras Mountains. Esp, Prt.

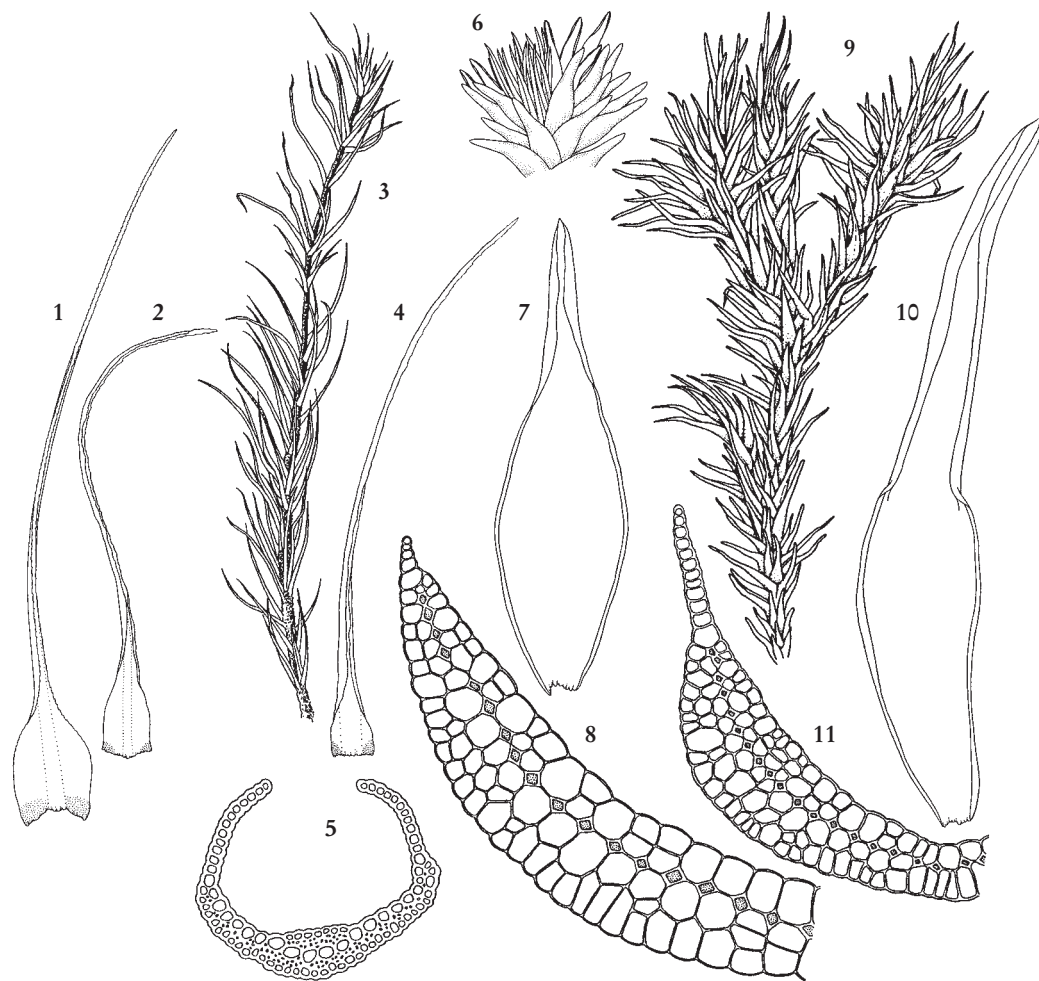


FIGURE 32. 1, *Dicranodontium asperulum*, leaf. 2, *D. uncinatum*, leaf. 3-5, *D. denudatum*: 3, habit; 4, leaf; 5, leaf section. 6-8, *Leucobryum glaucum*: 6, stem tip with caducous leaves; 7, leaf; 8, leaf section. 9-11, *L. juniperoideum*: 9, habit; 10, leaf; 11, leaf section. 9 ( $\times 2$ ); 3, 6 ( $\times 4$ ); 7, 10 ( $\times 14$ ); 1, 2, 4 ( $\times 16$ ); 8, 11 ( $\times 100$ ); 5 ( $\times 200$ ).

## O. Pottiales Fam. Pottiaceae

### Acaulon Müll.Hal.

Plants very small, to 0,2 mm tall, bulbiform. Stem very short. Leaves erect, imbricate, ovate, concave or carinate, margin entire or dentate, plane or recurved; cells hexagonal, rhomboidal or elliptical, smooth or papillose; nerve thin, faint, excurrent in arista or apiculus, or percurrent. Seta very short, straight or curved; capsule immersed, globose, indehiscent, without apiculus or sometimes with minute apiculus.

- 1    Laminal cells papillose 2
- 1    Laminal cells smooth 3
- 2    Leaf margin strongly dentate in the upper half, with forked and recurved teeth (fig. 33, 1) A. **casasianum** Brugués & H.A. Crum  
      Plants whitish. Leaves with recurved margin; laminal cells with papillae 7-8 µm high; nerve excurrent in long, reflexed, papillose or dentate arista. Spores 22-26 µm. Plants isolated or gregarious on gypsum substrata of arable field sides and scrub margins, in the Mediterranean region. Esp.
- 2    Leaf margin slightly dentate in the upper half, with simple and straight teeth (fig. 33, 2) A. **dertosense** Casas, Sérgio, Cros & Brugués  
      Plants golden brown. Leaf margin narrowly recurved; nerve excurrent in apiculus or often reflexed arista, papillose or not. Laminal cells with papillae 4 µm high. Spores 28-32 µm. Plants solitary or gregarious on exposed, calcareous soil of the Mediterranean region. Esp.
- 3    Plants triangular in section; leaves carinate; seta curved (fig. 33, 3-4) A. **triquetrum** (Spruce) Müll.Hal.  
      Nerve excurrent in reflexed arista. Plants brownish yellow. Gregarious on dry, exposed, clayey soils in the lowlands. Widespread throughout the Peninsula, Mallorca and Pithyusic Islands. Esp, Prt, Bl.
- 3    Plants circular in section; leaves concave; seta straight 4
- 4    Nerve section with 2-5 large, prominent cells on ventral side; nerve excurrent in arista (fig. 33, 5-6) A. **fontiquerianum** Casas & Sérgio  
      Arista orange yellow, 80-250 µm long or more; spores 18-28 µm. On slopes and exposed soils. Rare, in southern and eastern part of the Peninsula. Esp, Prt.
- 4    Nerve section without differentiated cells on ventral side; nerve excurrent in apiculus 5
- 5    Leaves dentate at apex; apical cells rhomboidal, twice as long as wide; spores with short papillae (fig. 33, 7-8) A. **muticum** (Hedw.) Müll.Hal.  
      Plants green, isolated, on exposed soils in the lowlands. Scattered in the Peninsula. Esp, Prt.

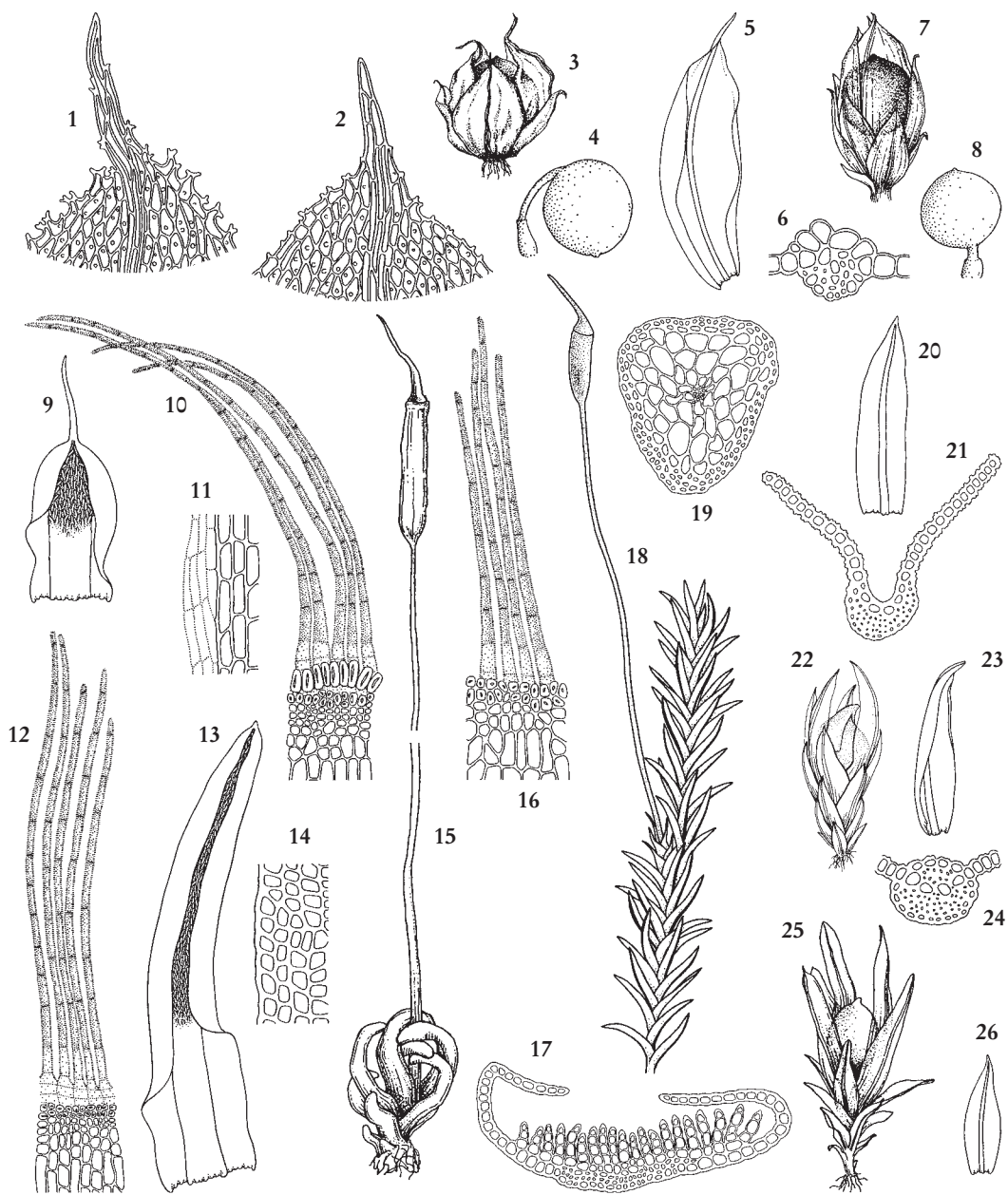


FIGURE 33. 1, *Acaulon casasianum*, leaf apex. 2, *A. dertosense*, leaf apex. 3-4, *A. triquetrum*: 3, habit; 4, capsule. 5-6, *A. fontiquerianum*: 5, leaf; 6, nerve section. 7-8, *A. muticum*: 7, habit; 8, capsule. 9, *Aloina bifrons*, leaf. 10-11, *A. rigida*: 10, peristome; 11, marginal cells near base. 12-14, *A. ambigua*: 12, peristome; 13, leaf; 14, marginal cells near base. 15-17, *A. aloides*: 15, habit when dry; 16, peristome; 17, leaf section. 18-21, *Anoectangium aestivum*: 18, habit; 19, stem section; 20, leaf; 21, leaf section. 22-24, *Aschisma cuynetii*: 22, habit; 23, leaf; 24, nerve section. 25-26, *A. carniolicum*: 25, habit; 26, leaf. 15, 18 ( $\times 9$ ); 3, 4, 5, 7, 8, 9, 13, 20, 22, 23, 25, 26 ( $\times 18$ ); 10, 12, 16 ( $\times 80$ ); 1, 2, 17 ( $\times 100$ ); 6, 11, 14, 19, 21, 24 ( $\times 180$ ).

- 5 Leaves entire; apical cells shortly rhomboidal or elliptical, less than twice as long as wide; spores spinose **A. mediterraneum** Limpr.

**A. muticum** (Hedw.) Müll.Hal. var. **mediterraneum** (Limpr.) Sérgio

Plants green, isolated on exposed, clayey soils in the lowlands. Scattered in the Peninsula. Esp, Prt.

### **Aloina** Kindb.

Plants gregarious. Stem 0,2-0,5 cm high, dark green. Leaves thick, rigid, lingulate to ovate-lingulate, base wide, margin entire, broadly incurved covering the upper lamina; nerve broad, percurrent or excurrent, densely covered with chlorophyllose filaments on the ventral side. Capsule cylindrical, straight or slightly inclined, annulus persistent or caducous; peristome teeth 16, divided to base, almost straight or spirally twisted.

- 1 Leaves with hyaline hair-point (fig. 33, 9) **A. bifrons** (De Not.) Delgad.

Forms turfs on dry, calcareous or gypsum stony soils, in the centre and east of the Peninsula. Esp.

- 1 Leaves without hyaline hair-point, apiculate or mucronate, often cucullate 2

- 2 Marginal cells near leaf base hyaline, thin-walled, mostly longer than wide, forming at margin a well-differentiated border; annulus caducous (fig. 33, 10-11)

**A. rigida** (Hedw.) Limpr.

Leaves 4-6 as long as wide, concave, cucullate, obtuse, lower leaves orbicular. Capsule straight; lid rostrate; peristome teeth spirally twisted when dry; spores 14-16  $\mu\text{m}$ . Plants solitary or forming loose turfs on dry, open, calcareous or gypsum soils mainly in the lowlands. Widespread throughout the Peninsula and in Mallorca, Menorca and Pithyusic Islands. Esp, Prt, Bl.

- 2 Most marginal cells near leaf base not hyaline, thick-walled, quadrate, as wide as adjacent cells, not forming a distinct border; annulus persistent 3

- 3 Basal membrane high, visible above mouth of capsule; spores 12-16  $\mu\text{m}$  (fig. 33, 12-14)

**A. ambigua** (Bruch & Schimp.) Limpr.

**A. aloides** (Schultz) Kindb. var. **ambigua** (Bruch & Schimp.) E.J. Craig

Capsule cylindrical, straight; peristome teeth spirally twisted when dry. Plants solitary or forming loose turfs on dry, exposed, calcareous or siliceous, stony soils and walls in the lowlands. Widespread throughout the Peninsula and in Mallorca, Menorca and Pithyusic Islands. Esp, Prt, Bl.

- 3 Basal membrane short, not visible above mouth of capsule; spores 18-25  $\mu\text{m}$  (fig. 33, 15-17) **A. aloides** (Koch ex Schultz) Kindb.

Capsule cylindrical, straight or inclined; peristome teeth incurved when dry. Plants isolated or in loose turfs on dry, open, calcareous or siliceous, stony soils or walls in the lowlands. Widespread throughout the Peninsula and in Mallorca, Menorca and Pithyusic Islands. Esp, Prt, Bl.

### **Anoetangium Schwägr.**

Plants slender, yellowish green in upper part, brownish and radiculose below. Stem triangular in section, with central strand. Leaves erect-spreading, incurved,  $\pm$  curled when dry, carinate, lanceolate to oblong-lanceolate, acute, margin papillose-crenulate; upper cells quadrate or rounded, strongly papillose, apical cells smooth; nerve ending near apex, with 1 stereid band. Seta seemingly lateral. Capsule exserted, ellipsoidal; lid rostrate and oblique; peristome lacking (fig. 33, 18-21)

**A. aestivum** (Hedw.) Mitt.

Forms compact turfs to 10 cm high in rock crevices and on rock ledges, often where basic and shady, by mountain streams and cascades, in high mountains of the Pyrenees and in the northwest of the Peninsula. Esp (Extinct).

### **Aschisma Lindb.**

Plants minute, to 0,2 cm tall. Leaves oblong-lanceolate or ovate-lanceolate, apiculate, concave, margin plane, entire or sinuose-crenulate at apex or slightly dentate at base; laminal cells 6-10  $\mu$ m wide, quadrate or rounded, papillose, basal cells rectangular and smooth; nerve excurrent in mucro or apiculus, with dorsal and ventral stereid bands. Seta very short; capsule immersed, indehiscent, globose, reddish or brownish, with short apiculus.

- 1 Leaves cucullate, nerve 50-60  $\mu$ m wide in the upper part, prominent on dorsal side (fig. 33, 22-24)

**A. cuynetii** (Bizot & R.B. Pierrot) J. Guerra & M.J. Cano

**Phascum cuynetii** Bizot & R.B. Pierrot

Forms loose turfs on dry, exposed, acidic or calcareous soils, in coastal Mediterranean areas. Esp.

- 1 Leaves not cucullate, nerve 25-30  $\mu$ m wide in the upper part, not prominent on dorsal side (fig. 33, 25-26)

**A. carniolicum** (F. Weber & D. Mohr) Lindb.

Grows on dry, exposed, calcareous, sandy or clayey ledges, in the lowlands, mainly in coastal areas. Esp, Prt.

### **Astomum Hampe**

Plants small. Leaves erect to erecto-patent, lanceolate to linear-lanceolate, acuminate, incurved or crisped when dry, margin entire or sinuose-crenulate; upper cells quadrate, rounded or shortly rectangular, papillose; nerve percurrent or shortly excurrent. Seta shorter than capsule, straight; capsule immersed, globose to ellipsoidal, dehiscent or indehiscent.

- 1 Capsule dehiscent (fig. 34, 1-2)

**A. levieri** Limpr.

\* **Weissia levieri** (Limpr.) Kindb.

Plants to 1 cm tall. Leaves erect or erecto-patent. Perichaetial leaves similar to stem leaves. Forms small tufts on often basic soils in the lowlands near coastal areas. Scattered in the south and east of the Peninsula and in Mallorca. Esp, Prt, Bl.

- 1 Capsule indehiscent (fig. 34, 3)

**A. crispum** (Hedw.) Hampe

\* **Weissia longifolia** Mitt.

Plants to 1 cm tall. Leaves erecto-patent. Perichaetial leaves much longer than stem leaves. Lid more or less marked but not coming off when mature. Forms small, loose or compact tufts on exposed soils in the lowlands and montane areas. Common in the eastern half of the Peninsula and in Mallorca, Menorca and Pithyusic Islands, rarer in the west of the Peninsula. Esp, Prt, Bl.

### **Barbula** Hedw.

Plants to 4 cm tall. Leaves lanceolate to lingulate, apex acute or obtuse, margin plane or recurved in the lower half, entire or denticulate at apex; laminal cells rounded or quadrate, papillose, basal cells rectangular, smooth and pellucid; nerve excurrent or percurrent, dorsal and ventral surface cells usually rectangular. Axillary hairs composed of hyaline cells. Capsule cylindrical; peristome teeth 16, divided to base, filiform, twisted.

- 1 Stem with tomentum 2  
1 Stem without tomentum or only slightly tomentose 4

- 2 Leaf apex denticulate; axillary gemmae pedicellate, pluricellular; high mountain plants, hygrophilous (fig. 34, 4-5) **B. crocea** (Brid.) F. Weber & D. Mohr  
Leaves ovate-lanceolate; basal cells elongated, thick-walled, yellowish; nerve percurrent, reddish. Forms dark green turfs 1-3 cm high on seeping, calcareous rocks in the Pyrenees. Esp.

- 2 Leaf apex entire; axillary gemmae lacking; lowland plants, living in dry sites 3

- 3 Plants to 5 mm tall; basal cells quadrate or shortly rectangular (fig. 34, 6-8)

**B. convoluta** Hedw.

Plants green. Stem without central strand or slightly differentiated, with reddish rhizoids, occasionally with globose rhizoidal gemmae. Leaves ovate-lanceolate, apiculate, carinate, less than 1 mm long, margin plane or slightly undulate; nerve ending below apex or shortly excurrent. Seta yellowish. Forms dense turfs on calcareous rocks ledges, walls, dry, open soils. Widespread throughout the Peninsula and in Mallorca, Menorca and Pithyusic Islands. Esp, Prt, Bl.

- 3 Plants 5-10 mm tall; basal cells of lamina longly rectangular **B. commutata** Jur.

\* **B. convoluta** Hedw. var. **sardoa** Schimp.

Plants yellowish green. Stem with central strand and reddish rhizoids, without rhizoidal gemmae. Leaves oblong-lanceolate, widely acuminate, carinate, more than 1 mm long, margin undulate. Seta yellow. Forms dense turfs on calcareous rocks in the lowlands, mainly in the eastern part of the Iberian Peninsula and in Mallorca and Menorca. Esp, Prt, Bl.

- 4 Leaves lanceolate, flexuose, margin plane; nerve ending below apex; plants aquatic (fig. 34, 9-12) **B. bolleana** (Müll.Hal.) Broth.

**B. ehrenbergii** (Lorentz) M. Fleisch.

Leaves with obtuse apex, often cucullate; laminal cells 15 µm, almost smooth. Often with red, fusiform gemmae, formed on branched filaments in the axils of upper leaves. Forms lax turfs, 1-4 cm high, frequently with calcium carbonate encrustations, on rocks, water tanks and



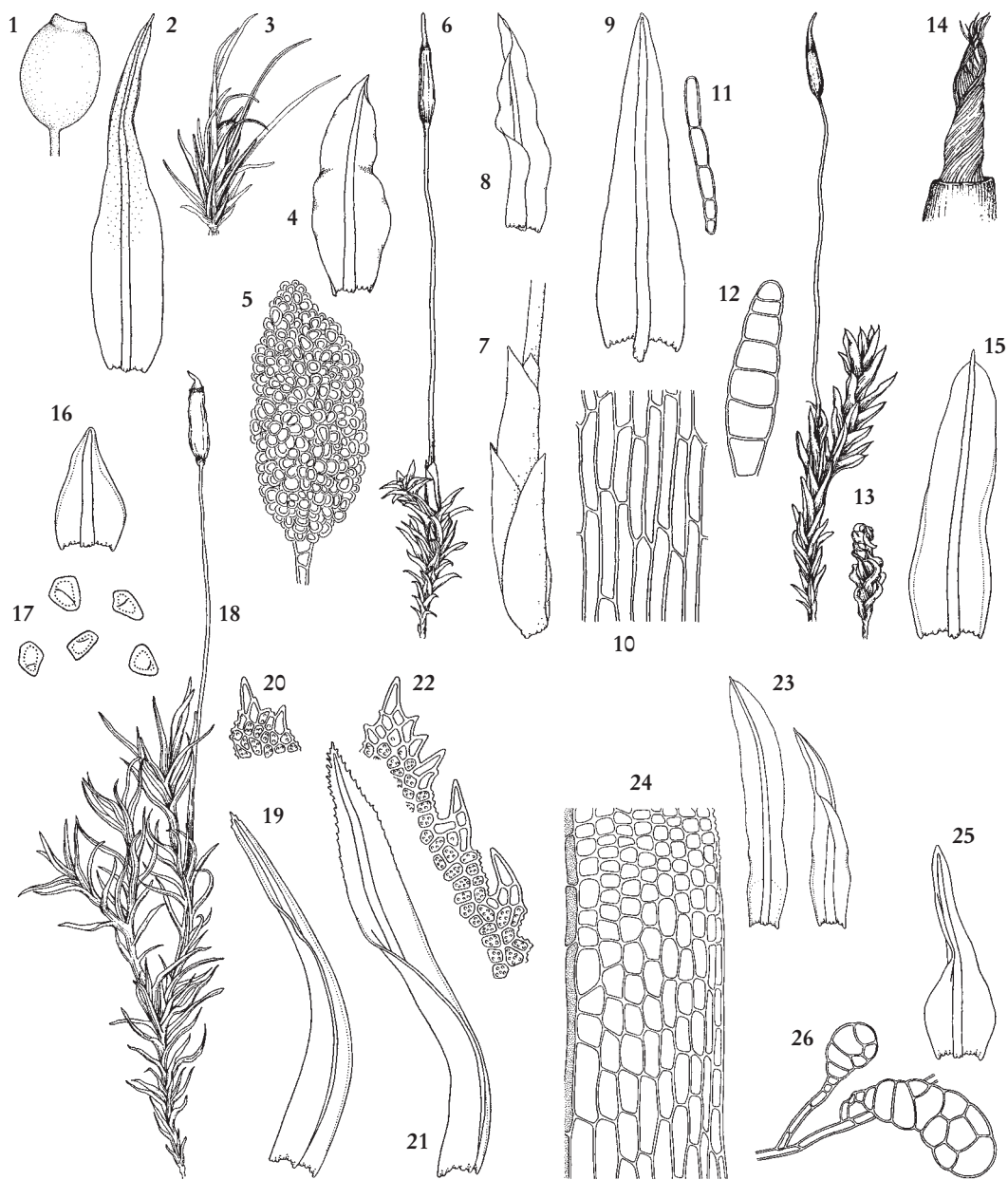


FIGURE 34. 1-2, *Astomum levieri*: 1, capsule; 2, perichaetial leaf. 3, *A. crispum*, habit. 4-5, *Barbula crocea*: 4, leaf; 5, gemma. 6-8, *B. convoluta*: 6, habit; 7, perichaetial leaves; 8, leaf. 9-12, *B. bolleana*: 9, leaf; 10, basal cells; 11, axillary hair; 12, gemma. 13-15, *B. unguiculata*: 13, plants, with sporophyte when moist and without sporophyte when dry; 14, peristome; 15, leaf. 16-17, *Bryoerythrophyllum inaequalifolium*: 16, leaf; 17, gemmae. 18-20, *B. recurvirostrum* var. *recurvirostrum*: 18, habit; 19, leaf; 20, leaf apex. 21-22, *B. recurvirostrum* var. *robustum*: 21, leaf; 22, upper leaf margin. 23-24, *B. campylocarpum*: 23, leaves; 24, basal cells. 25-26, *B. ferruginascens*: 25, leaf; 26, gemmae. 18 ( $\times 4$ ); 6, 13 ( $\times 5$ ); 3 ( $\times 7$ ); 1, 2, 4, 7, 8, 9, 15, 16, 19, 21, 23, 25 ( $\times 18$ ); 14 ( $\times 25$ ); 5, 26 ( $\times 80$ ); 10, 11, 12, 17, 20, 22, 24 ( $\times 180$ ).

irrigation channels in the lowlands. Common in the Mediterranean coastal area, rare in the centre and west of the Peninsula and in Mallorca. Esp, Prt, Bl.

- 4 Leaves lingulate, flat, margin plane in the upper part, recurved at base; nerve excurrent in apiculus; plants of dry sites (fig. 34, 13-15) **B. unguiculata** Hedw.  
Leaves with obtuse or rounded apex, apiculate; laminal cells strongly papillose. Seta reddish. Forms turfs 0,5-3 cm high, at side of roads, on walls and arable fields. Widespread throughout the Peninsula and in Mallorca, Menorca and Pithyusic Islands. Esp, Prt, And, Bl.  
Sterile specimens may be confused with *Trichostomum brachydontium*, but in that species the nerve has quadrate or rounded cells on ventral side.

### **Bryoerythrophyllum** P.C. Chen

Plants rusty red or brownish green. Leaves appressed, erect or reflexed, curled when dry, ovate-triangular to lanceolate, usually sheathing at base, margin entire, crenulate or dentate; laminal cells quadrate, thin-walled or incrassate, with c-shaped papillae, basal cells rectangular, smooth and thin-walled; nerve ending below apex to percurrent. Often with hyaline axillary hairs. Capsule erect, cylindrical, annulus wide, caducous; peristome teeth 16, papillose, divided to the middle or to base; calyptra cucullate.

- 1 Leaves ovate-lanceolate, obtuse, cucullate, margin entire, strongly recurved to apex (fig. 34, 16-17) **B. inaequalifolium** (Taylor) R.H. Zander  
Plants slender, to 0,5 cm tall. Mostly with axillary gemmae, unicellular, yellowish to brownish, angulate, 14-22 µm wide. Forms compact turfs on calcareous rocks in montane areas. Rare, in the eastern Pyrenees. Esp.

- 1 Leaves ovate-lanceolate, lanceolate or oblong-lanceolate, acute, margin dentate, crenulate or entire, plane or recurved 2
- 2 Leaves lanceolate, not carinate; leaf margin narrowly recurved to near apex; monoicous, dioicous or polyicous (fig. 34, 18-22)

#### **B. recurvirostrum** (Hedw.) P.C. Chen

Plants to 2 cm tall. Leaves narrow, from wide base to acute apex, often dentate, with teeth and terminal cell smooth and pellucid. Forms compact turfs on calcareous rocks and soils, in montane areas and high mountains.

var. **recurvirostrum**: Leaf margin entire or with unicellular teeth in the upper part. Distributed in the Peninsula and in Mallorca. Esp, And, Bl (fig. 34, 18-20).

var. **robustum** K. Saito: Leaf margin deeply dentate, teeth of 1-3 cells. Distributed in the Pyrenees. Esp (fig. 24, 21-22).

- 2 Leaves ovate-lanceolate or lanceolate, carinate at apex; leaf margin plane or recurved at base; dioicous 3
- 3 Leaves lingulate, crenulate, entire or dentate at apex, with a basal margin of narrower cells (fig. 34, 23-24) **B. campylocarpum** (Müll.Hal.) H.A. Crum

#### **Hyophila lusitanica** Cardot & Dixon, **H. machadoana** (Sérgio) M.O. Hill

Plants to 1,5 cm tall. Leaves with a terminal cell as an apiculus pellucid, brownish yellow, margin rarely dentate; transition between basal smooth cells and upper papillose cells abrupt. Grows on wet slopes by streams, in the northwest of the Peninsula. Prt.



- 3 Leaves ovate-lanceolate, crenulate, without teeth at apex, basal margin of narrower cells absent (fig. 34, 25-26) **B. ferruginascens** (Stirt.) Giacom.

Plants to 2 cm tall. Transition between basal smooth cells and upper papillose cells gradual. Often with dark brownish, pluricellular rhizoidal gemmae. Forms loose turfs on damp, calcareous soils, in montane areas and high mountains of the Pyrenees. Rare. Esp.

### **Cinclidotus** P. Beauv.

Plants aquatic or growing in very moist sites, large and robust. Stem without central strand. Leaves erect or falciform, lanceolate to oblong, apex obtuse or acute, margin plane, thick, of (2-)4-6-stratose; laminal cells hexagonal, smooth or slightly papillose, basal cells rectangular; nerve stout, percurrent or excurrent in mucro. Capsule immersed or exserted; peristome teeth 16, bifurcate above.

- 1 Leaves falciform, linear-lanceolate, very long and rigid; nerve 240  $\mu$ m wide or more at base (1/3 width of leaf base) (fig. 35, 1) **C. aquaticus** (Hedw.) Bruch & Schimp.

Stem mostly very long, to 20 cm long, denudate at base, with short branches in the upper part. Capsule immersed. Grows on submerged calcareous rocks, in the lowlands and montane areas, in the east, south and west of the Peninsula and in Mallorca. Esp, Prt, Bl.

- 1 Leaves straight or slightly incurved or falciform, elliptical, lanceolate or oblong, rigid or not; nerve less than 230  $\mu$ m wide at base (less 1/3 width of leaf base) **2**

- 2 Leaves elliptical or oblong, widest at middle (fig. 35, 2)

**C. riparius** (Host ex Brid.) Arn.

Stem with abundant short branches. Leaves slightly twisted when dry. Seta to 3 mm long; capsule exceeding perichaetial leaves. Plants 2-5 cm long, straight, forming lax, blackish green cushions on submerged calcareous rocks, in montane areas and high mountains, in the north of the Peninsula, in Sierra Nevada and in Mallorca. Esp, Prt, Bl.

- 2 Leaves oblong or lanceolate, with maximum width at base **3**

- 3 Leaves oblong-lanceolate, carinate, twisted when dry (fig. 35, 3-6)

**C. fontinaloides** (Hedw.) P. Beauv.

Stem to 12 cm long, usually not denudate at base. Seta short, 0,5 mm long; capsule immersed. Submerged or periodically submerged, forms loose, dark or blackish turfs on rocks and tree bases, and in waterfalls and mountain streams. Widespread throughout the Peninsula and in Mallorca. Esp, Prt, Bl.

- 3 Leaves lanceolate, plane, straight, slightly incurved or falciform when dry

**C. vivesii** Ederra & J. Guerra

Plants rigid. Stem to 6 cm long, not denudate at base. Found submerged in a fountain. Very rare, in the northeastern part of the Peninsula. Esp.

### **Crossidium** Jur.

Plants small, often forming dense turfs or cushions. Leaves wide, ovate or oblong, concave, margin plane, recurved or revolute; cells quadrate, rhomboidal to shortly

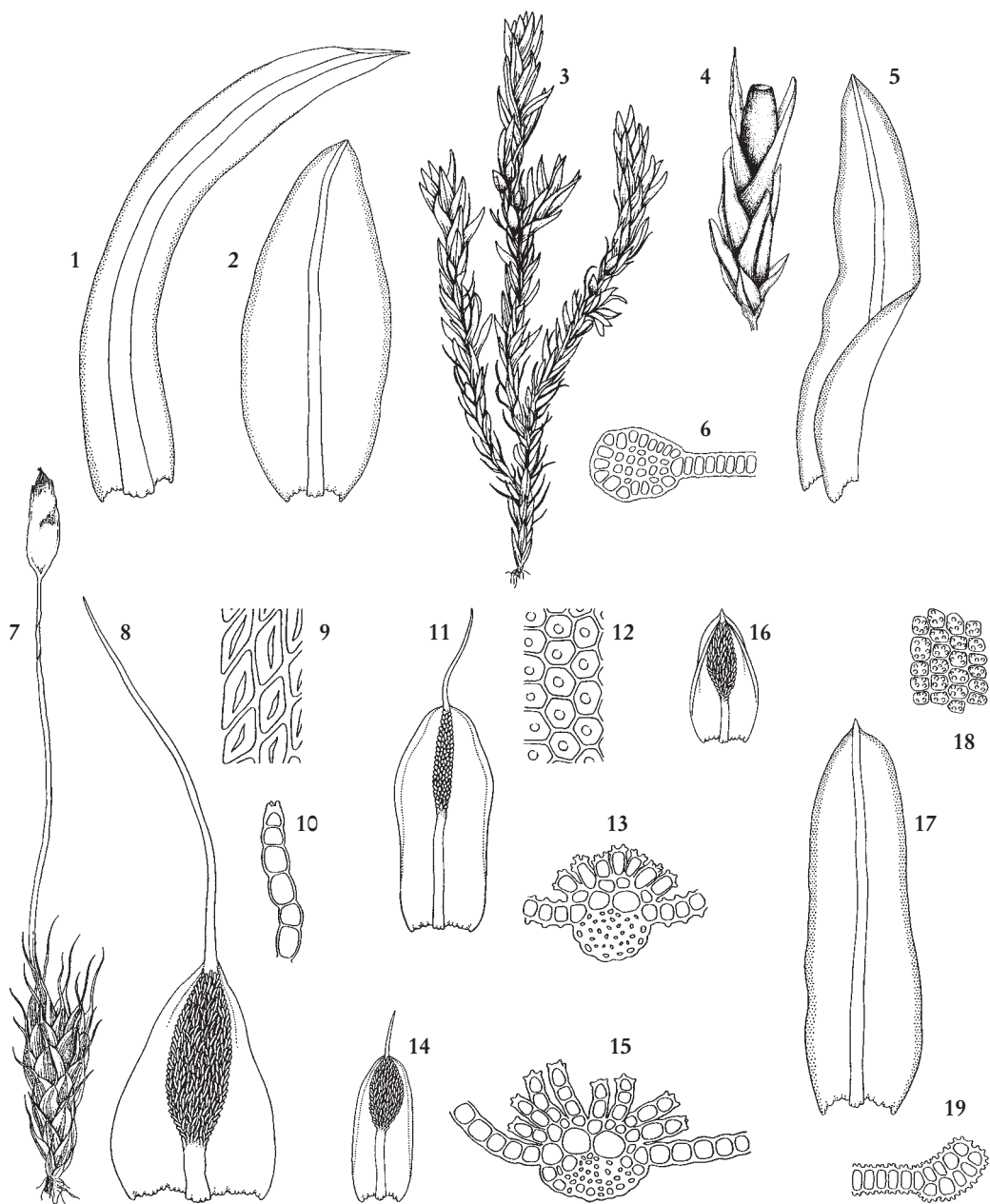


FIGURE 35. 1, *Cinclidotus aquaticus*, leaf. 2, *C. riparius*, leaf. 3-6, *C. fontinaloides*: 3, habit; 4, capsule; 5, leaf; 6, leaf margin section. 7-10, *Crossidium squamiferum*: 7, habit; 8, leaf; 9, upper cells; 10, filament of nerve. 11-13, *C. aberrans*: 11, leaf; 12, upper cells; 13, nerve section. 14-15, *C. crassinerve*: 14, leaf; 15, nerve section. 16, *C. laevipilum*, leaf. 17-19, *Dialytrichia mucronata* var. *mucronata*: 17, leaf; 18, median cells; 19, leaf margin section. 3 (×2,5); 4, 7 (×7); 1, 2, 5 (×16); 8, 11, 14, 16, 17 (×18); 6, 10, 13, 15, 19 (×180); 9, 12, 18 (×280).

rectangular; nerve excurrent in apiculus or in hair-point, with chlorophyllose filaments, branched or unbranched, on ventral side. Seta long; capsule ovoid or cylindrical; peristome of 32 filiform teeth.

- 1 Upper laminal cells strongly incrassate, lumen hard to discern, marginal cells hyaline (fig. 35, 7-10) **C. squamiferum** (Viv.) Jur.

Plants to 1 cm tall. Filaments of the ventral side of the nerve 8-12 cells high, the terminal cell conical, thick-walled and with 2-5 long papillae. Forms dense light green or whitish turfs on rock ledges and open calcareous soils, in the lowlands and montane areas of the Peninsula and in Mallorca and Pithyusic Islands. Esp, Prt, Bl.

- 1 Upper laminal cells thin-walled, lumen large, marginal cells green or brownish 2

- 2 Upper laminal cells smooth or with one papilla on each side; filaments 1-2(-3) cells high, occupying a narrow leaf area (fig. 35, 11-13) **C. aberrans** Holz. & E.B. Bartram

Plants to 0,3 cm. Leaf margin recurved or revolute. Filaments with the terminal cells subspherical or cylindrical, with 2-4 short papillae. Grows solitary or forming loose turfs on dry, sandy or clayey, calcareous, often gypsum-rich soils, in the eastern part of the Peninsula. Esp.

- 2 Upper laminal cells smooth, rarely with one papilla on dorsal side near apex; filaments (2)4-12 cells high, occupying a wide leaf area 3

- 3 Nerve often excurrent in a hyaline hair-point; apex not cucullate; peristome long and curled (fig. 35, 14-15) **C. crassinerve** (De Not.) Jur.

**C. laxefilamentosum** W. Frey & Kürschner

Plants to 0,3 cm tall. Filaments 3-12 cells high, the terminal cell cylindrical, conical or globose, with 2-4 short papillae or smooth. Grows solitary or forming small turfs on dry, exposed rocks and soils, in the lowlands, in the eastern Mediterranean region, rare in the western part of the Peninsula, and in Mallorca and Pithyusic islands. Esp, Prt, Bl.

- 3 Nerve often excurrent in mucro; apex cucullate; peristome short and straight (fig. 35, 16) **C. laevipilum** Thér. & Trab.

Plants to 0,3 cm tall. Filaments (2)4-10 cells high, with terminal cell cylindrical, conical or subspherical, with 2-6 short papillae. Forms turfs on very dry, exposed, saline, gypsum or calcareous soils, in the lowlands of the eastern half of the Mediterranean region of the Peninsula and in Mallorca and Pithyusic Islands. Esp, Bl.

Some authors regard this species as a variety of *C. crassinerve*.

### **Dialytrichia** (Schimp.) Limpr.

Plants 1-3 cm tall. Stem with central strand. Leaves erecto-patent to spreading, oblong, obtuse or mucronate, regularly curled when dry, margin recurved, entire or crenulate, thickened, 2-4-stratose; laminal cells irregularly quadrate-hexagonal, strongly papillose, basal cells rectangular; nerve stout, excurrent in mucro. Capsule exserted, ellipsoidal to cylindrical; peristome teeth 32, filiform (fig. 35, 17-19) **D. mucronata** (Brid.) Broth.

**Cinclidotus mucronatus** (Brid.) Guim.

Plants usually acidophilous, grows in the lowlands and montane areas. Scattered in the Peninsula, mainly in the western part, and in Mallorca. Esp, Prt, Bl.

var. **mucronata**: Leaves not fragile, curled when dry, margin entire. Forms rather compact, dark green or brownish cushions at tree bases and on rocks by watercourses, in periodically waterlogged places (fig. 35, 17-19).

var. **fragilifolia** Bizot & J. Roux (\* *D. fragilifolia* (Bizot & J. Roux) F. Lara): Leaves fragile, narrow and slightly curled when dry and margin crenulate 1/3 way up leaf. Epiphytic or saxicolous in shaded places.

var. **conferta** (Corb.) Corb.: Plants small. Leaves not fragile, strongly curled when dry, margin entire. Grows in dry, exposed sites.

### **Didymodon** Hedw.

Plants 0,2-4 cm tall. Leaves appressed to twisted when dry, ovate-lanceolate to linear, apex acuminate, acute or obtuse, margin entire, crenulate or denticulate at apex, plane or recurved, unistratose or bistratose; laminal cells rounded or quadrate, thick-walled or thin-walled, smooth, papillose, basal cells not differentiated or rectangular and smooth; nerve percurrent or excurrent in short or long point, cells quadrate and papillose or rectangular and smooth on ventral side; axillary hairs hyaline, with brownish yellow basal cell. Some species have globose, pluricellular gemmae on branched axillary filaments, or rhizoidal gemmae. Capsule ovoid to cylindrical; peristome teeth 16-32, rudimentary to long, twisted and very papillose.

1 Leaves ovate-lanceolate, obtuse to acuminate, translucent; laminal cells smooth or slightly papillose or mamilllose 2

1 Leaves linear, lanceolate or ovate-lanceolate, acuminate, obscure; laminal cells strongly papillose, mostly with 1-3 translucent cells at apex 14

2 Ventral cells of nerve rectangular, smooth; laminal cells papillose 3

2 Ventral cells of nerve quadrate, papillose; laminal cells papillose, mamilllose or smooth 6

3 Leaves strongly reflexed; stem branched (fig. 36, 1)

**D. ferrugineus** (Schimp. ex Besch.) M.O. Hill

**Barbula reflexa** (Brid.) Brid.

Forms loose, green to reddish brown turfs, 2-3 cm high on calcareous soils and rocks in montane areas, in the northwest and eastern half of the Peninsula. Esp.

3 Leaves erecto-patent; stem unbranched 4

4 Leaf apex obtuse (fig. 36, 2-4)

**D. tophaceus** (Brid.) Lisa

**Barbula tophacea** (Brid.) Mitt.

Leaves ovate to ovate-oblong, margin plane or recurved; basal cells of lamina rectangular; nerve ending below apex. Forms olive-green to brownish turfs, 0,3-2,5 cm high, on calcareous soils and seeping rocks in the lowlands and montane areas, throughout the Peninsula and in Mallorca, Menorca and Pithyusic Islands. Esp, Prt, Bl.

4 Leaf apex acute 5

- 5 Leaf margin recurved from base to 3/4 way up; nerve percurrent or excurrent; plants growing on dry, calcareous soils (fig. 36, 5) **D. fallax** (Hedw.) R.H. Zander

**Barbula fallax** Hedw.

Leaves carinate, flexuose or twisted when dry; basal cells rectangular, median cells irregularly hexagonal. Forms loose, green to brownish turfs, 1-2 cm high, in calcareous arable fields, walls, roadsides in the lowlands and montane areas, throughout the Peninsula and in Mallorca, Menorca and Pithyusic Islands. Esp, Prt, And, Bl.

- 5 Leaf margin recurved below; nerve percurrent; plants growing on humid or wet soils (fig. 36, 6) **D. spadiceus** (Mitt.) Limpr.

**Barbula spadicea** (Mitt.) Braithw.

Leaves flexuose or twisted when dry. Forms green to brownish turfs, 1-3 cm high on calcareous rocks by springs and streams in montane areas, in the north and northeastern southwestern part of the Peninsula and in Mallorca and Pithyusic Islands. Esp, Prt, And, Bl.

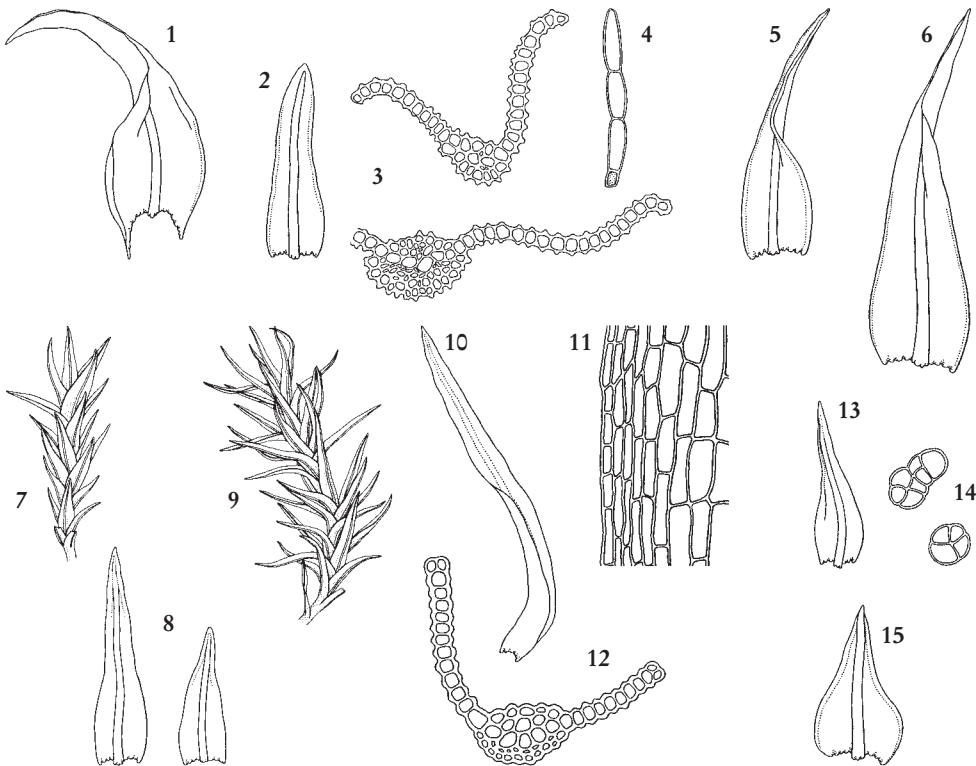


FIGURE 36. 1, *Didymodon ferrugineus*, leaf. 2-4, *D. tophaceus*: 2, leaf; 3, leaf sections; 4, axillary hair. 5, *D. fallax*, leaf. 6, *D. spadiceus*, leaf. 7-8, *D. australasiae*: 7, habit; 8, leaves. 9-12, *D. umbrosus*: 9, habit; 10, leaf; 11, basal cells; 12, leaf section. 13-14, *D. rigidulus*: 13, leaf; 14, gemmae. 15, *D. cordatus*, leaf. 7, 9 ( $\times 10$ ); 1, 2, 5, 6, 8, 10, 13, 15 ( $\times 18$ ); 3, 4, 11, 12, 14 ( $\times 180$ ).

- 6 Basal cells of lamina rectangular, hyaline, narrower at margin 7
- 6 Basal cells of lamina quadrate or shortly rectangular, not narrower at margin 8
- 7 Leaves oblong-lanceolate to lanceolate, 2-3 mm long; stem without hyaloderm (fig. 36, 7-8) **D. australasiae** (Hook. & Grev.) R.H. Zander  
**Trichostomopsis australasiae** (Hook. & Grev.) H. Rob.  
 Leaves erecto-patent to spreading, curled when dry, margin bistratose; median cells papillose; nerve to 150  $\mu$ m wide. Forms dense turfs, to 1,5 cm high on rocky soils. Scattered in the Peninsula. Esp.
- 7 Leaves lanceolate, 2,5-4 mm long; stem with hyaloderm (fig. 36, 9-12) **D. umbrosus** (Müll.Hal.) R.H. Zander  
**Trichostomopsis umbrosa** (Müll.Hal.) H. Rob.  
 Leaves spreading or reflexed, curled when dry, margin bistratose; cells quadrate, papillose, usually thick-walled; nerve to 75  $\mu$ m wide. Occasionally with gemmae. Forms turfs to 1,5 cm high on disturbed soils. Scattered in the Peninsula. Esp, Prt.
- 8 Axillary gemmae abundant, globose, ovoid or ellipsoidal 9
- 8 Axillary gemmae rare or lacking 10
- 9 Leaves ovate-lanceolate, gradually narrowed in long point; laminal cells smooth or papillose (fig. 36, 13-14) **D. rigidulus** Hedw.  
**D. mamillosus** (Crundw.) M.O. Hill, **Barbula rigidula** (Hedw.) Milde  
 Leaves erecto-patent, appressed when dry, margin recurved from base to upper third, 2-4-stratose in the upper part; laminal cells near apex mostly papillose; nerve percurrent or excurrent. Axillary gemmae present. Forms light green to dark green turfs on basic walls, rocks and soils in the lowlands and montane areas. Widespread throughout the Peninsula and in Mallorca and Menorca. Esp, Prt, And, Bl.
- 9 Leaves widely ovate-cordiform; laminal cells mamilliose (fig. 36, 15) **D. cordatus** Jur.  
**Barbula cordata** (Jur.) Loeske  
 Leaf slightly decurrent, margin revolute from base to apex, unistratose, occasionally bistratose near apex; laminal cells quadrate or rounded, 6-8  $\mu$ m; nerve excurrent in apiculus, 70-100  $\mu$ m wide at base. Forms dark green turfs 0,5-1 cm high on humid rocks, in the northeastern part of the Peninsula. Esp.
- 10 Leaf apex acute to rounded; nerve ending below apex, percurrent or excurrent in apiculus 11
- 10 Leaf apex gradually tapered into  $\pm$  long point; nerve ending below apex or excurrent in short or long point 13
- 11 Leaf apex mostly cucullate; leaf margin partially bistratose (fig. 37, 1-2) **D. nicholsonii** Culm.  
 Leaves patent, ovate-lanceolate, flexuose when dry, margin recurved at base; laminal cells quadrate or hexagonal, papillose, basal cells shortly rectangular nerve with 2 guide cells bands and

1 dorsal stereid band. Forms light green turfs 0,5-2 cm high, on rocks often below flood level of streams in the lowlands, in the northwest and east of the Peninsula and in Mallorca. Esp, Prt, Bl.

- 11 Leaf apex plane; leaf margin unistratose 12

- 12 Median cells of lamina smooth, basal cells quadrate or rectangular, to 20 µm long (fig. 37, 3) **D. luridus** Hornsch.

**D. trifarius** (Hedw.) Röhl., **Barbula lurida** Hornsch.

Leaves patent, imbricate when dry, appressed, margin recurved at base, upper leaves with rounded apex. Forms olive-green turfs 0,5-1,5 cm high, on exposed, calcareous rocks, walls and rocks in the lowlands and montane areas. Widespread throughout the Peninsula and in Mallorca, Menorca and Pithyusic Islands. Esp, Prt, Bl.

- 12 Median cells of lamina papillose, basal cells rectangular, to 50 µm long  
**D. sicculus** M.J. Cano, Ros, García-Zamora & J. Guerra

Plants to 0,2 cm tall, olive-green to brownish. Leaves with acute or rounded apex, margin recurved to 3/4 way up leaf, occasionally bistratose. Grows on dry, sandy soils. Sporadic in the centre and east of the Peninsula and in Mallorca. Esp, Bl.

- 13 Nerve broad, excurrent in long or short point; laminal cells rounded to quadrate, thick-walled, smooth; lowland plants (fig. 37, 4-5) **D. acutus** (Brid.) K. Saito

**Barbula acuta** (Brid.) Brid.

Leaves erecto-patent, erect when dry. Forms dark green to brown turfs 0,5-2,5 cm high, on exposed, calcareous soils, rock ledges, walls and by road sides. Widespread throughout the Peninsula and in Mallorca, Menorca and Pithyusic Islands. Esp, Prt, Bl.

- 13 Nerve narrow, ending below apex; laminal cells hexagonal, papillose, basal cells rectangular; high mountains plants (fig. 37, 6-7)

**D. asperifolius** (Mitt.) H.A. Crum, Steere & L.E. Anderson

Plants robust, to 3 cm tall, reddish brown. Leaves patent, flexuose when dry, curved, margin recurved from base to apex. Forms loose turfs on calcareous rocks, in the Central Pyrenees. Esp.

- 14 Leaves linear to lanceolate; lamina unistratose; leaf margin irregularly notched 15

- 14 Leaves lanceolate to ovate-lanceolate; lamina unistratose or bistratose; leaf margin not notched 16

- 15 Leaves patent, linear-lanceolate, not carinate; margin unistratose; nerve percurrent (fig. 37, 8) **D. sinuosus** (Mitt.) Delogne

**Barbula sinuosa** (Mitt.) Grav.

Plants greenish brown, to 2 cm tall. Leaves flexuose, curved when dry, fragile, margin papillose-crenulate, young leaves dentate at apex; median cells ± quadrate, 5-12 x 5-10 µm, with 1-8 papillae, basal cells rectangular; nerve with 1-3 stereid layers. Forms loose turfs on basic rocks in the lowlands and montane areas, in the eastern half of the Peninsula and in Mallorca. Esp, Bl.

- 15 Leaves patent to spreading, lanceolate, carinate; margin bistratose in the upper 2/3-3/4 of leaf; nerve shortly excurrent (fig. 37, 9-11) **D. eckeliae** R.H. Zander

Plants dark green, to 1 cm tall. Leaves flexuose, incurved when dry, margin recurved in the lower 1/3, papillose-crenulate, young leaves not dentate at apex; marginal cells often oblate,



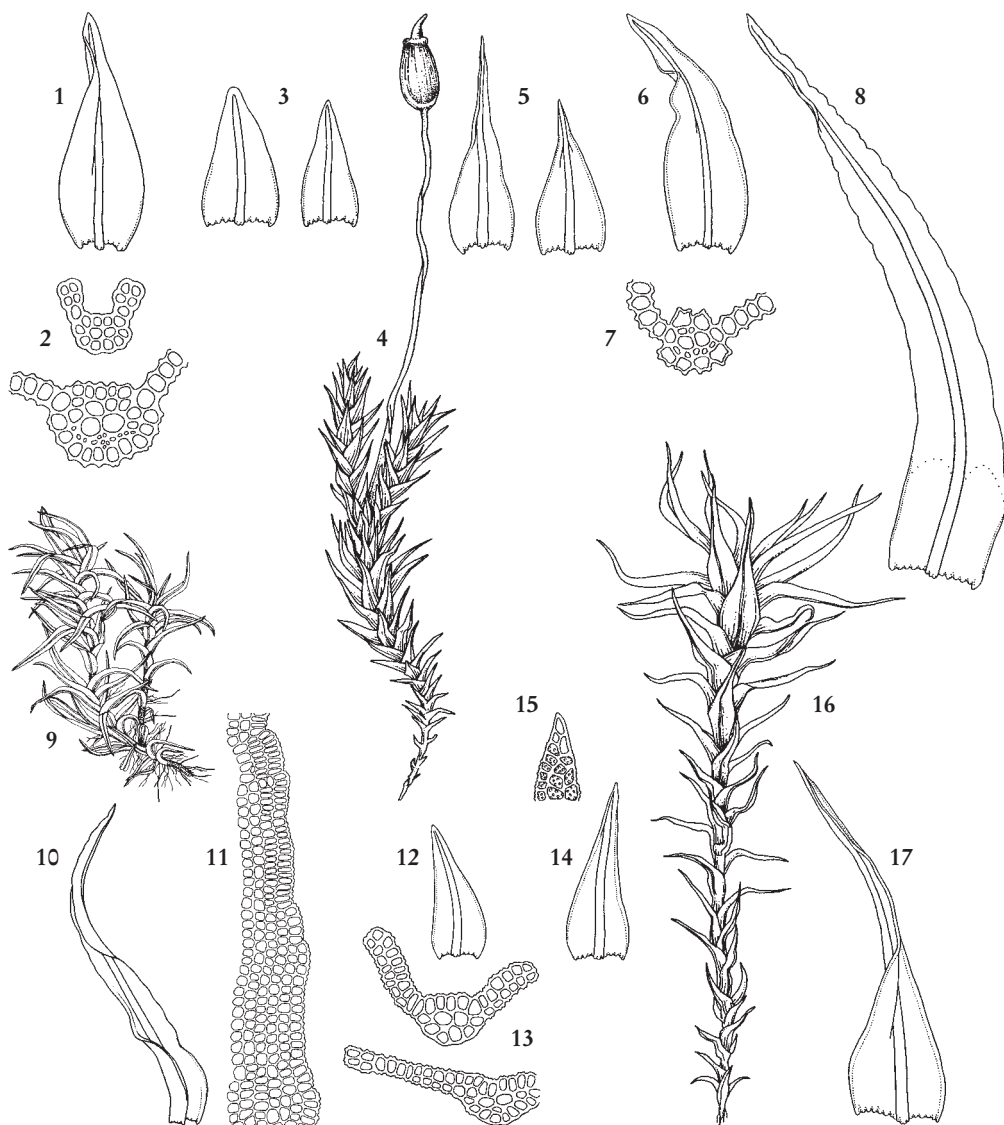


FIGURE 37. 1-2, *Didymodon nicholsonii*: 1, leaf; 2, leaf sections. 3, *D. luridus*, leaves. 4-5, *D. acutus*: 4, habit; 5, leaves. 6-7, *D. asperifolius*: 6, leaf; 7, nerve section. 8, *D. sinuosus*, leaf. 9-11, *D. eckeliae*: 9, habit; 10, leaf; 11, leaf margin. 12-13, *D. bistratosus*: 12, leaf; 13, leaf sections. 14-15, *D. vinealis*: 14, leaf; 15, leaf apex. 16-17, *D. insulanus*: 16, habit; 17, upper leaf. 4, 9, 16 ( $\times 7$ ); 1, 3, 5, 6, 8, 10, 12, 14, 17 ( $\times 18$ ); 2, 7, 11, 13, 15 ( $\times 180$ ).



upper cells quadrate to shortly rectangular, 10-15 x 10-12  $\mu\text{m}$ , with 2-4 papillae, median and basal cells 12-22 x 10-12  $\mu\text{m}$ ; nerve with 1-2 stereid bands. Forms loose turfs on calcareous rocks in the lowlands, in the east of the Peninsula. Esp.

- 16 Leaves ovate-lanceolate; lamina bistratose; leaf margin recurved in the lower half (fig. 37, 12-13) **D. bistratosus** Hébr. & R.B. Pierrot

Plants 0,3-0,4 cm tall, brownish, reddish at base. Leaves with papillose-crenulate margin in the upper part. Forms turfs on dry rocks or sandy soils, in the southwestern part of the Peninsula. Esp, Prt.

- 16 Leaves lanceolate; lamina unistratose; leaf margin narrowly recurved from base to apex 17

- 17 Leaves 1-3 mm long (fig. 37, 14-15) **D. vinealis** (Brid.) R.H. Zander  
**Barbula vinealis** Brid.

Plants 0,5-1 cm. Leaves erecto-patent, flexuose, twisted when dry, all similar in length, margin entire or slightly papillose-crenulate; nerve percurrent. Forms light green turfs on walls and exposed, calcareous rocks in the lowlands and montane areas. Widespread throughout the Peninsula and in Mallorca, Menorca and Pithyusic Islands. Esp, Prt, Bl.

- 17 Leaves 2-5(-6) mm long (fig. 37, 16-17) **D. insulanus** (De Not.) M.O. Hill  
**Barbula cylindrica** (Taylor) Schimp.

Plants 0,5-1,5 cm. Leaves erecto-patent, twisted when dry, margin entire or slightly papillose-crenulate, upper leaves longer with percurrent or excurrent nerve. Forms green turfs on humid, calcareous soils, rocks and walls in the lowlands and montane areas. Widespread throughout the Peninsula and in Mallorca and Menorca. Esp, Prt, Bl.

### **Ephemerum** Hampe

Plants annual, minute, 0,1-0,2 mm tall, growing from a persistent protonema. Stem very short. Leaves linear, lanceolate or ovate-lanceolate, crowded in rosette, margin usually dentate or denticulate; nerve present or lacking, occasionally nerve absent at the leaf base. Seta very short; capsule indehiscent, immersed, globose or ellipsoidal, apiculate. Plants growing on wet or periodically waterlogged, exposed soil, usually in the lowlands.

- 1 Leaves with nerve 2

- 1 Leaves without nerve 5

- 2 Upper cells of lamina prorate; leaf margin dentate to spinose (fig. 38, 1)  
**E. spinulosum** Bruch & Schimp. ex Schimp.

Leaves linear to linear-lanceolate; lamina and nerve with prorate cells above, with prominent spinose projections similar to those of the leaf margin; nerve percurrent or excurrent. Grows on wet mud. Very rare, in the north of the Peninsula. Esp.

- 2 Upper cells of lamina smooth; leaf margin dentate 3

- 3 Leaves oblong or oblong-lanceolate; nerve percurrent or ending before apex (fig. 38, 2)  
**E. cohaerens** (Hedw.) Hampe

Leaves mostly with asymmetrical shoulders. Grows on wet mud. Very rare, in the north of the Peninsula. Esp.

- 3    Leaves lanceolate or linear-lanceolate; nerve excurrent 4
  
- 4    Capsule with stomata only at base, obliquely apiculate (fig. 38, 3)
 

**E. recurvifolium** (Dicks.) Boulay

Leaves with reflexed apex. Spores papillose or nearly so. Grows on periodically inundated, calcareous clayey soil. In the east and south of the Peninsula and in Mallorca. Esp, Prt, Bl.
- 4    Capsule with stomata scattered over the whole surface, with straight apiculus (fig. 38, 4)
 

**E. sessile** (Bruch) Müll.Hal.

Leaves erecto-patent, with flat apex. Spores verrucose. Grows on mud in temporary ponds. In the western and northeastern part of the Peninsula and in Menorca. Esp, Prt, Bl.
- 5    Leaf margin entire or denticulate; median laminal cells 50-90 µm long; leaves spreading
 

**E. stellatum** H. Philib.

Leaves oblong-lanceolate or lanceolate, divergent in stellate way. Grows on decalcified soils. Very rare, in the western part of the Peninsula. Prt.
- 5    Leaf margin dentate; median laminal cells 100-160 µm long; leaves erecto-patent 6
  
- 6    Widest part of lamina 10-20 cells wide (fig. 38, 5-6) **E. serratum** (Hedw.) Hampe

Leaves lanceolate, rarely faint nerve present in the upper part of leaf. Spores 75-100 µm, coarsely verrucose. Grows on sandy and clayey soils, in temporary ponds and open bush lands, in the northeast and southwest quadrants of the Peninsula. Esp, Prt.
- 6    Widest part of lamina 8-10 cells wide (fig. 38, 7) **E. minutissimum** Lindb.

Leaves narrowly lanceolate. Spores 60-80 µm, finely papillose, covered by a hyaline veil when mature. Grows on bare soils in Mediterranean bush lands, olive tree fields, arable fields and temporary ponds, in the lowlands. Scattered in the Peninsula. Esp, Prt.

### **Eucladium** Bruch & Schimp.

Stem 1-3 cm high. Leaves linear to linear-lanceolate, erecto-patent, appressed when dry, margin plane, with some reflexed teeth near base; laminal cells 10 µm wide, quadrate, papillose, basal cells longer, smooth, hyaline; nerve ending below apex or excurrent. Sometimes with fusiform, pluricellular gemmae on axillary rhizoidal filaments. Capsule ovoid to cylindrical, smooth and straight; lid rostrate; peristome teeth 16, papillose, nodulose and perforated; spores 12 µm, smooth, yellowish (fig. 38, 8-10)

**E. verticillatum** (With.) Bruch & Schimp.

Forms dense, light green turfs, often with calcium carbonate encrustations, in dripping places and calcareous springs in the lowlands and montane areas. Widespread throughout the Peninsula and in Mallorca, Menorca and Pithyusic Islands. Esp, Prt, Bl.

var. **verticillatum**: Leaves linear-lanceolate (fig. 38, 8-10).

var. **angustifolium** Lindb.: Leaves linear.

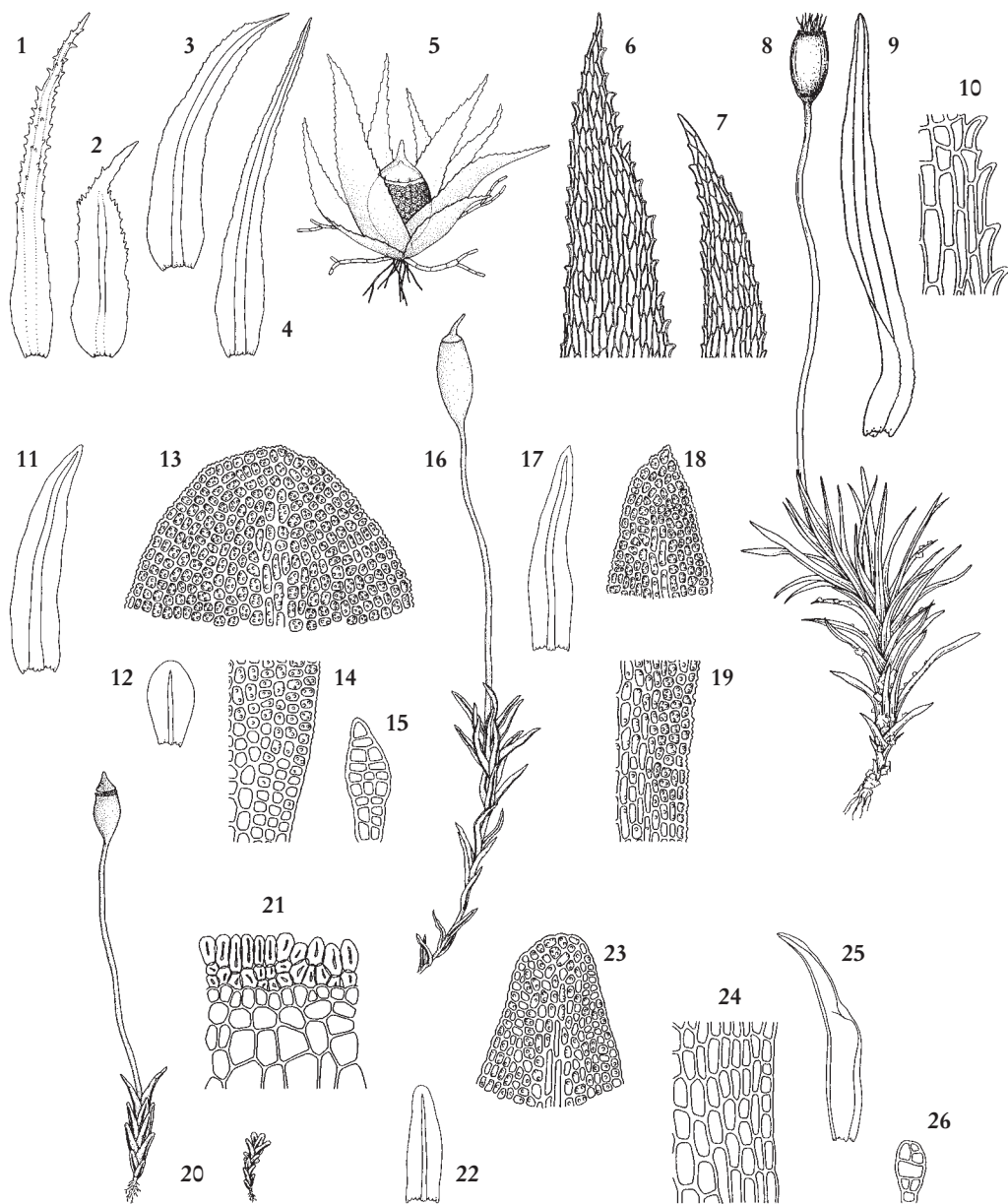


FIGURE 38. 1, *Ephemerum spinulosum*, leaf on dorsal side. 2, *E. cohaerens*, leaf. 3, *E. recurvifolium*, leaf. 4, *E. sessile*, leaf. 5-6, *E. serratum*: 5, habit; 6, upper part of leaf. 7, *E. minutissimum*, upper part of leaf. 8-10, *Eucladium verticillatum* var. *verticillatum*: 8, habit; 9, leaf; 10, basal margin. 11, *Gymnostomum aeruginosum*, leaf. 12-15, *G. viridulum*: 12, leaf; 13, leaf apex; 14, basal cells; 15, gemma. 16-19, *G. calcareum* var. *calcareum*: 16, habit; 17, leaf; 18, leaf apex; 19, basal cells. 20-26, *Gyroweisia tenuis*: 20, habit, plants with and without sporophyte; 21, annulus; 22, leaf; 23, leaf apex; 24, basal cells; 25, perichaetial leaf; 26, gemma. 8 ( $\times 7$ ); 16 ( $\times 9$ ); 20 ( $\times 11$ ); 5 ( $\times 15$ ); 1, 2, 3, 4, 9, 11, 12, 17, 22, 25 ( $\times 30$ ); 6, 7 ( $\times 40$ ); 10, 13, 14, 15, 18, 19, 21, 23, 24, 26 ( $\times 200$ ).

### **Gymnostomum** Nees & Hornsch.

Plants medium-sized to small. Leaves linear, lingulate, ovate or ovate-lanceolate, apex rounded to widely acute, frequently apiculate, margin plane, entire or crenulate; laminal cells quadrate or rounded, pluripapillose, basal cells quadrate or shortly rectangular, longer and smooth; nerve ending below apex or percurrent. Capsule ellipsoidal, annulus persistent or caducous, of 1-3 rows of small, oblate cells; lid longly rostrate, oblique; peristome lacking.

- 1 Nerve 60-110  $\mu\text{m}$  wide near base; laminal cells more than 15  $\mu\text{m}$  (fig. 38, 11)

#### **G. aeruginosum** Sm.

Plants to 4 cm tall. Leaves lingulate or linear, obtuse, erect or  $\pm$  contorted, twisted when dry. Forms dense turfs or cushions on wet or seeping, calcareous rocks in montane areas and high mountains. Widespread in the northern half of the Peninsula and in Sierra Nevada. Esp.

- 1 Nerve to 45  $\mu\text{m}$  wide near base; laminal cells to 10  $\mu\text{m}$

2

- 2 Leaves ovate or obovate, 2-4 times as long as wide, with rounded apex (fig. 38, 12-15)

#### **G. viridulum** Brid.

Plants 1,5-5 mm tall. Pluricellular, obovoid, biseriate gemmae in leaf axils frequent. Perichaetial leaves short, similar to stem leaves, with unistratose margin. Grows on rocks and dry, calcareous soils in the lowlands. Widespread throughout the Peninsula and in Mallorca and Pithyusic Islands. Esp, Prt, Bl.

- 2 Leaves lingulate or linear, 4-7(8) times as long as wide, with obtuse or acute apex (fig. 38, 16-19)

#### **G. calcareum** Nees & Hornsch.

var. **calcareum**: Plants to 2 cm tall. Leaves flexuose or crisped when dry; margin unistratose. Perichaetial leaves larger than stem leaves. Forms dense, light green turfs on damp, calcareous rocks. Widespread throughout the Peninsula and in Mallorca and Pithyusic Islands. Esp, Prt, Bl (fig. 38, 16-19).

var. **atlanticum** Sérgio: Plants to 0,5 cm tall. Leaves erect or erecto-patent when dry; margin frequent and regularly bistratose. Pluricellular, fusiform clavate uniseriate gemmae in leaf axils frequently present. Perichaetial leaves little longer than stem leaves, linear-lanceolate, frequently bistratose from 1/3 to apex. Annulus absent. Grows on wet, calcareous soils and rocks in the lowlands or mountains of the oceanic areas. Esp, Prt.

var. **lanceolatum** M.J. Cano, Ros & J. Guerra: Plants to 1 cm tall. Leaves erect or erecto-patent when dry; margin frequent and regularly bistratose. Pluricellular gemmae in leaf axis infrequently present. Perichaetial leaves much longer than stem leaves, linear-lanceolate, frequently bistratose from to apex. Annulus absent or vestigial, caducous. Grows on dry, calcareous or gypsum soils in the lowlands of the Mediterranean region of the Peninsula and Mallorca. Esp, Bl.

### **Gyroweisia** Schimp.

Fertile plants to 0,3 cm tall, sterile plants shorter. Leaves lingulate, apex obtuse or rounded, margin plane, finely crenulate; cells  $\pm$  quadrate, finely papillose, basal cells narrowly rectangular, occupying 1/2-1/4 of lamina; nerve nearly reaching apex. Perichaetial leaves lanceolate, longer than stem leaves, with longly sheathing base. Often

with pluricellular rhizoidal gemmae. Capsule with persistent annulus, of large and often inflated cells; lid conical; peristome lacking or rudimentary.

- 1 Peristome lacking; upper and perichaetial leaves patent to reflexed; annulus of inflated, well differentiated cells (fig. 38, 20-26) **G. tenuis** (Hedw.) Schimp.  
Forms turfs on calcareous rocks or sandstone in damp, shady sites. Scattered in the north and east of the Peninsula and Pithyusic Islands. Esp, Prt, Bl.
- 1 Peristome rudimentary; upper and perichaetial leaves reflexed to squarrose; annulus of slightly differentiated cells **G. reflexa** (Brid.) Schimp.  
Forms turfs on soil and calcareous rocks. Scattered throughout the Peninsula. Esp, Prt.

### **Hennediella** Paris

Plants to 1 cm tall. Leaves oblong-elliptical or ovate, margin dentate at apex, plane with patches of elongate cells; laminal cells quadrate or hexagonal, papillose, marginal cells smooth or slightly papillose, thick-walled but not forming distinct border. Capsule cylindrical, short; lid attached to columella after dehiscence; peristome lacking (fig. 39, 1-3)

**H. heimii** (Hedw.) R.H. Zander

**Pottia heimii** (Hedw.) Hampe

Forms loose, yellowish green turfs in the salt-marshes. Only one locality in the centre of the Peninsula. Esp.

### **Hymenostylium** Brid.

Stem to 10 cm high, rounded pentagonal to triangular in section, without central strand. Leaves linear-lanceolate to oblong-lanceolate, gradually tapering into acute or acuminate point, carinate in upper part, margin finely crenulate, recurved on one or both sides; laminal cells quadrate, rhomboidal or rectangular, smooth or papillose, thin-walled or thick-walled; nerve percurrent, with 2 stereid bands. Capsule erect, ovoid; lid rostrate, attached to columella after ripening of spores; peristome lacking (fig. 39, 4-7)

**H. recurvirostrum** (Hedw.) Dixon

**Gymnostomum recurvirostrum** Hedw.

Plants very variable in habit and in shape of leaf cells. Forms dense turfs 1-4(-10) cm high, often with calcium carbonate encrustations, on calcareous rocks, in waterfalls and dripping places, in montane areas of the Peninsula. Esp.

var. **recurvirostrum**: Leaves with basal cells not or slightly porose; nerve to 50 µm wide (fig. 39, 4-7).

var. **insigne** (Dixon) E.B. Bartram (*H. insigne* (Dixon) Podp.): Leaves with broad sheathing base; basal cells porose; nerve more than 50 µm wide.

### **Leptobarbula** Schimp.

Plants to 0,3 cm tall. Leaves lanceolate, erecto-patent, apex abuse or acute, margin plane, papillose-crenulate; laminal cells 5-7 µm wide, strongly papillose on both sides, basal cells larger, thick-walled, smooth; nerve percurrent. Perichaetial leaves sheathing,

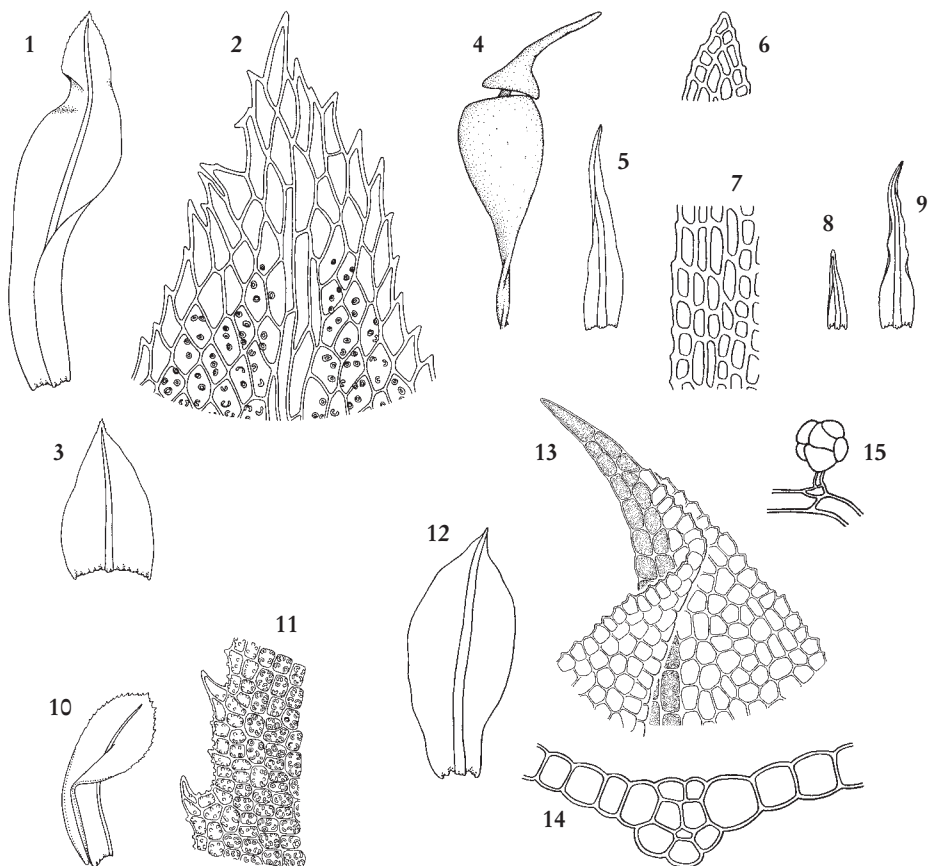


FIGURE 39. 1-3, *Hennediella heimii*: 1, upper leaf; 2, leaf apex; 3, lower leaf. 4-7, *Hymenostylium recurvirostrum* var. *recurvirostrum*: 4, capsule; 5, leaf; 6, leaf apex; 7, basal cells. 8-9, *Leptobarbula berica*: 8, leaf; 9, perichaetial leaf. 10-11, *Leptodontium flexifolium*: 10, leaf; 11, upper cells. 12-15, *Leptophascum leptophyllum*: 12, leaf; 13, leaf apex; 14, nerve section; 15, gemma. 1, 3, 4, 5, 8, 9, 10, 12 ( $\times 18$ ); 13, 15 ( $\times 140$ ); 2, 6, 7, 11, 14 ( $\times 200$ ).

larger than stem leaves. Mostly with sporophytes. Capsule smooth, ovoid to ellipsoidal; peristome teeth 16, filiform, divided to base, slightly twisted (fig. 39, 8-9)

**L. berica** (De Not.) Schimp.

Forms loose turfs on open, calcareous rocks and soils in the lowlands, near to coastal areas of the Peninsula and in Mallorca and Menorca. Esp, Prt, Bl.

### **Leptodontium** (Müll.Hal) Lindb.

Plants to 1,5 cm tall, green or brownish. Leaves erect to patent, incurved and flexuose when dry, oblong-lanceolate to lingulate-spathulate, apex rounded to widely acute, apiculate,

margin plane, recurved below, coarsely toothed above; median cells quadrate, rounded or hexagonal, densely papillose; nerve ending below apex. Occasionally with stalked, obovoid axillary gemmae (fig. 39, 10-11)

**L. flexifolium** (Dicks.) Hampe

Forms lax turfs on acidic soils and rocks, in montane areas. Very rare, in the north and western part of the Peninsula. Esp, Prt (Extinct).

### **Leptophascum** (Müll.Hal) J. Guerra & M.J. Cano

Plants to 0,6 cm, gregarious, glossy green to brownish. Leaves obovate or oblong-spathulate, apex acute, nerve excurrent in small, reflexed, brownish yellow apiculus, margin irregularly denticulate above; laminal cells quadrate or hexagonal, 16-30 µm wide, smooth, thin-walled, brownish; nerve thin, of slightly differentiated cells. Rhizoidal gemmae brownish or reddish (fig. 39, 12-15)

**L. leptophyllum** (Müll.Hal.) J. Guerra & M.J. Cano

**Chenia leptophylla** (Müll.Hal.) R.H. Zander, **Phascum leptophyllum** Müll.Hal.,

**Tortula rhizophylla** (Sakurai) Z. Iwats. & K. Saito

In nitrophilous sites in the lowlands of the eastern half and southwest Peninsula. Esp, Prt.

### **Microbryum** Schimp.

Plants small, brownish or reddish. Leaves ovate, oblong, elliptical or lanceolate, apiculate or mucronate, margin recurved in the upper part; nerve excurrent in mucro or in apiculus, percurrent or ending below apex, stereids few, 2-3, in 1-2 bands; laminal cells quadrate, hexagonal or shortly rectangular, papillose. Seta straight or curved, short or long; capsule erect, globose, ellipsoidal or cylindrical, dehiscent or indehiscent, exserted, immersed or emergent; lid conical or not differentiated; peristome well developed (with 16 teeth), rudimentary or lacking.

1 Capsule exserted 2

1 Capsule immersed or laterally emergent 6

2 Capsule globose (fig. 40, 1) **M. rectum** (With.) R.H. Zander

**Pottia recta** (With.) Mitt.

Leaves oblong-lanceolate, margin recurved; cells 10-12 µm, papillose. Capsule with a small apiculus delimited from the rest of the capsule by 1 row of isodiametric, thick-walled cells. Plants very small, to 1,2 mm tall, brownish, forming loose turfs on open, calcareous soils, by roadsides and in gardens, in the lowlands in the eastern part of the Peninsula and in Mallorca, Menorca and Pityusic Islands. Esp, Prt, Bl.

2 Capsule cylindrical or ellipsoidal 3

3 Spores with big, rounded warts 4

3 Spores spinose or smooth 5



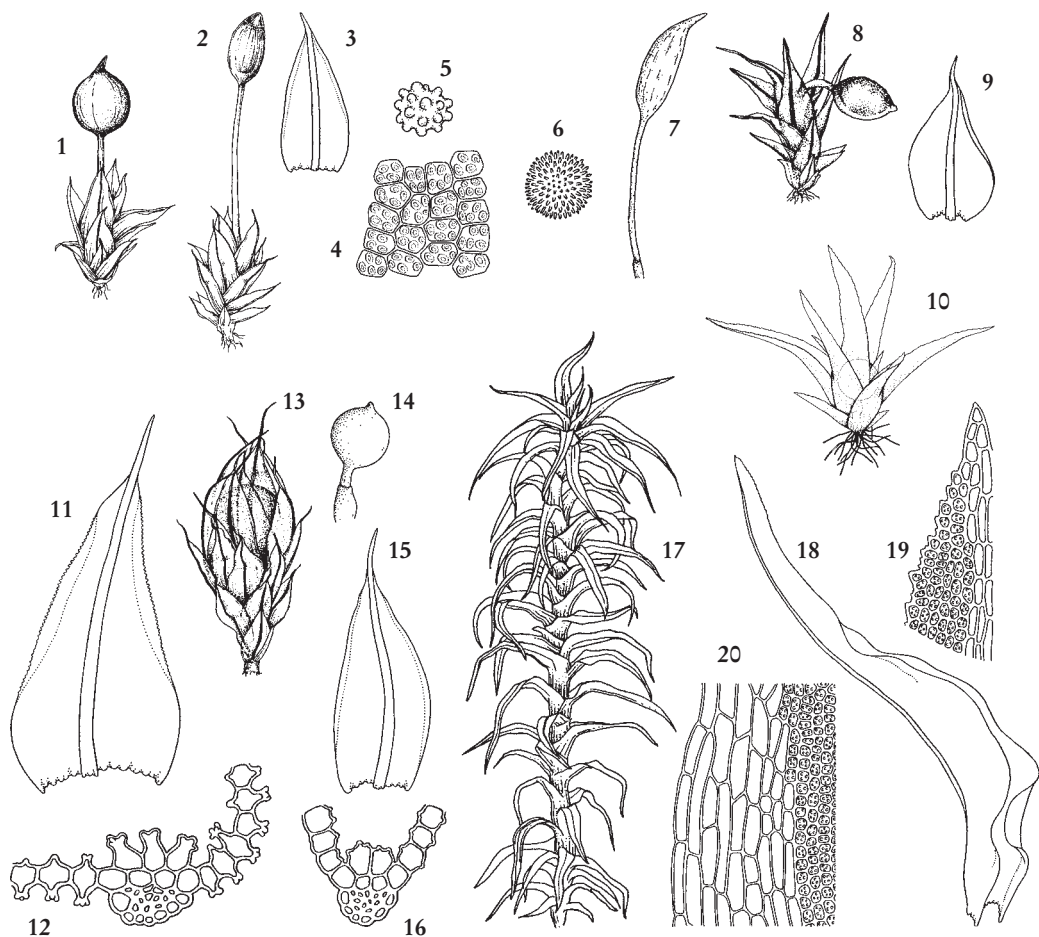


FIGURE 40. 1, *Microbryum rectum*, habit. 2-5, *M. starckeanum*: 2, habit; 3, leaf; 4, upper cells; 5, spore. 6, *M. davallianum*, spore. 7, *M. longipes*, capsule and seta. 8, *M. curvicollum*, habit. 9, *M. floerkeanum*, leaf. 10, *Micromitrium tenerum*, habit. 11-12, *Phascum vlassovii*: 11, leaf; 12, nerve section. 13-16, *P. cuspidatum* var. *cuspidatum*: 13, habit; 14, capsule and seta; 15, leaf; 16, nerve section. 17-20, *Pleurochaete squarrosa*: 17, habit; 18, leaf; 19, apical cells; 20, basal cells. 17 ( $\times 5$ ); 1, 2, 7, 8, 13, 14 ( $\times 10$ ); 10 ( $\times 12$ ); 3, 9, 11, 15, 18 ( $\times 18$ ); 12, 16, 19, 20 ( $\times 180$ ); 5, 6 ( $\times 280$ ); 4 ( $\times 380$ ).

4 Capsule dehiscent (fig. 40, 2-5)

*M. starckeanum* (Hedw.) R.H. Zander

*Pottia starckeanum* (Hedw.) Müll.Hal.

Plants very small, to 1,5 mm tall, bright green or brownish. Leaves ovate-lanceolate; nerve excurrent in apiculus. Peristome rudimentary to well developed, teeth lingulate, strongly papillose. Grows on dry, exposed soils, in the Mediterranean region of the Peninsula and in Mallorca and Menorca. Esp, Prt, Bl.



- 4 Capsule indehiscent **M. fosbergii** (E.B. Bartram) Ros, O. Werner & Rams  
**Pottia xandalusica** Ros & R. Oliva, **P. fosbergii** E.B. Bartram  
 Plants to 2,3 mm tall. Leaves ovate or ovate-lanceolate; nerve excurrent in apiculus. Capsule ellipsoidal; lid not differentiated. Grows on exposed soils in grasslands and clearings. Distributed in the southwestern part of the Peninsula. Esp, Prt.
- 5 Spores spinose; capsule dehiscent (fig. 40, 6) **M. davallianum** (Sm.) R.H. Zander  
**Pottia davalliana** (Sm.) C.O.E. Jensen, **P. commutata** Limpr.,  
**P. conica** (Schleich. ex Schwägr.) Fűrnr. ex Paris  
 Plants to 1,5 mm tall. Leaves ovate-lanceolate; nerve excurrent. Peristome with well-developed teeth or with short, irregular teeth or lacking. Plants very small, brownish, gregarious or forming loose turfs on dry soils. Scattered in the lowlands, in the Mediterranean region of the Peninsula and in Mallorca, Menorca and Pithyusic Islands. Esp, Prt, Bl.
- 5 Spores smooth; capsule indehiscent (fig. 40, 7) **M. longipes** (J. Guerra, J.J. Martínez & Ros) R.H. Zander  
**Phascum longipes** J. Guerra, J.J. Martínez & Ros  
 Plants gregarious, very small to 1,2 mm tall. Leaves ovate-lanceolate, acuminate, margin recurved or plane; nerve reaching apex or shortly excurrent. Seta about 2 mm long; capsule longly exserted, ellipsoidal or cylindrical, yellowish, with apiculus to 0,3 mm long. Grows on exposed, gypsum soils or on sheltered, calcareous soils. Distributed in the southeastern part of the Peninsula. Esp.
- 6 Seta curved; capsule laterally emergent (fig. 40, 8) **M. curvicollum** (Hedw.) R.H. Zander  
**Phascum curvicollum** Hedw., **P. piptocarpum** Durieu & Mont.  
 Plants reddish brown to 2 mm tall. Leaves ovate-lanceolate, acuminate, margin strongly recurved; nerve excurrent in apiculus. Capsule ellipsoidal. Grows among other mosses or forming loose turfs on dry, exposed, clayey or sandy basic soils, in the lowlands. Mainly in the eastern half of the Peninsula and in Mallorca and Pithyusic Islands. Esp, Bl.
- 6 Seta straight; capsule immersed (fig. 40, 9) **M. floerkeanum** (F. Weber & D. Mohr) Schimp.  
**Phascum floerkeanum** F. Weber & D. Mohr  
 Plants reddish brown to 2 mm tall. Leaves ovate, elliptical or lanceolate, concave; nerve brownish red, excurrent in apiculus. Capsule sub-globose. Spores to 32 µm. Grows isolated on dry, exposed basic soils, in the lowlands, in the eastern part of the Peninsula. Esp, Prt.

### **Micromitrium** Austin

Plants minute, 0,1-0,3 cm tall, arising from scarce, persistent protonema. Stem very short. Leaves ovate-lanceolate or ovate, acuminate, margin entire or finely denticulate; laminal cells hexagonal, 20-25 µm wide; nerve lacking. Seta very short; capsule indehiscent, globose; calyptra minute (fig. 40, 10) **M. tenerum** (Bruch & Schimp.) Crosby  
 Grows on mud by ponds and lake and reservoir margins. Rare, in the north and west of the Peninsula. Esp, Prt.

### Phascum Hedw.

Plants light green to brownish, small, less than 1 cm tall, often forming lax turfs. Stem erect. Leaves ovate to lanceolate, margin recurved, entire; laminal cells quadrate, hexagonal or rhomboidal, smooth or papillose; nerve excurrent in apiculus, in arista or in a hair-point, with numerous dorsal stereids, in 2-3(-4) layers, flask-shaped cells on ventral side above present or not. Capsule globose or ovoid, apiculate, indehiscent, immersed or laterally emergent; seta straight or curved, short.

- 1 Nerve with flask-shaped, papillose cells on ventral side above; upper laminal cells with 1 central, high papilla bi- or trifurcate (fig. 40, 11-12) **P. vlassovii** Laz.

**Microbryum vlassovii** (Laz.) R.H. Zander

Stem to 0,4 cm high. Upper leaves widely ovate, acute; nerve excurrent in arista 0,3-0,7 mm long, yellowish green or hyaline. Capsule immersed. Forms loose turfs on dry, exposed, gypsum soils, in the eastern part of the Peninsula. Esp.

- 1 Nerve with rectangular, not flask-shaped cells, smooth or papillose on ventral side above; upper laminal cells smooth or with 1-2(-5) low papillae, simple to trifurcate (fig. 40, 13-16) **P. cuspidatum** Hedw.

Plants greenish or yellowish, to 0,9 cm tall. Upper leaves ovate or ovate-lanceolate, acute; nerve excurrent in a mucro, in brown, yellowish arista or in hyaline hair. Seta usually short, straight or curved, occasionally to 1,5 mm long and cygneous; spores more than 25  $\mu$ m. Grows on exposed, acidic or basic soils in the lowlands, in the eastern and southern half of the Peninsula and in Mallorca and Menorca. Esp, Prt, Bl.

Taxon very variable, and includes diverse varieties:

var. **cuspidatum**: Nerve excurrent in a hair less than 0,4 mm long (fig. 40, 13-16).

var. **papillosum** (Lindb.) G. Roth.: Upper cells of lamina strongly papillose, with 3-4(5) conical, bifurcate or trifurcate papillae.

var. **piliferum** (Hedw.) Hook. & Taylor: Nerve excurrent in a hair more than 0,4 mm long.

var. **retortifolium** J. Guerra & Ros: Leaves strongly curled; nerve excurrent in yellowish green hair to 1,5 mm long. Seta curved; capsule laterally emergent.

var. **schreberianum** (Dicks.) Brid.: Stem to 9 mm high, branched. Nerve excurrent in a hair to 0,5 mm long.

### Pleurochaete Lindb.

Stem 2-3 cm high. Leaves lanceolate, squarrose, crisped when dry, base erect, sheathing, apical margin incurved and dentate; laminal cells 8-10  $\mu$ m, hexagonal, papillose, basal cells rectangular, forming at margin a wide and hyaline border, narrowing when ascending up margin; nerve percurrent or excurrent and ending in a mucro. Seta lateral; capsule cylindrical, straight or slightly inclined; peristome teeth 32, filiform, papillose, slightly twisted (fig. 40, 17-20) **P. squarrosa** (Brid.) Lindb.

Forms light green or yellowish, loose turfs, on dry, open, sandy, calcareous soils, in the lowlands of the Mediterranean region and in Mallorca, Menorca and Pithyusic Islands. Esp, Prt, And, Bl.

**Pottia** (Reichenb.) Fűrnr.

Plants minute or small, scattered, gregarious or forming loose or dense turfs, mainly on disturbed soils, in roadside ledges, gardens or arable fields. Leaves ovate-lanceolate to oblong, lingulate or spatulate, margin plane or recurved; laminal cells quadrate or hexagonal, papillose or smooth; nerve percurrent or excurrent in apiculus, arista or hair-point. Seta straight; capsule exserted, dehiscent, ovoid, ellipsoidal or cylindrical; lid rostrate; peristome lacking, rudimentary or with 16 long and well-developed teeth; calyptra cucullate.

- 1 Peristome with well-developed teeth (fig. 41, 1-3) **P. lanceolata** (Hedw.) Müll.Hal.  
\* **Tortula lanceolata** R.H. Zander

Plants to 0,4 cm tall. Leaves oblong-lanceolate or lingulate, twisted when dry; laminal cells papillose or almost smooth; nerve excurrent in arista longer than 150 µm. Capsule cylindrical; peristome red or whitish, irregularly divided and perforated, with long teeth, 230-500 µm. Forms dense or loose, green turfs on open, basic or even gypsiferous soils, in the Mediterranean region of the Peninsula and in Mallorca. Esp, Prt, Bl.

- 1 Peristome lacking or rudimentary 2

- 2 Mature capsule turbinate, widest at mouth (fig. 41, 4)  
**P. truncata** (Hedw.) Bruch & Schimp.  
\* **Tortula truncata** (Hedw.) Mitt.

Plants to 0,5 cm tall. Leaves broadly oblong or oblong-lanceolate, margin plane or recurved at base; laminal cells quadrate, smooth or slightly papillose; nerve percurrent or excurrent in short apiculus. Capsule ovoid, short, wide-mouthed after ripening of spores; peristome lacking or very reduced. Forms very lax turfs on acidic soils, in the lowlands, rarely in montane areas. Scattered in the Peninsula and in Menorca. Esp, Prt, Bl.

- 2 Mature capsule not turbinate, widest below mouth 3

- 3 Laminal cells papillose 4

- 3 Laminal cells smooth 5

- 4 Laminal cells 10-18 µm wide (fig. 41, 5) **P. wilsonii** (Hook.) Bruch & Schimp.  
\* **Tortula wilsonii** (Hook.) R.H. Zander

Leaves obovate or spatulate, apex acute or obtuse; nerve excurrent in apiculus or in yellowish hair-point. Capsule ellipsoidal or cylindrical; peristome rudimentary. Spores more than 16 µm. Plants to 0,4 cm tall, gregarious or forming green turfs on wet slopes and arable fields, in the lowlands and montane areas. Scattered in the Peninsula and in Menorca. Esp, Prt, Bl.

- 4 Laminal cells 18-28 µm wide (fig. 41, 6) **P. crinita** Bruch & Schimp.  
\* **Tortula viridifolia** (Mitt.) Blockeel & A.J.E. Sm.

Plants to 0,3 cm tall. Leaves spatulate, apex rounded; laminal cells 16 µm wide or more; nerve excurrent in apiculus or in yellowish hair-point. Capsule ovoid; peristome rudimentary; spores more than 20 µm. Forms cushions on calcareous rocks. Scattered in the northeast, centre and northwest of the Peninsula and in Mallorca and Menorca. Esp, Bl.

- 5 Leaf apex acute (fig. 41, 7)

**P. intermedia** (Turner) Fürnr.

\* **Tortula modica** R.H. Zander

Plants to 0,5 cm tall. Leaves oblong-lanceolate or spatulate; laminal cells quadrate, smooth or slightly papillose; nerve excurrent in apiculus. Capsule ellipsoidal or cylindrical; peristome rudimentary or incompletely developed. Spores to 34 µm. Forms lax, olive-green turfs on exposed, often saline soils, in the lowlands and montane areas, in the Peninsula and in Mallorca and Menorca. Esp, Prt, Bl.

- 5 Leaf apex rounded or obtuse (fig. 41, 8)

**P. pallida** Lindb.

\* **Tortula pallida** (Lindb.) R.H. Zander

Plants to 0.5 cm tall. Leaves oblong-spatulate; nerve excurrent in apiculus or in yellow hair-point; laminal cells smooth or scarcely papillose. Capsule cylindrical or ellipsoidal, yellowish; peristome lacking or rudimentary. Spores to 28 µm. Forms compact, yellowish green turfs on temporarily wet, saline soils. Scattered in the Mediterranean region of the Peninsula and in Mallorca, Menorca and Pithyusic Islands. Esp, Prt, Bl.

### **Pottiopsis** Blockeel & A.J.E. Sm.

Plants minute. Leaves oblong-lanceolate, acute, margin plane, entire; laminal cells quadrate or rounded, thick-walled; nerve excurrent in apiculus. Perichaetial leaves broader than stem leaves, sheathing, concave. Seta long; capsule dehiscent, ovoid; lid conical, oblique; peristome short, with irregular teeth, rudimentary (fig. 41, 9-12)

**P. caespitosa** (Bruch ex Brid.) Blockeel & A.J.E. Sm.

**Pottia caespitosa** (Bruch ex Brid.) Müll.Hal.

Forms small, loose turfs on soils and in calcareous rock crevices, in the lowlands. Distributed in the south and east of the Peninsula and in Mallorca. Esp, Prt, Bl.

### **Protobryum** J. Guerra & M.J. Cano

Plants very small, to 0,6 cm tall, brownish. Leaves lanceolate or ovate-lanceolate, margin entire, recurved; laminal cells quadrate, 15-20 µm, smooth or slightly papillose; nerve excurrent in a yellowish green arista. Seta long; capsule emergent or shortly exerted, ellipsoidal, longly apiculate, indehiscent; lid differentiated but persistent (fig. 41, 13)

**P. bryoides** (Dicks.) J. Guerra & M.J. Cano

**Pottia bryoides** (Dicks.) Mitt.

Scattered or gregarious on open, calcareous soils, in the Mediterranean region of the Peninsula and in Mallorca. Esp, Bl.

### **Pseudocrossidium** R.S. Williams

Plants 0,3-1,5 cm tall. Leaves spirally twisted when dry, ovate, lanceolate, triangular or lingulate; margin entire, revolute from base to apex; laminal cells quadrate or oblate, thick-walled, papillose, basal cells rectangular; nerve stout, excurrent in mucro. Gemmae often present, pluricellular, on ventral side of nerve. Capsule ellipsoidal; lid rostrate; peristome teeth 16, filiform, divided to base, spirally twisted.

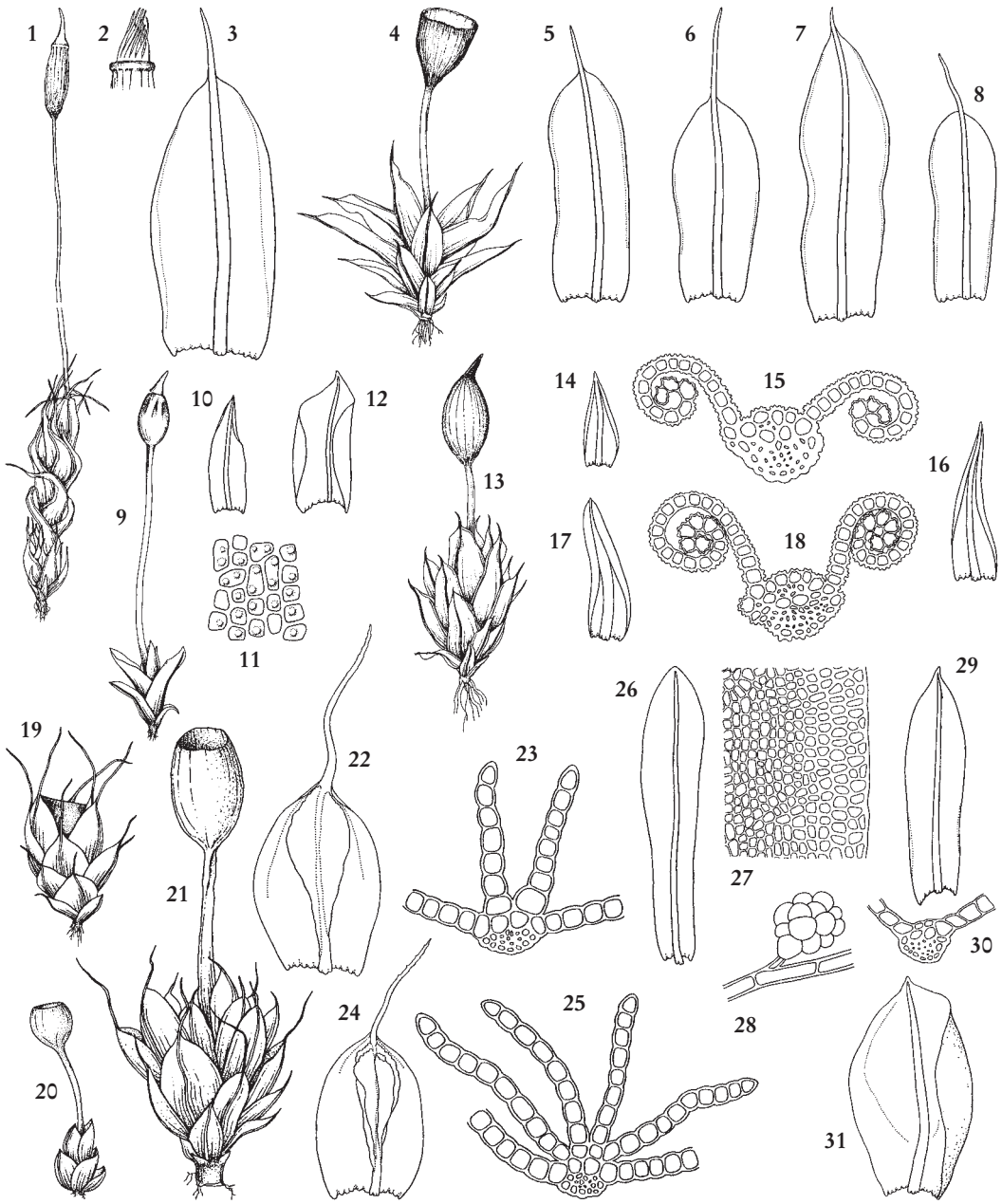


FIGURE 41. 1-3, *Pottia lanceolata*: 1, habit when dry; 2, peristome; 3, leaf. 4, *P. truncata*, habit. 5, *P. wilsonii*, leaf. 6, *P. crinita*, leaf. 7, *P. intermedia*, leaf. 8, *P. pallida*, leaf. 9-12, *Pottiopsis caespitosa*: 9, habit; 10, leaf; 11, upper cells; 12, perichaetial leaf. 13, *Protobryum bryoides*, habit. 14-15, *Pseudocrossidium obtusulum*: 14, leaf on dorsal side; 15, leaf section. 16, *P. hornschurchianum*, leaf on dorsal side. 17-18, *P. revolutum*: 17, leaf on dorsal side; 18, leaf section. 19, *Pterygoneurum subsessile*, habit. 20, *P. sampaianum*, habit. 21-25, *P. ovatum*: 21, habit; 22, 24, leaves; 23, 25, nerve sections. 26-28, *Scopelophila ligulata*: 26, leaf; 27, marginal cells; 28, gemma. 29-30, *S. cataractae*: 29, leaf; 30, nerve section. 31, *Stegonia latifolia*, leaf. 1, 4, 9, 13, 19, 20, 21 ( $\times 10$ ); 2, 3, 5, 6, 7, 8, 10, 12, 14, 16, 17, 22, 24, 26, 29, 31 ( $\times 18$ ); 15, 18, 23, 25, 27, 28, 30 ( $\times 180$ ); 11 ( $\times 380$ ).

- 1 Leaves ovate or ovate-lanceolate; slightly spirally twisted when dry (fig. 41, 14-15)  
**P. obtusulum** (Lindb.) H.A. Crum & L.E. Anderson  
 Leaf apex obtuse and apiculate or acute, margin once revolute. Grows on calcareous, saline or gypsum soils. Scattered in the Peninsula. Esp, And.
- 1 Leaves triangular, lanceolate, oblong or lingulate, strongly spirally twisted when dry  
 2
- 2 Leaves triangular, lanceolate, with acuminate apex (fig. 41, 16)  
**P. hornschurchianum** (Schultz) R.H. Zander  
**Barbula hornschurchiana** Schultz  
 Leaf margin narrowly revolute more than 1 turn. Gemmae lacking. Forms compact turfs on disturbed soils of arable fields, walls and calcareous rocks, in the lowlands. Widespread throughout the Peninsula and in Mallorca, Menorca. and Pithyusic Islands. Esp, Prt, Bl.
- 2 Leaves oblong or lingulate, with obtuse apex (fig. 41, 17-18)  
**P. revolutum** (Brid.) R.H. Zander  
**Barbula revoluta** Brid.  
 Leaf margin widely revolute, often with pluricellular gemmae on the ventral side of nerve. Forms dense, dark green turfs on dry, calcareous soils and rocks, in open sites, in the lowlands. Widespread throughout the Peninsula and in Mallorca and Menorca. Esp, Prt, Bl.

### **Pterygoneurum Jur.**

Plants small. Stem to 0,5 cm high, branched or not. Leaves ovate or oblong-ovate, concave, margin plane or narrowly recurved; cells short, variable in shape; nerve ending below apex or excurrent in hyaline hair-point, in apiculus or in mucro, with 2-4 lamellae on ventral side 4-20 cells high, in the upper part or from base to apex, occasionally with filaments on both sides of lamella. Seta short or long; capsule immersed or exserted, globose to cylindrical; peristome rudimentary or lacking.

- 1 Seta short, capsule immersed (fig. 41, 19) **P. subsessile** (Brid.) Jur.  
 Plants to 0,3 cm tall. Nerve excurrent in hyaline hair-point, with 2-4 lamellae, usually in the upper half, occasionally with short filaments. Forms loose turfs on saline, periodically wet soils. Scattered in the eastern part of the Peninsula. Esp.
- 1 Seta long, capsule exserted  
 2
- 2 Nerve ending below leaf apex or excurrent in mucro; capsule globose or sub-globose (fig. 41, 20) **P. sampaianum** (Guim.) Guim.  
 Plants to 0,2 cm tall. Nerve with 2-4 lamella from near leaf base to apex. Spores 30-60 µm. Grows isolated on clayey soils. Scattered in the Mediterranean region of the Peninsula and in Mallorca. Esp, Prt (Extinct), Bl.
- 2 Nerve excurrent in hyaline hair-point or yellowish long apiculus; capsule ovoid or cylindrical  
 3

- 3 Capsule cylindrical; lid cells in helicoidal rows; peristome usually rudimentary  
**P. lamellatum** (Lindb.) Jur.

**P. compactum** M.J. Cano, J. Guerra & Ros

Plants to 0,5 cm tall. Nerve excurrent in hyaline hair-point or yellowish apiculus, with 2-3 lamellae in the upper part, usually with branched filaments. Spores 10-20 µm. Grows on dry, exposed soils in the lowlands, in the eastern part of the Peninsula. Esp.

- 3 Capsule ovoid or ovate-ellipsoidal; lid cells in straight rows; peristome lacking (fig. 41, 21-25)  
**P. ovatum** (Hedw.) Dixon

**P. squamosum** Segarra & Kürschner

Plants to 0,3 mm. Nerve excurrent in hyaline hair, smooth or slightly dentate, longer than leaf or more, rarely short; 2-4 lamellae from base to apex, sometimes transversely divided, occasionally with short filaments. Spores 25-35 µm. Forms cushions in exposed, calcareous soils in the lowlands, occasionally in montane areas. Mainly in the Mediterranean region of the Peninsula and in Mallorca and Pithyusic Islands. Esp, And, Bl.

### **Scopelophila** (Mitt.) Lindb.

Plants small. Leaves long, lingulate or spatulate, apex rounded to acute, margin entire, plane, recurved at base; cells quadrate or hexagonal, smooth or finely papillose, 6-11 µm wide; nerve ending below apex or percurrent. Plants growing on mineral-rich substrata.

- 1 Leaf apex acute; nerve section with 1 layer of differentiated ventral cells (fig. 41, 29-30)  
**S. cataractae** (Mitt.) Broth.

Plants to 1 cm tall. Forms dense, dark green turfs on deep blue grey muds, rich in heavy metals. Rare in the north and in the south of the Peninsula. Esp.

- 1 Leaf apex obtuse or rounded; nerve section without differentiated ventral cells (fig. 41, 26-28)  
**S. ligulata** (Spruce) Spruce

Plants to 1,5 cm tall, rhizoids with pluricellular gemmae. Leaves with several rows of thick-walled, marginal cells. Forms olive-green turfs on humid, iron-rich rocks and soils in montane areas, in the Central and Eastern Pyrenees. Esp.

### **Stegonia** Venturi

Plants small, 0,2 mm tall, bulbiform. Leaves obovate, wide, very concave, imbricate, apex rounded or obtuse, obtuse, apiculate and denticulate, margin plane, entire; laminal cells rhomboidal and smooth; nerve thin, percurrent. Seta long; capsule cylindrical, straight; peristome teeth 16, irregularly cleft at apex and perforated; spores 40 µm, papillose, reddish brown (fig. 41, 31)  
**S. latifolia** (Schwägr.) Venturi ex Broth.

Forms small light green turfs on rocky and calcareous clearings of grasslands, in high mountains. Rare, in the Pyrenees and in the north of the Peninsula. Esp, And.

### **Syntrichia** Brid.

Plants 0,2-10 cm tall. Leaves lingulate, spatulate or oblong-lanceolate, apex mostly obtuse; laminal cells quadrate or rounded, papillose, basal cells rectangular, hyaline, smooth,



thin-walled, forming a distinct ovate group on both sides of nerve; nerve excurrent in arista, in smooth or denticulate hair-point, or in mucro or percurrent. Seta long; capsule cylindrical; peristome with 32 filamentous, spirally twisted teeth, basal membrane  $\pm$  high.

- 1 Plants with axillary propagules or gemmae on leaves 2
- 1 Plants without axillary propagules or gemmae 4

- 2 Plants with foliose axillary propagules (fig. 42, 1-3) **S. laevipila** Brid.

**S. pagorum** (Milde) J.J. Amann

Plants to 2 cm tall. Leaves ovate, lingulate or spatulate, rounded or emarginate at apex, constricted at middle, margin narrowly recurved at middle, plane at base; marginal cells not differentiated or forming a border of 2-5 rows of slightly papillose and thick-walled cells, reaching the apex; nerve with several rows of stereids on dorsal side, excurrent in long, nearly smooth hair-point, brown at base. Propagules in dense groups in upper leaves, ovate or elliptical, papillose, with a hyaline apical cell. Peristome with high basal membrane, reticulate in helix, teeth spirally twisted in 2-3 turns. Forms small to medium-sized, dense, brownish green turfs on bark of trees, in the lowlands and montane areas throughout the Peninsula and Mallorca. Esp, Prt, And, Bl.

- 2 Plants with globose gemmae on ventral side of leaf 3

- 3 Nerve percurrent; gemmae on leaf lamina

**S. latifolia** (Bruch ex C. Hartm.) Huebener

**Tortula latifolia** Bruch ex Hartm.

Plants small, about 1 cm tall. Leaves spatulate, constricted at middle, apex rounded or obtuse; cells with more than 4 papillae. Gemmae pluricellular. Mostly epiphytic, but also on rocks. Scattered in the Peninsula. Esp, Prt.

- 3 Nerve excurrent in hair-point; gemmae on nerve (fig. 42, 4-5)

**S. papillosa** (Wilson) Jur.

**Tortula papillosa** Wilson

Plants short, 0,2-1 cm tall. Leaves ovate-spatulate, constricted below middle, margin plane or incurved above; nerve broad, excurrent in smooth, hyaline hair-point; laminal cells with 1-2 papillae on dorsal side. Gemmae on younger leaves, irregularly globose, pluricellular. Forms dense, small turfs on bark of trees. Scattered in the lowlands and montane areas of greater part of the Peninsula. Esp, Prt, And.

- 4 Upper lamina totally or partially bistratose 5

- 4 Upper lamina unistratose 6

- 5 Leaves widely ovate or ovate-lingulate, with strongly recurved margin to apex; nerve strongly papillose at back (fig. 42, 6) **S. caninervis** Mitt.

**Tortula caninervis** (Mitt.) Broth.

Plants to 2 cm tall. Nerve excurrent in hyaline, strongly spinose hair-point, rarely in mucro, upper part strongly papillose at back, with high, usually more than 2,5  $\mu$ m, simple, bifurcate or branched papillae. Grows on dry, exposed, calcareous or gypsum soils, in arid areas of the southern, central and northeastern part of the Peninsula. Esp.



var. **caninervis**: Upper leaves regularly bistratose (fig. 42, 6).

var. **gypsophyla** (J.J. Amann ex G. Roth) Ochyra: Upper leaves irregularly bistratose, middle leaves unistratose.

var. **abrangesii** (Luisier) R.H. Zander: Leaves mucronate, irregularly bistratose.

- 5 Leaves lingulate or lingulate-lanceolate, with narrowly recurved margin to 3/4 way up leaf; ; nerve slightly papillose at back **S. handelii** (Schiffn.) S. Agnew & Vondr.

**Tortula handelii** Schiffn.

Plants to 3 cm tall. Nerve excurrent in hyaline hair-point strongly spinose, cells with simple papillae on ventral side to 2,5 mm high. Grows on calcareous rocks. Very rare in the south of the Peninsula. Esp.

- 6 Leaves fragile, mostly broken (fig. 42, 7) **S. fragilis** (Taylor) Ochyra

**Tortula fragilis** Taylor

Stem 1-1,5 cm high. Leaves spatulate, mucronate, margin plane above. It is distinguished from other close species by its fragile leaves, even the youngest ones. Forms cushions on shaded, siliceous rocks, in the montane areas of the Eastern Pyrenees. Esp.

- 6 Leaves mostly not broken 7

- 7 Nerve excurrent in short hair-point or arista or in mucro 8

- 7 Nerve excurrent in long hair-point 9

- 8 Nerve excurrent in short hair-point or arista (fig. 42, 8)

**S. sinensis** (Müll.Hal.) Ochyra

**Tortula sinensis** (Müll.Hal.) Broth.

Plants 1-1,5 cm tall. Leaves lingulate, apex rounded, margin revolute to the middle, arista denticulate, reddish at base. Forms somewhat compact, glaucous cushions, reddish at base, on shaded, siliceous rocks, in the montane areas of the Eastern Pyrenees. Esp.

- 8 Nerve excurrent in mucro

**S. montana** Nees var. **calva** (Durieu & Sagot ex Bruch & Schimp.) J.J. Amann

Stem 1-2,5 cm high. Leaves spatulate or lingulate, constricted in the middle, margin recurved to 2/3 way up leaf; laminal cells 8-12 µm wide. Grows on rocks and soil of the southern part of the Peninsula. Esp.

- 9 Nerve excurrent in reddish brown hair-point (fig. 42, 9) **S. norvegica** F. Weber

**Tortula norvegica** (F. Weber) Lindb.

Plants large, to 6 cm tall. Leaves oblong, attenuate in reddish brown hair-point, sometimes hyaline at apex, margin recurved to 2/3-3/4 way up leaf. Forms lax, brownish cushions on calcareous rock ledges, in high mountain areas of the Pyrenees, Cantabrian Mountains and Sierra Nevada. Esp, And.

- 9 Nerve excurrent in hyaline hair-point 10

- 10 Leaves constricted at middle 11

- 10 Leaves not constricted at middle 14

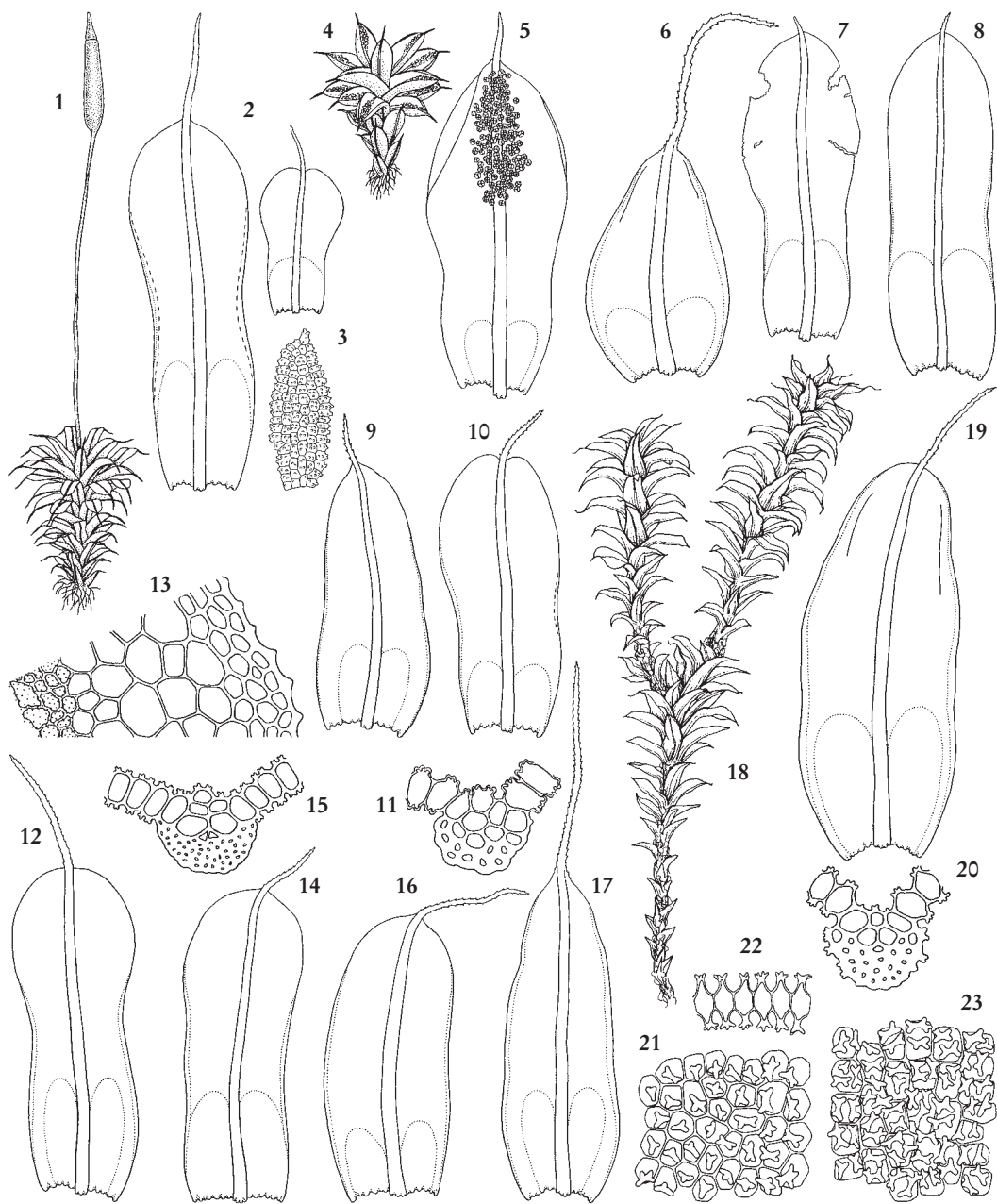


FIGURE 42. 1-3, *Syntrichia laevispila*: 1, habit; 2, leaves; 3, propagule. 4-5, *S. papillosa*: 4, habit; 5, leaf. 6, *S. caninervis* var. *caninervis*, leaf. 7, *S. fragilis*, leaf. 8, *S. sinensis*, leaf. 9, *S. norvegica*, leaf. 10-11, *S. virescens* var. *virescens*: 10, leaf; 11, nerve section. 12, *S. montana* var. *montana*, leaf. 13-15, *S. princeps*: 13, stem section; 14, leaf; 15, nerve section. 16, *S. calcicola*, leaf. 17, *S. ruralis* var. *ruraliformis*, leaf. 18-20, *S. ruralis* var. *ruralis*: 18, habit; 19, leaf; 20, nerve section. 21-22, *S. papillosissima*: 21, median cells; 22, lamina section. 23, *S. subpapillosissima*, median cells. 18 ( $\times 2.5$ ); 1, 4 ( $\times 4.5$ ); 2, 5, 6, 7, 8, 9, 10, 12, 14, 16, 17, 19 ( $\times 16$ ); 3 ( $\times 100$ ); 11, 13, 15, 20, 22 ( $\times 200$ ); 21, 23 ( $\times 300$ ).

- 11 Nerve with 1-2 rows of stereids on dorsal side (fig. 42, 10-11)

**S. virescens** (De Not.) Ochyra

**Tortula virescens** (De Not.) De Not.

Stem about 1 cm high. Leaves slightly twisted, oblong-spathulate, rounded or emarginate at apex, margin plane or slightly recurved above. Forms small turfs on stumps and rocks of the Mediterranean region. Esp, Prt.

var. **virescens**: Laminal cells with more than 4 bifurcate, not pedicellate papillae (fig. 42, 10-11).

var. **minor** (Bizot) Ochyra (= *S. minor* (Bizot) M.T. Gallego, J. Guerra, M.J. Cano, Ros & Sanchez-Moya): Laminal cells with one branched and pedicellate papilla.

- 11 Nerve with more than 2 rows of stereids on dorsal side

12

- 12 Hair-point smooth (fig. 42, 1-3)

**S. laevipila** Brid.

**Tortula pagorum** (Milde) De Not.

Plants to 2 cm tall. Leaves lingulate or spathulate, rounded or emarginate at apex, margin narrowly recurved at middle of leaf, plane at base, border of 2-5 rows of slightly papillose and thick-walled cells to apex or indistinct; nerve excurrent in long, nearly smooth hair-point, brownish at base, in section with several rows of stereids on dorsal side. Peristome with high basal membrane, reticulate in helix, teeth spirally twisted in 2-3 turns. Forms small, dense, brownish green turfs on bark of trees, in the lowlands and montane areas of the Peninsula and Mallorca. Esp, Prt, And, Bl.

- 12 Hair-point spinose

13

- 13 Plants dioicous; laminal cells less than 12  $\mu\text{m}$  wide (fig. 42, 12)

**S. montana** Nees var. **montana**

**S. intermedia** Brid., **Tortula intermedia** (Brid.) De Not.

Stem 1-2,5 cm high, without central strand. Leaves patent or spreading, spathulate or lingulate, not squarrose, margin recurved to 2/3 way up leaf. Differs from *S. ruralis* in the leaf arrangement; from *S. calcicola* in the constriction at mid-leaf and the laminal cell size. Forms compact turfs on soils, exposed rocks and walls, mainly calcareous, in montane areas throughout the Peninsula and Mallorca. Esp, Prt, Bl.

- 13 Plants synoicous; laminal cells 12  $\mu\text{m}$  wide or more (fig. 42, 13-15)

**S. princeps** (De Not.) Mitt.

**Tortula princeps** De Not.

Stem to 4 cm high, with central strand. Leaves lingulate or spathulate, margin slightly revolute to 3/4 way up leaf. Peristome with high basal membrane, teeth spirally twisted in 4 turns. Forms olive green or brownish turfs in humus-rich soils and on artificial walls and rocks. Scattered in the Peninsula and Mallorca. Esp, Prt, And, Bl.

- 14 Leaves patent, margin recurved to 2/3 way up; laminal cells more than 12  $\mu\text{m}$  wide (fig. 42, 16)

**S. calcicola** J.J. Amann

**Tortula calcicolens** W.A. Kramer

Leaves lingulate or spathulate; hyaline group of basal cells small, well differentiated. Forms dense, brownish turfs on calcareous soils and disintegrated rocks, mainly in montane areas and in the lowlands of the Mediterranean region of the Peninsula and Mallorca. Esp, And, Bl.

- 14 Leaves reflexed or squarrose, margin revolute from base to apex; laminal cells 12  $\mu\text{m}$  wide or less 15

- 15 Leaves gradually narrowed in acute or acuminate apex, tapering into hair-point; laminal cells with non-pedicellate papillae (fig. 42, 17)

**S. ruralis** (Hedw.) F. Weber & D. Mohr var. **ruraliformis** (Besch.) Delogne

**Tortula ruraliformis** (Besch.) Grout var. **ruraliformis**

Plants to 5 cm tall. Laminal cells with several, simple or bifurcate, non-pedicellate papillae. Distinguished from var. *ruralis* by its gradually acuminate leaves and by the hyaline margin at hair-point base. Forms extensive, brownish turfs on sandy soils, frequently in pine woods of montane areas. Widespread throughout the Peninsula, also in Mallorca. Esp, Prt, And, Bl.

- 15 Leaves with rounded or obtuse apex not tapering into hair-point; laminal cells with non- or pedicellate papillae 16

- 16 Laminal cells with non-pedicellate papillae (fig. 42, 18-20)

**S. ruralis** (Hedw.) F. Weber & D. Mohr var. **ruralis**

**Tortula ruralis** (Hedw.) P. Gaertn., B. Mey. & Scherb. var. **ruralis**

Leaves widely lingulate, recurved to near apex; laminal cells with several, simple or bifurcate papillae; laminal cells pluripapillose. Peristome with high basal membrane, teeth spirally twisted in 2 turns. Forms lax, brownish red cushions on rock ledges, walls and at tree bases, from the lowlands to the high mountains. Common throughout the Peninsula and Mallorca. Esp, Prt, And, Bl.

- 16 Laminal cells with pedicellate papillae 17

- 17 Laminal cells unipapillose, papillae star-shaped, branched at apex (fig. 42, 21-22)

**S. papillosissima** (Copp.) Loeske

**S. ruralis** (Hedw.) F. Weber & D. Mohr var. **hirsuta** (Venturi) Podp.,

**Tortula ruralis** (Hedw.) P. Gaertn., B. Mey. & Scherb. var. **hirsuta** (Venturi) Paris

Leaves recurved to near apex, hair-point spinose. Grows on calcareous soils and rock ledges and artificial walls, in the central and southern part of the Peninsula. Esp, Prt.

- 17 Laminal cells pluripapillose, papillae bifurcate (fig. 42, 23)

**S. subpapillosissima** (Bizot & R.B. Pierrot ex W.A. Kramer)

M.T. Gallego & J. Guerra

**Tortula ruraliformis** (Besch.) Grout var. **subpapillosissima** Bizot & R.B. Pierrot ex W.A. Kramer

Leaves recurved to near apex. Grows on soils and rocks, rarely epiphytic. Scattered throughout Mediterranean region of the Peninsula. Esp, Prt.

### **Timmiella** (De Not.) Shimp.

Plants 0.5-2 cm tall. Stem simple or bifurcate. Leaves erecto-patent, oblong-lanceolate, crisped when dry, apex acute, margin incurved, dentate in the upper part; lamina bistratose, median cells quadrate, mamillate, basal cells smooth, translucent; nerve percurrent. Capsule cylindrical, straight or curved, annulus large, revolute, peeling off

during the dehiscence or annulus lacking; peristome of 16 teeth divided to near base, teeth straight or twisted.

- 1 Plants paroicous; capsule without annulus (fig. 43, 1-2)

**T. barbuloides** (Brid.) Mönk.

Plants to 2 cm tall, isolated or forming loose turfs on wet, calcareous slopes and soils. Widespread in the lowlands, near coastal areas in the east, south and west of the Peninsula and in Mallorca, Menorca and Pithyusic Islands, rare inland. Esp, Prt, Bl.

- 1 Plants autoicous or dioicous; capsule with annulus

2

- 2 Plants dioicous; seta flexuose; peristome teeth straight **T. flexiset** (Bruch) Limpr.

Plants to 4-6 mm tall. Capsule with large, revoluble annulus. Grows on wet soils. Very rare, in the southwest of the Peninsula. Prt.

- 2 Plants autoicous; seta straight; peristome teeth twisted (fig. 43, 3)

**T. anomala** (Bruch & Schimp.) Limpr.

Plants to 2 cm tall. Capsule with large, revoluble annulus. Grows on exposed, acidic soils. Very rare, in the south of the Peninsula. Esp.

### **Tortella** (Müll.Hal.) Limpr.

Stem 0,2-5 cm high. Leaves lanceolate to linear-lanceolate, crisped or curved when dry, margin plane or incurved at apex; lamina usually unistratose, laminal cells quadrate, papillose, basal cells smooth, hyaline, ascending up margin, usually the transition to papillose cells is abrupt and in a v-shape; nerve percurrent or excurrent in apiculus. Capsule cylindrical, straight or slightly inclined; peristome teeth 32, filiform, papillose, spirally twisted.

- 1 Leaf apex hooked and cucullate; stem 0,2-0,5 cm high (fig. 43, 4)

**T. inflexa** (Bruch) Broth.

Leaves linear-lanceolate, strongly curled when dry, upper leaves with inflexed, incurved apex; transition to papillose cells gradual. Forms loose turfs on calcareous rocks in areas near sea-coast, in the east, south and southeast of the Peninsula and in Mallorca, Menorca and Pithyusic Islands. Esp, Prt, Bl.

- 1 Leaves lacking above combination of characters; stem more than 0,5 cm high

2

- 2 Leaves with subulate and fragile apices

3

- 2 Leaves with apices not as above

4

- 3 Stem without tomentum, with central strand; lamina irregularly bistratose in the upper part; laminal cells 14 µm wide

**T. alpicola** Dixon

Leaves curled, contorted, occasionally crisped when dry. Forms dense or loose turfs to 1,5 cm tall. Grows on rocks. Rare, in Sierra Nevada. Esp.

- 3 Stem with tomentum, without central strand; lamina 2-3-stratose in the upper part; laminal cells 10-12 µm wide (fig. 43, 5-6)

**T. fragilis** (Hook. & Wilson) Limpr.

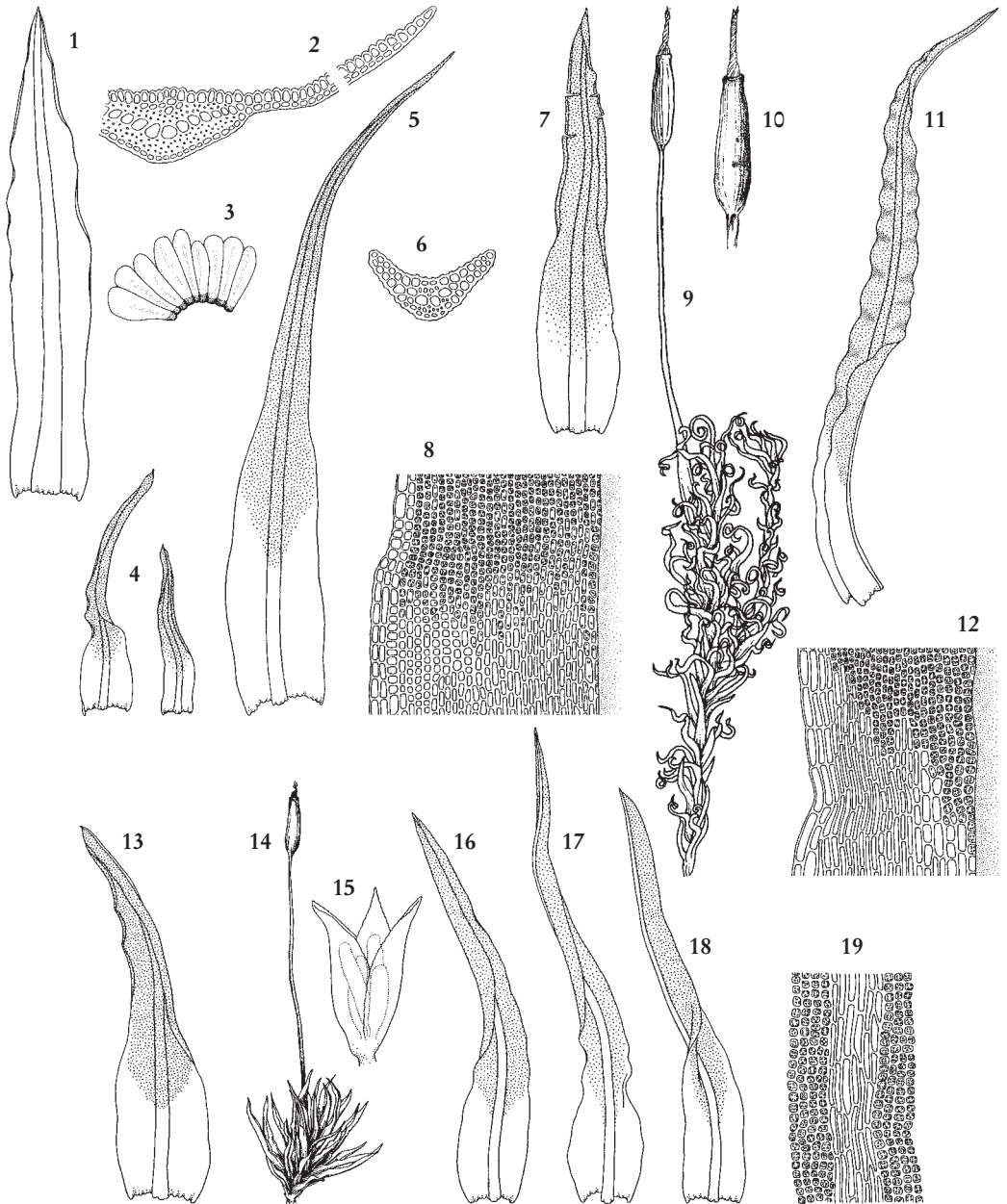


FIGURE 43. 1-2, *Timmiella barbulooides*: 1, leaf; 2, leaf section. 3, *T. anomala*, annulus. 4, *Tortella inflexa*, leaves. 5-6, *T. fragilis*: 5, leaf; 6, leaf section at apex. 7-8, *T. nitida*: 7, leaf; 8, basal cells. 9-12, *T. tortuosa* var. *tortuosa*: 9, habit when dry; 10, capsule; 11, leaf; 12, basal cells. 13, *T. flavovirens* var. *flavovirens*, leaf. 14-16, *T. humilis*: 14, habit; 15, perigonium; 16, leaf. 17, *T. densa*, leaf. 18-19, *T. inclinata*: 18, leaf; 19, nerve on ventral side. 9, 14 ( $\times 3.5$ ); 10 ( $\times 7$ ); 1, 4, 5, 7, 11, 13, 16, 17, 18 ( $\times 16$ ); 15 ( $\times 40$ ); 6, 8, 12, 19 ( $\times 110$ ); 2, 3 ( $\times 140$ ).



Leaves rigid, straight or slightly curved when dry. Forms dense turfs, to 2 cm high, on damp, acidic rocks and soils and bases of stumps in high mountain areas of the Pyrenees and Sierra Nevada. Esp.

- 4 Leaf margin incurved; nerve conspicuous, glossy at back, excurrent in small mucro; transition to papillose cells gradual (fig. 43, 7-8) **T. nitida** (Lindb.) Broth.

Lamina very fragile, often erose near apex. Forms dense turfs, 1 cm high, on dry, exposed, calcareous rocks, in the lowlands of the eastern Mediterranean region and in Mallorca, Menorca and Pithyusic Island, rarer in montane areas and in the north and west of the Peninsula. Esp, Prt, And, Bl.

- 4 Leaf margin plane; nerve dull or slightly glossy at back, percurrent or excurrent in mucro; transition to papillose cells abrupt 5

- 5 Ventral cells of nerve mostly short and papillose, similar to laminal cells 6

- 5 Ventral cells of nerve elongated and smooth 7

- 6 Stem tomentose; leaves linear-lanceolate, flexuose, undulate, longly tapering (fig. 43, 9-12) **T. tortuosa** (Hedw.) Limpr.

Leaves with nerve excurrent in apiculus. Forms light green cushions, 1-5 cm high, on calcareous rocks and soils. Grows in calcareous rock crevices. Widespread in the lowlands and montane areas throughout the Peninsula and in Mallorca, Menorca and Pithyusic Islands. Esp, Prt, And, Bl.

var. **tortuosa**: Leaves not fragile or truncate at tips, strongly undulate, unistratose (fig. 43, 9-12).  
var. **fragilifolia** (Jur.) Limpr.: Leaves truncate at tips, upper part circinate when dry, slightly undulate, unistratose with bistratose patches besides nerve.

var. **bambergeri** (Schimp.) Düll. (\* *Tortella bambergeri* (Schimp.) Broth.): Plant to 2 cm tall. Stem usually with central strand. Leaves linear, longly acuminate, channelled, slightly undulate.

- 6 Stem not tomentose; leaves lanceolate, not flexuose or undulate, apex obtuse, mucronate, often cucullate (fig. 43, 13) **T. flavovirens** (Bruch) Broth.

Seta reddish at base. Forms dense light green turfs, 1-2 cm high.

var. **flavovirens**: Laminal cells having low papillae. Grows on sandy soils. It is the commonest species on coastal dunes and inland saline sandy grounds. Widespread throughout the Peninsula and in Mallorca, Menorca and Pithyusic Islands. Esp, Prt, Bl (fig. 43, 13).

var. **papillosissima** Sérgio & Casas: Laminal cells having high papillae Grows on stony soils in the east and southeast of the Peninsula. Esp.

- 7 Plants autoicous (fig. 43, 14-16) **T. humilis** (Hedw.) Jenn.

Plants ramose, stem 0.5-1 cm high, with tomentum. Leaf margin plane. Antheridia in small axillary branches. Seta yellow. Forms loose, light green turfs on humus-rich calcareous soils in pinewoods and evergreen oak forests. Widespread throughout the Peninsula and in Mallorca, Menorca and Pithyusic Islands. Esp, Prt, Bl.

- 7 Plants dioicous 8

- 8 Leaves linear-lanceolate, rigid, straight or nearly so, appressed, gradually tapering to long point (fig. 43, 17) **T. densa** (Lorentz & Molendo) Crundw. & Nyholm

\* **T. inclinata** (R. Hedw.) Limpr. var. **densa** (Lorentz & Molendo) Limpr.

Rhizoids few or lacking. Nerve percurrent or excurrent. Forms compact turfs, 2-3 cm high, on calcareous rocks in montane areas and high mountains, in the north of the Peninsula. Esp.

- 8 Leaves oblong-linear, patent or spreading, apex obtuse, slightly cucullate (fig. 43, 18-19) **T. inclinata** (R. Hedw.) Limpr.

Stem tomentose, often with small propaguliferous branches near apex. Nerve excurrent. Capsule erect or slightly inclined. Forms dense turfs, 1-2 cm high, on sandy, calcareous soils and rock ledges. Widespread throughout the Peninsula and in Mallorca. Esp, Prt, And, Bl. Similar to *T. flavovirens*, but distinguished by the elongated ventral cells of the nerve.

### **Tortula Hedw.**

Plants small, 0,2-3 cm tall. Leaves obovate, elliptical, ovate, lanceolate, lingulate or spatulate; laminal cells quadrate, rounded, hexagonal or rhomboidal, papillose, occasionally smooth, basal cells rectangular, thin-walled, hyaline, not forming a distinct group; nerve ending near apex, percurrent or excurrent in a mucro, in hyaline hair-point or in arista. Capsule cylindrical or ovoid, smooth; peristome short or long, teeth filiform, straight, curved or spirally twisted, basal membrane variable in length, low not projecting above mouth to very high.

- |   |   |   |
|---|---|---|
| 1 | Nerve ending below apex, percurrent or excurrent in mucro   | 2 |
| 1 | Nerve excurrent in hyaline hair-point or in arista  | 8 |
| 2 | Leaves bordered   | 3 |
| 2 | Leaves not distinctly bordered  | 4 |
| 3 | Laminal cells smooth or slightly papillose; border of 4-8 rows of rectangular or linear, pale, thick-walled, smooth cells, not reaching the apex (fig. 44, 1-3) |   |

#### **T. freibergii** Dixon & Loeske

Plants to 0,5 cm tall. Leaves obovate to spatulate, apex rounded to obtuse, mostly apiculate; nerve ending below apex or percurrent. Peristome with low basal membrane, hardly projecting above mouth, teeth spirally twisted. Grows on calcareous rocks and walls. Scattered in the Peninsula and Menorca. Esp, Prt, Bl.

- 3 Laminal cells strongly papillose; border of 3-4 rows of smooth or slightly papillose, quadrate or rectangular, pale, thick-walled cells, reaching the apex (fig. 44, 4-5)

#### **T. solmsii** (Schimp.) Limpr.

#### **T. marginata** (Bruch & Schimp.) Spruce subsp. **limbata** (Lindb.) Podp.

Plants small, less than 0,5 cm tall. Leaves lingulate or spatulate. Peristome with low basal membrane, hardly projecting above capsule mouth, teeth spirally twisted. Grows on calcareous rocks and walls, near streams. Very rare, in northwestern part of the Peninsula. Esp, Prt.

- |   |  |   |
|---|--|---|
| 4 | Leaves lingulate                                       | 5 |
| 4 | Leaves oblong-lanceolate, obovate, ovate or elliptical | 6 |



- 5 Upper cells of leaf  $7-10 \times 5-7,5 \mu\text{m}$ ; plants rare, dioicous; basal membrane of peristome low **T. bolanderi** (Lesq. & James) M. Howe  
Plants 0,5-0,7 cm tall, irregularly crisped when dry. Leaves with rounded apices, occasionally acute. Forms loose turfs on acidic soils in Sierra Nevada. Esp.
- 5 Upper cells of leaf  $12,5-15 \times 10-12,5 \mu\text{m}$ ; plants common, monoicous; basal membrane of peristome high (fig. 44, 6) **T. inermis** (Brid.) Mont.  
Plants to 2 cm tall. Leaf apex rounded to acute. Peristome teeth spirally twisted. Forms compact turfs on dry, exposed, rocky soils and in rock crevices, in calcareous, montane areas of the Peninsula and Mallorca. Esp, Prt, Bl.
- 6 Leaf margin recurved from base to  $1/2-1/3$  (fig. 44, 7-9) **T. hoppeana** (Schultz) Ochrya  
**T. eucalyptrata** Lindb., **Desmatodon latifolius** (Hedw.) Brid.  
Plants to 2 cm tall. Leaves oblong-lanceolate, acute or obtuse; laminal cells quadrate or rounded, papillose, basal cells larger, hyaline. Capsule ovoid to cylindrical; peristome with very short basal membrane, teeth straight, filiform, irregularly divided, perforated. Forms dense turfs in grasslands on acidic substrata in high mountains. Esp, And.
- 6 Leaf margin revolute from base to apex 7
- 7 Leaves oblong-lanceolate or obovate, concave (fig. 44, 10) **T. atrovirens** (Sm.) Lindb.  
Plans small, about 0,5 cm tall. Leaves spirally twisted around stem when dry. Nerve widened in the upper part. Peristome with short basal membrane, teeth irregularly divided, oblique or curved a half turn. Forms short, compact, dark green to brownish turfs, on soils, walls and exposed rocks. Scattered in the lowlands of the whole Peninsula and in Mallorca. Esp, Prt, Bl.
- 7 Leaves ovate or elliptical, strongly concave (fig. 44, 11) **T. revolvens** (Schimp.) G. Roth  
Plants small, 0,5-1 cm tall. Leaves straight to spirally twisted around stem or appressed when dry, apex rounded to acute; nerve ending below apex, percurrent or excurrent in mucro, mostly widened in the upper part. Peristome teeth entire, spirally twisted to 1 turn. Forms compact turfs on calcareous, clayey soils and rocks in arid lowland areas. Scattered in the Peninsula and Pithyusic Islands. Esp, Bl.  
var. **revolvens**: Leaves with acute apex; nerve excurrent in a mucro. Grows on rocks (fig. 44, 11).  
var. **obtusata** Reimers (*T. fiorii* (Venturi) G. Roth): Leaves with rounded apices; nerve percurrent. Grows on soil.
- 8 Laminal cells smooth or nearly so 9
- 8 Laminal cells papillose 10
- 9 Leaves lingulate or spatulate, elongated; basal membrane of peristome high, longly projecting above capsule mouth (fig. 44, 12-14) **T. mucronifolia** Schwägr.  
Plants to 1 cm tall or a little more. Leaf apex acute, border of narrow cells, not very distinct, margin recurved to  $1/2-2/3$  way up leaf; nerve excurrent in arista. Peristome teeth spirally twisted. Similar to *T. subulata*, but with larger laminal cells,  $18-28 \mu\text{m}$ , smooth or slightly papillose. Forms turfs on soils and in rock crevices, chiefly calcareous, in Pyrenees montane areas. Esp, And.

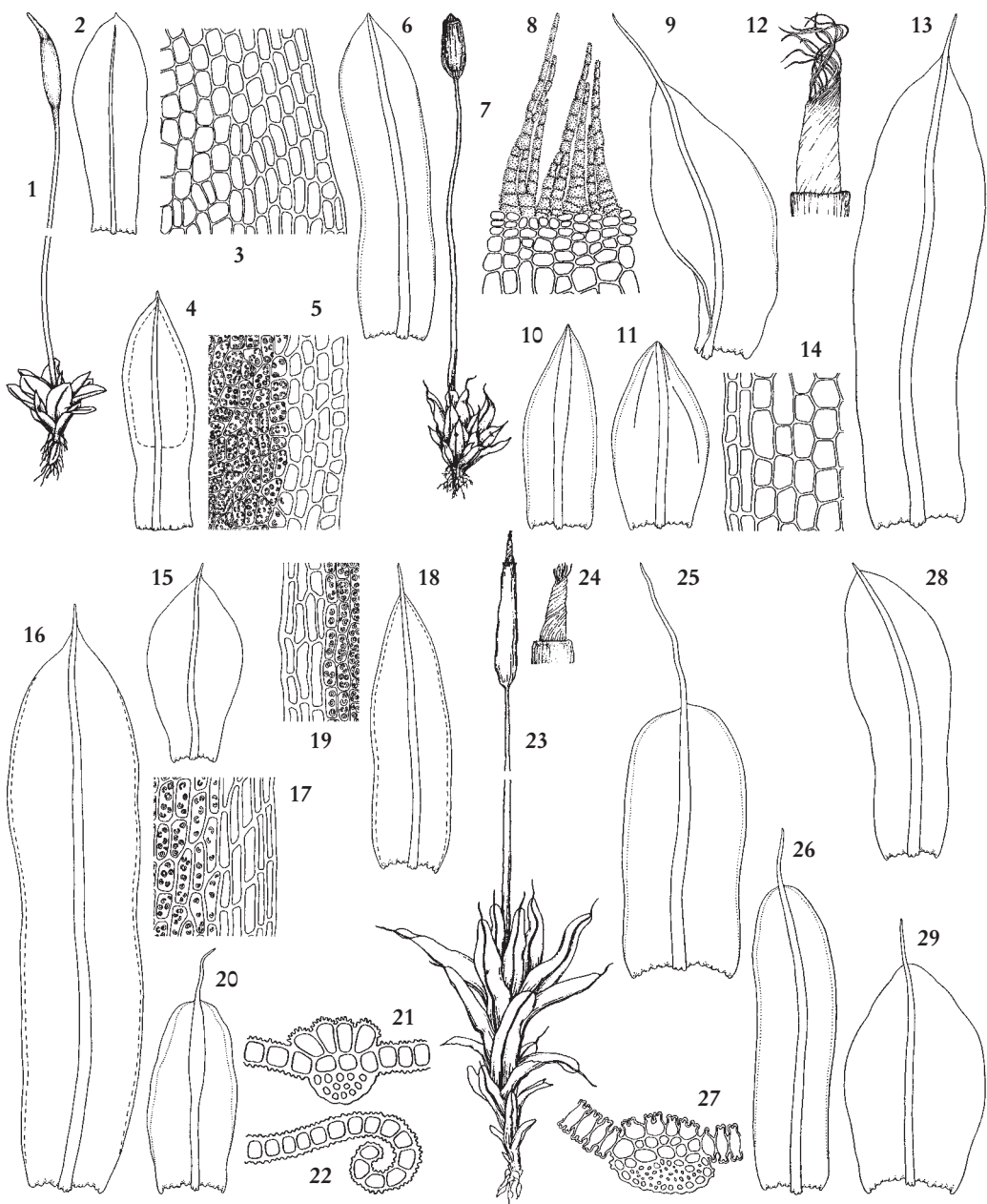


FIGURE 44. 1-3, *Tortula freibergii*: 1, habit; 2, leaf; 3, marginal cells. 4-5, *T. solmsii*: 4, leaf; 5, marginal cells. 6, *T. inermis*, leaf. 7-9, *T. hoppeana*: 7, habit; 8, peristome; 9, leaf. 10, *T. atrovirens*, leaf. 11, *T. revolvens* var. *revolvens*, leaf. 12-14, *T. mucronifolia*: 12, peristome; 13, leaf; 14, marginal cells. 15, *T. cuneifolia*, leaf. 16-17, *T. subulata* var. *subulata*: 16, leaf; 17, marginal cells. 18-19, *T. marginata*: 18, leaf; 19, marginal cells. 20-22, *T. brevissima*: 20, leaf; 21, nerve section; 22, leaf margin section. 23-25, *T. muralis*: 23, habit; 24, peristome; 25, leaf. 26-27, *T. israelis*: 26, leaf; 27, nerve section. 28, *T. vahliana*, leaf. 29, *T. canescens*, leaf. 1, 7, 23 ( $\times 5.5$ ); 2, 4, 6, 9, 10, 11, 12, 13, 15, 16, 18, 20, 24, 25, 26, 28, 29 ( $\times 16$ ); 8 ( $\times 100$ ); 3, 5, 14, 17, 19, 21, 22, 27 ( $\times 180$ ).

- 9 Leaves obovate, short; basal membrane of peristome low, hardly projecting above capsule mouth (fig. 44, 15) **T. cuneifolia** (Dicks.) Turner  
Stem to 1 cm high. Leaves curved when dry, concave, with narrow base; nerve excurrent in yellowish arista or hyaline hair-point. Peristome teeth spirally twisted. Isolated or forming loose turfs in glades in forests and on acidic slopes, in the lowlands and montane areas of the Peninsula and Menorca. Esp, Prt, Bl.
- 10 Leaves bordered 11
- 10 Leaves not distinctly bordered 14
- 11 Border of 3-4 rows of quadrate or rectangular cells (fig. 44, 4-5) **T. solmsii** (Schimp.) Limpr.  
**T. marginata** (Bruch & Schimp.) Spruce subsp. **limbata** (Lindb.) Podp.  
Plants small, less than 0,5 cm tall. Leaves lingulate or spatulate, margin plane; marginal cells smooth or slightly papillose, thick-walled, forming a border to apex. Peristome with low basal membrane, hardly projecting above capsule mouth, teeth spirally twisted. Grows on calcareous rocks and walls, near streams. Very rare, in the northwestern part of the Peninsula. Esp, Prt.
- 11 Border of 1-4 rows of narrow elongated cells 12
- 12 Leaf margin bistratose **T. schimperii** M.J. Cano, Werner & J. Guerra  
**T. subulata** Hedw. var. **angustata** (Schimp.) Kindb.  
Plants 0,5-1 cm tall. Leaves linear-lanceolate, acuminate, with a border of linear cells to near apex; margin irregularly denticulate in the upper part; laminal cells 13-20 µm, papillose; nerve excurrent in apiculus or in short arista. Peristome teeth spirally twisted. Grows on slopes and at bases of rocks and trees, in the north and northeast of the Peninsula. Esp.
- 12 Leaf margin unistratose 13
- 13 Plants 1-3 cm tall; basal membrane very high, longly projecting above capsule mouth (fig. 44, 16-17) **T. subulata** Hedw.  
Leaves oblong, gradually acuminate; laminal cells 13-20 µm long, mostly very papillose; nerve excurrent in short or elongated arista. Peristome teeth spirally twisted in 2-3 turns. A very variable species in stem and arista length, leaf form, papillae and border length. Forms dense turfs on slopes and rock ledges in high mountains and montane areas of the Peninsula, Mallorca and Menorca. Esp, Prt, And, Bl.  
var. **subulata**: Leaves with distinct border, 1/2-3/4 way up; laminal cells strongly papillose (fig. 44, 16-17).  
var. **graeffii** Warnst.: Leaves with slightly distinct border, not reaching the leaf half; laminal cells slightly papillose.
- 13 Plants 0,2-0,4 cm tall; basal membrane low, hardly projecting above mouth of capsule (fig. 44, 18-19) **T. marginata** (Bruch & Schimp.) Spruce  
**Desmatodon meridionalis** Luisier  
Leaves lanceolate to lingulate, border to apex, of 2-4 rows of narrow, pale, thick-walled marginal cells; nerve excurrent in hyaline hair-point or in arista. Peristome teeth divided to base, spirally twisted. Grows on shady, calcareous walls and rocks of the lowlands in the Peninsula, Mallorca, Menorca and Pithyusic Islands. Esp, Prt, Bl.

- 14 Nerve widened above, with high, papillose cells on ventral side (fig. 44, 20-22) **T. brevissima** Schiffn.  
Stem 0,2-0,5 cm high, often earth covered in such a way that only the leaf hair-points protrude. Leaves ovate, strongly concave, margin strongly revolute above; laminal cells very papillose. Peristome with low basal membrane, teeth filiform, twisted. Forms small turfs on ledges and bare patches on very arid, calcareous, rich-clay soils of the Peninsula. Esp.
- 14 Nerve not widened above, without high papillose cells on ventral side 15
- 15 Leaf margin recurved from base to apex 16
- 15 Leaf margin plane at apex 17
- 16 Laminal cells with low papillae; very common species (fig. 44, 23-25) **T. muralis** Hedw.  
Plants small, rarely more than 1 cm tall. Leaves twisted when dry, lingulate or lingulate-spathulate, apex obtuse or rounded, often emarginate; marginal cells less papillose than the rest of laminal cells, yellowish, forming a border of 1-2 rows of cells; nerve excurrent in smooth, long hyaline hair-point. Peristome teeth spirally twisted in 2-3 turns, basal membrane low. Species very polymorphic: based on lamina form, hair-point length and plant size, different varieties have been described. Forms small, greyish cushions on calcareous rocks and walls, in the lowlands and montane areas of the Peninsula, Mallorca, Menorca and Pithyusic Islands. Esp, Prt, And, Bl.
- 16 Laminal cells with high, conical papillae; uncommon species (fig. 44, 26-27) **T. israelis** Bizot & F. Bilewsky  
**T. muralis** Hedw. var. **baetica** Casas & R. Oliva  
Similar to *T. muralis* in habit. Upper cells of nerve with conical, very high papillae on ventral side. Forms glaucous cushions on calcareous rocks and walls in the lowlands of the Mediterranean region. Esp, Prt.
- 17 Peristome teeth long, spirally twisted 18
- 17 Peristome teeth short, straight or slightly curved 19
- 18 Capsule longly cylindrical; peristome with low basal membrane, hardly projecting above capsule mouth (fig. 44, 28) **T. vahliana** (Schultz) Mont.  
Plants to 0,5 cm tall. Leaves twisted when dry, narrow, spathulate or lingulate, margin plane or slightly recurved to the middle; marginal cells less papillose than the rest of laminal cells, forming a slightly distinct border; nerve excurrent in short, yellowish arista. Peristome teeth divided nearly to base, spirally twisted. Forms small turfs on dry, calcareous soils, in the lowlands of the Peninsula and Mallorca and Pithyusic Islands. Esp, Prt, Bl.
- 18 Capsule shortly cylindrical; peristome with high basal membrane, longly projected above capsule mouth (fig. 44, 29) **T. canescens** Mont.  
Plants 0,2-0,5 cm tall. Leaves broad, elliptical-lanceolate or ovate-lanceolate, margin slightly recurved, frequently plane above; nerve excurrent in long hyaline hair-point; laminal cells 10-18 µm wide. Peristome teeth spirally twisted. Similar to *T. muralis* but with shorter and broader leaves and less recurved margin. Forms small turfs on exposed, clayey ledges in the lowlands and montane areas of the Peninsula. Esp, Prt.

- 19 Lid cells in straight rows; high mountain plants (fig. 44, 7-9)

**T. hoppeana** (Schultz) Ochyra

**T. eucalyptrata** Lindb., **Desmatodon latifolius** (Hedw.) Brid.

Plants to 2 cm tall. Leaves oblong-lanceolate, acute or obtuse; laminal cells quadrate or rounded, papillose, basal cells larger, hyaline; nerve percurrent or excurrent in smooth, long hyaline hair-point. Capsule ovoid to cylindrical; peristome with very short basal membrane, teeth straight, filiform, irregularly divided, perforated. Forms dense turfs in grasslands of acidic, high mountain areas of the Peninsula. Esp, And.

- 19 Lid cells in helicoidal rows; lowland plants **T. guepinii** (Bruch & Schimp.) Broth.

**Desmatodon guepinii** Bruch & Schimp.

Plants to 0,5 cm tall. Leaves oblong or oblong-lanceolate; nerve excurrent in hair-point. Capsule ovoid-cylindrical; peristome teeth slightly spirally twisted, basal membrane low, hardly projecting above mouth of capsule. Grows on exposed, acidic soils of the south and central part of Peninsula. Esp, Prt.

### **Trichostomum** Bruch

Plants 0,5-2 cm tall. Leaves erecto-patent, linear-lanceolate to lingulate, acute or obtuse, crisped when dry, margin plane or incurved, entire or crenulate; median cells rounded or hexagonal, papillose, obscure, basal cells rectangular, hyaline; nerve stout, excurrent in mucro or in apiculus or percurrent, with quadrate or rounded on ventral side and dorsal and ventral stereid bands. Seta yellow; capsule ellipsoidal or cylindrical, straight; lid rostrate; peristome teeth straight, irregularly divided, perforated or entire.

- 1 Plants to 0,5 cm tall; leaf margin incurved; leaves not cucullate or slightly so (fig. 45, 1-2)

**T. triumphans** De Not.

**T. pallidisetum** H. Müll., **Weissia triumphans** (De Not.) M.O. Hill

Leaves erecto-patent; nerve excurrent in mucro. Perichaetial leaves similar to stem leaves lanceolate with sheathing base. Peristome long, with  $\pm$  divided teeth. Forms dense turfs on exposed, calcareous, often gypsum soils in the lowlands. Widespread throughout the Peninsula and in Mallorca. Esp, Prt, Bl.

- 1 Plants more than 0,5 cm tall; leaf margin plane or only slightly incurved in the upper part; leaves cucullate or not 2

- 2 Leaves cucullate (fig. 45, 3-4)

**T. crispulum** Bruch

Laminal cells 6-9  $\mu$ m wide; nerve excurrent in mucro or ending near apex. Seta reddish at base; spores 12-17  $\mu$ m. Forms compact, yellowish green turfs on exposed, calcareous soils and rocks in the lowlands and montane areas. Widespread throughout the Peninsula and in Mallorca, Menorca and Pityusic Islands. Esp, Prt, And, Bl.

- 2 Leaves not cucullate (fig. 20, 5-8)

3

- 3 Leaf margin entire; leaves not sinuose or undulate; nerve excurrent in stout apiculus (fig. 45, 5-8)

**T. brachydontium** Bruch

Leaf margin plane; laminal cells 8-10  $\mu$ m wide. Seta yellowish; spores 15-20  $\mu$ m. Forms compact, light green turfs, brownish below, on dry rocks and soils. Widespread in the lowlands

and montane areas throughout the Peninsula and in Mallorca, Menorca and Pithyusic Islands. Esp, Prt, Bl.

Species very polymorphic in width and length of leaves and shape of peristome.

var. **brachydontium**: Leaves not cuspidate, margin entire (fig. 45, 5-8).

var. **littorale** (Mitt.) C.O.E. Jensen: Leaves with denticulate margin at base. Quite frequent.

var. **cuspidatum** (Braithw.) Sav.: Leaves cuspidate.

- 3 Leaf margin crenulate and notched; leaves sinuose and undulate; nerve percurrent or excurrent in apiculus (fig. 45, 9-10) **T. tenuirostre** (Hook. & Taylor) Lindb.

\* **Oxystegus tenuirostris** (Hook. & Taylor) A.J.E. Sm.

Leaves linear-lanceolate, curled when dry, margin plane; laminal cells quadrate or rounded, 8-10  $\mu\text{m}$ , papillose, basal cells rectangular, smooth, apical cells translucent; nerve with long ventral cells in the upper half. Vegetative propagation frequent, by means of leaf apex fragmentation. Capsule cylindrical, straight; peristome teeth red, irregularly perforated or divided, basal membrane lacking. Forms loose turfs, light green above, on wet rocks and soils in montane areas. Scattered in the Peninsula. Esp, Prt.

### **Triquetrella** Müll.Hal.

Plants 2-4 cm tall, with thin, yellowish green branches. Stem leaves closely arranged, tristichous, erecto-patent, appressed when dry, ovate-lanceolate, acuminate, acumen keeled, margin entire, revolute; median cells rounded polygonal, 6-8  $\mu\text{m}$  wide, with 1 papilla on each side of cell to 12  $\mu\text{m}$  high, simple or forked; nerve evanescent. Axillary, easily detached propaguliferous buds present (fig. 45, 11-13) **T. arapilensis** Luisier

Forms loose patches on dry sandy soils among acidic rocks. Common in the western half of the Peninsula, rarer in the central part. Esp, Prt.

### **Weissia** Hedw.

Plants small. Leaves lanceolate to linear, crisped when dry, margin entire, incurved or plane; upper cells of lamina isodiametric, small, papillose, basal cells rectangular, hyaline; nerve excurrent. Seta long; capsule ovoid to cylindrical; lid rostrate; peristome with 16 short, straight, usually perforated teeth, or rudimentary or lacking, when peristome lacking often epiphragm present.

- |   |  |   |
|---|--|---|
| 1 | Peristome lacking  | 2 |
| 1 | Peristome more or less well developed or rudimentary   | 4 |
| 2 | Nerve more than 60 $\mu\text{m}$ wide near base; spores up to 18 $\mu\text{m}$ (fig. 45, 14) |   |

**W. condensa** (Voit) Lindb.

**W. tortilis** (Schwägr.) Müll.Hal.

var. **condensa**: Plants to 1,5 cm tall. Leaves patent, margin strongly incurved; upper cells of lamina with papillae to 5  $\mu\text{m}$  high; nerve glossy at back. Forms dense turfs on dry, calcareous soils in the lowlands, in the eastern half and the south of the Peninsula and in Mallorca, Menorca and Pithyusic Islands. Esp, Prt, Bl (fig. 45, 14).

var. **armata** (Thér. & Trab.) M.J. Cano, Ros & J. Guerra (*W. papillosissima* Laz.): Plants to 0,5 cm tall. Leaves patent, margin slightly incurved; upper cells of lamina with papillae 8-10  $\mu\text{m}$

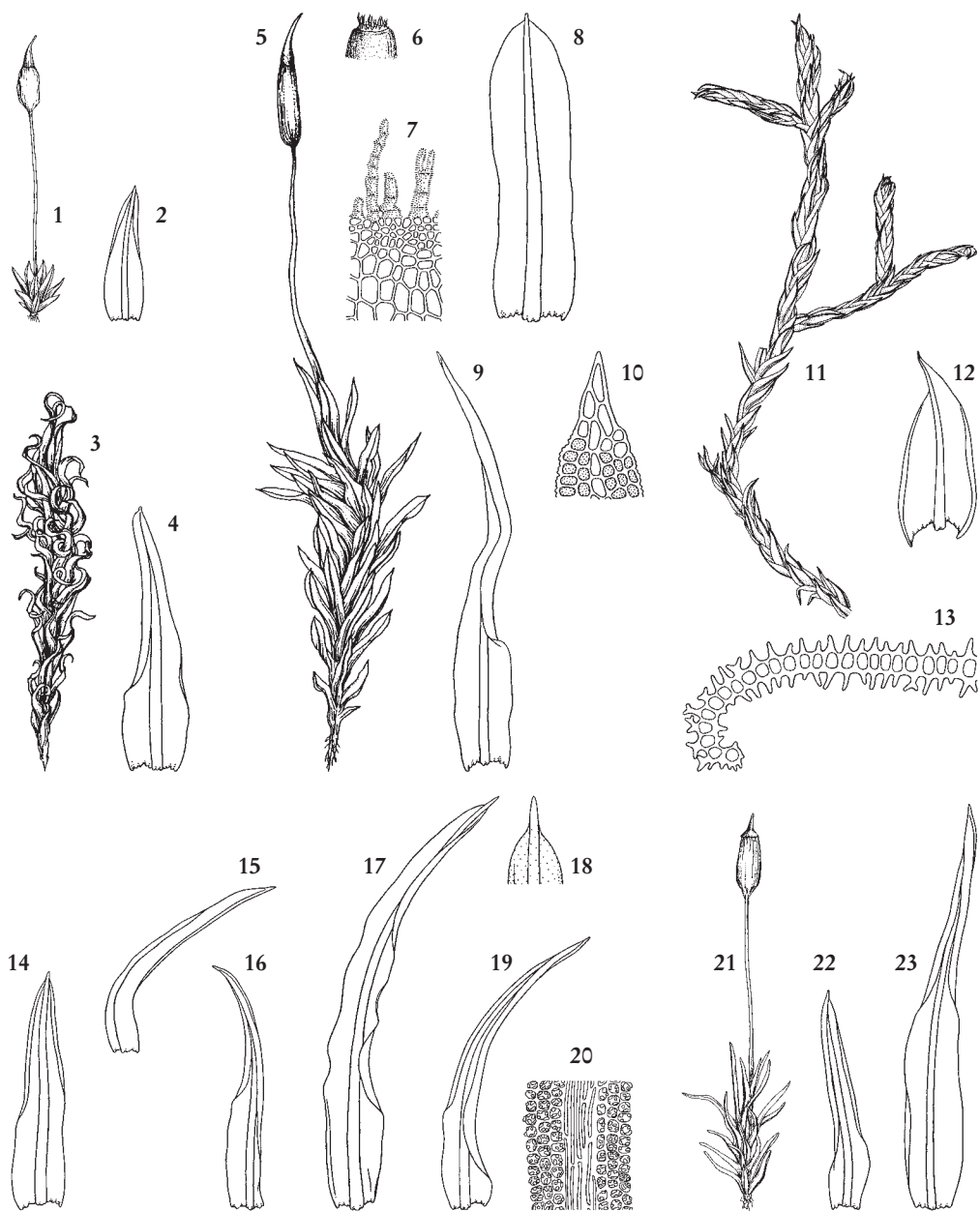


FIGURE 45. 1-2, *Trichostomum triumphans*: 1, habit; 2, leaf. 3-4, *T. crispulum*: 3, habit when dry; 4, leaf. 5-8, *T. brachydontium* var. *brachydontium*: 5, habit; 6, upper part of capsule; 7, peristome; 8, leaf. 9-10, *T. tenuirostre*: 9, leaf; 10, leaf apex. 11-13, *Triquetrella arapilensis*: 11, habit when dry; 12, leaf on dorsal side; 13, leaf margin section. 14, *Weissia condensata* var. *condensata*, leaf. 15, *W. squarrosa*, leaf. 16, *W. brachycarpa*, leaf. 17-18, *W. rutilans*: 17, perichaetial leaf; 18, leaf apex. 19-20, *W. perssonii*: 19, leaf; 20, median cells. 21-23, *W. controversa* var. *controversa*: 21, habit; 22, leaf; 23, perichaetial leaf. 1, 3, 5, 11, 21 ( $\times 6$ ); 2, 4, 6, 8, 9, 12, 14, 15, 16, 17, 19, 22, 23 ( $\times 18$ ); 18 ( $\times 60$ ); 7 ( $\times 100$ ); 10, 13, 20 ( $\times 200$ ).



high. Grows on arid, calcareous, often gypsum soils, mainly on coastal areas in the east and south of the Peninsula, rare inland and in Mallorca. Esp, Prt, Bl.

- 2 Nerve to 60  $\mu$ m wide near base; spores more than 18  $\mu$ m 3

- 3 Leaves spreading to squarrose, margin plane or partially and narrowly incurved in the upper part (fig. 45, 15) **W. squarrosa** (Nees & Hornsch.) Müll.Hal.

Plants about 0,5 cm tall, with the old part prostrate, with innovations from below perichaetium. Perichaetial leaves longer than stem leaves. Capsule cylindrical, with fragile walls. Grows on exposed, acidic soils. Very rare, in the northeastern part of the Peninsula and in Menorca. Esp, Bl.

- 3 Leaves erecto-patent, margin often incurved (fig. 45, 16) **W. brachycarpa** (Nees & Hornsch.) Jur.

**Hymenostomum microstomum** (Hedw.) R.Br. ex Nees & Hornsch.

Plants to 1,5 cm tall. Perichaetial and upper leaves much longer than lower leaves. Perichaetial leaves mostly exceeding the capsule base. Seta variable in length; capsule ovoid to cylindrical. Grows on dry, calcareous soils from the lowlands to high mountains. Widespread throughout the Peninsula and in Mallorca and Menorca. Esp, Prt, Bl.

- 4 Margin plane (fig. 45, 17-18) **W. rutilans** (Hedw.) Lindb.

Plants to 1 cm tall. Leaves erecto-patent, lanceolate; nerve stout, excurrent in long apiculus. Perichaetial leaves linear, longer than stem leaves. Seta yellow; capsule slightly striate; peristome to 90  $\mu$ m long, often caducous. Grows on wet, shady soils in the lowlands and montane areas. Scattered in the northern half of the Peninsula and in Menorca. Esp, Bl.

- 4 Margin strongly incurved 5

- 5 Ventral cells of nerve elongated and smooth (fig. 45, 19-20) **W. perssonii** Kindb.

Plants to 0,5 cm tall. Perichaetial leaves longer and narrower than stem leaves. Capsule ovoid to ellipsoidal, constricted at mouth. Rare, near coast in the northwest of the Peninsula. Esp. May be confused with *W. controversa*, which can have some elongated cells on ventral side of nerve, but in *W. perssonii* all cells on ventral side of nerve are elongated.

- 5 Ventral cells of nerve usually quadrate and papillose 6

- 6 Plants autoicous (fig. 45, 21-23) **W. controversa** Hedw.

Plants to 1 cm tall. Leaves patent to spreading, narrowly lanceolate or linear. Perichaetial leaves longer and narrower than stem leaves. Grows on wet,  $\pm$  shaded soils and in usually acidic rock crevices from the lowlands to montane areas. Widespread throughout the Peninsula and in Mallorca and Menorca. Esp, Prt, And, Bl.

var. **controversa**: Leaves with nerve 30-60  $\mu$ m wide at base, greenish. Peristome well developed (fig. 45, 21-23).

var. **crispata** (Nees & Hornsch.) Nyholm (*W. fallax* Sehm.): Leaves with nerve more than 60  $\mu$ m wide at base, brownish. Peristome rudimentary.

- 6 Plants paroicous **W. wimmeriana** (Sendtn.) Bruch & Schimp.

**W. controversa** (Sendtn.) Bruch & Schimp. var. **wimmeriana** (Sendtn.) Blockeel & A.J.E. Sm. Plants to 0,5 cm tall. Leaves patent, lanceolate, subulate. Peristome with short teeth. Forms dense turfs in rock crevices in high mountains of the Pyrenees and Sierra Nevada. Esp.



## **O. Splachnales** **Fam. Splachnaceae**

### **Splachnum Hedw.**

Stem to 2 cm high. Leaves ovate-lanceolate, longly acuminate, margin sharply toothed from apex to middle of leaf; laminal cells hexagonal or rhomboidal, more than 25  $\mu\text{m}$  wide; nerve ending in apex. Seta straight, long; urn shortly cylindrical with pyriform apophysis, much wider than the urn, rugose when dry; columella emergent in mature capsules; peristome teeth 16, in pairs (fig. 46, 1-2) **S. ampullaceum Hedw.**

Light green turfs on dung in damp habits and peaty grasslands, in mountains of the north of the Peninsula. Esp.

### **Tayloria Hook.**

Stem to 2 cm high, with purple rhizoids below. Leaves crowded at the stem tip, obovate-spathulate; laminal cells hexagonal, more than 20  $\mu\text{m}$  wide. Capsule cylindrical, erect or slightly inclined, symmetrical, brownish red, neck as long as urn, gradually tapered towards seta; seta straight, long, flexuose; peristome teeth reflexed when dry and columella emergent or not in mature capsule.

- 1 Leaves with acuminate, reflexed apex, margin dentate; spores about 12  $\mu\text{m}$ , pale yellow, smooth (fig. 46, 3-4) **T. tenuis (Dicks.) Schimp.**

**T. serrata (Hedw.) Bruch & Schimp. var. tenuis (Dicks.) Bruch & Schimp.**

Forms loose turfs on rotten stumps and herbivore dung, in permanently wet sites, in the high mountains of the Pyrenees. Esp.

- 1 Leaves with obtuse apex, margin entire; spores 30-40  $\mu\text{m}$ , dark brown, papillose (fig. 46, 5) **T. froelichiana (Hedw.) Mitt. ex Broth.**

Very rare, grows on humus-rich soils in the high mountains of the Pyrenees. Esp.

## **Fam. Meesiaceae**

### **Amblyodon P. Beauv.**

Stem about 1 cm high. Leaves oblong-lanceolate, acute, margin entire or denticulate near apex; upper laminal cells longly hexagonal, 15-30  $\mu\text{m}$  wide, smooth; nerve percurrent, stout, occupying, at least 1/2 of leaf base width. Seta straight; capsule pyriform, curved, asymmetrical, inclined to horizontal, neck shorter than urn; peristome double, exostome shorter than endostome, basal membrane short and without cilia; spores 40  $\mu\text{m}$  (fig. 46, 6-8)

**A. dealbatus (Hedw.) P. Beauv.**

Plants isolated or forming very loose, light green or yellowish turfs on flushed or peaty soils, in high mountains of the Pyrenees and Sierra Nevada. Esp.

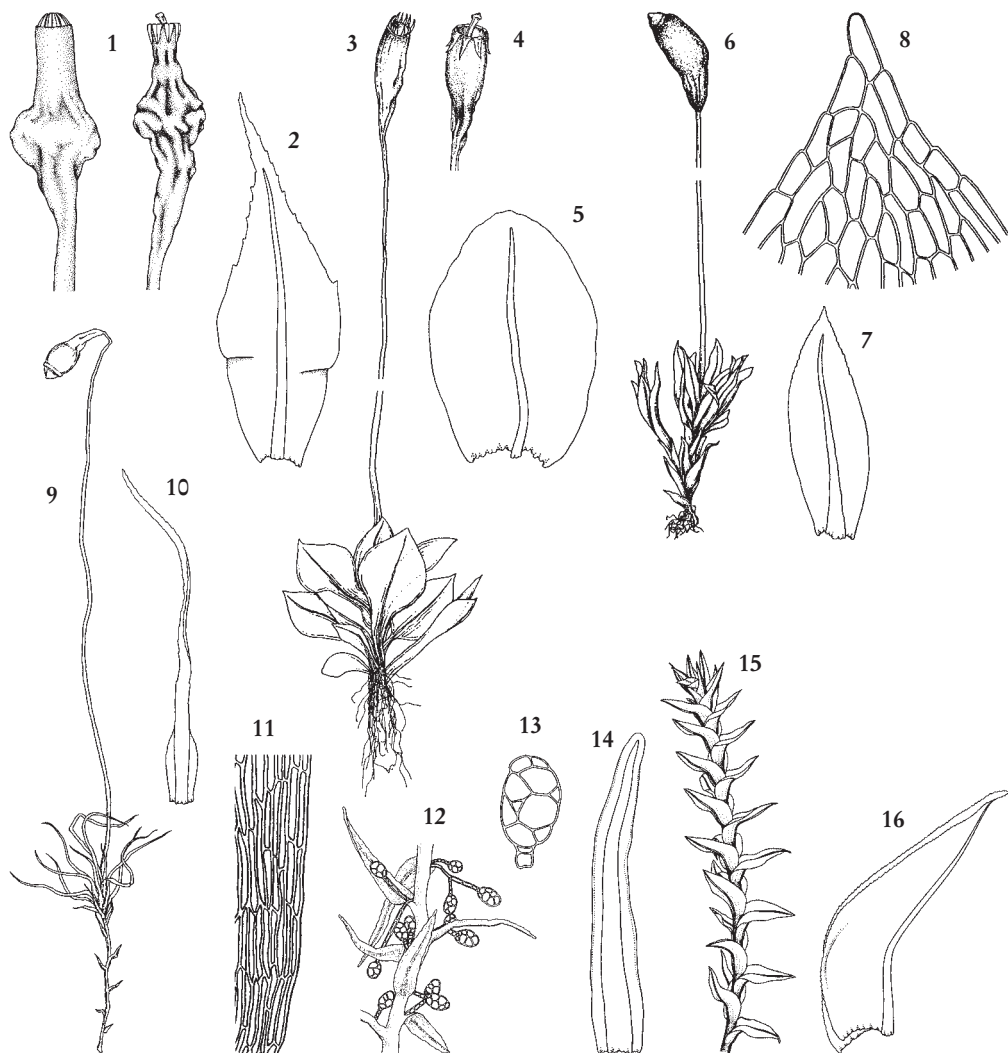


FIGURE 46. 1-2, *Splachnum ampullaceum*: 1, capsules when moist and when dry; 2, leaf. 3-4, *Tayloria tenuis*: 3, habit; 4, capsule when dry. 5, *T. froehlichiana*, leaf. 6-8, *Amblyodon dealbatus*: 6, habit; 7, leaf; 8, leaf apex. 9-13, *Leptobryum pyriforme*: 9, habit; 10, upper leaf; 11, laminal cells; 12, axillary gemmae; 13, gemma. 14, *Meesia uliginosa*, leaf. 15-16, *Meesia triquetra*: 15, habit; 16, leaf. 3, 6, 15 ( $\times 4.5$ ); 9 ( $\times 5$ ); 1, 4 ( $\times 8$ ); 2, 5, 7, 10, 14, 16 ( $\times 16$ ); 12 ( $\times 20$ ); 13 ( $\times 80$ ); 8, 11 ( $\times 140$ ).

**Leptobryum** (Bruch & Schimp.) Wilson

Stem to 2 cm high. Leaves long, narrow, linear, flexuose, dentate at apex; laminal cells 8-10 times as long as wide; nerve occupying 1/3 width of leaf base. Rhizoids mostly with pyriform, brown gemmae. Capsule pyriform, inclined or pendulous, neck as long as urn (fig. 46, 9-13)

**L. pyriforme** (Hedw.) Wilson

Forms loose, pale green turfs on wet soils, especially in nitrophilous sites (greenhouses and commercial flower fields). Scattered in the northern and eastern part of the Peninsula. Esp, Prt.

**Meesia** Hedw.

Plants small to large. Leaves erect or squarrose, ovate-lanceolate or lingulate, apex obtuse or acute, margin entire or dentate; laminal cells shortly rectangular, 10-15 µm wide, smooth; nerve stout, ending near apex. Capsule pyriform, asymmetrical, curved, neck as long as urn; peristome double, exostome shorter than endostome, the latter with short basal membrane and rudimentary cilia.

- 1 Leaves erect, lingulate; nerve occupying 1/2-3/4 of leaf base width (fig. 46, 14)

**M. uliginosa** Hedw.

Stem 1-2 cm high. Leaves with rounded apex, margin entire; laminal cells narrowly rectangular, smooth, 9-14 µm wide, basal cells longer. Forms light green turfs on wet soils, in high mountains, in the Pyrenees. Esp.

- 1 Leaves squarrose from an erect base, ovate-lanceolate; nerve occupying less than 1/3 of leaf base width (fig. 46, 15-16)

**M. triquetra** (L. ex Jolycl.) Ångstr.

Stem 3-10 cm high. Leaves tristichous, with sheathing base, keeled above, with acute apex, margin plane, totally dentate. Grows on peaty soils. Rare, in the Pyrenees and the Spanish Central Range. Esp.

## **O. Orthotrichales**

### **Fam. Orthotrichaceae**

**Orthotrichum** Hedw.

Plants small or medium-sized forming tufts or cushions. Stem mostly branched. Leaves erect or imbricate, sometimes twisted when dry, lanceolate, apex acute to obtuse, margin recurved, rarely plane or incurved; upper cells rounded, papillose, basal cells enlarged, smooth; nerve ending near apex. Gemmae frequent on both sides of leaf, filamentous or fusiform. Seta short or long, vaginula glabrous or hairy; capsule immersed, emergent or exerted, stomata superficial or immersed; peristome double or single, teeth occasionally in pairs; calyptra campanulate or cucullate, glabrous or hairy. Autoicous or dioicous.

- |   |                               |   |
|---|-------------------------------|---|
| 1 | Leaves with hyaline apices    | 2 |
| 1 | Leaves without hyaline apices | 3 |

- 2 Leaves with long hyaline apices (fig. 47, 1-2) **O. diaphanum** Schrad. ex Brid.  
Plants up to 1 cm tall, dark green, grey green or brownish. Upper cells of leaf loose, bulging, 10-16  $\mu\text{m}$ , thin-walled. Capsule emergent, pale yellowish, smooth or slightly sulcate, stomata immersed; peristome teeth recurved when dry. Gemmae frequent, fusiform, colourless. Forms tufts or cushions, epiphytic or more often on rocks. Widespread and frequent in the lowlands and montane areas of the peninsular Mediterranean region and in Mallorca, Menorca and Pityusic Islands, rarer in the northwestern part of the Peninsula. Esp, Prt, Bl.
- 2 Leaves with short hyaline apices, often hardly visible (fig. 47, 3) **O. vittii** F. Lara, Garilleti & Mazimpaka  
Plants small 0,3-0,7(1,0) cm tall, olive green. Leaves keeled, apex plane, dentate, acumen fragile; upper cells of leaf firm, not bulging, thick-walled. Capsule emergent, yellowish with well-marked ribs, orange-ribbed, stomata immersed; exostome orange, reflexed when dry, endostome segments yellowish and frequently appendiculate, joining adjacent segments. Forms small cushions or turfs, epiphytic, preferring *Juniperus thurifera* L. in continental environments of the northern half of the Peninsula, rare in the south. Esp.
- 3 Leaves with rounded apices 4
- 3 Leaves with acute, obtuse or apiculate apices 7
- 4 Leaf margin plane or incurved at the middle (fig. 47, 4-5) **O. obtusifolium** Brid.  
Plants small, to 0,5 cm tall, dark green. Leaves imbricate, elliptical, concave; upper laminal cells isodiametric, 10-14  $\mu\text{m}$  wide, with 1 papilla on each side. Gemmae scattered over surface of leaves, shortly fusiform, 2-5(6) celled, rarely long and branched, reddish to brownish. Capsule emergent, attenuate at base, with superficial stomata; exostome teeth recurved. Dioicous. Forms compact, yellowish-green turfs, corticolous on deciduous trees. Widespread and frequent in montane areas of the central Peninsula, rarer in the east. Esp, And.
- 4 Leaf margin revolute, plane near apex 5
- 5 Leaves concave, carinate, with cucullate apex; xerophilous plants (fig. 47, 6-7) **O. macrocephalum** F. Lara, Garilleti & Mazimpaka  
Plants to 0,6 cm tall. Leaves imbricate, lingulate or lanceolate-lingulate; upper laminal cells 14-19 x 9-12  $\mu\text{m}$ , rounded to elliptical. Gemmae on both sides of leaf, filamentous, usually more than 5 cells, brown. Capsule emergent, sharply contracted at seta, with immersed stomata. Autoicous. Forms compact cushions, epiphyte in montane areas in the central and eastern part of the Peninsula, often in man-made environments. Esp.
- 5 Leaves plane, with flat apex; hydrophilous plants 6
- 6 Plants 0,5-1 cm tall; upper cells of leaf 16-20  $\mu\text{m}$  wide, smooth; leaf apex entire or 1-cell apiculate (fig. 47, 8) **O. sprucei** Mont.  
Leaves lingulate to lanceolate; nerve weak. Capsule annulus of 2 rows of cells. Grows at base of riparian trees. Scattered localities in the northern half of the Peninsula. Esp, Prt.
- 6 Plants 1-3 cm tall; upper cells of leaf 10-14  $\mu\text{m}$  wide, with 1-3 small conical papillae; leaf apex irregularly dentate (fig. 47, 9-10) **O. rivulare** Turner

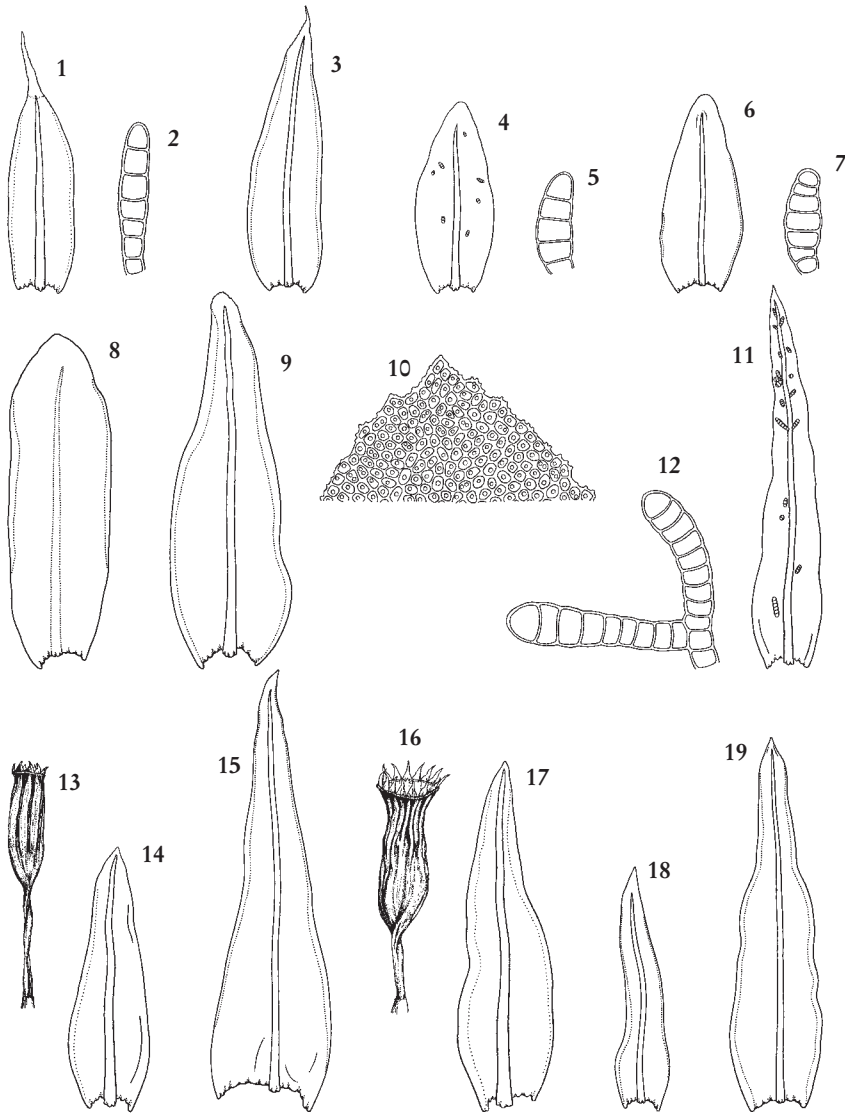


FIGURE 47. 1-2, *Orthotrichum diaphanum*: 1, leaf; 2, gemma. 3, *O. vittii*, leaf. 4-5, *O. obtusifolium*: 4, leaf; 5, gemma. 6-7, *O. macrocephalum*: 6, leaf; 7, gemma. 8, *O. sprucei*, leaf. 9-10, *O. rivulare*: 9, leaf; 10, leaf apex. 11-12, *O. lyellii*: 11, leaf; 12, gemma. 13-14, *O. anomalum*: 13, capsule when dry; 14, leaf. 15, *O. urnigerum*, leaf. 16-17, *O. cupulatum* var. *cupulatum*: 16, capsule when dry; 17, leaf. 18, *O. pulchellum*, leaf. 19, *O. consimile*, leaf. 13, 16 ( $\times 10$ ); 1, 3, 4, 6, 8, 9, 11, 14, 15, 17, 18, 19 ( $\times 16$ ); 2, 5, 7, 12 ( $\times 140$ ); 10 ( $\times 160$ ).

Leaves ovate-lanceolate to oblong-lingulate; nerve stout. Capsule annulus of 4-5 rows of small cells. Forms cushions or short tufts on tree roots and tree bases, occasionally on rocks near streams, in montane areas of the northern half of the Peninsula. Esp, Prt.

- 7 Leaves with acute apex, margin plane; gemmae abundant; dioicous, mostly sterile (fig. 47, 11-12) **O. lyellii** Hook. & Taylor  
Plants large, 3-4 cm tall, dark green, with powdery appearance due to the abundant gemmae on leaves. Leaves narrowly lanceolate. Gemmae filamentous, branched or not, brownish. Capsule immersed. Epiphyte, forming loose tufts in montane areas. Widespread throughout Peninsula and in Mallorca. Esp, Prt, Bl.
- 7 Leaves with obtuse or acute apex, margin recurved; with or without gemmae; autoicous, mostly fertile 8
- 8 Stomata immersed (fig. 48, 10) 9
- 8 Stomata superficial (fig. 48, 30) 29
- 9 Exostome teeth straight or spreading when dry; mostly saxicolous plants 10
- 9 Exostome teeth recurved or reflexed when dry; mostly epiphytic plants 12
- 10 Capsule exserted (fig. 47, 13-14) **O. anomalum** Hedw.  
Plants to 1 cm tall. Leaves ovate-lanceolate, apex acute or obtuse. Seta orange, about 2 mm long, vaginula glabrous or slightly hairy; capsule cylindrical, constricted at base, with 8 long sulci alternating with 8 shorter ones; peristome single, transversely striate at base and longitudinally striate in the upper part of teeth; calyptra hairy. Forms dark green to brownish tufts on calcareous rocks, usually in montane areas. Widespread in the Peninsula and in Mallorca. Esp, Prt, And, Bl.
- 10 Capsule immersed or emergent 11
- 11 Stem with reddish tomentum; vaginula strongly hairy (fig. 47, 15) **O. urnigerum** Myrin  
Plants to 2 cm tall. Leaves lanceolate, acute. Capsules short cylindrical to ovoid, laterally emergent; exostome teeth strongly papillose, endostome of 8 or 16 smooth or striate segments. Forms loose, green to brownish green turfs in shaded places on acidic rocks. Scattered localities in the centre and south of the Peninsula. Esp, Prt.
- 11 Stem without reddish tomentum; vaginula glabrous or with few, short hairs (fig. 47, 16-17) **O. cupulatum** Hoffm. ex Brid.  
Plants 1-2 cm tall. Leaves ovate-lanceolate to oblong-lanceolate, apex acute or obtuse, margin recurved; lamina unistratose, bistratose or partially bistratose, cells pluripapillose. Seta pale green, brownish when old; capsule straight, ovoid or ellipsoidal, immersed to emergent, abruptly or gradually narrowed at base; endostome often missing or rudimentary; calyptra cucullate, with few plicae and several hairs; spores 12-16 µm. Forms dense, dark green or blackish brown tufts on exposed, basic rocks, rarely epiphytic, in montane areas. Esp, Prt, Bl. The papillosity of the laminal cells and the shape of the capsule neck are very variable characters. var. **cupulatum**: Exostome teeth papillose, striate, endostome lacking or of short and hyaline segments. Widespread in the Peninsula and Mallorca (fig. 47, 16-17).

var. **riparium** Huebener: Capsule longly emergent; endostome well developed; calyptra glabrous. Grows on calcareous rocks by streams and rivers. Scattered localities in the north of the Peninsula and in Mallorca.

var. **bistratosum** Schiffn.: Plants blackish. Leaves bistratose in the upper part, margin plane. Exostome nearly smooth. Grows on basic rocks, in montane areas of the eastern half of the Peninsula.

- 12 Capsule exserted 13
- 12 Capsule immersed to emergent 14
- 13 Exostome teeth 16, orange-red, irregularly papillose-reticulate; stomata only on the upper half of capsule (fig. 47, 18) **O. pulchellum** Brunt.  
Plants to 1 cm tall. Leaves crisped and flexuose when dry, lanceolate to ovate-lanceolate. Capsule shortly exserted, pale yellow; endostome red-orange; calyptra campanulate, slightly plicate, with obscure longitudinal bands not covering the capsule base. Epiphyte in humid forest and riparian formations in oceanic mountainous areas. Scattered in the north of the Peninsula. Esp.
- 13 Exostome teeth 8, yellow to whitish-yellow, finely papillose on the outside; stomata on the lower half of the capsule (fig. 47, 19) **O. consimile** Mitt.  
Plants (0,4) 0,8-1 cm tall. Leaves appressed to slightly flexuose and contorted when dry. Capsule longly exserted; endostome segments connecting membranes uniting at the base; calyptra oblong-conical,  $\pm$  plicate, covering the whole capsule. Epiphyte in deciduous woods, in the north and northwestern part of the Peninsula. Esp, Prt.
- 14 Vaginula hairy 15
- 14 Vaginula glabrous or sparsely hairy 18
- 15 Calyptra glabrous; vaginula with short hairs (fig. 48, 1) **O. stellatum** Brid.  
Leaves lanceolate to oblong-lanceolate, bluntly acute or acute, apex entire; upper cells of leaf about 12  $\mu$ m wide. Capsule obovoid, in upper half with 8 orange, 4 cells wide striae, furrowed and constricted below mouth when dry, stomata in the lower part; spores 14-18  $\mu$ m. Forms yellow green to brown, small turfs on trees in the north of the Peninsula. Rare. Esp.
- 15 Calyptra and vaginula with numerous long hairs 16
- 16 Calyptra not dark-tipped; exostome papillose, striate in upper part **O. alpestre** Bruch & Schimp.  
Upper cells of leaf 10-14  $\mu$ m wide, with high and often branched papillae. Endostome smooth, with thickened and coloured transverse walls; calyptra papillose, with papillose hairs. Forms dense, glaucous to dark green tufts on rocks and at tree bases, in montane areas and high mountains. Scattered in the north and the eastern half of the Peninsula. Esp, And.  
Can be confused with *O. stramineum*.
- 16 Calyptra dark-tipped; exostome finely papillose 17
- 17 Capsule constricted below mouth when dry, longly attenuated at base, with ribs of up to 4 rows of differentiated, yellowish to orange cells (fig. 48, 2-3) **O. stramineum** Hornsch. ex Brid.  
**O. gergeri** Brid. var. **defluens** (Venturi) Venturi

Plants small, green to yellowish green. Leaves acute, margin recurved; upper cells 9-10  $\mu\text{m}$  wide, with short and simple papillae. Capsule ellipsoidal, with 8 complete striae; exostome teeth orange; spores 12-14  $\mu\text{m}$ ; calyptra with few, smooth hairs. Epiphyte, forming tufts. Widespread in forests of the northern half of the Peninsula and in Mallorca. Esp, Prt, Bl.

- 17 Capsule not constricted below mouth when dry, abruptly tapered at base, with ribs of 2 rows of differentiated, yellowish to orange cells **O. patens** Bruch ex Brid.

Plants small. Capsule cylindrical, sometimes with 1-2 additional rows of narrower cells in the upper part. Epiphyte, forming tufts. Rare, scattered in the north of the Peninsula. Esp  
Can be confused with *O. stramineum*.

- 18 Endostome with 16 long segments 19

- 18 Endostome with 8 long segments or alternating with 8 short or rudimentary segments 21

- 19 Endostome with appendiculate segments, often interconnected (fig. 47, 3)

**O. vittii** F. Lara, Garilleti & Mazimpaka

Plants small 0,3-0,7(1,0) cm tall, olive green. Leaves keeled, with short hyaline apices, often inconspicuous, acumen fragile, margin dentate; upper cells of leaf firm, not bulging, thick-walled. Capsule emergent, yellowish with well-marked orange ribs, stomata immersed; exostome orange, reflexed when dry, endostome segments yellowish and frequently appendiculate, joining adjacent segments. Forms small cushions or turfs, epiphyte preferentially on *Juniperus thurifera* L. in continental environments of the northern half of the Peninsula, rare in the south. Esp.

- 19 Endostome segments not appendiculate, not interconnected 20

- 20 Capsule uniformly dark brown; exostome teeth scarcely papillose on the outer side, reticulate; leaf apices incurved when dry, concave; endostome segments strongly incurved, shorter than exostome teeth (fig. 48, 4)

**O. casasianum** F. Lara, Garilleti & Mazimpaka

Plants 0,6-1-cm tall. Leaves flexuose when dry, linear-lanceolate or linear-oblong, keeled, apices obtuse and with a small 1-celled mucro, margin recurved. Capsule cylindrical-urceolate with ventricose base, when dry with 8 ribs that do not reach the base; endostome segments smooth or with thin longitudinal striae. Forms small irregular cushions or patches, epiphyte in riparian woods on the banks of rivers, in the Basque Mountains. Esp.

- 20 Capsule pale brown, neck paler than urn; exostome teeth densely papillose on the outer side, not reticulate; leaf apices plane when dry, not concave; endostome segments erect or slightly incurved, as long as exostome teeth (fig. 48, 5-6)

**O. pallens** Bruch. ex Brid.

Plants small, greenish yellow to brownish green. Leaves oblong-lanceolate, upper leaves lingulate; upper cells of leaf less than 14  $\mu\text{m}$  wide, with simple or branched papillae. Seta light yellow, brownish when old; capsule emergent, with 8 striae; exostome with vertical striae in the upper part, horizontal striae at base; spores 11-15  $\mu\text{m}$ . Autoicous, perigonia and perichaetia on separate branches, perigonia terminal. Forms compact turfs, epiphyte in *Quercus ilex* L. forests in montane areas. Widespread and relatively frequent in the eastern half of the Peninsula Esp, And. Taxon very variable.



- 21 Endostome with 8 long segments usually alternating with 8 shorter ones 22
- 21 Endostome with 8 long segments or with 8 long segments alternating with 8 rudimentary ones 24
- 22 Exothelial bands forming 2(3) rows of cells; spores more than 18  $\mu\text{m}$   
**O. scanicum** Gronvall  
**O. lewinskyae** F. Lara, Garilleti & Mazimpaka  
 Leaves flexuose, twisted when dry, apex sinuose, some denticulate, obtuse or shortly acute. Capsule with well marked exothelial bands. Exostome teeth 8 pairs, regularly recurved, brown, splitting in mature capsules; endostome finely papillose. Forms small, loose, pale green tufts, epiphyte on trunks and bases of trees, rarer on calcareous rocks. Scattered in the central Pyrenees and in the western part of the Peninsula. Esp, Prt.
- 22 Exothelial bands forming 4-5 rows of cells; spores less than 18  $\mu\text{m}$  23
- 23 Leaves lanceolate; exostome of 8 pairs of teeth, splitting to 16 recurved, often irregularly twisted teeth; stomata slightly to complete covered by exothelial cells (fig. 48, 7)  
**O. hispanicum** F. Lara, Garilleti & Mazimpaka  
 Leaf apex entire, acute or acuminate. Capsule emergent, pale yellowish, constricted below mouth; endostome strongly papillose; calyptra conical-oblong, slightly plicate. Plants dull olive green. Grows in small cushions as epiphyte, in scattered and shaded sites, in montane areas of the northern half of the Peninsula. Esp.
- 23 Leaves oblong-lanceolate, upper leaves lingulate; exostome of 8 pairs of regularly recurved teeth; stomata slightly covered by exothelial cells (fig. 48, 5-6)  
**O. pallens** Bruch ex Brid.  
 Plants small, greenish yellow to brownish green. Upper cells of leaf less than 14  $\mu\text{m}$  wide, with simple or branched papillae. Seta light yellow, brownish when old; capsule emergent, with 8 striae, gradually tapering to the seta; exostome with a dense cover of short papillae and vertical striae in the upper part, horizontal striae at base; calyptra conic-oblong, strongly plicate; spores 11-15  $\mu\text{m}$ . Autoicous, perigonia and perichaetia on separate branches, perigonia terminal. Forms compact turfs, epiphyte in *Quercus ilex* L. forests in montane areas. Widespread and relatively frequent in the eastern half of the Peninsula. Esp, And.  
 Taxon very variable.
- 24 Segments of endostome remaining erect when dry; spores 18-24  $\mu\text{m}$  (fig. 48, 8)  
**O. rogeri** Brid.  
 Plants up to 1 cm tall, olive green. Different leaf shape in male and female shoots. Capsule ovoid before maturity and cylindrical when empty, with a very long neck, stomata immersed, half to completely covered, located in the lower half of capsule; exostome orange, with recurved teeth when dry, endostome hyaline, with long, linear segments, as long as exostome teeth; spores 18-30  $\mu\text{m}$ . Perigonia on the main stem and in lateral branches; perichaetia on lateral branches. Forms dense cushions as epiphyte in the Pyrenees. Esp.
- 24 Segments of endostome incurved when dry; spores less than 18  $\mu\text{m}$  25
- 25 Stomata half to completely covered by exothelial cells 26
- 25 Stomata half or slightly covered by exothelial cells 28

- 26 Calyptra glabrous; leaves gradually tapered to apex (fig. 48, 9-11)  
**O. pumilum** Sw. ex anon.  
 Plants small. Leaves lanceolate, apex acute, sometimes with a mucro of 1-2 cells. Capsule oblong-cylindrical, gradually attenuated at base; endostome segments more than 2/3 of the exostome length. Epiphyte in montane areas, in the northern half of the Peninsula. Esp.
- 26 Calyptra with several hairs; at least some leaves abruptly narrowed at apex 27
- 27 Leaf apex obtuse or acute, incurved or channelled; calyptra oblong, with slightly papillose hairs near apex (fig. 48, 12-14)  
**O. tenellum** Bruch ex Brid.  
 Plants small, 0.3-1 cm tall, light green to brownish. At least some leaves with channelled apiculus when dry; laminal cells 11-12  $\mu\text{m}$ , with 2 papillae per cell. Mostly with filamentous gemmae. Capsule cylindrical to ellipsoidal, deeply sulcate, reddish around mouth, stomata in the lower third; exostome light brown, endostome segments subulate, shorter than exostome teeth. Grows in cushions as epiphyte, rarely on rocks, in the lowlands and montane areas, mainly in the western half of the Peninsula and in Mallorca. Esp, Prt, Bl.
- 27 Leaf apex apiculate, plane; calyptra campanulate, with some short, thick, papillose hairs (fig. 48, 15)  
**O. philibertii** Venturi  
 Similar to depauperate forms of *O. pumilum*, can be distinguished by the hairy calyptra and the yellowish to orange endostome segments. Forms dense, dark green tufts on evergreen oaks in the lowlands. Scattered in the southwest of the Peninsula and in Mallorca. Esp, Prt, Bl.
- 28 Capsule abruptly narrowed into seta; calyptra oblong, plicate, naked or with few, short, scattered hairs; leaves widely ovate-lanceolate, acute or obtuse, mucronate, mucro of 1-2 hyaline cells  
**O. schimperi** Hammar  
 Plants minute. Upper cells of leaf more than 12  $\mu\text{m}$  wide, smooth or with conical papillae. Gemmae often present. Seta orange; capsule immersed or emergent, ovoid or pyriform, stomata in the middle of capsule; exostome teeth orange, endostome segments to 2/3 of the exostome length; spores 14-16  $\mu\text{m}$ . Perigonia axillary, under perichaetia. Epiphyte, forms loose, dark green tufts in the lowlands and montane areas. Widespread throughout the Peninsula. Esp, Prt.
- 28 Capsule gradually narrowed into seta; calyptra conical-oblong, strongly plicate, naked; leaves oblong-lanceolate, upper leaves lingulate, not mucronate (fig. 48, 5-6)  
**O. pallens** Bruch ex Brid.  
 Plants small, greenish yellow to brownish green. Upper cells of leaf less than 14  $\mu\text{m}$  wide, with simple or branched papillae. Seta light yellow, brownish when old; capsule emergent, with 8 striae; exostome with a dense cover of short papillae and vertical striae in the upper part, horizontal striae at base; spores 11-15  $\mu\text{m}$ . Autoicous, perigonia and perichaetia on separate branches, perigonia terminal. Forms loose or compact turfs, epiphyte in *Quercus ilex* L. forests in montane areas. Widespread and relatively frequent in the eastern half of the Peninsula. Esp, And. Taxon very variable.
- 29 Exostome teeth well developed, erect or spreading when dry, translucent, glossy (fig. 48, 16-18)  
**O. rupestre** Schleich. ex Schwägr.  
 Plants robust, to 3-4 cm tall, dark green. Leaves ovate-lanceolate, partially or totally bistratose, apex acute or obtuse, margin recurved; basal laminal cells elongated, nodulose. Capsule immersed or slightly emergent, with 8 faint striae; exostome teeth yellowish, endostome lacking or of 1 row of cells; calyptra oblong, strongly hairy, hairs long, exceeding

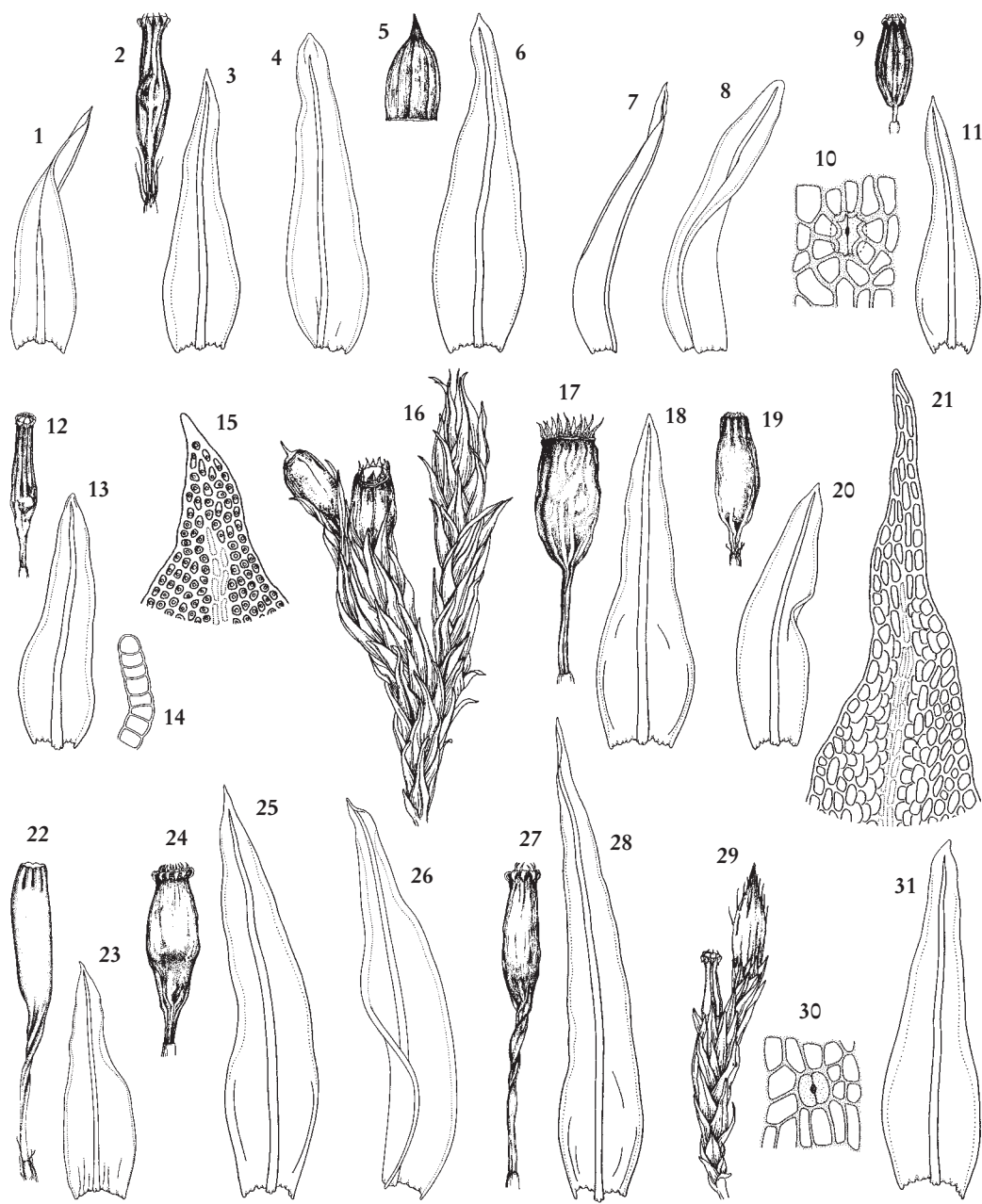


FIGURE 48. 1, *Orthotrichum stellatum*, leaf. 2-3, *O. stramineum*: 2, capsule when dry; 3, leaf. 4, *O. casasianum*, leaf. 5-6, *O. pallens*: 5, calyptra; 6, leaf. 7, *O. hispanicum*, leaf. 8, *O. rogeri*, leaf of a female shoot. 9-11, *O. pumilum*: 9, capsule when dry; 10, immersed stoma; 11, leaf. 12-14, *O. tenellum*: 12, capsule when dry; 13, leaf; 14, gemma. 15, *O. philibertii*, leaf apex. 16-18, *O. rupestre*: 16, habit; 17, capsule when dry; 18, leaf. 19-21, *O. acuminatum*: 19, capsule when dry; 20, leaf; 21, upper leaf apex. 22-23, *O. ibericum*: 22, capsule when dry; 23, leaf. 24-25, *O. striatum*: 24, capsule when dry; 25, leaf. 26, *O. tortidentium*, leaf. 27-28, *O. speciosum* var. *speciosum*: 27, capsule when dry; 28, leaf. 29-31, *O. affine*: 29, habit; 30, superficial stoma; 31, leaf. 16, 29 ( $\times 6$ ); 2, 5, 9, 12, 17, 19, 22, 24, 27 ( $\times 10$ ); 1, 3, 4, 6, 7, 8, 11, 13, 18, 20, 23, 25, 26, 28, 31 ( $\times 16$ ); 21 ( $\times 100$ ); 14, 15 ( $\times 140$ ); 10, 30 ( $\times 160$ ).

the apex of the calyptra. Forms loose tufts on acidic rocks, rarely on trees, from the lowlands to high mountains, throughout the Peninsula and in Mallorca. Esp, Prt, And, Bl.

- 29 Exostome rudimentary or if well-developed teeth twisted or reflexed when dry, at least in some capsules, obscure or translucent, dull 30
- 30 Exostome rudimentary, mostly inconspicuous 31
- 30 Exostome well developed 32
- 31 Capsule immersed; endostome well developed (fig. 48, 19-21)

**O. acuminatum** H. Philib.

Plants to 2 cm tall, olive green. Upper leaves narrowly and longly acuminate, keeled, apex recurved to revolute. Capsule slightly sulcate when dry, sulci short, contracting the mouth; endostome segments 8, wide, incurved when moist; spores 19-24  $\mu\text{m}$ . Epiphyte, rarely saxicolous, in moist forests of montane areas. Frequent in the southern half of the Peninsula and in Mallorca. Esp, Prt, Bl.

- 31 Capsule exserted or widely emergent; endostome lacking (fig. 48, 22-23)

**O. ibericum** F. Lara & Mazimpaka

Plants 1,0-2,5 cm tall. Leaves rigid, erect or erect-appressed when dry; upper leaves lanceolate to ovate-lanceolate, margin recurved to revolute, apex acute or shortly acuminate or apiculate, almost plane. Capsule with strongly contracted mouth when dry and short orange to dark brown striae. In montane areas of the central-western part of the Peninsula and rarer in the south. Esp, Prt.

- 32 Exostome with 16 twisted or regularly reflexed teeth 33
- 32 Exostome with 8 pairs of teeth or 16 irregularly reflexed teeth 35
- 33 Endostome of 16 segments irregularly crenulate and strongly papillose (fig. 48, 24-25)

**O. striatum** Hedw.

Plants to 2 cm tall, olive green. Leaves straight, lanceolate, acuminate, margin recurved. Seta very short; capsule smooth, immersed to emergent; exostome teeth yellow or orange; calyptra widely oblong, hairy; spores 20-28  $\mu\text{m}$ . Forms loose brownish yellow tufts, epiphyte, rarely on calcareous rocks. Widespread and very common in the Mediterranean region of the Peninsula. Esp, Prt, And.

- 33 Without endostome or with 8 not crenulate, smooth segments 34
- 34 Endostome usually lacking or with 8 rudimentary segments; leaf apex plane

**O. shawii** Wilson

Plants up to 4 cm tall. Capsule smooth or scarcely striate, stomata in the middle and upper half of capsule; exostome teeth recurved or reflexed, white-yellowish, opaque. Forms small, dark olive green cushions on the trunks of deciduous oaks and beeches in montane areas. Very rare in the north of the Peninsula. Esp, Prt.

- 34 Endostome of 8 thin segments as long as teeth; leaf forming a twisted apiculus (fig. 48, 26)

**O. tortidontium** F. Lara, Garilieti & Mazimpaka

Plants up to 2 cm tall. Leaves acuminate or acute, margin recurved above, frequently one margin incurved in upper part. Capsule scarcely sulcate, hardly constricted below mouth

when dry, when empty slightly striate; stomata in the middle of capsule; exostome teeth pale yellow, twisted when dry and fragile (apical part soon falling off), papillae or striae radially disposed on each of the cells. Forms olive green cushions on coniferous, mainly trunks of *Juniperus thurifera* L. in montane areas of the Iberian Range and the Spanish Central Range and in the southern part of the Peninsula. Esp.

- 35 Capsule, in lower part, smooth, with 8 narrow, short sulci below mouth; exostome teeth reflexed when dry, in contact at apex with exothecium; calyptra with numerous, long hairs (fig. 48, 27-28) **O. speciosum** Nees

Plants up 3-4 cm tall. Leaves lanceolate, apex acute or shortly acuminate, keeled, margin recurved to revolute. Capsule mouth with 1-2 rows of red cells; endostome segments incurved when moist; spores (12-)24-28  $\mu$ m. Epiphytic, rarely saxicolous, in montane areas of the northern and eastern part of the Peninsula, rare in the south and west of the Peninsula and in Mallorca. Esp, Prt, And, Bl.

var. **speciosum**: Seta as long or longer than capsule; capsule exserted or widely emergent; calyptra fusiform or ellipsoidal, with golden yellow or discoloured hairs (fig. 48, 27-28).

var. **brevisetum** F. Lara, Garilleti & Mazimpaka: Seta shorter than capsule; capsule immersed or emergent; calyptra conical, with numerous long, yellow-greenish hairs. Forms dense tufts.

- 35 Capsule strongly sulcate from mouth to base, constricted below mouth; exostome teeth reflexed at least in some capsules, mostly attached to the exothecium; calyptra with scarce short hairs (fig. 48, 29-31) **O. affine** Schrad. ex Brid.

Plants to 1(-3) cm tall, olive green to brownish. Leaves lanceolate, acute or obtuse, apiculate, apex often asymmetrical. Seta 0,4-1,2 mm long; spores 20-24  $\mu$ m. Forms dense tufts, epiphytic, rarely saxicolous, in wet forests of montane areas, occasionally in the lowlands. Widespread in the Mediterranean region of the Peninsula and in Mallorca. Esp, Prt, And, Bl.

*O. speciosum* and *O. affine* are often hard to separate.

### Ulota D. Mohr

Plants 0,5-2 cm tall, forming turfs; old parts of stems with reddish rhizoids. Leaves lanceolate, base wide and concave, twisted when dry, margin recurved, at least in the middle; upper laminal cells small, rounded or not, papillose, basal cells linear, extending up margin in 1-5 rows of rectangular cells with thickened transverse walls; nerve percurrent to excurrent. Capsule ovoid to pyriform, exserted, straight, with 8 longitudinal striae; peristome double, teeth in pairs; calyptra campanulate, usually strongly hairy.

- 1 Clusters of gemmae at tips of upper leaves; nerve excurrent; dioicous (fig. 49, 1-2) **U. phyllantha** Brid.

Plants to 2 cm tall. Leaves strongly crisped when dry. Gemmae ellipsoidal, brown, commonly produced from the excurrent part of nerve. Forms soft, yellowish-green to reddish to brown tufts on beech-trees,. Rare, in the Cantabrian mountains. Esp.

- 1 Gemmae absent; nerve ending in or below apex; autoicous 2

- 2 Capsule pyriform, smooth (fig. 49, 3-4) **U. coarctata** (P. Beauv.) Hammar  
Plants to 1 cm tall. Leaves slightly crisped when dry. Capsule inflated, whitish or pale brown and only striated or furrowed just below the mouth when dry; segments rudimentary or

lacking, exostome teeth whitish, straight when dry. Forms small, dull green or yellowish-green tufts on trees in moist forests, in montane areas of the north and northwestern part of the Peninsula. Esp.

- 2 Capsule ellipsoidal or cylindrical, strongly furrowed 3

- 3 Leaves imbricate, scarcely contorted when dry; plants saxicolous (fig. 49, 5)

**U. hutchinsiae** (Sm.) Hammar

Plants 1-2 cm tall. Leaves rigid; upper cells strongly incrassate with small lumen. Forms dark green to brownish, rigid turfs or tufts on siliceous rocks by streams in woods, in montane areas of the northern half of the Peninsula. Esp, Prt.

- 3 Leaves more or less crisped when dry; plants corticolous 4

- 4 Calyptra with a few sparse hairs; band of rectangular basal cells extending up margin (fig. 49, 6) **U. calvescens** Wilson

Plants 0,5-1,5 cm tall. Leaves strongly crisped when dry. Forms small tufts on trees. Scattered localities in the western part of the Peninsula. Esp, Prt.

- 4 Calyptra strongly hairy; band of rectangular basal cells not extending up margin 5

- 5 Capsule constricted some distance below mouth when dry; exothecium with 2-3 rows of cells, becoming abruptly isodiametric and uniformly thick-walled towards mouth of capsule; peristome teeth strongly papillose (fig. 49, 7-11)

**U. crispa** (Hedw.) Brid.

Plants glossy green. Leaves strongly crisped when dry; upper cells 8-10  $\mu\text{m}$  wide, strongly thick-walled, 4-5 rows of rectangular basal cells along margins. Epiphyte, forming small light yellowish-green tufts on trees in moist woods, especially in forest in montane areas. Common in the north of the Peninsula, scattered in the central part. Esp, Prt, And.

Montane species but at lower altitudes than *U. bruchii*.

- 5 Capsule constricted at mouth when dry; exothecium with cells becoming gradually smaller towards mouth of capsule; peristome teeth not strongly papillose in the upper part **U. bruchii** Hornsch. ex Brid.

**U. crispa** (Hedw.) Brid. var. **norvegica** (Grönvall) A.J.E. Sm. & M.O. Hill

Plants dark green. Leaves moderately or slightly crisped when dry; upper cells irregular, about 12  $\mu\text{m}$  wide, slightly thick-walled, 1-2 rows of rectangular basal cells along margins. Epiphyte, forms loose, yellowish-green tufts on trees, from the lowlands to the high mountains. Scattered in the northern half of the Peninsula. Esp, Prt.

### **Zygodon** Hook. & Taylor

Leaves contorted or flexuose when dry, lanceolate to oblong-lanceolate; upper laminal cells rounded or hexagonal, basal cells rectangular, hyaline; nerve ending near apex or excurrent in apiculus. Gemmae common, in leaf axils or on stems, pluricellular, fusiform or ellipsoidal. Capsule exserted, ovoid or pyriform, smooth or striate; peristome double, rudimentary or lacking, teeth in pairs. Autoicous or dioicous.



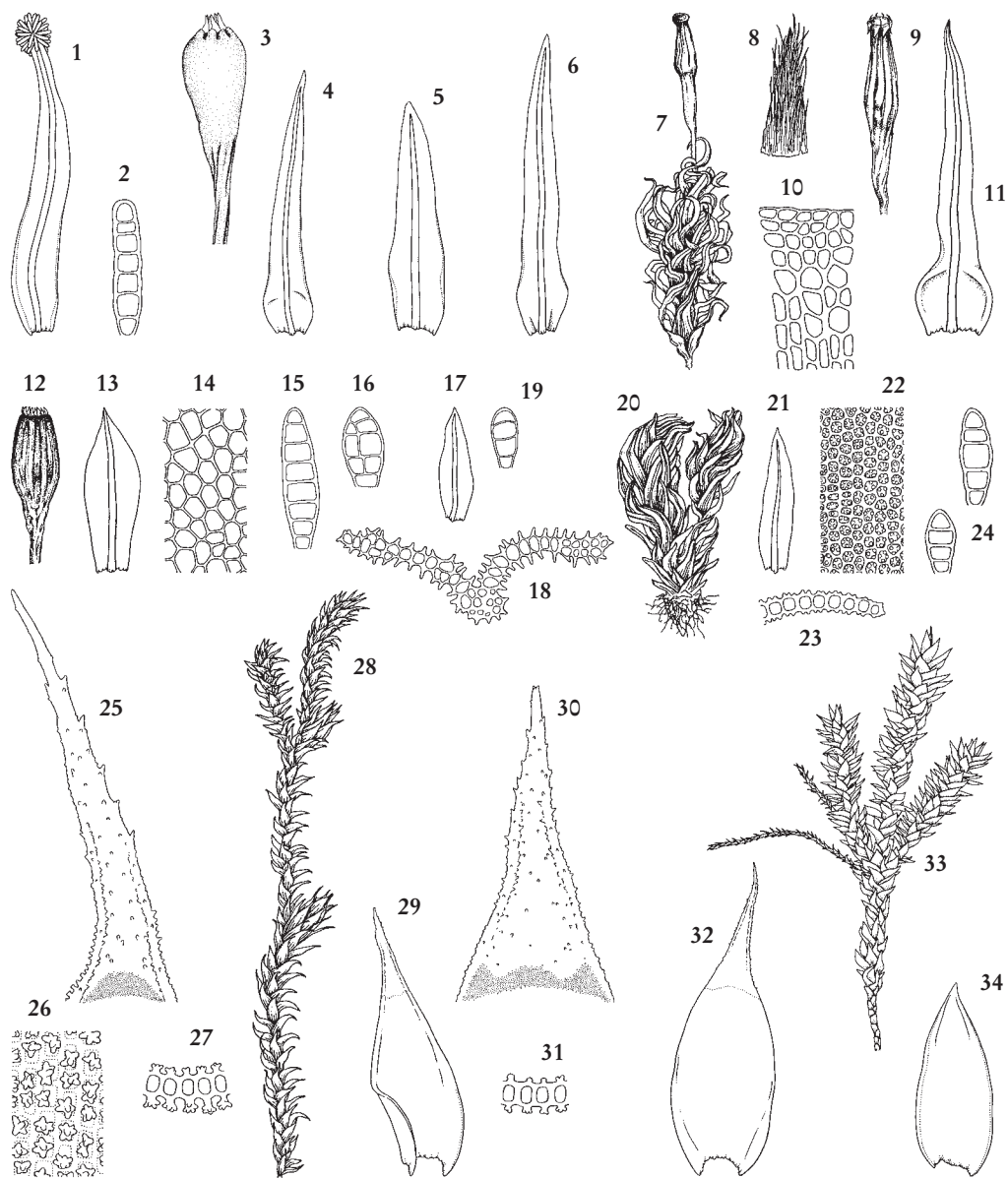


FIGURE 49. 1-2, *Ulota phyllantha*: 1, leaf; 2, gemma. 3-4, *U. coarctata*: 3, capsule when dry; 4, leaf. 5, *U. hutchinsiae*, leaf. 6, *U. calvescens*, leaf. 7-11, *U. crispa*: 7, habit when dry; 8, calyptra; 9, capsule when dry; 10, exothecial cells; 11, leaf. 12-14, *Zygodon forsteri*: 12, capsule; 13, leaf; 14, median cells. 15, *Z. conoideus*, gemma. 16, *Z. viridissimus*, gemma. 17-19, *Z. catarinoides*: 17, leaf; 18, leaf section; 19, gemma. 20-24, *Z. rupestris*: 20, habit; 21, leaf; 22, median cells; 23, leaf margin section; 24, gemmae. 25-27, *Hedwigia stellata*: 25, leaf apex; 26, cells on dorsal side of leaf; 27, lamina section. 28-31, *H. ciliata* var. *ciliata*: 28, habit; 29, leaf; 30, leaf apex; 31, lamina section. 32, *H. ciliata* var. *leucophaea*, leaf. 33-34, *H. integrifolium*: 33, habit; 34, leaf. 28, 33 ( $\times 3$ ); 7, 20 ( $\times 6$ ); 3, 8, 9, 12 ( $\times 12$ ); 1, 4, 5, 6, 11, 13, 17, 21, 29, 32, 34 ( $\times 16$ ); 25, 30 ( $\times 70$ ); 2, 15, 16, 19, 24 ( $\times 140$ ); 10, 14, 18, 22, 23 ( $\times 180$ ); 26, 27, 31 ( $\times 200$ ).

- 1 Upper cells of leaf 14-24  $\mu\text{m}$  wide, smooth; gemmae lacking; autoicous (fig. 49, 12-14)  
**Z. forsteri** (Dicks.) Mitt.

Plants glossy, dark green; stem 0,5-1 cm high, with whitish tomentum. Leaves flexuose, obovate-lanceolate, acuminate. Capsule pyriform longitudinally sulcate; peristome double, exostome teeth pale yellow, reflexed when dry. Monoicous. Grows on stumps, horizontal branches and bases of *Quercus ilex* L. and *Quercus faginea* Lam. Scattered localities, usually in montane areas, in the Peninsula. Esp, Prt.

- 1 Upper cells of leaf 7-12  $\mu\text{m}$  wide, papillose; gemmae present; dioicous 2

- 2 Upper cells of leaf 10-12  $\mu\text{m}$  wide; gemmae fusiform, 7-9 cells long, without longitudinal walls; peristome double (fig. 49, 15) **Z. conoideus** (Dicks.) Hook. & Taylor

Plants to 5 cm tall. Leaves elliptical to lanceolate, in upper part suddenly narrowed into apex. Gemmae 18-20  $\mu\text{m}$  wide. Capsule ovoid, with long neck. Forms green or yellowish-green tufts on bark. Occasional, scattered in the northern half of the Peninsula. Esp, Prt.

- 2 Upper cells of leaf 7-9  $\mu\text{m}$  wide; gemmae ovoid or shortly ellipsoidal, 4-6 cells long, with or without longitudinal walls; peristome lacking or rudimentary 3

- 3 Gemmae 30-40  $\mu\text{m}$  wide, with some longitudinal walls (fig. 49, 16)  
**Z. viridissimus** (Dicks.) Brid.

Plants to 2 cm tall, with dark tomentum. Leaves contorted when dry, elongate-lanceolate to lanceolate. Capsule ovoid; peristome rudimentary or lacking. Similar to *Z. rupestris* but without peristome. Forms green or dark-green tufts on trees, rocks and walls. Widespread in the western half of the Peninsula. Esp, Prt.

- 3 Gemmae 20-30  $\mu\text{m}$  wide, without longitudinal walls 4

- 4 Lamina in upper part scattered or densely bistratose, rarely tristratose in patches; upper and median leaf cells with 1-3 papillae per cell, 3-10  $\mu\text{m}$  long, acute (fig. 49, 17-19)

**Z. catarinói** C. Garcia, F. Lara, Sérgio & Sim-Sim

**Z. bistratus** Calabrese & J. Muñoz

Plants 0,2-1cm tall, with shining appearance, brown below. Leaves irregularly twisted, lanceolate to narrowly lanceolate, with 1-3 hyaline cells. Capsule ellipsoidal to oblong-cylindrical; peristome lacking. Forms yellowish green or olivaceous small, dense tufts, epiphyte, on tree trunks in different types of Mediterranean forests. Scattered in the south, northern, central and south-eastern part of the Peninsula. Esp, Prt.

- 4 Lamina in upper part unistratose; upper and median leaf cells with 3-6 papillae per cell, low, to 3  $\mu\text{m}$  long, blunt (fig. 49, 20-24) **Z. rupestris** Schimp. ex Lorentz

**Z. baumgartneri** Malta, **Z. viridissimus** (Dicks.) Brid. var. **rupestris** C. Hartm

Plants 0,5-3 cm tall, with dark tomentum. Leaves contorted, oblong-lanceolate to lanceolate, apex with 1-3 hyaline cells. Capsule ovoid to ellipsoidal; peristome absent or rudimentary. Epiphyte, rarely on rocks, forming soft, slender, yellowish green tufts on tree trunks, from the lowland to montane areas up to 1000 m. Widespread in the Peninsula and in Mallorca, Menorca and Pithyusic Islands. Esp, Prt, Bl.



## O. Hedwigiales

### Fam. Hedwigiaceae

#### Hedwigia P. Beauv.

Plants to 8 cm tall. Stem erect or procumbent with erect branches. Leaves imbricate when dry, erecto-patent to spreading when moist, ovate-lanceolate, concave, with elongate hyaline or coloured point, margin recurved; laminal cells thick-walled, strongly papillose, basal cells longer, narrower and porose; nerve lacking. Perichaetial leaves ciliate. Capsule obovoid, nearly globose or ovoid, immersed to slightly emergent; peristome lacking.

- 1 Leaves with coloured point; leaf margin recurved from base to apex (fig. 49, 33-34)  
**H. integrifolia** P. Beauv.

**Hedwigidium integrifolium** (P. Beauv.) Dixon

Plants to 2 cm long, yellowish green, brownish below. Stem procumbent, with straight branches. Leaf margin entire; laminal cells incrassate, porose, papillose, quadrate or shortly rectangular, basal cells longly rectangular, sinuose. Flagelliform branchlets sometimes present. Grows on shaded sandstone in the north of the Peninsula. Esp.

- 1 Leaves with hyaline point; leaf margin plane or recurved to 2/3 way up of leaf 2

- 2 Leaves ending in long, filiform, reflexed hyaline point, with acute, nearly smooth apex; laminal cells with high, branched papillae (fig. 49, 25-27) **H. stellata** Hedenäs

Leaves with denticulate hyaline-point. Forms lax, whitish cushions on siliceous rocks in montane areas. Widespread throughout the Peninsula but more frequent in the western part. Esp, Prt, And.

- 2 Leaves ending in wide, straight, hyaline, dentate point, with truncate apex; laminal cells with low, simple or slightly branched papillae (fig. 49, 28-32)

**H. ciliata** (Hedw.) P. Beauv.

Leaves with spinosely toothed hyaline-point. Forms dense, whitish cushions on siliceous or poorly basic rocks, in montane areas. Widespread throughout the Peninsula but more frequent in the western and northeastern parts. Esp, Prt, And.

var. **ciliata**: Leaves with short hyaline point, narrower at base (fig. 49, 28-31).

var. **leucophaea** Bruch & Schimp.: Leaves with long and hyaline point, wide at base, is common in the Pyrenees (fig. 49, 32).

## O. Bryales

### Fam. Catosciaceae

#### Catoscopium Brid.

Plants 2-4 cm tall. Leaves erect, lanceolate, margin entire; laminal cells quadrate to rectangular, 8-10 µm wide, smooth, cells towards nerve narrower; nerve percurrent. Seta long, straight; capsule horizontal, to 1 mm in diameter, globose, smooth, glossy,

black; lid conical; exostome slightly developed, endostome lacking or rudimentary (fig. 50, 1-3)

**C. nigratum** (Hedw.) Brid.

Forms compact turfs on calcareous rocks by streams, in high mountains of the Central Pyrenees. Esp.

## Fam. Bartramiaceae

### *Anacolia* Schimp.

Plants 1.5-5 cm tall, erect or decumbent. Stem branched at base, with dense, reddish tomentum. Leaves erecto-patent, ovate-lanceolate, subulate, plicate at base, margin denticulate, recurved in the lower half; lamina totally or partially bistratose towards apex, median cells rectangular,  $\pm$  mamilliose; nerve stout, excurrent.

- 1 Median cells of lamina 4-6  $\mu$ m wide, with abundant, prominent mamillae; upper lamina uniformly bistratose (fig. 50, 4-5) **A. webbii** (Mont.) Schimp.

Grows on exposed, acidic rocks, in montane areas, in the south and west of the Peninsula. Esp, Prt.

- 1 Median cells of lamina 6-12  $\mu$ m wide, with low mamillae; upper lamina partially bistratose **A. menziesii** (Turner) Paris

Forms dense turfs on acidic rock ledges, in montane areas, in the southeast of the Peninsula. Esp.

### *Bartramia* Hedw.

Plants green to glaucous, on siliceous substrata. Stem simple or bifurcate, tomentose at base. Leaves erecto-patent to spreading, linear-lanceolate to lanceolate, falciform or attenuate in long, rigid, flexuose or crisped upper part, with  $\pm$  sheathing base, margin plane, dentate; laminal cells quadrate to rectangular, thick-walled, mamilliose, basal cells longer, smooth; nerve percurrent to excurrent. Capsule globose, striate, symmetrical or with oblique mouth; peristome double or single.

- 1 Leaves with wide, glossy sheathing base, abruptly narrowed in long subula; upper laminal cells narrowly rectangular (fig. 50, 6-7) **B. ithyphylla** Brid.

Forms lax, glaucous green turfs, 1-2 cm high, in wet grasslands and acidic rock crevices, in montane areas and high mountains in the northern half of the Peninsula, rarer in the south. Esp, Prt, And.

- 1 Leaves lanceolate, gradually tapering into long point, dull at base; upper laminal cells quadrate or rectangular 2

- 2 Leaves straight, rigid when dry; nerve papillose at back; capsule symmetrical; peristome single (fig. 50, 8-9) **B. stricta** Brid.

Forms cushions or turfs, 1-3 cm high, on slopes and in siliceous rock crevices, in the east, south and west of the Peninsula, sporadic in the rest, and in Mallorca and Menorca. Esp, Prt, Bl.

- 2 Leaves flexuose or crisped when dry; nerve dentate at back; capsule with oblique mouth; peristome double 3

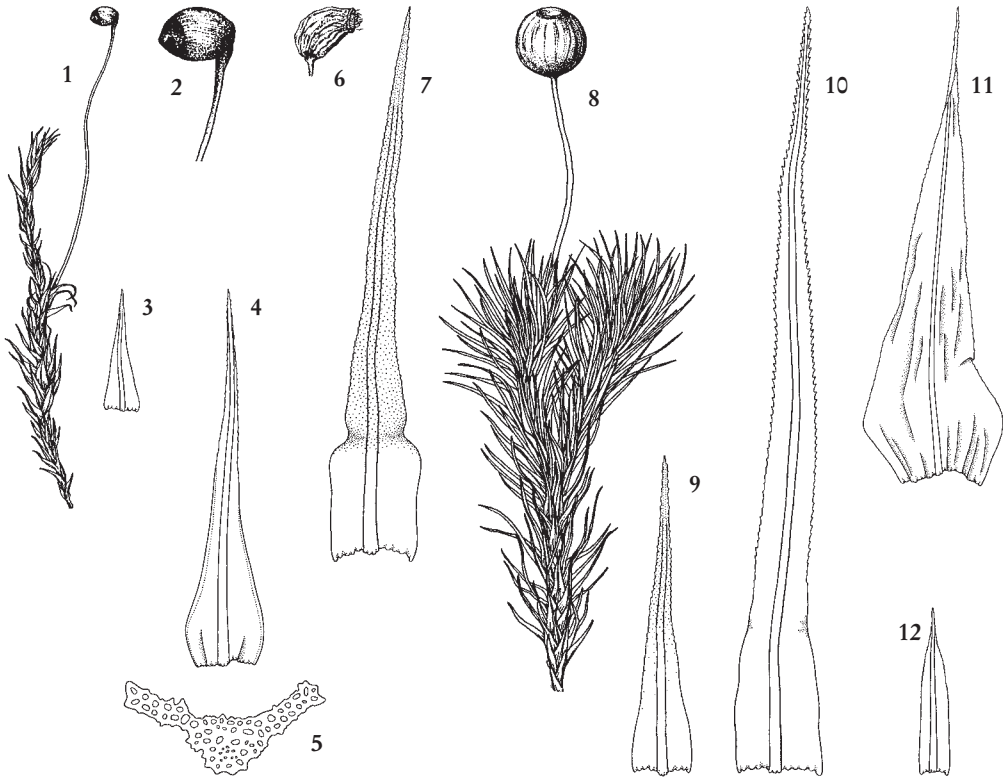


FIGURE 50. 1-3, *Catoscopium nigratum*: 1, habit; 2, capsule; 3, leaf. 4-5, *Anacolia webbii*: 4, leaf; 5, leaf section. 6-7, *Bartramia ithyphylla*: 6, capsule when dry; 7, leaf. 8-9, *B. stricta*: 8, habit; 9, leaf. 10, *B. pomiformis*, leaf. 11, *Breutelia chrysocoma*, leaf. 12, *Conostomum tetragonum*, leaf. 6, 8 ( $\times 4$ ); 1 ( $\times 4, 5$ ); 2 ( $\times 12$ ); 3, 4, 7, 9, 10, 11, 12 ( $\times 16$ ); 5 ( $\times 200$ ).

- 3 One sporophyte per perichaetium; seta long, straight; capsule exserted (fig. 50, 10)  
***B. pomiformis* Hedw.**  
 Forms green to brownish turfs, to 5 cm high, on wet slopes and in rock crevices, in montane areas. Widespread throughout the Peninsula. Esp, Prt, And.
- 3 More than one sporophyte per perichaetium; seta short, curved; capsule hidden among leaves  
***B. halleriana* Hedw.**  
 Plants to 15 cm high. Leaves falciform, secund. Forms glaucous green turfs in calcareous or siliceous rock crevices and on wet, shaded stony slopes, in montane areas. Distributed in the north of the Peninsula. Esp.

### ***Breutelia* (Bruch & Schimp.) Schimp.**

Plants erect or prostrate, yellowish green, brownish below. Stem to 10 cm high, irregularly branched, densely tomentose. Leaves spreading, lanceolate, acuminate,

longitudinally plicate, margin plane or slightly recurved, slightly denticulate; cells rectangular, mamilliose, basal cells narrowly rectangular or linear; nerve ending in apex. Seta short, cygneous. Capsule pendulous, globose, deeply furrowed when dry, peristome double (fig. 50, 11)

**B. chrysocoma** (Hedw.) Lindb.

Forms lax turfs on wet, shaded slopes in the north of the Peninsula. Esp.

### **Conostomum** Sw. ex F. Weber & D. Mohr

Stem about 2 cm high, branched, tomentose. Leaves rigid, linear-lanceolate, acuminate, imbricate, denticulate at apex, arranged in 5 rows, margin plane; median cells rectangular, narrow, 8-13  $\mu\text{m}$  wide, apical cells quadrate, marginal cells narrower but not forming a distinct border, smooth or nearly so; nerve excurrent. Capsule inclined, asymmetrical, sub-globose, striate; peristome single, teeth joined at apex forming a cone (fig. 50, 12)

**C. tetragonum** (Hedw.) Lindb.

Forms small, dense, dark green to glaucous patches in rock crevices and on rock ledges, in high mountains of the Central Pyrenees and Cantabrian Mountains. Esp.

### **Philonotis** Brid.

Stem erect, tomentose below or with scarce rhizoids, fertile shoots with whorled innovations below the female inflorescences. Leaves of sterile shoots lanceolate to ovate-lanceolate, acute to acuminate, often falciform or secund, margin plane or recurved, dentate; laminal cells rectangular, mamilliose or smooth; nerve percurrent to excurrent. In some species, fertile male stems have leaves appressed and different in shape to the sterile or the female ones. Capsule globose, striate, inclined; peristome double. Autoicous or dioicous. Plants hydrophilous or hygrophilous, growing on exposed rocks and soils.

In some cases, the presence of perigonial leaves is essential for a reliable determination.

- |   |  |   |
|---|--|---|
| 1 | Laminal cells smooth or with distal mamillae; leaf margin with simple teeth  | 2 |
| 1 | Laminal cells with proximal mamillae, often also with distal mamillae at apex; leaf margin with geminate or simple teeth | 4 |

- |   |   |
|---|---|
| 2 | Autoicous; leaves densely imbricate, green; nerve mamilliose at back (fig. 51, 1-2) |
|---|---|

**P. rigida** Brid.

Stem radiculose, 1-2 cm high. Leaf margin plane. Mostly with axillary bulbils. Forms dense turfs on slopes and seeping or wet acidic rocks, in the lowlands and montane areas. Common in the north and west of the Peninsula, rare in Algeciras Mountains and in Mallorca. Esp, Prt, Bl.

- |   |  |   |
|---|--|---|
| 2 | Dioicous; leaves lax, glaucescent; nerve smooth or papillose at back                 | 3 |
| 3 | Most leaf cells with distal mamillae; perigonial leaves erecto-patent (fig. 51, 3-5) |   |

**P. marchica** (Hedw.) Brid.

Stem straight, 1-3 cm high. Leaves lanceolate, apex acute to acuminate, margin plane at base; nerve percurrent or slightly excurrent, papillose. Axillary ovate bulbils present. Forms lax

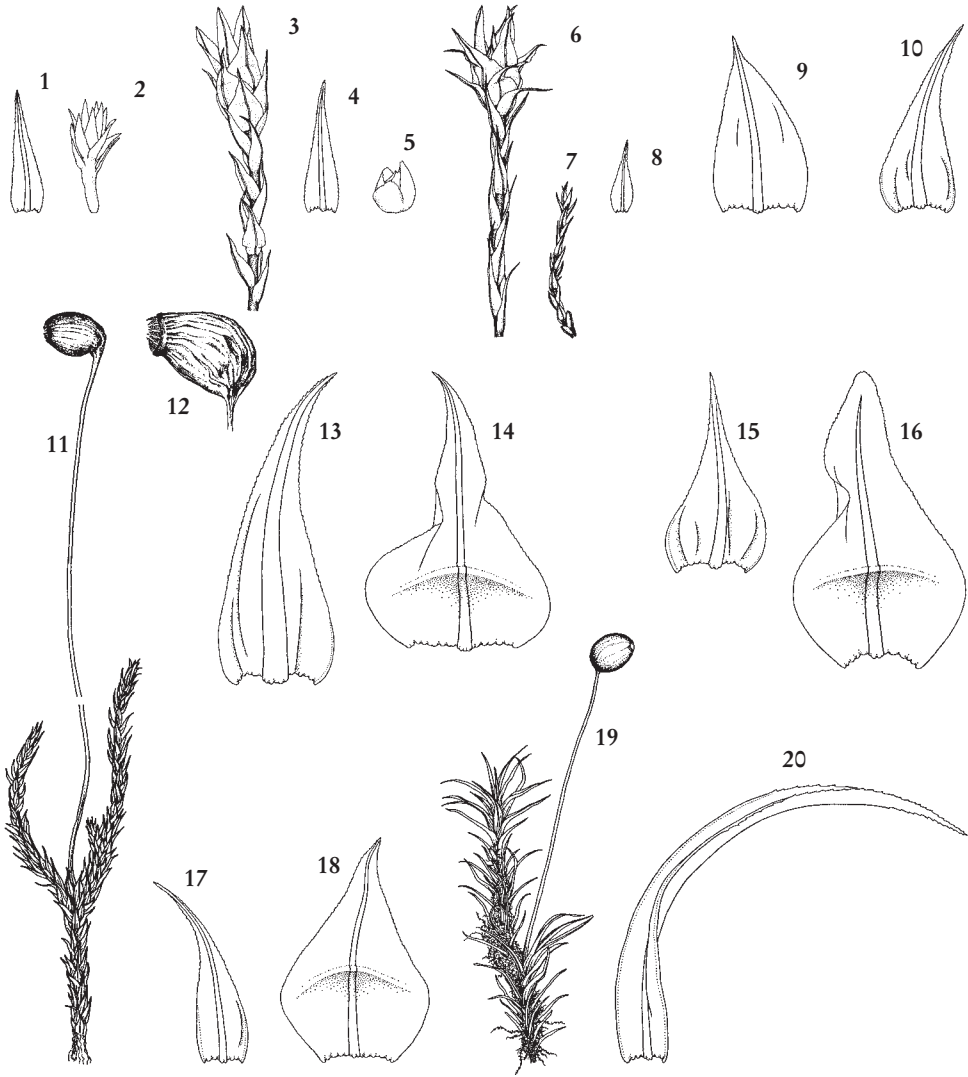


FIGURE 51. 1-2, *Philonotis rigida*: 1, leaf; 2, axillary bulbil. 3-5, *P. marchica*: 3, perigonium; 4, leaf; 5, axillary bulbil. 6-8, *P. arnellii*: 6, perigonium; 7, propagule; 8, leaf. 9, *P. caespitosa*, leaf. 10, *P. seriata*, leaf. 11-14, *P. calcarea*: 11, habit; 12, capsule when dry; 13, leaf; 14, perigonal leaf. 15-16, *P. fontana*: 15, leaf; 16, perigonal leaf. 17-18, *P. tomentella*: 17, leaf; 18, perigonal leaf. 19-20, *Plagiopus oederianus*: 19, habit; 20, leaf. 11 ( $\times 2$ ); 19 ( $\times 3$ ); 12 ( $\times 4$ ); 3, 6, 7 ( $\times 8$ ); 1, 4, 8, 9, 10, 13, 14, 15, 16, 17, 18, 20 ( $\times 16$ ); 2 ( $\times 20$ ); 5 ( $\times 26$ ).

turfs by irrigation channels, on slopes and seeping rocks, in the lowlands and montane areas. Scattered in the Peninsula and in Mallorca. Esp, Prt, Bl.

- 3 Upper cells of leaf smooth or with some distal mamillae, basal cells smooth; perigonial leaves reflexed (fig. 51, 6-8) **P. arnellii** Husn.  
Plants straight or procumbent, stem filiform, radiculose, 0,5-2 cm high. Leaves small, lanceolate, apex acuminate to longly acuminate, margin plane or narrowly recurved; nerve excurrent, smooth. Usually with flagelliform axillary propagules. Forms lax patches on slopes and very moist soils. Scattered in the Peninsula. Esp, Prt.
- 4 Leaves non-plicate at base, margin plane, with simple teeth, occasionally with some geminate teeth; laminal cells uniform, rectangular throughout (fig. 51, 9) **P. caespitosa** Jur.  
Leaves ovate-lanceolate, erecto-patent. Forms turfs, to 3 cm high, on peaty soils and very moist slopes, in the lowlands and montane areas. Scattered in the Peninsula. Esp, Prt, And.
- 4 Leaves plicate at base, margin recurved, with geminate teeth; upper laminal cells narrower than lower cells **5**
- 5 Leaves spirally curved on stem; lamina and nerve strongly papillose at back (fig. 51, 10) **P. seriata** Mitt.  
Nerve 90-190  $\mu\text{m}$  wide at base, reddish. Perigonial leaves erect, short, obtuse. Forms tall turfs, by streams and in wet grasslands in high mountains. Common in the north of the Peninsula and in Sierra Nevada, rarer in Spanish Central Range. Esp, Prt, And.
- 5 Leaves not spirally curved on stem; lamina and nerve smooth or slightly papillose at back **6**
- 6 Leaf nerve 120-200  $\mu\text{m}$  wide at base; perigonial leaves acute (fig. 51, 11-14) **P. calcarea** (Bruch & Schimp.) Schimp.  
Plants robust, light green. Leaves ovate-lanceolate; nerve percurrent or slightly excurrent. Forms tall turfs by basic streams, from the lowlands to high mountains. Frequent in the north of the Peninsula, rarer in the south and in Mallorca. Esp, Prt, And, Bl.
- 6 Leaf nerve 60-120  $\mu\text{m}$  wide at base; perigonial leaves acute or obtuse **7**
- 7 Leaves with widely ovate base, acuminate in short point, slightly papillose; nerve percurrent or slightly excurrent; inner perigonial leaves with rounded apex and nerve ending below apex (fig. 51, 15-16) **P. fontana** (Hedw.) Brid.  
Forms tall, light green to dark green turfs on rocks, by waterfalls and neutral or slightly acidic streams. Frequent in the northern half of the Peninsula, rarer in the south and in Mallorca. Esp, Prt, And, Bl.
- 7 Leaves lanceolate, acuminate in long point, strongly papillose; nerve longly excurrent; inner perigonial leaves with longly acuminate or slightly obtuse apex and nerve percurrent or excurrent (fig. 51, 17-18) **P. tomentella** Molendo  
Stem densely tomentose to near apex. Forms dense turfs, to 5 cm high, on very wet or peaty soils, in high mountains, occasionally in the lowlands, in the north and centre of the Peninsula and in Sierra Nevada. Esp, Prt, And.

### Plagiopus Brid.

Stem branched, triangular in section, covered by dense, dark brown tomentum. Leaves lanceolate, acuminate, patent, twisted when dry, margin recurved at base, plane and dentate in the upper half; laminal cells quadrate to shortly rectangular, thick-walled, papillose-striate, basal cells rectangular; nerve percurrent or excurrent. Capsule globose, slightly inclined, striate, with oblique mouth; peristome double (fig. 51, 19-20)

**P. oederianus** (Sw.) H.A. Crum & L.E. Anderson

Forms dense, dark green cushions, 3-5 cm high, in calcareous rock crevices in montane areas and high mountains, in the north of the Peninsula, very rare in the south. Esp.

### Fam. Bryaceae

#### Anomobryum Schimp.

Plants small, to 1,5 cm tall, julaceous, filiform or clavate, glossy light green. Leaves imbricate, ovate, obtuse or apiculate, very concave or nearly plane, margin entire; median cells 4-10 times longer than wide, vermicular or rhomboidal, thick-walled, basal cells rectangular; nerve extending little more than half way up, or percurrent or excurrent in short apiculus. Capsule ovoid, oblong or pyriform, inclined to horizontal, neck half length of urn; peristome double.

- 1 Leaves appressed, ovate or oblong-lanceolate; median cells vermicular,  $\pm 100 \mu\text{m}$  long, 5-10 times as long as wide (fig. 52, 1-3)

**A. julaceum** (Schrader ex P. Gaertn., B. Mey. & Scherb.) Schimp.

Plants slender, filiform, to 1,5 cm tall, julaceous. Forms loose turfs on acidic slopes and disintegrated granitic rocks, in damp or seeping, shaded sites. Scattered from the lowlands to high mountains of the Peninsula. Esp, Prt, And.

var. **julaceum**: Leaves strongly concave; nerve extending half way up leaf or percurrent (fig. 52, 1-3).

var. **concinatum** (Spruce) J.E. Zetterst. (*A. concinatum* (Spruce) Lindb.): Leaves slightly concave and nerve percurrent or excurrent in short apiculus.

- 1 Leaves erecto-patent, broadly ovate to oblong; median cells longly rhomboidal,  $\pm 18-22 \mu\text{m}$  long, 4-5 times as long as wide (fig. 52, 4-5)

**A. lusitanicum** (I. Hagen ex Luisier) Thér.

Plants to 3,5 mm tall,  $\pm$  clavate. Rhizoidal gemmae filiform, green or brown, 30-240  $\mu\text{m}$ , of 1 row of 2-15 smooth cells. Capsule ovoid to pyriform, neck half length of urn; spores 8-10(-12)  $\mu\text{m}$ , smooth or nearly so. Grows in exposed, granitic rock crevices, in the western part of the Peninsula. Esp, Prt.

### Bryum Hedw.

Leaves crowded at stem apex or regularly arranged along the stem, lanceolate, ovate-lanceolate or spatulate; median cells hexagonal or rhomboidal, basal cells quadrate to rectangular, marginal cells often narrower and forming an obscure to distinct border;

nerve percurrent to excurrent, mostly in a long, filiform point. Capsule pyriform to cylindrical, often pendulous; peristome double, exostome of 16 teeth with transverse articulations, endostome joined to a basal membrane 1/3-1/2 peristome length, and of 16  $\pm$  perforated segments alternating with long, nodulose, appendiculate or rudimentary cilia. Plants dioicous, synoicous or autoicous.

- 1 Leaf base widely and longly decurrent (fig. 52, 6) **B. weigeli** Spreng.  
Leaves distant, regularly arranged along the stem, ovate-triangular, short-pointed; laminal cells 16-22  $\mu\text{m}$  wide; nerve narrow, percurrent. Forms lax, light green to reddish turfs to 7 cm high, on rocks by streams or on waterlogged soils, in montane areas and high mountains in the north of the Peninsula and in Sierra Nevada. Esp, And.
- 1 Leaf base not or only slightly decurrent 2
- 2 Apical cells of leaf hyaline (fig. 52, 7-8) **B. argenteum** Hedw.  
**B. argenteum** var. **lanatum** (P. Beauv.) Hampe  
Plants julaceous. Leaves widely ovate, concave, apiculate; nerve faint, evanescent to percurrent, occasionally excurrent in hyaline point. Axillary bulbils often present. Forms dense, glossy, silver turfs to 3 cm high on disturbed soils, walls, slopes, exposed rocks and by roadsides, from coastal areas to high mountains. Widespread throughout the Peninsula and Mallorca, Menorca and Pithyusic Islands. Esp, Prt, And, Bl.
- 2 Leaf cells all coloured 3
- 3 Leaf margin stout, 2-4-stratose (fig. 52, 9) **B. donianum** Grev.  
Leaves ovate-spathulate, denticulate at apex with geminate teeth; laminal cells 30-50 x 13-20  $\mu\text{m}$ ; nerve stout, excurrent in denticulate apiculus. Capsule cylindrical; spores 8-14  $\mu\text{m}$ . Forms lax turfs to 2 cm high, in grasslands, on slopes and bases of exposed or shaded rocks in pinewoods and evergreen oak forests, on coastal areas, in the lowlands and in montane areas of the Peninsula, Mallorca and Menorca. Esp, Prt, Bl.
- 3 Leaf margin unistratose or partially bistratose 4
- 4 Leaves with unistratose margin, mostly with reddish base 5
- 4 Leaves with partially bistratose margin, with green base 36
- 5 Leaves arranged in 2-3 successive comal tufts along the stem (fig. 52, 10-11) **B. canariense** Brid.  
**B. provinciale** H. Philib.  
Leaves elliptical, margin of 1-5 rows of cells, plane, dentate at apex, recurved at base; laminal cells 30-70 x 14-18  $\mu\text{m}$ , thick-walled, porose; nerve reddish brown, excurrent in denticulate point 150-400  $\mu\text{m}$  long. Occasionally with globose rhizoidal gemmae, 200  $\mu\text{m}$  wide. Capsule cylindrical, with narrow neck, 1/3 capsule length. Autoicous or synoicous. Forms lax turfs in calcareous, humus-rich soils in *Q. rotundifolia* Lam. forest and *Pinus sylvestris* L., *P. salzmännii* Dunal forest, in coastal areas, in the lowlands and montane areas. Widespread throughout the Peninsula and in Mallorca and Pithyusic Islands. Esp, Prt, Bl.
- 5 Leaves arranged in a comal tuft or regularly along the stem 6



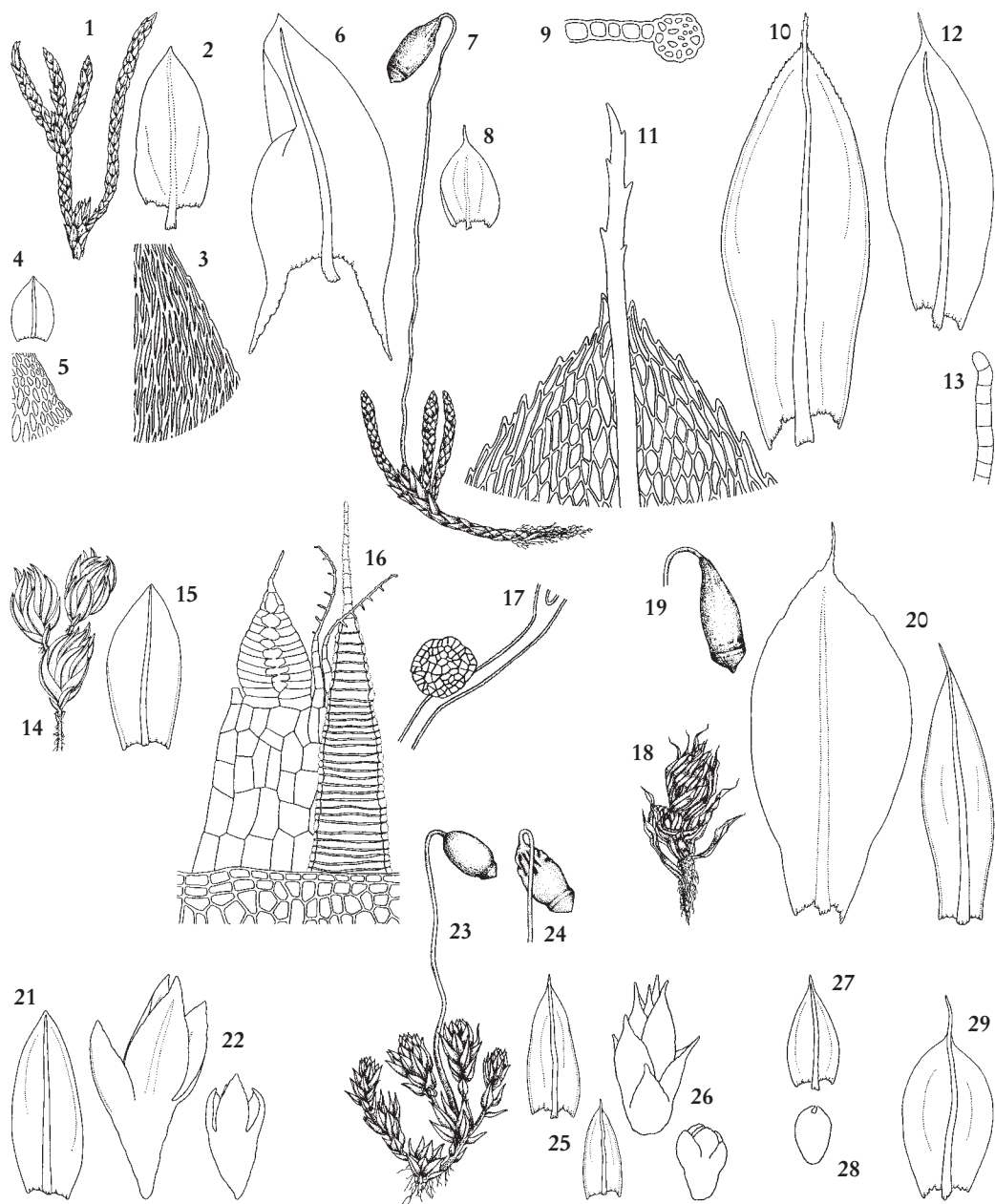


FIGURE 52. 1-3, *Anomobryum julaceum* var. *julaceum*: 1, habit; 2, leaf; 3, median cells. 4-5, *A. lusitanicum*: 4, leaf; 5, median cells. 6, *Bryum weigelii*, leaf. 7-8, *B. argenteum*: 7, habit; 8, leaf. 9, *B. donianum*, leaf margin section. 10-11, *B. canariense*: 10, leaf; 11, leaf apex. 12-13, *B. moravicum*: 12, leaf; 13, axillary gemma. 14-15, *B. minii*: 14, habit; 15, leaf. 16-17, *B. torquescens*: 16, peristome; 17, rhizoidal gemma. 18-20, *B. capillare*: 18, habit when dry; 19, capsule; 20, leaves. 21-22, *B. gemmiparum*: 21, leaf; 22, bulbils. 23-26, *B. dichotomum*: 23, habit; 24, capsule when dry; 25, leaves; 26, bulbils. 27-28, *B. gemmilucens*: 27, leaf; 28, bulbil. 29, *B. elegans*, leaf. 1, 7, 14, 18, 19, 23, 24 ( $\times 5$ ); 2, 4, 6, 8, 10, 12, 15, 20, 21, 25, 27, 29 ( $\times 16$ ); 22, 26, 28 ( $\times 40$ ); 13, 17 ( $\times 60$ ); 16 ( $\times 80$ ); 11 ( $\times 100$ ); 3, 5 ( $\times 120$ ); 9 ( $\times 160$ ).

- 6 Leaves arranged in 1 comal tuft 7
- 6 Leaves regularly arranged along the stem 11
- 7 Stem with filamentous axillary gemmae; leaves flexuose (fig. 52, 12-13)
  - B. moravicum** Podp.
  - B. laevifilum** Syed
  - Leaves elliptical, acuminate, flexuose, margin plane or slightly recurved at base, denticulate at apex, border of 1-3 rows of cells. Axillary gemmae abundant, finely papillose, brownish. Dioicous. Forms lax, yellowish green turfs, to 2 cm high, on soils, rocks, walls and trunks, in oakwoods, beechwoods, fir woods and pinewoods in montane areas, in the northern half of the Peninsula, rarer in the lowlands and in the south and in Menorca. Esp, And, Bl.
- 7 Stem without filamentous axillary gemmae; leaves twisted or flexuose 8
- 8 Leaves twisted, obtuse, acute or abruptly tapering in long point 9
- 8 Leaves flexuose, gradually tapering in  $\pm$  long point 30
- 9 Leaves glossy, ovate, concave, obtuse or acute; nerve ending below apex or shortly excurrent (fig. 52, 14-15)
  - B. minii** Podp.
  - Leaves ovate to ovate-oblong, upper border of 1-3 rows of cells, below with 4-6 rows. Capsule pyriform to cylindrical, with neck shorter than urn; exostome orange at base, colorless at apex. Forms dense turfs on open, wet or seeping, acidic soils, in the lowlands and montane areas, in the northwestern part of the Peninsula. Prt.
- 9 Leaves ovate, oblong or spatulate, abruptly tapering in  $\pm$  long point; nerve excurrent 10
- 10 Plants synoicous (fig. 52, 16-17)
  - B. torquescens** Bruch & Schimp.
  - B. capillare** Hedw. subsp. **torquescens** (Bruch & Schimp.) Kindb.
  - Leaves ovate-oblong, acuminate or spatulate, margin recurved, denticulate at apex, border of 2-4 rows of cells; laminal cells hexagonal, 18-22  $\mu$ m wide. Rhizoids pale brown, often with abundant spherical, magenta gemmae. Capsule cylindrical, glossy, brown to reddish brown. Forms lax turfs, to 2 cm high, on exposed dry rocks, arable or rocky soils and sandy ledges, usually on calcareous substrata, in the Peninsula and in Mallorca, Menorca and Pithyusic Islands. Esp, Prt, Bl.
- 10 Plants dioicous (fig. 52, 18-20)
  - B. capillare** Hedw.
  - Leaves ovate-oblong or spatulate, abruptly narrowed into cuspidate or piliferous point, border of 3-7 rows of narrow cells; nerve excurrent or ending below apex. Occasionally with red to brown rhizoidal gemmae. Capsule longly pyriform, inclined to pendulous; endostome with wide perforations and long, appendiculate cilia. Forms dense turfs, to 2 cm high, on soils, walls, rocks and tree trunks, from the lowlands to montane areas, in the Peninsula and in Mallorca, Menorca and Pithyusic Islands. Esp, Prt, And, Bl.
  - This species is very polymorphic.
- 11 Plants with axillary bulbils 12
- 11 Plants without axillary bulbils 15

- 12 Bulbils attenuate at base, with primordia from the middle; nerve ending in or below apex; plants glossy, growing by streams (fig. 52, 21-22) **B. gemmiparum** De Not.  
Leaves ovate, concave, obtuse or sub-acute. Bulbils more than 250  $\mu$ m long, occasionally with rhizoidal light brown gemmae. Forms  $\pm$  dense turfs, 2-3 cm high, on wet rocks by streams, from coastal to montane areas, in the northeast, east and south of the Peninsula and Mallorca and Menorca, rare in the centre of the Peninsula. Esp, Prt, Bl.
- 12 Bulbils  $\pm$  ovoid to pyriform, with primordia from base or only at apex; nerve excurrent; plants slightly glossy, growing on dry soils (*B. bicolor* complex) 13
- 13 Bulbils ovoid, 1 per axil, with acute primordia, rarely obtuse or rounded, from base to apex (fig. 52, 23-26) **B. dichotomum** Hedw.  
**B. barnesii** J.B. Wood ex Schimp., **B. bicolor** Dicks.,  
**B. dunense** A.J.E. Sm. & H. Whitehouse, **B. versicolor** A. Braun ex Bruch & Schimp.  
Leaves widely ovate or ovate-lanceolate, obtuse to acuminate, margin plane, slightly recurved or recurved from base to apex; nerve green to yellow, brownish when old, excurrent in apiculus or long arista. Bulbils yellowish green to green, 40-250  $\mu$ m long, primordia acute, rarely obtuse or rounded. Capsule widely ovoid, reddish, occasionally with rugose neck. Species very variable, forming lax or compact, pale green or yellowish green turfs, reddish below, to 2 cm high, on exposed, sandy or rocky soils, walls and by roadsides. Widespread throughout the Peninsula, but commoner in the Mediterranean region, and in Mallorca, Menorca and Pithyusic Islands. Esp, Prt, Bl.
- 13 Bulbils ovoid to pyriform, 1-5 per axil, with primordia dentiform or lacking 14
- 14 Bulbils ovoid, yellow, orange or reddish, 65-100  $\mu$ m long, with narrow, dentiform primordia to 1/3 total length of bulbil **B. gemmiferum** R. Wilczek & Demaret  
Leaves ovate-acuminate, margin recurved; nerve brownish yellow, excurrent in denticulate point to 250  $\mu$ m long. Capsule ellipsoidal, pendulous, constricted below mouth. Forms yellowish green turfs, to 1.5 cm high, on exposed disturbed soils and walls. Distributed in the Peninsula and in Menorca. Esp, Prt, Bl.
- 14 Bulbils ellipsoidal to pyriform, glossy, lemon yellow or orange to reddish 120-230  $\mu$ m long, primordia lacking or with very short, incurved teeth (fig. 52, 27-28) **B. gemmilucens** R. Wilczek & Demaret  
Leaves ovate to ovate-lanceolate, acute, cucullate, margin plane; nerve percurrent to excurrent. Forms small turfs, to 1 cm high, on disturbed soils and by roadsides, on coastal areas in the east, south and southeast of the Peninsula and in Mallorca. Esp, Prt, Bl.
- 15 Plants julaceous; leaves ovate, concave, abruptly tapering in long point (fig. 52, 29) **B. elegans** Nees  
Leaves strongly concave, elongated in long, narrow point, margin plane, entire, border of 2-3 rows of cells; nerve excurrent. Forms compact turfs, to 3 cm high, on wet or dry, exposed, basic rocks. Esp, Prt.
- 15 Plants not julaceous; leaves lanceolate, ovate-lanceolate or ovate-oblong,  $\pm$  erecto-patent, apiculate 16

- 16 Plants more than 2,5 cm tall 17
- 16 Plants to 2,5 cm tall 21
- 17 Leaves ovate-oblong, apex obtuse or rounded 18
- 17 Leaves ovate-lanceolate, apex acute or apiculate 19
- 18 Leaf border indistinct (fig. 53, 1) **B. muehlenbeckii** Bruch & Schimp.  
Leaves concave, margin plane, recurved at base; nerve stout, reddish. Occasionally with  $\pm$  spherical, reddish rhizoidal gemmae. Forms dense, glossy brownish red turfs, to 3 cm high, on waterlogged or seeping, acidic slopes, soils and rocks, in montane areas and high mountains, in the north of the Peninsula and in Sierra Nevada. Esp, Prt.
- 18 Leaf border yellowish, of 2-3 rows of narrow cells (fig. 53, 2-3) **B. neodamense** Itzigs.  
Leaves spreading, distant, ovate-oblong, concave, finely crenulate, margin entire or denticulate at apex; nerve reaching apex; laminal cells hexagonal, 16-30  $\mu\text{m}$  wide. Forms lax turfs on flushed soils in the Pyrenees and in the southwest of the Peninsula. Esp, Prt.
- 19 Leaves widely bordered; margin strongly recurved (fig. 53, 4) **B. pseudotriquetrum** (Hedw.) P. Gaertn., B. Mey. & Scherb.  
Species very polymorphic, plants to 10 cm tall. Stem tomentose. Leaves straight, ovate-lanceolate, decurrent, margin wide, recurved, plane and denticulate at apex; laminal cells 16-20  $\mu\text{m}$  wide; nerve stout, reddish, percurrent or excurrent in apiculus. Capsule ovoid-oblong; exostome teeth yellow or orange, with hyaline apex, endostome segments widely perforated; spores 12-18  $\mu\text{m}$ . Forms dense, dark green to reddish turfs by streams and torrents, from the lowlands to high mountains, in the Peninsula and in Mallorca and Menorca. Esp, And, Prt, Bl.  
var. **pseudotriquetrum**: Plants dioicous, to 10 cm tall (fig. 53, 4).  
var. **bimum** (Schreb.) Lilj.: Plants monoicous, to 2 cm tall.
- 19 Leaves unbordered; margin plane or recurved at base 20
- 20 Median cells of leaf narrowly rhomboidal to linear, 8-12  $\mu\text{m}$  wide, thick-walled (fig. 53, 5) **B. alpinum** Huds. ex With.  
Leaves applied, slightly concave, margin plane or narrowly recurved. Occasionally with rhizoidal gemmae 100-200  $\mu\text{m}$  wide. Capsule ellipsoidal to cylindrical, reddish. Forms dense, dark red or green turfs, by streams and on wet, seeping, acidic soils and rocks, from coastal areas to high mountains, in the Peninsula and in Mallorca and Menorca. Esp, Prt, And, Bl.
- 20 Median cells of leaf rhomboidal, 12-14  $\mu\text{m}$  wide, thin-walled (fig. 53, 6) **B. mildeanum** Jur.  
Leaves concave, gradually acuminate, margin plane at apex, recurved below, border indistinct; nerve stout, reddish at least at base, excurrent in short point. Forms dense, glossy yellow green turfs on calcareous or siliceous rocks, by streams or in periodically flushed sites. Scattered in the north of the Peninsula. Esp, Prt, And.
- 21 Rhizoidal gemmae to 100  $\mu\text{m}$  wide 22
- 21 Rhizoidal gemmae more than 120  $\mu\text{m}$  wide 25

- 22 Gemmae pyriform 23
- 22 Gemmae globose 24
- 23 Gemmae  $60-100 \times 40-60 \mu\text{m}$ , with cells  $20-35 \mu\text{m}$  wide (fig. 53, 7-8)  
**B. sauteri** Bruch & Schimp.  
 Plants with finely papillose, red-brown rhizoids. Leaves ovate to oblong, acuminate; nerve stout, green to brownish red, percurrent to excurrent in apiculus. Rhizoidal gemmae brown. Forms turfs on wet, exposed soils in montane areas. Sporadic, in the north of the Peninsula. Esp.
- 23 Gemmae  $40-60 \times 30-40 \mu\text{m}$ , with cells  $15-20 \mu\text{m}$  wide (fig. 53, 9-10)  
**B. valparaisense** Thér.  
**B. pyrifenum** Crundw. & H. Whitehouse  
 Rhizoids brown, papillose. Leaves erecto-patent, ovate-lanceolate, slightly decurrent, margin entire or denticulate; nerve percurrent or excurrent; median cells  $45-80 \times 9-13 \mu\text{m}$ . Gemmae yellow or brownish, often rounded. Dioicous. Forms loose turfs on wet soils, in the southwest of the Peninsula. Prt.
- 24 Rhizoids light brown; gemmae red crimson, with protuberant cells (fig. 53, 11-12)  
**B. klinggraeffii** Schimp.  
 Leaves ovate to oblong, acuminate; nerve of upper leaves excurrent. Forms loose turfs in wet hollows in sandy or clayey soils, in the east and south of the Peninsula. Esp, Prt.
- 24 Rhizoids mauve or violet; gemmae red or orange, with cells not protuberant  
**B. violaceum** Crundw. & Nyholm  
 Rhizoids smooth. Leaves ovate-lanceolate, acuminate; nerve stout, excurrent. Forms turfs on wet, acidic soils. Distribution poorly known. Sporadic, in the east of the Peninsula. Esp.
- 25 Rhizoids violet **B. ruderale** Crundw. & Nyholm  
 Leaves ovate-acuminate; nerve stout, green, reddish or brownish, excurrent in denticulate apiculus. Gemmae red, occasionally purple, brown in old plants. Capsule ovoid or pyriform. Forms lax turfs on dry, exposed, sandy or clayey soils, in arable fields or in clearings in Kermes Oak shrubs (Garriga) in the lowlands. Widespread throughout the Peninsula. Esp, Prt.
- 25 Rhizoids brownish 26
- 26 Gemmae yellow,  $120-180(-220) \mu\text{m}$  wide **B. tenuisetum** Limpr.  
 Leaves ovate-lanceolate, acuminate, denticulate at apex, border not very distinct, margin recurved, partially bistratose; laminal cells thick-walled; nerve stout, excurrent, reddish when old. Forms lax turfs in wet, exposed, clayey or sandy soils in the Mediterranean region lowlands, in the east of the Peninsula. Esp.
- 26 Gemmae red, orange or brown,  $200-250 \mu\text{m}$  wide or larger 27
- 27 Leaves with only slightly distinct border; rhizoidal gemmae with non-protuberant cells 28
- 27 Leaves with distinct border; rhizoidal gemmae with protuberant cells or not 29



FIGURE 53. 1, *Bryum muchlenbeckii*, leaf. 2-3, *B. neodamense*: 2, leaf; 3, leaf apex. 4, *B. pseudotriquetrum* var. *pseudotriquetrum*, leaf. 5, *B. alpinum*, leaf. 6, *B. mildeanum*, leaf. 7-8, *B. sauteri*: 7, leaf; 8, rhizoidal gemma. 9-10, *B. valparaisense*: 9, leaf; 10, rhizoidal gemmae. 11-12, *B. klinggraeffii*: 11, leaf; 12, rhizoidal gemma. 13-15, *B. radiculosum*: 13, habit; 14, leaf; 15, rhizoidal gemma. 16, *B. rubens*, axillary gemmae. 17, *B. algovicum*, peristome. 18-19, *B. pallescens*: 18, habit; 19, endostome. 20, *B. funckii*, leaf. 21, *B. caespiticium*, leaf. 18 ( $\times 4$ ); 13 ( $\times 5$ ); 1, 2, 4, 5, 6, 7, 9, 11, 14, 20, 21 ( $\times 16$ ); 16 ( $\times 20$ ); 12, 15 ( $\times 60$ ); 17, 19 ( $\times 80$ ); 8, 10 ( $\times 100$ ); 3 ( $\times 120$ ).

- 28 Nerve yellow to reddish, excurrent in smooth arista (fig. 53, 13-15)

**B. radiculosum** Brid.

Leaves ovate-lanceolate, acuminate, denticulate at apex, plane or slightly recurved; nerve stout. Capsule ovoid-cylindrical, reddish, blackish when old. Forms dense, compact turfs on calcareous, exposed walls, rocks and soils, in the Mediterranean region, throughout the Peninsula and in Mallorca, Menorca and Pithyusic Islands. Esp, Prt, Bl.

- 28 Nerve green to reddish, excurrent in denticulate apiculus

**B. subapiculatum** Hampe

**B. microerythrocarpum** Müll.Hal. & Kindb. ex Macoun

Leaves oblong-acuminate, margin plane or slightly recurved. Forms lax, reddish green turfs, to 1 cm high, on exposed soils in the lowlands. Distribution poorly known. Esp, Prt.

- 29 Gemmae rarely more than 250 µm wide, mostly axillary; nerve narrow, excurrent in denticulate apiculus (fig. 53, 16)

**B. rubens** Mitt.

Leaves ovate-lanceolate to elliptical-acuminate, margin plane or slightly recurved, border yellow, of 1-3 rows of narrow, long thick-walled cells. Gemmae 180-260 µm wide, red crimson, with protuberant cells, abundant on short rhizoids or in clusters at stem base, occasionally in the leaf axils. Capsule cylindrical. Forms loose turfs, to 1 cm high, in openings, on wet, exposed slopes and nitrophilous soils, in the peninsular Mediterranean region and in Mallorca. Esp, Prt, Bl.

- 29 Gemmae usually more than 250 µm wide, never axillary; nerve stout, excurrent in denticulate arista to 450 µm long

**B. bornholmense** Wink. & R. Ruthe

Leaves ovate-acuminate, margin plane, border distinct, sometimes yellow. Rhizoidal gemmae on long rhizoids, 160-300 µm wide, orange to reddish, with slightly or non-protuberant cells. Capsule cylindrical. Forms lax turfs on slopes and by roadsides. Distribution poorly-known, scattered in the east of the Peninsula. Esp.

- 30 Endostome with short or rudimentary cilia, rarely long and appendiculate; plants synoicous 31

- 30 Endostome with long, appendiculate cilia; plants autoicous, dioicous or synoicous 33

- 31 Endostome partially joined to exostome, inner side of exostome with transverse striae united by oblique bands (fig. 53, 17)

**B. algovicum** Sendtn. ex Müll.Hal.

Leaves ovate-lanceolate, acuminate, margin recurved from base to apex, border of 5 rows of cells; laminal cells hexagonal, about 15 µm wide; nerve stout, excurrent, red at base. Capsule cylindrical-ovoid or ovoid-oblong, mouth constricted, reddish; spores 22-36 µm. Forms dense turfs on calcareous rocks and soils and on dunes, in the north of the Peninsula and in Sierra Nevada. Esp.

- 31 Endostome not joined to exostome, inner side of exostome with transverse striae without oblique bands or bands inconspicuous 32

- 32 Capsule symmetrical; endostome segments with narrow or wide, ovate perforations, cilia short

**B. archangelicum** Bruch & Schimp.

**B. imbricatum** (Schwägr.) Bruch & Schimp., **B. stenotrichum** Müll.Hal.

Leaves ovate-lanceolate, acuminate, margin recurved from base to apex, border wide, of 3-5 rows of cells; laminal cells 14-18 µm wide; nerve stout, reddish at base, excurrent in long,



denticulate point. Capsule ovoid-oblong, constricted at mouth, neck 1/3 of urn length; exostome teeth yellow or orange at base, hyaline at apex, cilia fragile, rarely solitary, narrow and appendiculate. Forms dense, green to brownish green turfs, to 2 cm high, on dry soils, walls and in rock crevices, in the north of the Peninsula and in Sierra Nevada. Esp, And.

- 32 Capsule  $\pm$  gibbous; endostome segments with ovate perforations, cilia long, nodulose or appendiculate **B. intermedium** (Brid.) Blandow

Leaves ovate to widely ovate-lanceolate, acuminate, red at base, border of 2-3 rows of cells; laminal cells about 15  $\mu$ m wide; nerve stout, excurrent in denticulate point. Exostome orange at base, with yellow or brownish yellow teeth; spores 18-24  $\mu$ m. Forms dense, green or yellowish green turfs on wet, usually calcareous soils, in the Pyrenees. Esp.

- 33 Leaf border distinct, of several rows of narrow cells; autoicous or synoicous 34

- 33 Leaf border narrow or indistinct; dioicous 35

- 34 Plants autoicous or synoicous; spores 14-22  $\mu$ m, papillose, brownish green; stem simple or densely branched (fig. 53, 18-19) **B. pallescens** Schleich. ex Schwägr.

Stem with abundant rhizoids. Leaves at stem apex ovate to ovate-lanceolate, acuminate, margin recurved from base to apex, border of 3-5 rows of cells; laminal cells 40-60 x 14-18(-22)  $\mu$ m; nerve stout at base, noticeably narrower above, percurrent to excurrent. Capsule inclined to horizontal, longly pyriform, symmetrical, neck nearly half of the urn length; exostome orange at base, with yellow teeth, endostome pale yellow. Forms dense or compact turfs, to 3 cm high, on wet soils, walls and calcareous or siliceous rocks, in montane areas and high mountains, in the north of the Peninsula. Esp, And, Prt.

- 34 Plants synoicous; spores 10-14  $\mu$ m, smooth, yellowish; stem slightly branched **B. creberrimum** Taylor

**B. cuspidatum** (Bruch & Schimp.) Schimp.

Leaves crowded at stem apex, ovate-lanceolate, acuminate, margin recurved from base to apex, border wide; laminal cells 40-50 x 14  $\mu$ m; nerve stout, excurrent in long point. Capsule longly ovoid, neck 1/3 of the urn length; exostome red to orange at base, with yellow teeth. Forms dense turfs, to 2 cm high, on wet soils and walls, in montane areas and high mountains. Scattered in the Peninsula. Esp.

- 35 Leaves widely ovate, concave; nerve excurrent in short point (fig. 53, 20) **B. funckii** Schwägr.

Stem with innovations, fertile shoots capitate, the sterile ones julaceous, fragile. Leaves imbricate, margin plane, border indistinct; laminal cells 30-45 x 16-20  $\mu$ m; nerve stout, reddish at base. Spores 16-18  $\mu$ m. Forms lax, glossy pink turfs, to 1 cm high, in calcareous grasslands in the Pyrenees. Esp.

- 35 Leaves ovate-lanceolate; nerve excurrent in arista (fig. 53, 21) **B. caespiticium** Hedw.

Stem with innovations. Leaves erect, in comal tufts, margin recurved, border indistinct; laminal cells 30-70 x 12-15  $\mu$ m. Capsule ovoid to pyriform, neck nearly half of the urn length; spores 9-15  $\mu$ m. Forms dense or compact, light green to yellowish or brownish turfs, to 2 cm high, on exposed, calcareous or siliceous soils, from coastal areas to high mountains, in the Peninsula and in Mallorca and Pithyusic Islands. Esp, Prt, And, Bl.



- 36 Leaves ovate, obtuse to rounded (fig. 54, 1-3)  
**B. cyclophyllum** (Schwägr.) Bruch & Schimp.  
 Laminal cells  $\pm 20 \mu\text{m}$  at apex, irregularly hexagonal; nerve thin, ending below apex. Forms turfs, by streams or on wet, sandy or muddy soils. Reported from the southwest of the Peninsula. Esp, Prt.
- 36 Leaves ovate-lanceolate or widely ovate, acute to acuminate 37
- 37 Endostome yellow to brownish yellow; plants synoicous or dioicous 38
- 37 Endostome pale yellow or hyaline; plants dioicous or autoicous 39
- 38 Exostome teeth opaque, brownish at base, strongly papillose, with articulations joined by longitudinal lamellae; endostome segments with narrow perforations and short, rudimentary cilia; capsule  $\pm$  gibbous; synoicous (fig. 54, 4-5)  
**B. arcticum** (R. Br.) Bruch & Schimp.  
 Leaves ovate-lanceolate, acuminate; nerve green or brownish, percurrent. Capsule pyriform, constricted at mouth. Forms short, reddish turfs on calcareous rocks and in wet rock crevices, in montane areas and high mountains, in the north of the Peninsula. Esp (Extinct).
- 38 Exostome teeth yellow from base, with articulations not joined by longitudinal lamellae; endostome segments with ovate perforations and long, appendiculate cilia; capsule symmetrical, pyriform; dioicous (fig. 54, 6) **B. pallens** Sw. ex anon.  
 Leaves ovate-lanceolate, margin recurved. Forms dense, dark green to wine-coloured turfs to 2 cm high, on wet or seeping soils and rocks and by streams, in the Pyrenees. Esp, And.
- 39 Nerve entirely dark brown; plants autoicous; capsule asymmetrical (fig. 54, 7-8)  
**B. uliginosum** (Brid.) Bruch & Schimp.  
 Stem to 2,5 cm high, with rhizoids. Leaves ovate-lanceolate, acuminate. Capsule neck as long as urn; endostome hyaline. Forms dark green turfs on seeping soils in montane areas, in the Pyrenees. Esp.
- 39 Nerve yellow or brownish at base; plants dioicous; capsule symmetrical 40
- 40 Leaves ovate-triangular, acuminate, plane, with wide base (fig. 54, 9-11)  
**B. turbinatum** (Hedw.) Turner  
 Leaves with yellowish border; laminal cells about  $18 \mu\text{m}$  wide, longly hexagonal; nerve brownish,  $\pm$  stout, percurrent to excurrent. Forms dense turfs, to 2,5 cm high, on flushed, acidic or basic soils and by streams, in the north of the Peninsula and in Sierra Nevada. Esp.
- 40 Leaves widely ovate, acute, concave, with narrow base, occasionally red (fig. 54, 12)  
**B. schleicheri** DC.  
 Laminal cells hexagonal, about  $30 \mu\text{m}$  wide; nerve yellow to brown, percurrent or excurrent. Capsule pyriform, constricted at mouth. Forms loose, light green turfs, to 10 cm high, on flushed soils and by streams, in high mountains in the north of the Peninsula and in Sierra Nevada. Esp, Prt, And.

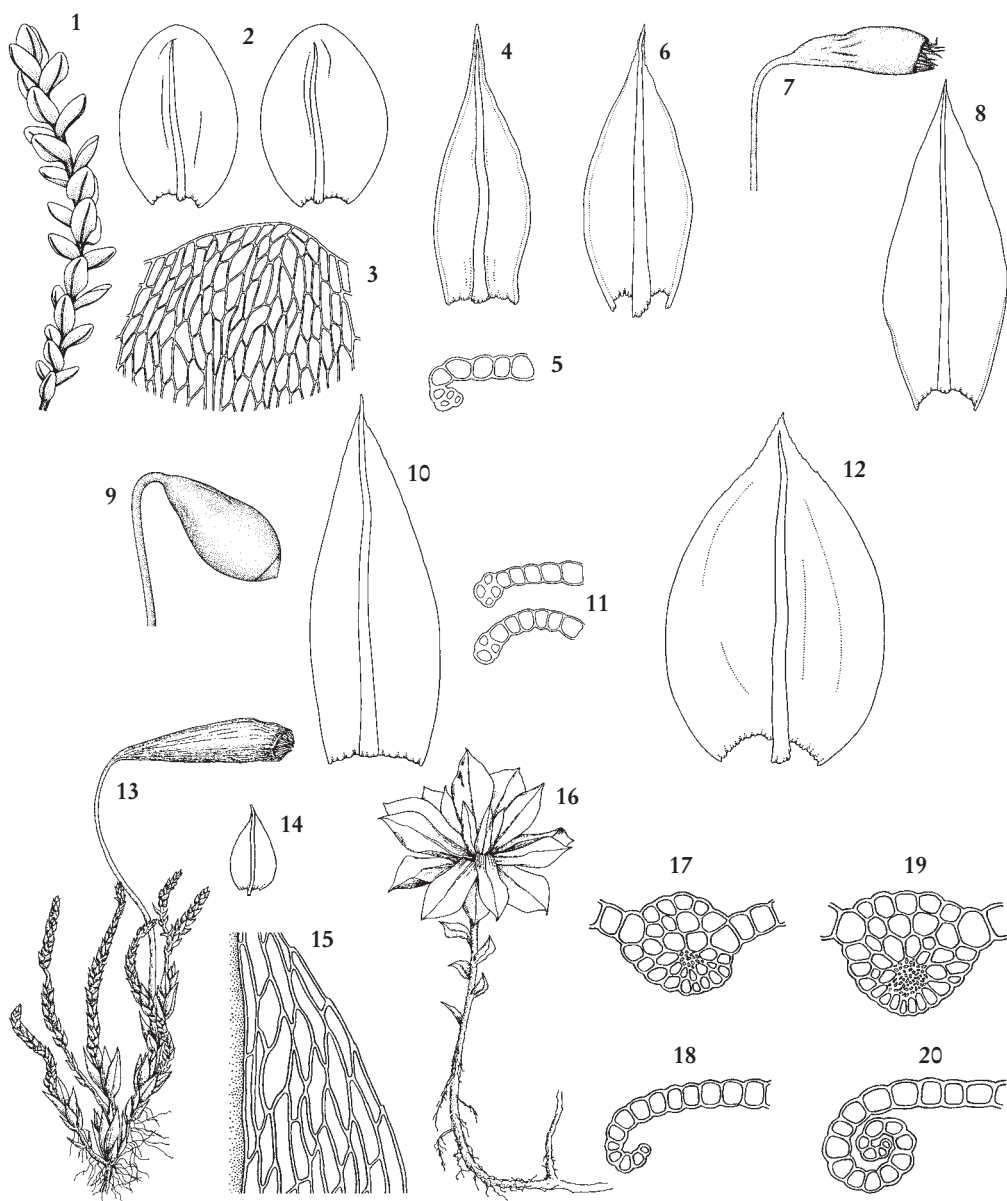


FIGURE 54. 1-3, *Bryum cyclophyllum*: 1, habit; 2, leaves; 3, leaf apex. 4-5, *B. arcticum*: 4, leaf; 5, leaf margin section. 6, *B. pallens*, leaf. 7-8, *B. uliginosum*: 7, capsule; 8, leaf. 9-11, *B. turbinatum*: 9, capsule; 10, leaf; 11, leaf margin sections. 12, *B. schleicheri*, leaf. 13-15, *Plagiobryum zieri*: 13, habit; 14, leaf; 15, laminal cells. 16-18, *Rhodobryum roseum*: 16, habit; 17, nerve section; 18, leaf margin section. 19-20, *R. ontariense*: 19, nerve section; 20, leaf margin section. 16 (x2); 1, 13 (x4); 7, 9 (x5); 2, 4, 6, 8, 10, 12, 14 (x16); 17, 18, 19, 20 (x100); 3, 15 (x120); 5, 11 (x160).

**Plagiobryum** Lindb.

Plants 1-3 cm tall, branched. Leaves ovate to ovate-lanceolate; laminal cells longly hexagonal to longly rhomboidal, lax; nerve percurrent to excurrent. Seta curved or sigmoid; capsule exserted, gibbous, mouth oblique, neck attenuate, as long as urn; peristome double, exostome shorter than endostome, cilia rudimentary.

- 1 Plants julaceous, whitish above, reddish below; leaves ovate, concave, imbricate; nerve percurrent (fig. 54, 13-15) **P. zieri** (Hedw.) Lindb.  
Median elongate-hexagonal or rectangular, cells of lamina 16-24  $\mu\text{m}$  wide, marginal cells narrower. Capsule horizontal. Grows in wet crevices of calcareous rocks, in the high mountains of the Pyrenees. Esp.
- 1 Plants hardly julaceous, reddish brown; leaves ovate-lanceolate, almost flat, not imbricate; nerve excurrent **P. demissum** (Hook.) Lindb.  
Median cells of lamina hexagonal to rectangular, 16-18  $\mu\text{m}$  wide, marginal cells narrower. Capsule pendulous. Grows on wet soils. Very rare in the high mountains of the Pyrenees. Esp.

**Rhodobryum** (Schimp.) Limpr.

Plants rhizomatous, with erect branches. Leaves crowded in terminal rosette, spatulate, dentate at apex, margin of narrow cells, recurved to revolute; median cells rhomboidal or hexagonal, 24-36  $\mu\text{m}$  wide, basal cells rectangular; nerve percurrent to excurrent. Capsule pendulous, ellipsoidal, with short neck.

- 1 Rosette of 16-21 leaves; leaf margin narrowly recurved; nerve percurrent, with a small stereid group, dorsal epidermis bistratose (fig. 54, 16-18) **R. roseum** (Hedw.) Limpr.  
Plants to 5 cm tall, dark green. Leaves 9-10 mm long. Forms loose turfs on shady soils, in montane areas of the north of the Peninsula. Esp.
- 1 Rosette of 18-52 leaves; leaf margin strongly revolute; nerve percurrent to excurrent, with a numerous group of stereids, dorsal epidermis unistratose (fig. 54, 19-20) **R. ontariense** (Kindb.) Kindb.  
Plants to 3 cm tall, light green. Leaves 5-6 mm long. Forms lax turfs on shady, humus-rich soils, in montane areas of the northern part of the Peninsula. Esp.

**Fam. Mielichhoferiaceae****Epipterygium** Lindb.

Stem reddish, 0,5-1 cm high. Leaves broadly ovate, margin plane, entire or denticulate at apex; median cells longly hexagonal, 20-40  $\mu\text{m}$  wide, marginal cells narrower; nerve reddish, vanishing towards middle of leaf. Capsule pyriform to ovoid, horizontal to inclined, abruptly narrowed into short neck (fig. 55, 1-3) **E. tozeri** (Grev.) Lindb.

Plants gregarious or forming loose turfs on damp, acidic slopes, rotting trunks, by streams, in grasslands and rock crevices. Scattered from coastal to montane areas of the Peninsula, Menorca and Pithusic Islands. Esp, Prt, Bl.

### **Mielichhoferia** Nees & Hornsch.

Stem slender, 1-3 cm high, branched, forming dense turfs on heavy-metal-containing rocks and soils. Leaves imbricate, ovate to lanceolate,  $\pm$  denticulate at apex; cells rhomboidal, long, thin-walled or thick-walled, basal cells rectangular; nerve percurrent. Capsule exserted, pyriform, straight, horizontal or pendulous, with distinct neck; peristome single, consisting of exostome with papillose teeth, endostome lacking or rudimentary. Dioicous.

- 1 Leaves ovate-lanceolate, margin plane, denticulate towards apex; median cells 10-20  $\mu\text{m}$  wide, thin-walled; nerve weak (fig. 55, 4-5)

**M. elongata** (Hoppe & Hornsch. ex Hook) Hornsch.

Stem simple or slightly branched. Forms light green or glaucous turfs, glossy above, brown below. Rare in the Central Pyrenees. Esp.

- 1 Leaves lanceolate, margin plane or slightly recurved, denticulate in the upper part; median cells 7-10  $\mu\text{m}$  wide, thick-walled; nerve stout (fig. 55, 6-8)

**M. mielichhoferiana** (Funck) Loeske

Stem branched. Forms light green turfs, glossy above, golden or brown below, in montane areas and high mountains of the Pyrenees, also very localized in the west of the Peninsula. Esp, Prt, And.

### **Pohlia** Hedw.

Plants variable in size, 1-10 cm tall. Stem branched or not. Leaves ovate to lanceolate, longer and narrower towards stem tip, apex acute or acuminate, rarely obtuse, denticulate above; laminal cells narrow, linear to longly hexagonal; nerve percurrent to excurrent. Capsule pendulous, ovoid to ellipsoidal, with short or long neck; peristome double, endostome with basal membrane and cilia sometimes rudimentary.

- |   |  |    |
|---|--|----|
| 1 | Stem without axillary bulbils                        | 2  |
| 1 | Stem with axillary bulbils                           | 11 |
| 2 | Leaf base longly and narrowly decurrent (fig. 55, 9) |    |

**P. ludwigii** (Spreng. ex Schwägr.) Broth.

Leaves more or less distant, erecto-patent, concave and ovate or ovate-lanceolate, obtuse, sometimes cucullate. Dioicous. Very rare, forms dark green turfs on damp soils, mainly in snow-beds in high mountains in the Pyrenees. Esp.

- |   |  |    |
|---|--|----|
| 2 | Leaf base slightly decurrent or not decurrent  | 3  |
| 3 | Median cells of lamina long and narrow, 6-14(-16) $\mu\text{m}$ wide; capsule cylindrical or pyriform; mainly monoicous plants | 4  |
| 3 | Median cells of lamina wide, 14-22 $\mu\text{m}$ wide; capsule ovoid, short; dioicous plants                                   | 10 |

- 4 Plants  $\pm$  glaucous, glossy, with metallic sheen 5
- 4 Plants not distinctly glossy, without metallic sheen 6
- 5 Plants to 4 cm tall; leaves flat, with entire margin (fig. 55, 10)  
***P. cruda*** (Hedw.) Lindb.  
 Stem 2-4 cm high. Perichaetial leaves long and narrow. Dioicous, paroicous or synoicous. Forms lax, light green or glaucous turfs on rocks, dry or wet soils, slopes, sandy soils or rotting stumps and in acidic rock crevices, in montane areas and high mountains of the Peninsula. Esp, Prt, And.
- 5 Plants to 1(-2) cm tall; leaves carinate, with denticulate margin at apex  
***P. bolanderi*** (Lesq.) Broth.  
 Leaves erect, imbricate. Perichaetial leaves similar to stem leaves. Dioicous. Similar to *P. andalusica*, both species are sterile in our area. Forms compact turfs on acidic soils in high mountains, in Sierra Nevada. Esp.
- 6 Laminal cells sub-linear; neck of capsule as long as urn or more; endostome yellowish, segments with narrow perforations 7
- 6 Laminal cells longly hexagonal; neck of capsule shorter than urn; endostome hyaline or yellowish, segments with wide perforations 8
- 7 Laminal cell with thin walls; basal membrane half the height of endostome (fig. 55, 11)  
***P. longicolla*** (Hedw.) Lindb.  
 Plants to 3 cm tall, bright light green. Leaves erect, densely arranged along stem, apex often twisted through 180°. Paroicous. Forms dense turfs on soil and in rock crevices, in high mountains of the Pyrenees and the Serra da Estrela. Esp. Prt.
- 7 Laminal cell with walls 3  $\mu$ m thick or more; basal membrane 1/3-1/2 height of endostome (fig. 55, 12)  
***P. elongata*** Hedw.  
 Plants to 2 cm tall, light green. Lower leaves distant, upper leaves crowded at stem tip, margin plane or recurved. Capsule narrowly ovoid. Paroicous or autoicous. Forms loose turfs on soils and acidic rock crevices, in montane areas and high mountains of the northern half of the Peninsula, rare in the south. Esp, Prt, And.  
 var. ***elongata***: Stem to 2 cm high. Neck 1/2 of the capsule length. Paroicous (fig. 55, 12).  
 var. ***greenii*** (Brid.) A.J. Shaw (= *P. elongata* Hedw. var. *polymorpha* (Hoppe & Hornsch.) Nyholm, *P. minor* Schwägr.): Stem to 1 cm high. Neck less than 1/3 of the capsule length. Paroicous. Frequent in high mountains.  
 var. ***acuminata*** (Hoppe & Hornsch.) Huebener: Stem to 2 cm high. Neck 1/2 of the capsule length. Dioicous.
- 8 Plants with pyriform or globose rhizoidal gemmae (fig. 55, 13)  
***P. lescuriana*** (Sull.) Ochi  
 Plants to 1,5 cm tall, yellowish brown. Rhizoids dark brown and finely papillose and rhizoids light brown, smooth and bearing gemmae. Leaves lanceolate, acute, denticulate at apex; median cells rhomboidal, 9-12  $\mu$ m wide, marginal cells narrower. Forms loose turfs on wet soils in montane areas in the Pyrenees and in the northwestern part of the Peninsula. Esp, Prt.
- 8 Plants without rhizoidal gemmae 9

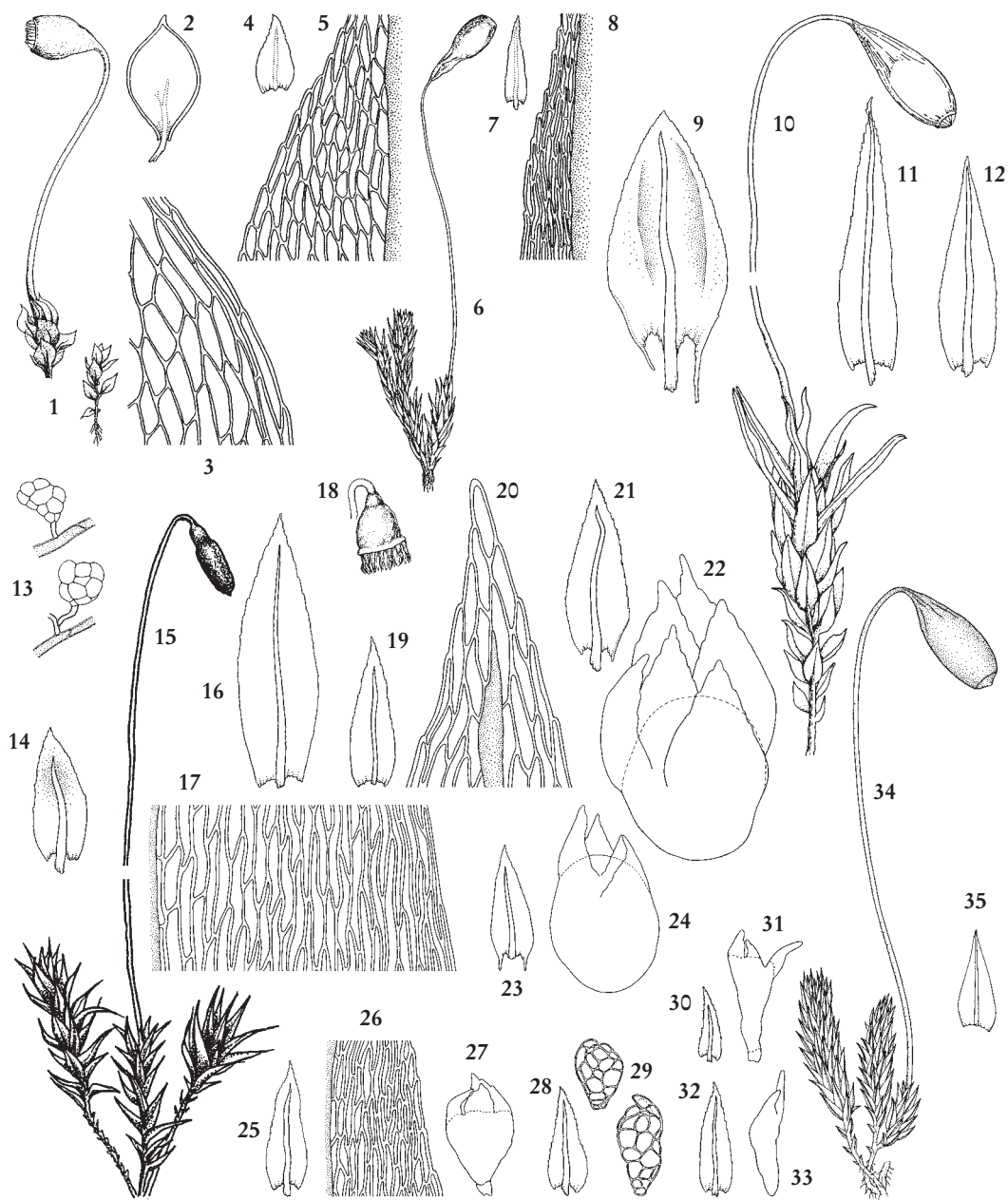


FIGURE 55. 1-3, *Epipterygium tozeri*: 1, habit, plants with and without sporophyte; 2, leaf; 3, laminal cells. 4-5, *Mielichhoferia elongata*: 4, leaf; 5, laminal cells. 6-8, *M. mielichhoferiana*: 6, habit; 7, leaf; 8, laminal cells. 9, *Pohlia ludwigii*, leaf. 10, *P. cruda*, habit. 11, *P. longicollis*, leaf. 12, *P. elongata* var. *elongata*, leaf. 13, *P. lescuriana*, rhizoidal gemmae. 14, *P. obtusifolia*, leaf. 15, *P. nutans*, habit. 16-17, *P. wahlenbergii*: 16, leaf; 17, laminal cells. 18-20, *P. melanodon*: 18, capsule; 19, leaf; 20, leaf apex. 21-22, *P. drummondii*: 21, leaf; 22, bulbil. 23-24, *P. filum*: 23, leaf; 24, bulbil. 25-27, *P. andalusica*: 25, leaf; 26, laminal cells; 27, bulbil. 28-29, *P. camptotrachela*: 28, leaf; 29, bulbils. 30-31, *P. annotina*: 30, leaf; 31, bulbil. 32-33, *P. prolifera*: 32, leaf; 33, bulbil. 34-35, *Schizymenium pontevedrensis*: 34, habit; 35, leaf. 1, 6, 10, 15, 34 ( $\times 5$ ); 18 ( $\times 10$ ); 2, 4, 7, 9, 11, 12, 14, 16, 19, 21, 23, 25, 28, 30, 32, 35 ( $\times 16$ ); 22 ( $\times 40$ ); 24 ( $\times 50$ ); 13, 27, 29, 31, 33 ( $\times 80$ ); 3, 5, 8, 17, 20, 26 ( $\times 120$ ).

- 9 Leaves widely ovate; laminal cells thin-walled; endostome faint, fragile with short basal membrane (fig. 55, 14) **P. obtusifolia** (Vill. ex Brid.) L.F. Koch  
Plants 1-2 cm tall. Leaves carinate, apex obtuse or acute. Paroicous. Forms dense, glossy pale green to blackish turfs in crevices and on rock ledges, in montane areas and high mountains, in the Pyrenees and the Iberian Range. Esp.
- 9 Leaves lanceolate; laminal cell walls 3  $\mu\text{m}$  thick or more; endostome well developed, basal membrane half the height of endostome (fig. 55, 15) **P. nutans** (Hedw.) Lindb.  
Stem simple, tomentose and with innovations at base. Capsule pyriform, pendulous, narrower below mouth. Paroicous. Forms loose or dense turfs, glossy, light or dark green on wet slopes and ledges by streams and peatlands, in montane areas and high mountains in the northern part of the Peninsula. Esp, Prt, And.
- 10 Plants light green, glaucous or whitish, 1-10 cm tall; leaves ovate-lanceolate (fig. 55, 16-17) **P. wahlenbergii** (F. Weber & D. Mohr) A.L. Andrews  
**Mniobryum wahlenbergii** (F. Weber & D. Mohr) Jenn.  
Forms lax turfs on seeping, acidic or basic soils and rocks, from the lowlands to the high mountains, in the Peninsula and Mallorca. Esp, Prt, And, Bl.
- 10 Plants pale green to reddish brown, to 1,5 cm tall; upper leaves narrowly lanceolate (fig. 55, 18-20) **P. melanodon** (Brid.) A.J. Shaw  
**Mniobryum delicatulum** (Hedw.) Dixon  
Sometimes with filamentous, hyaline rhizoidal gemmae. Forms loose turfs on damp, exposed, clayey soils and seeping slopes and rocks, from coastal to montane areas, in the Peninsula, Mallorca, Menorca and Pithyusic Islands. Esp, Prt, Bl.
- 11 Axillary bulbils solitary, ovoid 12
- 11 Axillary bulbils numerous, of various shapes 13
- 12 Leaves erect-spreading, ovate, concave, carinate, reddish at base; bulbils brownish red, primordia erect, arising from base or from middle of bulbil (fig. 55, 21-22) **P. drummondii** (Müll.Hal.) A.L. Andrews  
Plants 1-4 cm tall, light or dark green, slightly glossy. Bulbils 500-1000  $\mu\text{m}$ , brownish red, with green primordia. Forms dense turfs on damp, siliceous soils in high mountains, especially in snow-beds, in the north of the Peninsula and in Sierra Nevada. Esp, And.
- 12 Leaves erect, ovate-lanceolate, nearly plane, green at base; bulbils yellowish or brownish yellow, primordia apical (fig. 55, 23-24) **P. filum** (Schimp.) Martensson  
Bulbils 350-500  $\mu\text{m}$  with primordia short, triangular and wide at base. Forms loose turfs to 1,5 cm high in high mountains. Very rare, in the Central Pyrenees and in the northwest of the Peninsula. Esp, Prt.
- 13 Bulbils ovoid, the youngest yellowish green, 200-400  $\mu\text{m}$ , the oldest dark green or reddish, to 500  $\mu\text{m}$ , primordia erect, only at apex (fig. 55, 25-27) **P. andalusica** (Höhn.) Broth.



Plants 1-2 cm tall, bright green to glaucous. Leaves carinate. Forms dense or lax turfs on soils and in exposed, acidic rock crevices in the high mountains of the Pyrenees, Cantabrian Mountains and Sierra Nevada. Esp, And.

- 13 Bulbils ovoid, vermicular, turbinate or rounded, without primordia but with acute, more or less long teeth at apex 14
  
- 14 Bulbils  $\pm$  rounded (fig. 55, 28-29) **P. camptotrachela** (Renauld & Cardot) Broth.  
Plants 0,5-2 cm tall. Bulbils 80-130  $\mu$ m, yellowish, brownish when old, apical teeth of 1-2 cells. Forms loose, dull, pale green turfs on wet soils in montane areas of the northern half of the Peninsula. Esp, Prt.
  
- 14 Bulbils ovoid, turbinate or vermicular 15
  
- 15 Plants bright; bulbils turbinate, apical teeth 1/3 length of bulbil, oldest stems with obovate, turbinate bulbils with 2-4 unicellular or pluricellular teeth (fig. 55, 30-31)  
**P. annotina** (Hedw.) Lindb.  
Stem straight or prostrate, unbranched, 0,5-3 cm high. Forms lax, light green turfs on damp, shaded soils of montane areas. Scattered throughout the north and west of the Peninsula. Esp, Prt.
  
- 15 Plants somewhat bright, or dull; bulbils vermicular, apical teeth to 1/4 length of bulbil 16
  
- 16 Bulbils green or yellowish, with 1-2 long apical teeth, about 1/4 length of bulbil (fig. 55, 32-33) **P. proligera** (Kindb.) Lindb. ex Broth.  
Stem straight, unbranched, 1,5-2,5 cm high. Forms lax, glossy, light green turfs on wet soils. Scattered in the north of the Peninsula, rarer in the south. Esp, Prt.
  
- 16 Bulbils reddish, without apical teeth or with teeth up to 30  $\mu$ m long, 1/10 length of bulbil **P. flexuosa** Hook.  
Stem 0,5-2 cm high. Occasional obovoid bulbils have slightly differentiated primordia at stem base. Forms light green, dense or lax turfs, on slopes and wet grasslands in montane areas. Rare, in the Eastern Pyrenees. Esp.

### **Schizymenium** Harv.

Stem slender, to 1 cm high, yellowish green, branched at base. Leaves imbricate, ovate-lanceolate, acute, apex denticulate, margin recurved at base; median cells linear, 75-90  $\times$  7-8  $\mu$ m, basal cells shorter, wide; nerve percurrent or shortly excurrent. Capsule exserted, pyriform, with perceptible neck, inclined to pendulous, inclined when old; peristome single, consisting of endostome with smooth segments, exostome lacking. Synoicous (fig. 55, 34-35) **S. pontevedrensis** (Luisier) Sérgio, Casas, Cros & Brugués

Forms dense turfs on wet, shaded, granitic or schistose rocks, in the lowlands and montane areas, in the west of the Peninsula. Esp, Prt.



**Fam. Mniaceae****Mnium Hedw.**

Stem up to 4-5 cm high, generally unbranched. Leaves ovate or lanceolate; laminal cells rectangular or hexagonal, marginal cells longer, forming a border 2-3-stratose of elongate cells, with geminate teeth (except *M. stellare* which has leaves unbordered and simple teeth); nerve ending below apex, percurrent or excurrent in apiculus, often toothed at back above. Capsule oblong, inclined to pendulous; peristome double.

- 1 Plants bluish when dry; leaves unbordered; margin with simple teeth (fig. 56, 1-2)

**M. stellare** Hedw.

Dioicous. Laminal cells 20-40  $\mu\text{m}$  wide. Forms dense or lax turfs on usually calcareous soils and rocks, in montane areas of the north and west of the Peninsula. Esp, Prt, And.

- 1 Plants not bluish when dry; leaves bordered; margin with geminate teeth 2

- 2 Laminal cells rectangular or hexagonal, with uniformly thickened walls; lid rostrate or apiculate 3

- 2 Laminal cells isodiametric, some elongated, with thickened walls at corners; lid rostrate 5

- 3 Nerve smooth or with a few teeth at back above; synoicous (fig. 56, 3-4)

**M. spinulosum** Bruch & Schimp.

Leaves orbicular, bright, with stout margin. Lid rostrate. Forms lax turfs, 2-3 cm high in montane areas. Scattered in the northeast of the Peninsula. Esp.

- 3 Nerve with numerous acute teeth at back above; dioicous 4

- 4 Stem with abundant triangular leaves below; upper leaves elliptical, slightly decurrent; nerve ending below apex or percurrent (fig. 56, 5-8) **M. hornum** Hedw.

Stem straight or slightly curved, tomentose. Laminal cells 17-35  $\mu\text{m}$  wide. Lid apiculate. Forms lax turfs, 3-4 cm high on damp soils in beechwoods, oakwoods and pinewoods in the north and west of the Peninsula and in Algeciras Mountains. Esp, Prt, And.

- 4 Triangular leaves on lower part of stem scarce or absent; upper leaves elliptical to lanceolate, widely decurrent; nerve excurrent (fig. 56, 9-10)

**M. spinosum** (Voit.) Schwägr.

Laminal cells 20  $\mu\text{m}$  wide, in radiating rows. Lid rostrate. Forms lax turfs in fir woods, beechwoods, oakwoods and pinewoods in the northwest and northeast of the Peninsula. Esp, And.

- 5 Laminal cells of leaf homogeneous, 15-17  $\mu\text{m}$  wide (fig. 56, 11-12)

**M. thomsonii** Schimp.

Stem straight or slightly curved. Leaves ovate-lanceolate, decurrent; nerve stout, reddish, toothed at back above. Dioicous. Forms loose turfs on calcareous soils and rocks, in montane areas of the north of the Peninsula. Esp, And.

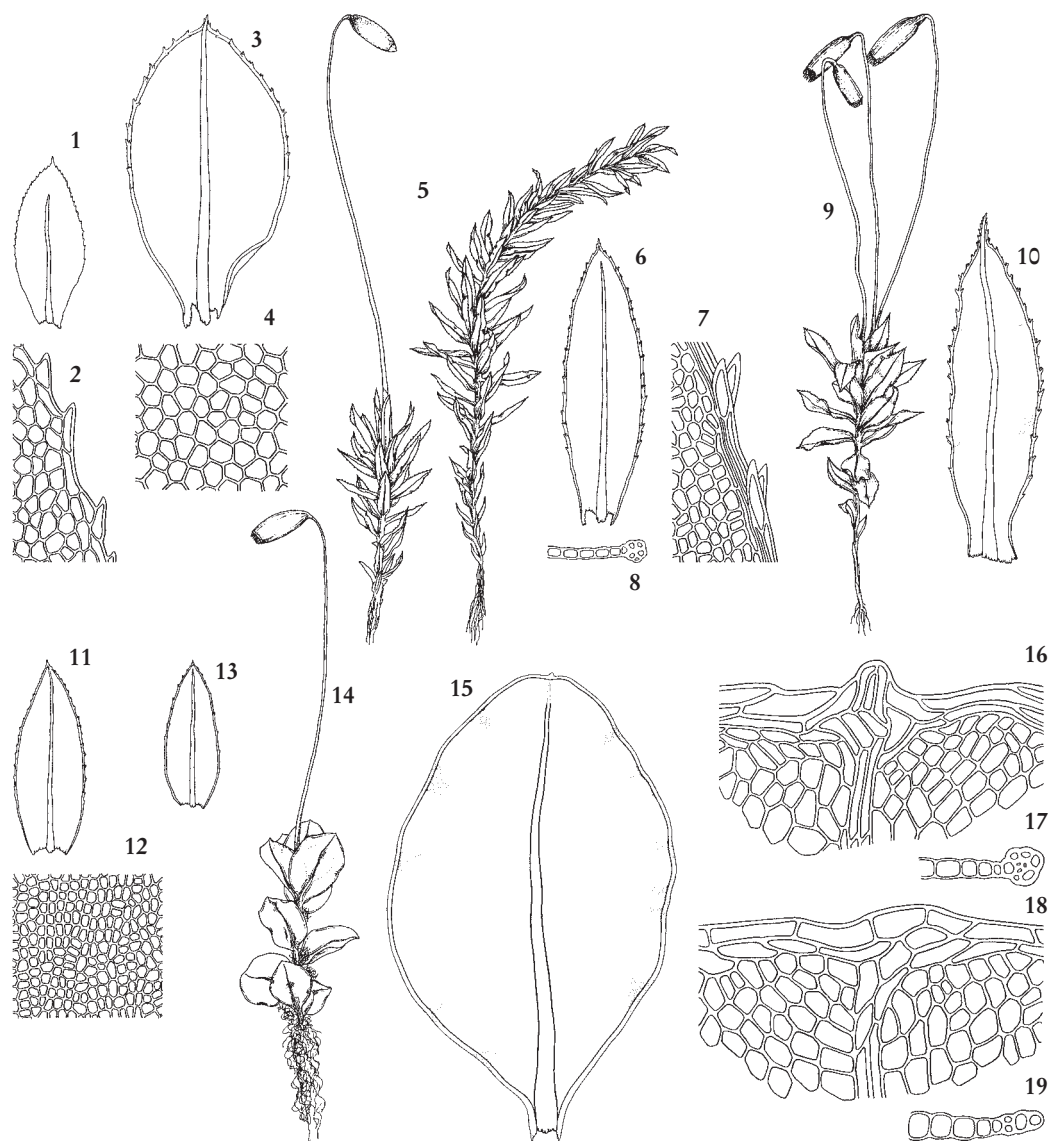


FIGURE 56. 1-2, *Mnium stellare*: 1, leaf; 2, leaf margin. 3-4, *M. spinulosum*: 3, leaf; 4, laminal cells. 5-8, *M. hornum*: 5, habit, plants with and without sporophyte; 6, leaf; 7, leaf margin; 8, leaf margin section. 9-10, *M. spinosum*: 9, habit; 10, leaf. 11-12, *M. thomsonii*: 11, leaf; 12, laminal cells. 13, *M. lycopodioides*, leaf. 14-17, *Rhizomnium punctatum*: 14, habit; 15, leaf; 16, leaf apex; 17, leaf margin section. 18-19, *R. magnifolium*: 18, leaf apex; 19, leaf margin section at base. 5, 9, 14 ( $\times 1,5$ ); 1, 3, 6, 10, 11, 13, 15 ( $\times 8$ ); 2, 4, 7, 8, 12, 16, 17, 18, 19 ( $\times 100$ ).

- 5 Laminar cells of leaf heterogeneous, more than 17  $\mu\text{m}$  wide, towards nerve wider, towards margin isodiametric 6
- 6 Synoicous; leaf apex apiculate; marginal teeth blunt; nerve percurrent, lacking teeth at back or with a few teeth in comal tuft leaves **M. marginatum** (Dicks.) P. Beauv.  
Stem and leaves often dark red. Forms lax turfs, to 3 cm high, on wet, usually calcareous rocks and soils, in montane areas of the north of the Peninsula, sporadic in the southeast and Mallorca. Esp, Bl.
- 6 Dioicous; leaf apex acute; marginal teeth sharp; nerve percurrent, with numerous, acute teeth at back (fig. 56, 13) **M. lycopodioides** Schwägr.  
**M. ambiguum** H. Müll.  
Leaves ovate, fertile shoots with longer leaves. Grows on wet, acidic slopes in montane areas of the north of the Peninsula. Esp, And.

### Fam. Cinclidiaceae

#### **Rhizomnium** (Broth.) T.J. Kop.

Plants erect, to 10 cm tall. Stem with macronemata, micronemata present or not. Leaves orbicular, elliptical or obovate, apex rounded, sometimes emarginate or apiculate, bordered by narrow, elongate cells, margin entire; laminar cells 30-50  $\mu\text{m}$  wide, longly hexagonal. Capsule ovoid to oblong, horizontal or pendulous. Dioicous.

- 1 Leaf margin pluristratose; stem with macronemata, micronemata lacking (fig. 56, 14-17) **R. punctatum** (Hedw.) T.J. Kop.  
Leaves 4-8 mm long, apex apiculate; nerve stout, reddish brown, percurrent or excurrent. Forms turfs 1-10 cm high on very wet soils and rocks, by streams and on rotting stumps, in the north of the Peninsula, rare in the southeast and in Mallorca. Esp, Prt, And, Bl.
- 1 Leaf margin unistratose, only pluristratose in lower part; stem with macronemata and micronemata (fig. 56, 18-19) **R. magnifolium** (Horik.) T.J. Kop.  
Leaves 4-10 mm long, with rounded or emarginate apex; nerve percurrent, stout at base. Forms turfs to 5 cm high by streams and on damp, peaty soils in high mountains of the north of the Peninsula. Esp, Prt, And.

### Fam. Plagiomniaceae

#### **Plagiomnium** T.J. Kop.

Plants medium-sized to robust. Fertile shoots straight, with leaves arranged in 3 rows, the sterile ones creeping, with complanate leaves. Leaves plane or undulate, margin with simple teeth; marginal cells forming a unistratose border of narrow and elongated cells; nerve percurrent or excurrent in apiculus. Capsule ovoid to oblong, inclined or pendulous.

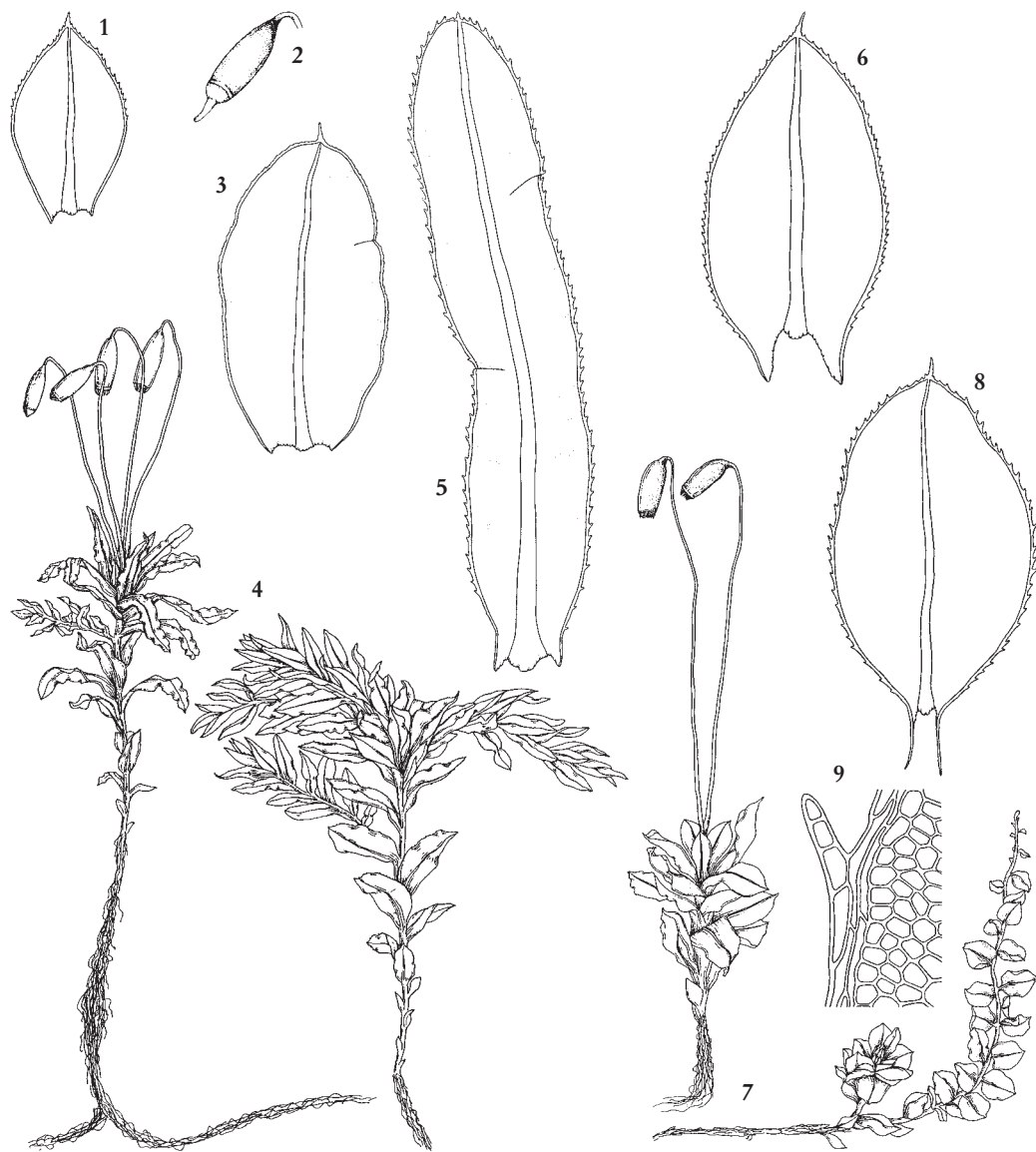


FIGURE 57. 1, *Plagiomnium cuspidatum*, leaf. 2, *P. rostratum*, capsule. 3, *P. ellipticum*, leaf. 4-5, *P. undulatum*: 4, habit, plants with and without sporophyte; 5, leaf. 6, *P. elatum*, leaf. 7-9, *P. affine*: 7, habit, plants with and without sporophyte; 8, leaf; 9, leaf margin. 4, 7 ( $\times 1,5$ ); 2 ( $\times 3$ ); 1, 3, 5, 6, 8 ( $\times 8$ ); 9 ( $\times 100$ ).

- 1 Leaves with dentate margin in upper half and acute apex (fig. 57, 1)  
**P. cuspidatum** (Hedw.) T.J. Kop.  
 Leave obovate, with acute marginal teeth; laminal cells with thickened walls at corners; nerve percurrent. Fertile shoots with one sporophyte per perichaetium. Forms lax turfs, 2-3 cm high, on wet soils of montane areas, rarely in the lowlands, in the north of the Peninsula and in Sierra Nevada. Esp.
- 1 Leaves with dentate margin from base, and acute or obtuse apex 2
- 2 Leaves not or only slightly decurrent 3
- 2 Leaves decurrent 4
- 3 Laminal cells hexagonal, isodiametric or slightly elongated,  $27-50 \times 20-30 \mu\text{m}$ ; marginal teeth blunt; lid rostrate; synoicous (fig. 57, 2)  
**P. rostratum** (Schrad.) T.J. Kop.  
 Laminal cells with thickened walls at corners; marginal teeth unicellular. Fertile shoots 2-5 cm high, 1-5 sporophytes per perichaetium. Forms lax, green or dark green turfs in wet soils, mainly in montane areas. Widespread in the northern half of the Peninsula, less frequent in the south and in Mallorca. Esp, Prt, Bl.
- 3 Laminal cells elongated,  $40-77 \times 22-37 \mu\text{m}$ ; marginal teeth sharp; lid convex; dioicous (fig. 57, 3)  
**P. ellipticum** (Brid.) T.J. Kop.  
 Leaves elliptical, apiculate, marginal teeth of 1-2 cells; laminal cells in divergent rows; nerve percurrent to excurrent. Fertile shoots about 10 cm high, 1-3 sporophytes per perichaetium. Forms turfs or patches on waterlogged soils in oakwoods and pinewoods of the north of the Peninsula. Esp, And.
- 4 Leaves oblong-lingulate, transversely undulate; laminal cells  $10-16 \mu\text{m}$  wide (fig. 57, 4-5)  
**P. undulatum** (Hedw.) T.J. Kop.  
 Fertile shoots branched, mostly with 2-5 sporophytes per perichaetium. Leaf margin with unicellular, sharp teeth. Forms turfs or patches about 10 cm high on damp or waterlogged soils, from the lowlands to montane areas. Common in the northern half of the Peninsula, Algeciras Mountains and in Mallorca. Esp, Prt, And, Bl.
- 4 Leaves widely elliptical, not undulate; laminal cells more than  $17 \mu\text{m}$  wide 5
- 5 Leaf with acute apex; laminal cells isodiametric or slightly elongated, with thickened walls at corners; marginal teeth of 1-2 cells; synoicous  
**P. medium** (Bruch & Schimp.) T.J. Kop.  
 Fertile shoots 3-9 cm high, densely tomentose, with 2-5 sporophytes per perichaetium. Sterile shoots arcuate, without rhizoids at apex. Forms turfs or patches on wet soils of montane areas in the northern half of the Peninsula. Esp, Prt, And.
- 5 Leaf with obtuse or mucronate apex; laminal cells elongated, cell walls uniformly thickened; marginal teeth of 1-4 cells; dioicous 6
- 6 Leaves longly and widely decurrent; marginal teeth of 1-2 cells (fig. 57, 6)  
**P. elatum** (Bruch & Schimp.) T.J. Kop.

Forms turfs or patches on wet, basic soils, mainly in montane areas, occasionally in the lowlands, in the northern half of the Peninsula and in Mallorca. Esp, And, Bl.

- 6 Leaves longly and narrowly decurrent; marginal teeth of 1-4 cells (fig. 57, 7-9)

**P. affine** (Blandow ex Funck) T.J. Kop.

Forms loose turfs or patches on wet soils and basic rocks, from the lowlands to montane areas. Scattered throughout the Peninsula and Mallorca. Esp, Prt, Bl.

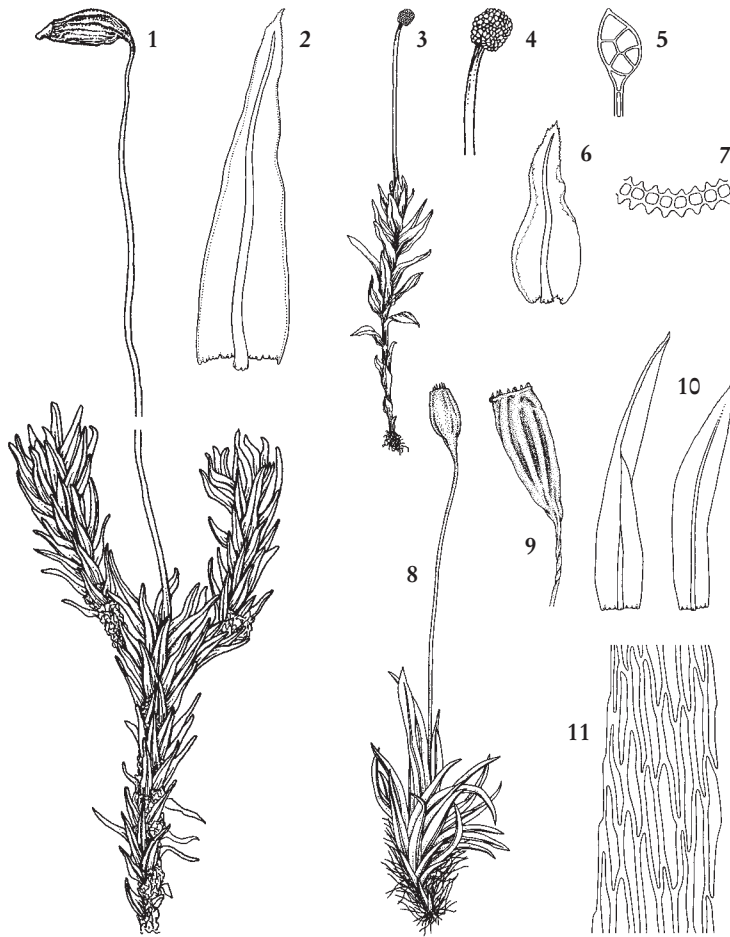


FIGURE 58. 1-2, *Aulacomnium palustre*: 1, habit; 2, leaf. 3-7, *A. androgynum*: 3, habit; 4, gemma cluster; 5, gemma; 6, leaf; 7, lamina section. 8-11, *Orthodontium pellucens*: 8, habit; 9, capsule when dry; 10, leaves; 11, median cells. 1 ( $\times 3$ ); 3 ( $\times 4$ ); 8 ( $\times 6$ ); 4, 9 ( $\times 10$ ); 2, 6, 10 ( $\times 16$ ); 5, 7, 11 ( $\times 160$ ).

**Fam. Aulacomniaceae****Aulacomnium** Schwägr.

Leaves ovate-lanceolate to lanceolate, crisped when dry, margin entire, denticulate at apex or crenulate, recurved or not; laminal cells rounded-hexagonal, thick-walled, with lumen stellate and single, conical papilla on both surfaces; nerve percurrent. Seta straight; capsule cylindrical, striate; peristome double. Often with gemmae in globose clusters at the end of leafless prolongations of stems.

- 1 Stem with dense, brown tomentum; median cells of lamina 8-14  $\mu\text{m}$  wide, basal cells rectangular, enlarged (fig. 58, 1-2) **A. palustre** (Hedw.) Schwägr.  
 Leaf apex entire or dentate, sometimes obtuse. Occasionally with fusiform gemmae. Forms extensive, dense or compact, light green or yellowish turfs, to 12 cm high, in peaty or wet grasslands and moorlands, in montane areas and high mountains. Widespread in the northern half of the Peninsula, rare in the south. Esp, Prt, And.
- 1 Stem with scarce tomentum; median cells of lamina 10-12  $\mu\text{m}$  wide, basal cells narrowly rectangular (fig. 58, 3-7) **A. androgynum** (Hedw.) Schwägr.  
 Leaf apex acute, dentate. Usually with pluricellular ovoid to spherical gemmae in globose clusters. Forms lax, green turfs, to 3 cm high, on wet, shaded, acidic slopes, bases of trees and tree stumps, in montane areas of the Peninsula. Esp, Prt.

**Fam. Orthodontiaceae****Orthodontium** Schwägr.

Stem to 0,5 cm high, densely tomentose at base. Leaves linear-lanceolate, acuminate, carinate, margin plane, denticulate at apex; median cells smooth, linear 60-180  $\times$  10-12  $\mu\text{m}$ ; nerve evanescent. Seta straight; capsule exserted, erect, oblong-pyriform, sulcate when dry, with short neck; peristome double, exostome pale yellow, with smooth, or finely papillose teeth, endostome with fragile segments, hyaline at base (fig. 58, 8-11)

**O. pellucens** (Hook.) Bruch & Schimp.

Grows in shaded, siliceous rock crevices and on rotten wood. Only one locality in the northwest of the Peninsula. Esp (Extinct).

**O. Hookeriales****Fam. Hypopterygiaceae****Hypopterygium** Brid.

Plants to 2,5 cm long. Primary stem creeping, secondary stems erect, pinnately branched, dendroid. Leaves with finely denticulate margin in the upper part, arranged in 3 rows, two rows of asymmetrical, ovate, distichous leaves with acute apex and a third row of symmetrical, orbicular, ventral leaves with acuminate apex; laminal cells quadrangular

to hexagonal, 10  $\mu\text{m}$  wide, 1-5 rows of longer marginal cells; nerve extending half way up to nearly reaching apex (fig. 59, 1-4)

**H. tamarisci** (Sw.) Brid. ex Müll.Hal.

**H. muelleri** Hampe

Grows on wet, shaded sites. Very rare, in Serra do Bussaco. Prt.

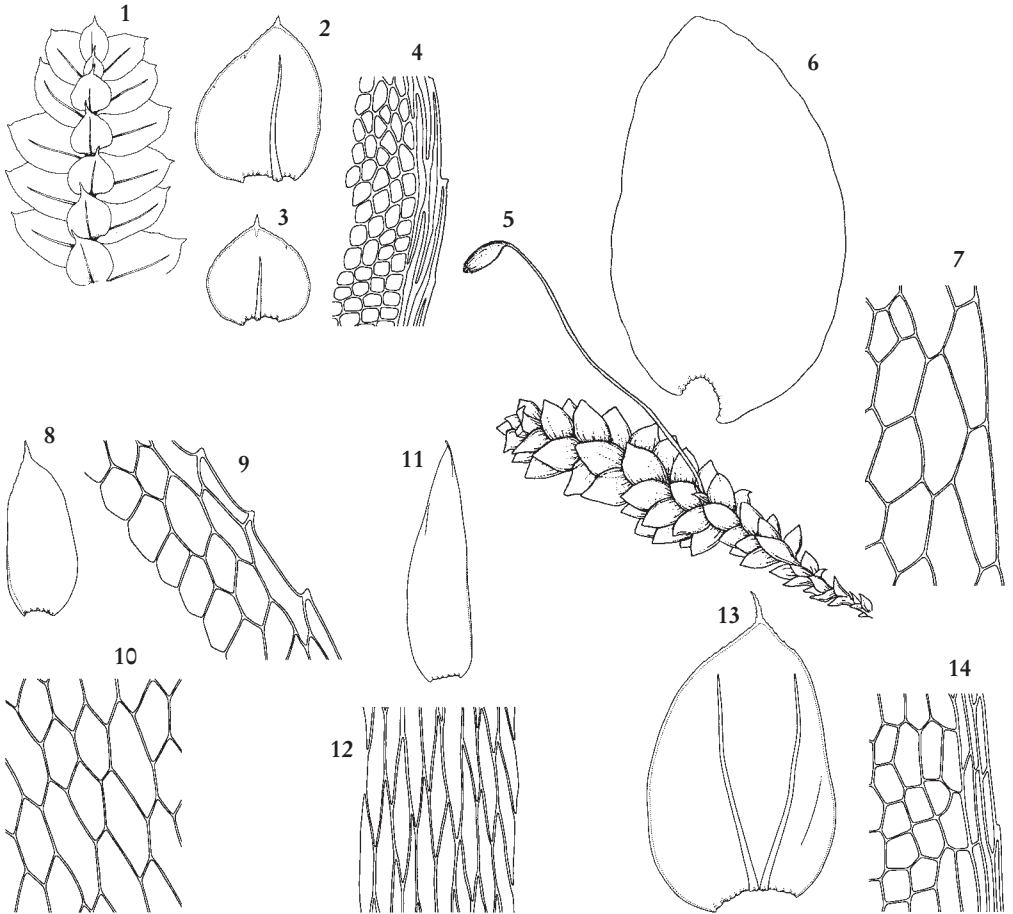


FIGURE 59. 1-4, *Hypopterygium tamarisci*: 1, habit; 2, leaf; 3, leaf on ventral side; 4, marginal cells. 5-7, *Hookeria lucens*: 5, habit; 6, leaf; 7, marginal cells. 8-10, *Tetrastichium fontanum*: 8, leaf; 9, upper marginal cells; 10, median cells. 11-12, *T. virens*: 11, leaf; 12, median cells. 13-14, *Cyclodictyon laetevirens*: 13, leaf; 14, marginal cells. 5 ( $\times 2$ ); 1 ( $\times 10$ ); 6 ( $\times 12$ ); 2, 3, 8, 11, 13 ( $\times 16$ ); 7 ( $\times 100$ ); 4, 9, 10, 12, 14 ( $\times 160$ ).



**Fam. Hookeriaceae****Hookeria Sm.**

Stem decumbent, 4 cm long, sparsely branched. Leaves ovate, obtuse, asymmetrical, complanate, margin plane, entire; laminal cells hexagonal, 60-100  $\mu\text{m}$  wide, smooth, usually narrower at margins; nerve lacking. Capsule ellipsoidal, horizontal, brownish; peristome double, exostome reddish, endostome yellowish (fig. 59, 5-7)

**H. lucens** (Hedw.) Sm.

Forms glossy, pale green patches on wet soils and seeping rocks in montane areas. Widespread in the northern half of the Peninsula, rare in the south. Esp, Prt.

**Fam. Leucomiaceae****Tetrastichium** (Mitt.) Cardot

Plants medium-sized. Stem irregularly branched. Stem leaves complanate, oblong, lanceolate to ovate, symmetrical to strongly asymmetrical, gradually or abruptly tapered, acute, acuminate or apiculate, concave, margin entire or denticulate at apex; lamina with marginal cells narrower than median cells, alar cells not differentiated, not decurrent; nerve short, single or double, or lacking. Branch leaves similar to stem leaves or smaller.

- 1 Leaves oblong to oblong-ovate, denticulate at apex; median cells 21-45  $\mu\text{m}$  wide (fig. 59, 8-10) **T. fontanum** (Mitt.) Cardot

Leaves often strongly asymmetrical, suddenly narrowed to acuminate or apiculate apex. Grows on wet, shaded rocks. Very rare, in Algeciras Mountains. Esp.

- 1 Leaves lanceolate to ovate-lanceolate, margin entire or slightly denticulate near apex; median cells 10-16  $\mu\text{m}$  wide (fig. 59, 11-12) **T. virens** (Cardot) S.P. Churchill

**Lepidopilum virens** Cardot

Leaves symmetrical or slightly asymmetrical, gradually or rather suddenly narrowed to acute or acuminate apex. Grows on seeping, shaded rocks. Very rare, in Algeciras Mountains. Esp.

**Fam. Pilotrichaceae****Cyclodictyon** Mitt.

Plants slender to medium-sized. Stem decumbent, pinnately branched, sparsely to densely tomentose. Leaves shrunk when dry, complanate, asymmetrical, concave, broadly ovate, acute or apiculate, margin denticulate near apex; laminal cells large, hexagonal, thin-walled, 15-20  $\mu\text{m}$  wide, 3-4 marginal rows very narrow, forming a distinct border; nerve double, divergent, extending to 3/4 way up leaf. Capsule horizontal, ovoid (fig. 59, 13-14) **C. laetevirens** (Hook. & Taylor) Mitt.

Forms soft dark green patches on seeping slopes by streams, in the lowlands in the northwest of the Peninsula. Esp, Prt (Extinct).

## O. Hypnales Fam. Fontinalaceae

### Dichelyma Myrin

Plants large, rheophilous, regularly branched. Leaves tristichous, lanceolate, carinate, acuminate,  $\pm$  falciform, secund, with denticulate apex; laminal cells uniform, very long and narrow, basal cells shorter; nerve percurrent to excurrent in short point. Capsule cylindrical, exserted (fig. 60, 1)

**D. falcatum** (Hedw.) Myrin

Plants dark green, flexuose. Forms loose tufts on submerged rocks in waterfalls in montane areas in the Pyrenees. Very rare. Esp.

### Fontinalis Hedw.

Plants slender to robust, rheophilous, sometimes floating. Stem flexuose, irregularly branched. Leaves lanceolate to ovate-lanceolate, plane, concave or carinate, margin plane, entire or denticulate at apex; laminal cells elongate, narrow, smooth, alar cells short and wider; nerve lacking. Perichaetial leaves short, wide, usually erose. Seta short; capsule ovoid, immersed; peristome double.

- 1 Leaves carinate (fig. 60, 2-3) **F. antipyretica** Hedw.

Plants robust, 10-25 cm long, dark green to brownish,  $\pm$  glossy. Leaves erect, decurrent; laminal cells 10-15  $\mu$ m wide, narrower towards margin. Species very polymorphic. Forms loose tufts, floating, fixed to rocks submerged in streams, from the lowlands to high mountains, in the Peninsula and in Mallorca and Menorca. Esp, Prt, And, Bl.

- 1 Leaves plane or concave, not carinate 2

- 2 Leaves plane, border not differentiated (fig. 60, 4-5)  
**F. hypnoides** C. Hartm. var. **duriaei** (Schimp.) Kindb.

**F. duriaei** Schimp.

Plants medium-sized to robust. Leaves ovate-lanceolate, with short, wide, denticulate point; cells 6-12  $\mu$ m wide, narrower towards margin, alar cells wide, yellow to brownish. Forms loose, floating or submerged tufts, 10-30 cm long, fixed to rocks in streams, pools or ponds, in the lowlands, rarer in montane areas, in the Peninsula and in Mallorca and Menorca. Esp, Prt, Bl.

- 2 Leaves concave, border of 1-4 rows of narrow cells 3

- 3 Border of 1-2 rows of narrow cells, yellowish or brownish; alar cells brownish (fig. 60, 6) **F. squamosa** Hedw.

Leaves imbricate, erecto-patent, ovate-lanceolate, acuminate; laminal cells 12  $\mu$ m wide. Forms loose, floating or submerged, dark green, olive or brownish tufts, 10-30 cm long, densely branched and fixed to rocks in streams of montane areas, in the northern half of the Peninsula. Esp, Prt, And.

- 3 Border of about 4 rows of narrow cells, green; alar cells hyaline (fig. 60, 7-11)  
**F. dalecarlica** Bruch & Schimp.

Plants slender, yellow green to golden, branches slender, attenuate-cuspidate at the tips. Leaves erect to erecto-spreading, ovate-lanceolate, acuminate, entire or slightly denticulate at apex; laminal cells 10  $\mu\text{m}$  wide, median cells incrassate. Perichaetial leaves with sharp point. Grows on submerged rocks, in the north of the Peninsula. Esp.

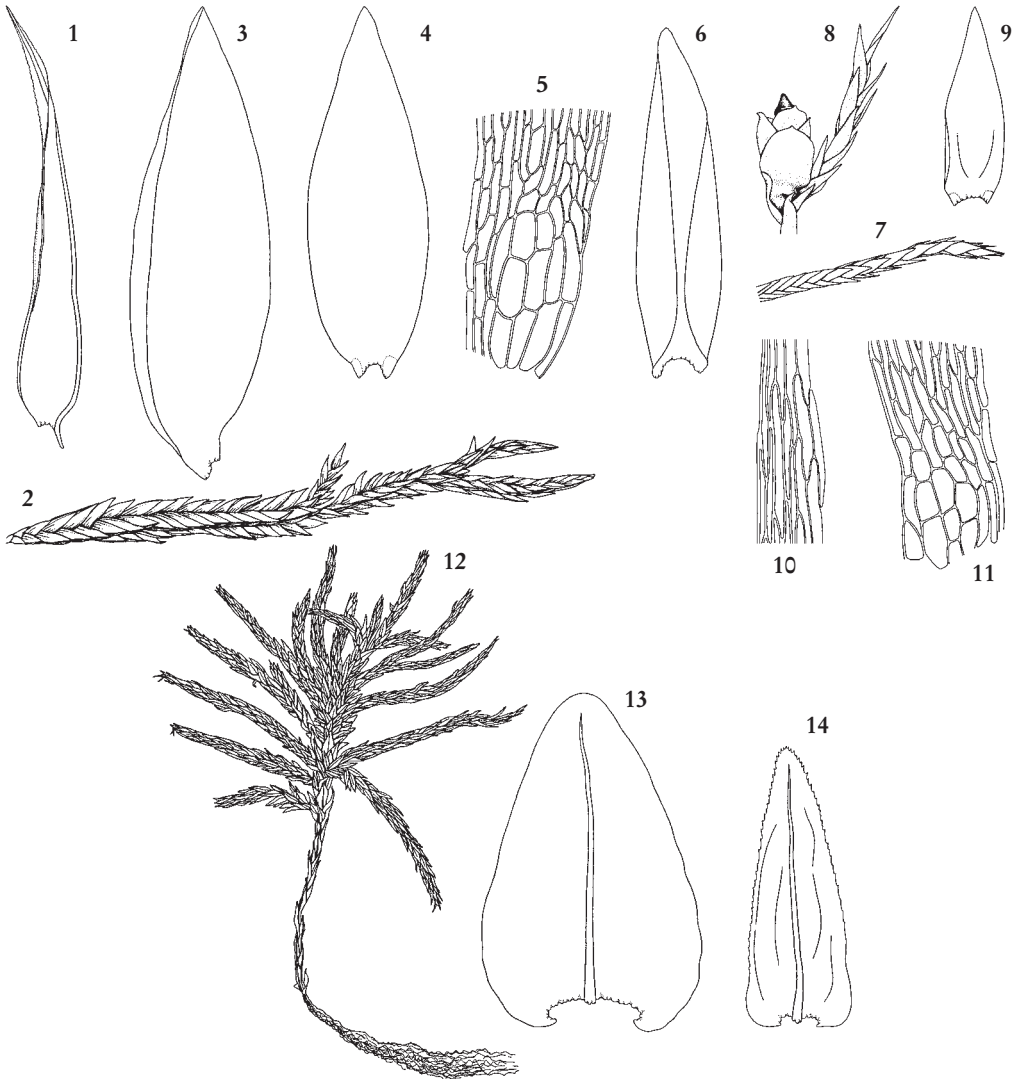


FIGURE 60. 1, *Dichelyma falcatum*, leaf. 2-3, *Fontinalis antipyretica*: 2, habit; 3, leaf. 4-5, *F. hypnoides* var. *duriaci*: 4, leaf; 5, alar cells. 6, *F. squamosa*, leaf. 7-11, *F. dalecarlica*: 7, habit; 8, capsule when dry; 9, leaf; 10, marginal cells; 11, alar cells. 12-14, *Climacium dendroides*: 12, habit; 13, leaf of secondary stem; 14, branch leaf. 2, 12 ( $\times 1,6$ ); 7 ( $\times 2,6$ ); 8 ( $\times 4$ ); 1, 3, 4, 6, 9, 13, 14 ( $\times 12$ ); 5, 10, 11 ( $\times 120$ ).

## Fam. Climaciaceae

### *Climacium* F. Weber & D. Mohr

Plants dendroid. Primary stem densely tomentose, subterranean, secondary stems erect. Leaves of secondary stems appressed, ovate-cordiform, obtuse or apiculate. Branch leaves ovate-lanceolate, obtuse, imbricate, plicate, margin plane or slightly recurved, dentate in the upper part; laminal cells elongate, smooth, alar cells quadrate; nerve nearly reaching the apex, stout at base. Seta long; capsule cylindrical (fig. 60, 12-14)

#### *C. dendroides* (Hedw.) F. Weber & D. Mohr

Secondary stems 3-10 cm high. Forms loose, glossy light green turfs in meadows, on damp soils and by streams, in montane areas and high mountains, in the northern half of the Peninsula. Esp, Prt, And.

## Fam. Amblystegiaceae

### *Amblystegium* Schimp.

Plants slender to medium size, usually in wet places. Stem procumbent, irregularly branched. Leaves straight or slightly curved, acuminate, margin entire or finely denticulate; laminal cells elliptical, rhomboidal or hexagonal, 2-6 times as long as wide, smooth; nerve, long or short, stout or thin, sometimes lacking. Capsule inclined, ellipsoidal to cylindrical, curved.

1 Plants very small; leaves to 0,5 mm long; nerve short and double, or lacking 2

1 Plants small to medium-sized; leaves more than 0,5 mm long; nerve long, single 3

2 Nerve lacking; plants saxicolous (fig. 61, 1-2) *A. confervoides* (Brid.) Schimp.

*Platydictya confervoides* (Brid.) H.A. Crum

Leaves to 0,3 mm long, erecto-spreading or erect, appressed when dry, ovate-lanceolate, straight or curved, margin entire; cells 2-4:1, apical cells shorter. Perichaetial leaves without nerve. Capsule curved to horizontal, asymmetrical. Forms rigid, dark green tufts on shaded, calcareous rocks, montane areas and high mountains. Rare, in the Pyrenees and Basque Mountains. Esp.

2 Nerve short; plants usually corticolous (fig. 61, 3-4) *A. subtile* (Hedw.) Schimp.

*Platydictya subtilis* (Hedw.) H.A. Crum

Plants rigid, dark green. Leaves 0,25-0,5 mm long, erecto-patent, ovate-lanceolate, longly acuminate, straight or curved, margin entire; apical cells of lamina elongate, 3-5:1, numerous, alar cells quadrate. Perichaetial leaves with nerve. Capsule erect or slightly inclined. Grows on rotting wood, rarely on rocks, in the lowlands and montane areas. Scattered in the northern half of the Peninsula. Esp.

3 Nerve reaching apex or nearly so; leaf cells mostly 2-4:1 (fig. 61, 5)

*A. varium* (Hedw.) Lindb.

*Hygroamblystegium varium* (Hedw.) Lindb.

Plants slender, light green or yellowish. Leaves 1-1,4 mm long, patent to spreading, ovate, abruptly tapering, margin finely denticulate; nerve yellow, curved. Forms loose patches on

soils by water and wet, shaded rocks and roots, on calcareous substrata, in the lowlands and montane areas. Distributed mainly in the eastern half of the Peninsula and in Mallorca. Esp, Prt, Bl.

- 3 Nerve extending to 3/4 way up leaf; leaf cells 3-6:1 4

- 4 Leaves to 1 mm long; plants slender (fig. 61, 6) **A. serpens** (Hedw.) Schimp.  
Stem procumbent, irregularly branched, with ascending branches or not. Leaves erecto-spreading, ovate to lanceolate, gradually tapering to long, fine acumen, margin finely denticulate. Forms small, light or dark green or yellowish patches on calcareous or siliceous soils and rocks, trunks and roots in wet, shaded sites, in the lowlands and montane areas. Widespread throughout the Peninsula. Esp, Prt.

- 4 Leaves more than 1 mm long; plants slender or medium sized (fig. 61, 7-8)  
**A. humile** (P. Beauv.) Crundw.

**Hygroamblystegium humile** (P. Beauv.) Vanderp., Goffinet & Hedenäs

Plants lax, yellowish green. Stem procumbent, with ascending branches or not. Leaves distant, ovate, abruptly tapering, margin entire; nerve yellowish, usually curved, extending more than 1/2 way up leaf. Grows on wet soils in grasslands and gardens and by waterways and pools in the lowlands. Scattered in the south and eastern part of the Peninsula. Esp, Prt.

### **Campyliadelphus** (Kindb.) R.S. Chopra

Plants slender. Stem procumbent, irregularly branched, with ascending or erect branches. Stem leaves straight or falciform, triangular or ovate, narrowed in channelled acumen, margin entire or denticulate; laminal cells linear, alar cells rectangular or quadrate, irregular, slightly inflated; nerve single, extending to 1/2 way up or more.

- 1 Nerve usually reaching the acumen; leaf margin denticulate (fig. 61, 9)  
**C. elodes** (Lindb.) Kanda

**Campylium elodes** (Lindb.) Kindb.

Plants slender. Leaves triangular, gradually acuminate into long, channelled acumen; alar cells rectangular. Forms tufts on lake shores. Very rare, in the northeast of the Peninsula. Esp.

- 1 Nerve extending to 1/2-3/4 way up leaf; leaf margin entire or denticulate at base (fig. 61, 10-11)  
**C. chrysophyllus** (Brid.) R.S. Chopra

**Campylium chrysophyllum** (Brid.) Lange

Plants small. Leaves with cordate or widely ovate base, abruptly narrowed into channelled acumen; alar cells quadrate or rectangular, thick-walled, forming a small group. Forms loose, golden or green tufts on dry or wet soils and exposed, calcareous rocks, in the lowlands and montane areas, in the Peninsula and in Mallorca. Esp, Prt, And, Bl.

### **Campylium** (Sull.) Mitt.

Plants medium-sized or robust, procumbent, ascending or erect, irregularly or pinnate branched. Leaves ovate-lanceolate, squarrose or reflexed, concave, with cordate base, tapering to long, channelled acumen, margin entire or finely denticulate at base;

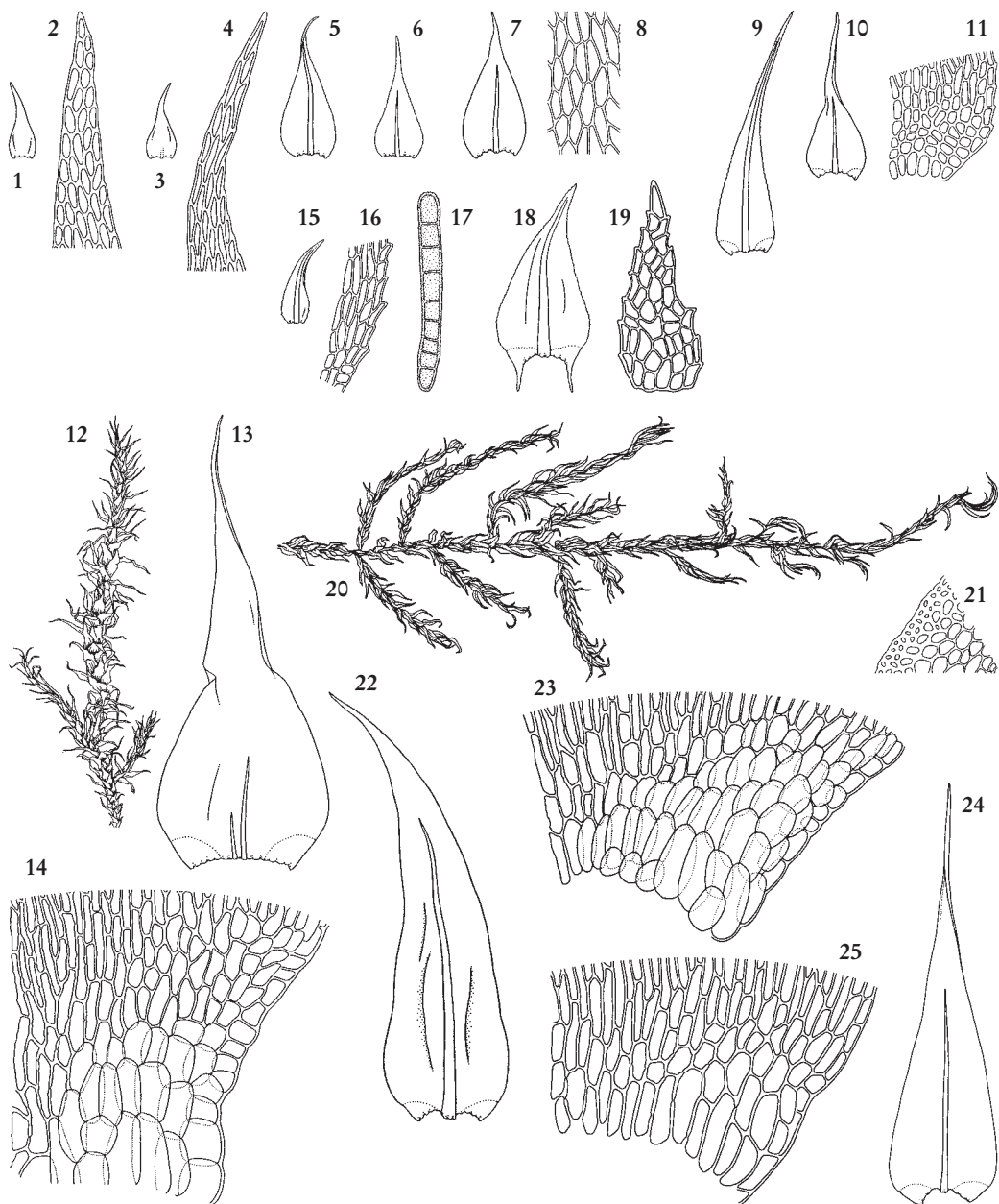


FIGURE 61. 1-2, *Amblystegium confervoides*: 1, leaf; 2, leaf apex. 3-4, *A. subtile*: 3, leaf; 4, leaf apex. 5, *A. varium*, leaf. 6, *A. serpens*, leaf. 7-8, *A. humile*: 7, leaf; 8, median cells. 9, *Campyliadelphus elodes*, leaf. 10-11, *C. chrysophyllus*: 10, leaf; 11, alar cells. 12-14, *Campylium stellatum* var. *stellatum*: 12, habit; 13, leaf; 14, alar cells. 15-17, *Conardia compacta*: 15, leaf; 16, lower leaf margin; 17, gemma. 18-19, *Cratoneuron filicinum*: 18, leaf; 19, paraphyllum. 20-23, *Drepanocladus aduncus*: 20, habit; 21, stem section; 22, leaf; 23, alar cells. 24-25, *D. polygamus*: 24, leaf; 25, alar cells. 20 ( $\times 1,3$ ); 12 ( $\times 2,3$ ); 1, 3, 5, 6, 7, 9, 10, 13, 15, 18, 22, 24 ( $\times 20$ ); 14 ( $\times 140$ ); 2, 4, 8, 11, 16, 17, 19, 21, 23, 25 ( $\times 160$ ).

laminal cells linear, alar cells quadrate or rectangular, large, inflated, forming a distinct group; nerve short, single or double, or lacking (fig. 61, 12-14)

**C. stellatum** (Hedw.) Lange & C.E.O. Jensen

Forms dense yellowish or golden tufts on damp, calcareous soils, wet grasslands and stream margins, from the lowlands to high mountains, in the north of the Peninsula. Esp, Prt, And.

var. **stellatum**: Plants usually robust, erect. Leaves abruptly tapered in acumen less than 1/2 length of lamina (fig. 61, 12-14).

var. **protensum** (Brid.) Bryhn (\**Campylium protensum* (Brid.) Kindb.): Plants medium-sized, prostrate. Leaves abruptly tapered in acumen 1/2 length of leaf.

**Conardia** H. Rob.

Plants very slender, prostrate, with branched, papillose rhizoids on stem and sometimes on lamina. Leaves lanceolate to ovate-lanceolate, margin strongly dentate at base with reflexed teeth, finely denticulate above; laminal cells longly rhomboidal, 5-6:1, smooth; nerve percurrent. Usually with uniseriate gemmae on lamina (fig. 61, 15-17)

**C. compacta** (Müll.Hal.) H. Rob.

**Amblystegium compactum** (Müll.Hal.) Austin

Forms lax patches on wet, shaded, calcareous rocks in montane areas. Scattered in the Peninsula. Esp.

**Cratoneuron** (Sull.) Spruce

Plants medium-sized, rigid. Stem erecto-ascending, sometimes prostrate, often pinnately branched, not complanate, rarely simple, usually covered by dense tomentum; paraphyllia foliose, dentate; branches with curved tips. Leaves cordate-triangular to lanceolate, acuminate, plane or nearly so, straight, curved or slightly falciform, narrower at base, margin dentate; laminal cells rhomboidal or oblong-rhomboidal, mostly 2-4 times as long as wide, smooth, alar cells inflated, forming a decurrent group reaching nerve; nerve broad, percurrent or excurrent (fig. 61, 18-19)

**C. filicinum** (Hedw.) Spruce

Plants very variable in habit. Forms dense, bright green, yellow or brownish tufts on moist or wet, calcareous soils and rocks and at tree bases, by streams, from the lowlands to high mountains, in the Peninsula and in Mallorca. Esp, Prt, And, Bl.

**Drepanocladus** (Müll.Hal.) G. Roth

Plants medium-sized to robust, without red coloration. Stem without hyaloderm, complanately branched. Leaves ovate-lanceolate, longly acuminate, ± falciform, rarely secund, margin entire; median cells of lamina linear, alar cells numerous, inflated, red, yellow or brownish, forming a distinct group nearly reaching the nerve, non- or hardly decurrent; nerve extending 1/2-3/4 way up leaf, narrow, less than 70 µm wide.

- 1 Leaf acumen plane; basal cells of lamina not porose (fig. 61, 20-23)

**D. aduncus** (Hedw.) Warnst.

Stem procumbent, with ascending tips. Leaves erecto-patent to patent, straight to falciform. Forms dense or lax wefts in wet sites, by streams or submerged, in the lowlands and coastal



areas, and montane areas, in the northern half of the Peninsula, Sierra Nevada and Mallorca. Esp, Prt, And, Bl.

In the northeast of the Peninsula, in coastal areas, there are soft, irregularly pinnate plants, with straight leaves or nearly so and short nerve not reaching the upper half of leaf.

- 1 Leaf acumen channelled; basal cells of lamina porose (fig. 61, 24-25)

**D. polygamus** (Schimp.) Hedenäs

**Campylium polygamum** (Schimp.) Lange & C.E.O. Jensen

Stem procumbent, irregularly branched. Leaves erecto-spreading or spreading, straight or curved. Forms yellowish green wefts on wet, shaded soils. Scattered in the northern half of the Peninsula. Esp, Prt.

### **Hygroamblystegium** Loeske

Plants slender to medium-sized, aquatic. Stem simple or slightly and irregularly or pinnately branched. Leaves erect or erecto-patent, usually slightly curved, ovate to lanceolate, suddenly narrowed in obtuse to longly acuminate apex, concave, margin entire or nearly so; laminal cells hexagonal or rhomboidal, 2-6:1, thick-walled; nerve stout, more than 40 µm wide at base, ending below apex, percurrent or excurrent.

- 1 Leaf apex obtuse (fig. 62, 1-2)

**H. fluviatile** (Hedw.) Loeske

**Amblystegium fluviatile** (Hedw.) Schimp.

Leaves erecto-patent, appressed when dry, slightly curved, abruptly narrowed to short, obtuse point; nerve green to brownish. Plants rigid, prostrate, medium-sized, dark green or brownish. Grows on rocks and roots by streams. Scattered in the northern half of the Peninsula. Esp.

- 1 Leaf apex acute or acuminate in fine, long point (fig. 62, 3-4)

**H. tenax** (Hedw.) Jenn.

**Amblystegium tenax** (Hedw.) C.E.O. Jensen

Plants rigid and prostrate, dark green or brownish. Paraphyllia on stem lacking or scarce. Leaves erect when dry, curved; nerve yellowish. Grows on rocks in streams. Rare, in the northwestern and northeastern part of the Peninsula. Esp, Prt (Extinct).

This species may be confused with *Cratoneuron filicinum*, but the latter has abundant paraphyllia.

### **Hygrohypnum** Lindb.

Plants small to robust. Stem procumbent, irregularly branched. Leaves imbricate to spreading, falciform or straight, widely ovate, oblong or orbicular, apex obtuse, sometimes ± acute, margin entire or denticulate; median cells linear, the apical ones shorter, alar cells short and wide, sometimes inflated, coloured or not; nerve short or long, single or double.

- 1 Leaves ovate, ovate-oblong or ovate-lanceolate, longer than wide, falciform or straight 2

- 1 Leaves widely ovate or orbicular, nearly as longer as wide, straight 3

- 2 Alar cells large, inflated, hyaline, thin-walled; stem with hyaloderm (fig. 62, 5-7)

**H. ochraceum** (Turner ex Wilson) Loeske



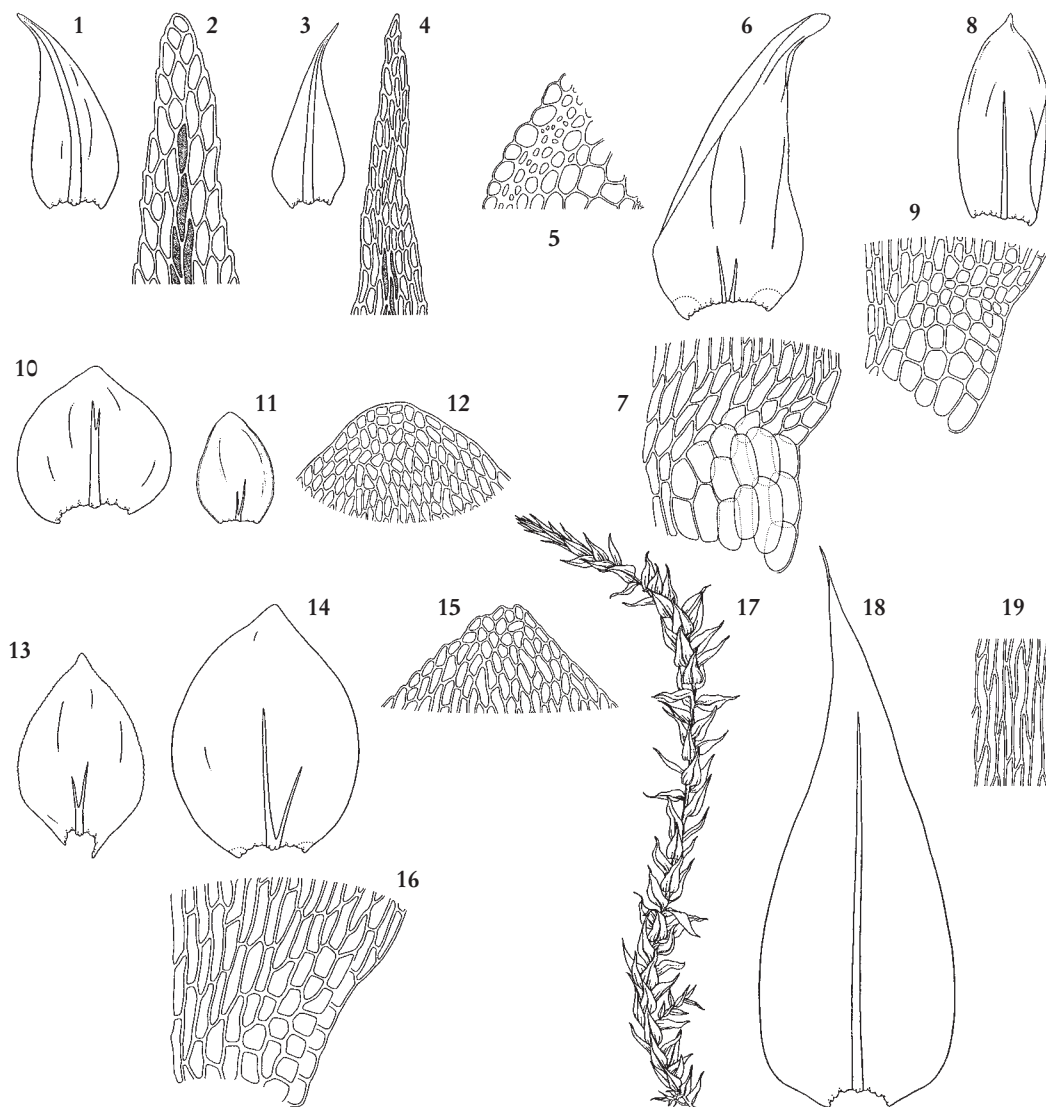


FIGURE 62. 1-2, *Hygroamblystegium fluviatile*: 1, leaf; 2, leaf apex. 3-4, *H. tenax*: 3, leaf; 4, leaf apex. 5-7, *Hygrohypnum ochraceum*: 5, stem section; 6, leaf; 7, alar cells. 8-9, *H. luridum*: 8, leaf; 9, alar cells. 10, *H. smithii*, leaf. 11-12, *H. cochlearifolium*: 11, leaf; 12, leaf apex. 13, *H. molle*, leaf. 14-16, *H. duriusculum*: 14, leaf; 15, leaf apex; 16, alar cells. 17-19, *Leptodictyum riparium*: 17, habit; 18, leaf; 19, median cells. 17 ( $\times 1,6$ ); 1, 3, 6, 8, 10, 11, 13, 14, 18 ( $\times 20$ ); 2, 4, 5, 7, 9, 12, 15, 16, 19 ( $\times 160$ ).

Plants green, brownish or yellowish. Leaves erect or spreading, usually falciform, concave, gradually tapering with obtuse apex, sometimes  $\pm$  acute, margin finely denticulate; nerve usually double, to 1/2 way up leaf. Forms loose tufts or wefts by streams and waterfalls, in montane areas and high mountains, in the northern half of the Peninsula. Esp, Prt, And.

- 2 Alar cells slightly differentiated; stem without hyaloderm (fig. 62, 8-9)

**H. luridum** (Hedw.) Jenn.

Leaves erect-spreading, usually straight, concave, usually abruptly tapering to short, obtuse point, margin dentate at apex; alar cells with granular contents; nerve faint or stout, single or double. Forms dense, green or yellowish patches on wet soils and rocks, in montane areas and high mountains, in the northern half of the Peninsula and in Mallorca. Esp, And, Bl.

- 3 Nerve single, stout, to 2/3 way up leaf, usually bifurcate or short and double; laminal cells 4-7:1 (fig. 59, 24) **4**

- 3 Nerve short and double; laminal cells more than 7:1 **5**

- 4 Nerve single, stout, reaching 1/2-2/3 way up leaf; leaves concave (fig. 62, 10)

**H. smithii** (Sw.) Broth.

Stem denudate at base. Leaves erecto-spreading or nearly spreading, margin plane or slightly recurved at base; apical cells of lamina rhomboidal. Forms bright or dark green to blackish tufts or wefts on rocks, wet soils or submerged in fast-flowing waters, in montane areas and high mountains of the Pyrenees. Esp.

- 4 Nerve short and double; leaves strongly concave (fig. 62, 11-12)

**H. cochlearifolium** (Venturi) Broth.

Leaves erecto-spreading, very wide, margin narrowly recurved; apical cells of lamina quadrate or rhomboidal. In the Central Pyrenees. Esp (Extinct).

- 5 Alar cells pale, slightly differentiated, thin-walled (fig. 62, 13)

**H. molle** (Hedw.) Loeske

Stem not denudate base. Leaves erect or spreading, plane or slightly concave, with rounded or obtuse apex, straight, dentate; apical cells of lamina rhomboidal, shorter towards margin. Forms loose, dark green tufts by streams, in montane areas and high mountains in the Pyrenees and Sierra Nevada. Esp.

- 5 Alar cells yellowish or brownish, thick-walled (fig. 62, 14-16)

**H. duriusculum** (De Not.) D.W. Jamieson

**H. dilatatum** (Wilson) Loeske

Plants rigid, dark green, brownish or yellowish. Stem and branches denudate at base. Leaves spreading, very wide, with obtuse or rounded apex, margin entire. Forms patches on rocks in waterfalls, seeping sites and by streams, in montane areas and high mountains, in the northern part of the Peninsula and in Sierra Nevada. Esp, And.

### **Leptodictyum** (Schimp.) Warnst.

Plants very variable in colour and size, slender to moderately robust, light green to golden green, aquatic. Stem procumbent or ascending, irregularly branched. Leaves erect to spreading,  $\pm$  complanate, lanceolate or ovate-lanceolate, acuminate, with long or short

point, straight or slightly curved, margin entire or nearly so; median laminal cells 7-15:1, 6-12 µm wide; nerve extending to 2/3 way up leaf. Capsule inclined, narrowly ellipsoidal or cylindrical (fig. 62, 17-19)

**L. riparium** (Hedw.) Warnst.

**Amblystegium riparium** (Hedw.) Schimp.

Grows submerged in pools and streams, in the lowlands and montane areas. Widespread in the Peninsula and in Mallorca and Menorca. Esp, Prt, Bl.

### Palustriella Ochyra

Plants pinnate or irregularly branched. Stem and branches tomentose; paraphyllia filiform, dentate. Leaves plicate, falciform or circinate, rarely straight, cordate-triangular, gradually or abruptly narrowed to acumen, margin dentate, especially at base; laminal cells elongate, alar cells large, inflated, hyaline, yellowish or brownish, forming a differentiated group which reaches the nerve and is decurrent; nerve broad and long.

- 1 Median laminal cells 3-6:1, papillose on dorsal side (fig. 63, 1-3)

**P. decipiens** (De Not.) Ochyra

**Cratoneuron decipiens** (De Not) Loeske

Plants medium-sized. Stem procumbent, pinnately branched, with short curved branches. Stem leaves widely cordate-triangular, abruptly tapering to acumen, margin denticulate; median laminal cells, at least in young leaves, with a terminal papilla on dorsal side. Branch leaves narrower and smaller. Forms greenish yellow to brownish tufts on wet, basic sites, by streams and springs, in montane areas and high mountains, in the northern part of the Peninsula and in Sierra Nevada. Esp, And.

- 1 Median laminal cells 6-15:1, smooth

2

- 2 Stem leaves ovate-lanceolate, gradually tapering in long acumen, falciform, margin dentate only at base; group of alar cells small (fig. 63, 4)

**P. falcata** (Hedw.) Hedenäs

**Cratoneuron commutatum** (Hedw.) G. Roth var. **falcatum** (Brid.) Mönk.

Plants robust, irregularly branched, green, brownish or yellowish; paraphyllia and rhizoids scarce. Branch leaves similar in shape to stem leaves; alar cells strongly inflated, hyaline or brownish, forming a distinct group. Common in spring, peat bogs, by torrents and streams, on basic substrata, in high mountains, in the northern part of the Peninsula and in Sierra Nevada. Esp, And.

- 2 Stem leaves widely cordate-triangular, abruptly tapering into ± long acumen, falciform, circinate or straight, margin slightly denticulate to dentate; group of alar cells large (fig. 63, 5-8)

**P. commutata** (Hedw.) Ochyra

**Cratoneuron commutatum** (Hedw.) G. Roth

Plants medium-size to robust, variable in habit. Stem procumbent, ascending or erect. Branch leaves narrower and smaller. Forms rigid, light or dark green wefts or tufts, often with calcium carbonate encrustations, on wet substrata, springs, by streams, calcareous torrents, from the lowlands to high mountains, in the Peninsula and in Mallorca. Esp, And, Bl.

var. **commutata**: Stem regularly pinnate. Leaves falciform or circinate, margin totally dentate; nerve stout, to 3/4 way up leaf. It is the commonest variety (fig. 63, 5-8).

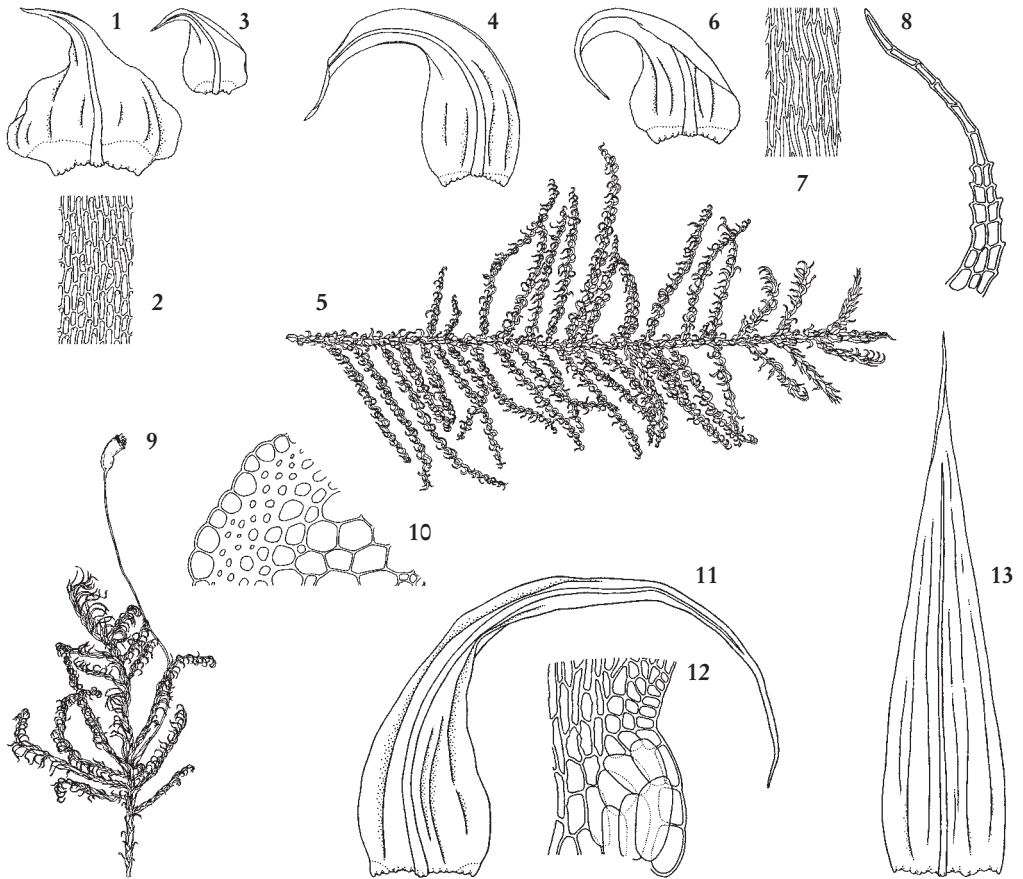


FIGURE 63. 1-3, *Palustriella decipiens*: 1, stem leaf; 2, median cells on dorsal side; 3, branch leaf. 4, *P. falcata*, leaf. 5-8, *P. commutata* var. *commutata*: 5, habit; 6, leaf; 7, median cells; 8, paraphyllium. 9-12, *Sanionia uncinata*: 9, habit; 10, stem section; 11, leaf; 12, alar cells. 13, *Tomentypnum nitens*, leaf. 5, 9 ( $\times 1.6$ ); 1, 3, 4, 6, 11, 13 ( $\times 20$ ); 2, 7, 8, 10, 12 ( $\times 160$ ).

var. *fluctuans* (Schimp.) Ochyra: Stem irregularly pinnate, sparsely branched. Leaves slightly curved or straight; nerve stout, percurrent or excurrent. Grows in montane areas by rapidly flowing waters, marshes and streams.

var. *sulcata* (Lindb.) Ochyra: Plants slender, sparsely branched. Leaves small, curved, longly acuminate, margin slightly denticulate; nerve extending to 1/2 way up leaf. Frequent in high mountain peat bogs.

### **Sanionia** Loeske

Plants medium-sized, green or yellowish green, without red coloration. Stem with hyaloderm, usually pinnate, with curved branches. Leaves plicate, ovate-lanceolate, gradually

tapering to filiform acumen, falciform or circinate, secund, margin finely denticulate; median cells of lamina long and narrow, alar cells few, hyaline, inflated, forming a distinct group; nerve extending to acumen. Capsule curved (fig. 63, 9-12)

**S. uncinata** (Hedw.) Loeske

**Drepanocladus uncinatus** (Hedw.) Warnst.

Grows on moist or wet soils and rocks and on tree trunks in pinewoods and fir woods, in montane areas, in the northern half of the Peninsula, rarer in the south. Esp, Prt, And.

### **Tomentypnum** Loeske

Plants robust, rigid. Stem and leaf nerve at back with branched, reddish or brownish rhizoids; branches ascending, pinnate, complanate. Stem and branch leaves similar, erect, strongly plicate, lanceolate, longly acuminate, margin plane, entire; laminal cells linear, basal cells shorter, wide, porose, alar cells slightly differentiated; nerve thin, long. Dioicous (fig. 63, 13)

**T. nitens** (Hedw.) Loeske

Forms loose, golden wefts in peat bogs. Rare, in the Pyrenees and in the Spanish Central Range. Esp.

## **Fam. Calliergonaceae**

### **Calliergon** (Sull.) Kindb.

Plants medium-sized to robust. Stem without hyaloderm. Leaves erect to spreading, ovate-cordate, concave, straight, apex obtuse or rounded; median cells elongate, alar cells rectangular, inflated, usually thin-walled, forming a distinct group; nerve stout, long, reaching the apex or nearly so.

- 1 Group of alar cells diffusely delimited, transition between alar cells and adjacent cells gradual; plants slightly branched (fig. 64, 1) **C. cordifolium** (Hedw.) Kindb.

Plants medium-sized to robust, green to brownish. Forms patches on very wet or peaty soils, in the north of the Peninsula and Iberian Range. Esp.

- 1 Group of alar cells clearly delimited, transition between alar cells and adjacent cells abrupt; plants densely branched (fig. 64, 2-3) **C. giganteum** (Schimp.) Kindb.

Plants large and robust, bright green, usually with cuspidate stems and branches. Grows by streams on acidic substrata. Rare, in the Pyrenees and Cantabrian Mountains. Esp.

### **Hamatocaulis** Hedenäs

Plants medium-sized to robust, procumbent to ascending, brownish or reddish, complanately branched. Stem without central strand, cortex of 1-2 layers of thick-walled cells, without hyaloderm. Leaves erect or patent, ovate-acuminate, longitudinally plicate, concave, strongly falciform; median cells of lamina linear, alar cells not differentiated; nerve ending in upper half of leaf (fig. 64, 4-7)

**H. vernicosus** (Mitt.) Hedenäs

**Drepanocladus vernicosus** (Mitt.) Warnst.

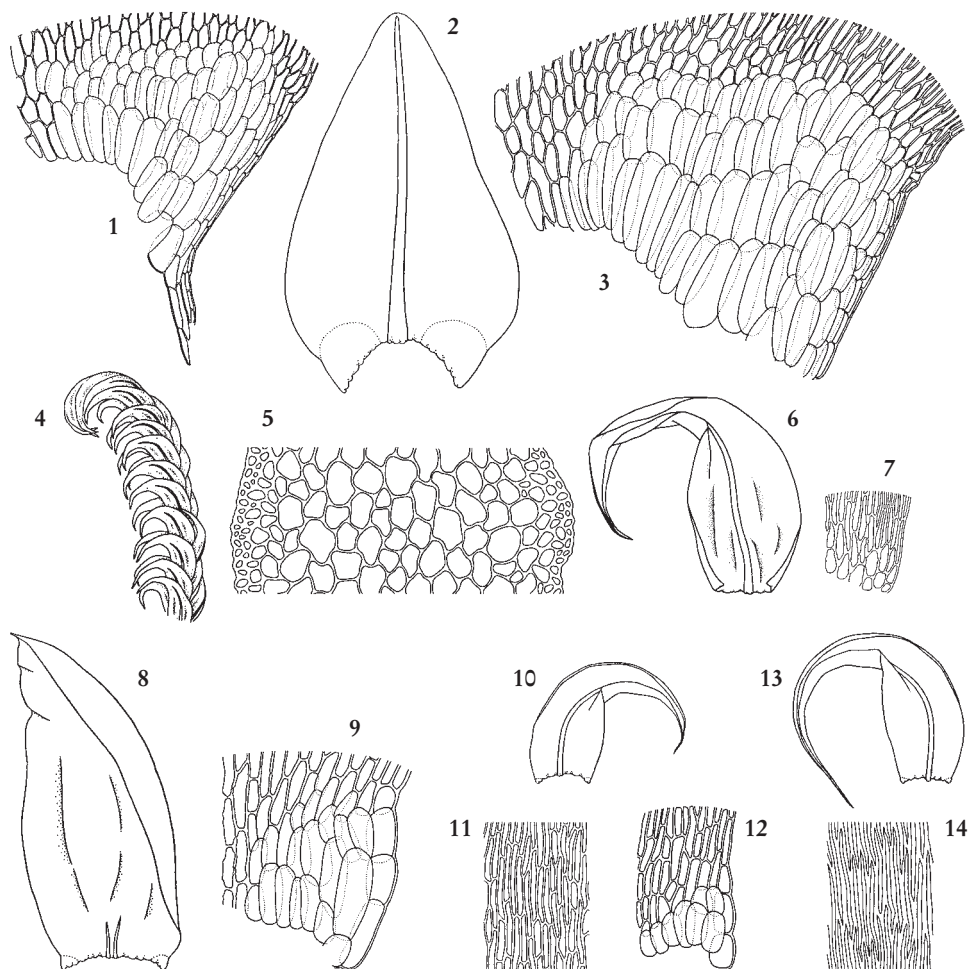


FIGURE 64. 1, *Calliergon cordifolium*, alar cells. 2-3, *C. giganteum*: 2, leaf; 3, alar cells. 4-7, *Hamatocaulis vernicosus*: 4, upper part of plant; 5, stem section; 6, leaf; 7, alar cells. 8-9, *Scorpidium scorpioides*: 8, leaf; 9, alar cells. 10-12, *S. cossonii*: 10, leaf; 11, median cells; 12, alar cells. 13-14, *S. revolvens*: 13, leaf; 14, median cells. 4 ( $\times 7$ ); 2, 6, 8, 10, 13 ( $\times 18$ ); 1, 3 ( $\times 90$ ); 7, 9, 12 ( $\times 140$ ); 5, 11, 14 ( $\times 160$ ).

Grows in springs and wetlands in montane areas. Scattered, in central western part of the Peninsula. Esp.

### *Scorpidium* (Schimp.) Limpr.

Plants medium-sized to robust. Stem with hyaloderm. Leaves erecto-patent to patent, not or weakly plicate, ovate-lanceolate or widely ovate, apex obtuse, acute or longly

acuminate, falciform to nearly straight, margin finely denticulate or smooth; median cells of lamina elongate, alar cells few, inflated, hyaline, forming a transverse triangular group, non- or hardly decurrent; nerve single, extending at least 1/2 way up leaf or shorter and double, rarely lacking.

- 1 Stem leaves strongly concave, widely ovate, with acute or obtuse apex, mostly apiculate; nerve short, double, rarely single, extending 1/2 way up leaf or nerve lacking (fig. 64, 8-9) **S. scorpioides** (Hedw.) Limpr.

Plants robust, turgid, dark green, reddish or brownish, often mud-encrusted. Stem with partial hyaloderm, sparsely branched, with short branches, stem and branches with curved tips. Leaves imbricate; alar cells hyaline, inflated, fragile. Submerged or floating in shallow pools, wet hollows or growing by streams, on calcareous or moderately acidic substrata. Very rare, in the Pyrenees and Iberian Range. Esp, And.

- 1 Stem leaves concave, ovate, gradually tapering to long, falciform or circinate acumen; nerve long, extending more than 1/2 way up leaf **2**

- 2 Median cells of stem leaves 14-95 µm long, with square or shortly tapering cells ends (fig. 64, 10-12) **S. cossonii** (Schimp.) Hedenäs

**Drepanocladus revolvens** (Sw. ex anon.) Rubers var. **intermedius** (Lindb.) Grout,

**Limprichtia cossonii** (Schimp.) L.E. Anderson, H.A. Crum & W.R. Buck

Plants medium-sized, rarely slender. Stem irregularly branched, ± complanate. Leaves sometimes slightly plicate; alar cells hyaline, strongly inflated, not or hardly decurrent. Forms lax, dark green or brownish patches on waterlogged or peaty soils, in montane areas and high mountains, in the northern half of the Peninsula and in Sierra Nevada. Esp, And.

- 2 Median cells of stem leaves 64-140 µm long, with longly tapering cells ends (fig. 64, 13-14) **S. revolvens** (Sw. ex anon.) Rubers

**Drepanocladus revolvens** (Sw. ex anon.) Warnst. var. **revolvens**,

**Limprichtia revolvens** (Sw. ex anon.) Loeske

Plants medium-sized, erect or ascending, pinnate or irregularly branched. Forms lax, yellowish green, brownish or reddish patches on peaty soil. Very rare, in the Pyrenees and in the western part of the Peninsula. Esp.

### **Straminergon** Hedenäs

Plants medium sized, light green, whitish or yellowish. Stem cuspidate, slightly branched, without hyaloderm. Leaves straight, oblong or elliptical, concave, apex obtuse often with rhizoids, margin entire; median cells elongate, alar cells rectangular, inflated, well differentiated, forming an ovate group extending up leaf margin; nerve single, faint, extending to 3/4 way up leaf or more (fig. 65, 1-3)

**S. stramineum** (Dicks. ex Brid.) Hedenäs

**Calliergon stramineum** (Dicks. ex Brid.) Kindb.

Forms loose patches on waterlogged soils, stream banks and marshes, in the northern half of the Peninsula and in Sierra Nevada. Esp, Prt, And.



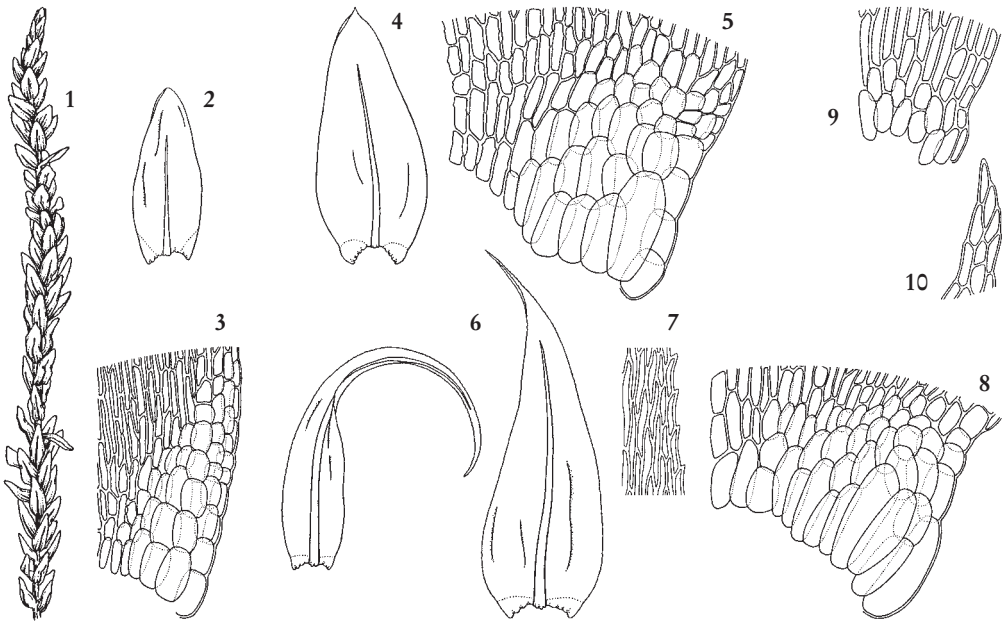


FIGURE 65. 1-3, *Straminergon stramineum*: 1, habit; 2, leaf; 3, alar cells. 4-5, *Warnstorfia sarmentosa*: 4, leaf; 5, alar cells. 6-8, *W. exannulata*: 6, leaves; 7, leaf margin; 8, alar cells. 9-10, *W. fluitans*: 9, alar cells; 10, pseudoparaphyllum. 1 ( $\times 5$ ); 2, 4, 6 ( $\times 18$ ); 3, 5, 8, 9, 10 ( $\times 140$ ); 7 ( $\times 160$ ).

### Warnstorfia Loeske

Plants medium-sized to robust, radially branched. Leaves triangular to ovate, narrow, gradually tapering to long acuminate or abruptly narrowed to an obtuse, usually apiculate apex, straight or falciform, margin entire, sinuose or denticulate; median cells elongate, alar cells inflated, hyaline, forming a distinct group transversely triangular or quadrate, non- or hardly decurrent; nerve single, long.

- 1 Leaves oblong or ovate, apex obtuse and apiculate, margin entire (fig. 65, 4-5)

***W. sarmentosa*** (Wahlenb.) Hedenäs

***Calliergon sarmentosum*** (Wahlenb.) Kindb.

Plants usually reddish. Stem and upper branches cuspidate, without hyaloderm. Leaves straight, concave; group of alar cells distinctly delimited, nearly reaching the nerve; nerve extending to 3/4 way up leaf. Rarely with rhizoids of a few cells at leaf apex. Grows in wet, acidic sites, by streams and around lakes, in high mountains. Rare, in the Pyrenees and Cantabrian mountains. Esp, And.

- 1 Leaves narrowly lanceolate or ovate-lanceolate, longly acuminate, margin  $\pm$  denticulate



- 2 Group of alar cells large, distinctly delimited; plants with red colours; pseudoparaphyllia broad (fig. 65, 6-8) **W. exannulata** (Schimp.) Loeske

**Drepanocladus exannulatus** (Schimp.) Warnst.

Plants very variable, reddish or brownish. Stem with partial hyaloderm. Leaves ovate-lanceolate, slightly concave, usually falciform, margin denticulate; group of alar cells  $\pm$  reaching the nerve; nerve extending 3/4 way up leaf, stout, 80-100  $\mu$ m wide near base. Forms patches on lake shores, by streams and in acidic peatlands, in montane areas and high mountains, in the northern half of the Peninsula and Sierra Nevada. Esp, Prt, And.

- 2 Group of alar cells small, indistinctly delimited; plants rarely with red colours; pseudoparaphyllia narrower, lanceolate (fig. 65, 9-10) **W. fluitans** (Hedw.) Loeske

**Drepanocladus fluitans** (Hedw.) Warnst.

Plants greenish to brownish. Stem without hyaloderm. Leaves falciform, sometimes straight, ovate-triangular to ovate-lanceolate, slightly denticulate; nerve extending to 4/5 way up leaf. Grows on peaty soils. Rare, in the north of the Peninsula. Esp, Prt.

## Fam. Leskeaceae

### Lescuraea Schimp.

Plants small or medium-sized. Stem prostrate, irregularly branched, with numerous, filamentous or lanceolate paraphyllia. Leaves spreading, imbricate when dry, straight, occasionally falciform, acuminate, with 2 plicae at base, margin entire or denticulate at apex, recurved; median cells elongate and narrow, smooth or with low, terminal papillae, basal cells also long (more than 2:1) but shorter than median ones, alar cells predominantly quadrate; nerve long. Branch leaves similar to stem leaves but smaller. Capsule erect, symmetrical. Dioicous.

- 1 Branch leaves with smooth cells and entire margin; plants corticolous (fig. 66, 1-3) **L. mutabilis** (Brid.) Lindb. ex I. Hagen

Tips of stem and branches straight. Leaves erect, lanceolate, gradually acuminate; dorsal side of lamina and nerve rarely papillose in the upper part, basal cells 3:1 or more, not porose. Forms green or yellowish green tufts on bark of trees, in montane areas and high mountains of the Pyrenees. Esp, And.

- 1 Branch leaves with papillose cells and dentate margin; plants saxicolous (fig. 66, 4-5) **L. saxicola** (Schimp.) Molendo

Plants densely branched, tips of stem and branches curved. Stem leaves mostly falciform, abruptly acuminate; basal cells 2-3:1, shorter and wider than median cells, rather thick-walled and with a few pores. Branch leaves with apical and nerve cells with terminal papillae on dorsal side, sometimes also on stem leaves. Forms compact, glossy greenish yellow or brownish tufts on rocks in high mountains, in the Pyrenees and Cantabrian Mountains. Esp, And.

### Leskea Hedw.

Stem procumbent, irregularly branched, with small paraphyllia. Leaves erecto-spreading, mostly secund, appressed when dry, asymmetrical, ovate-lanceolate, with broad, short

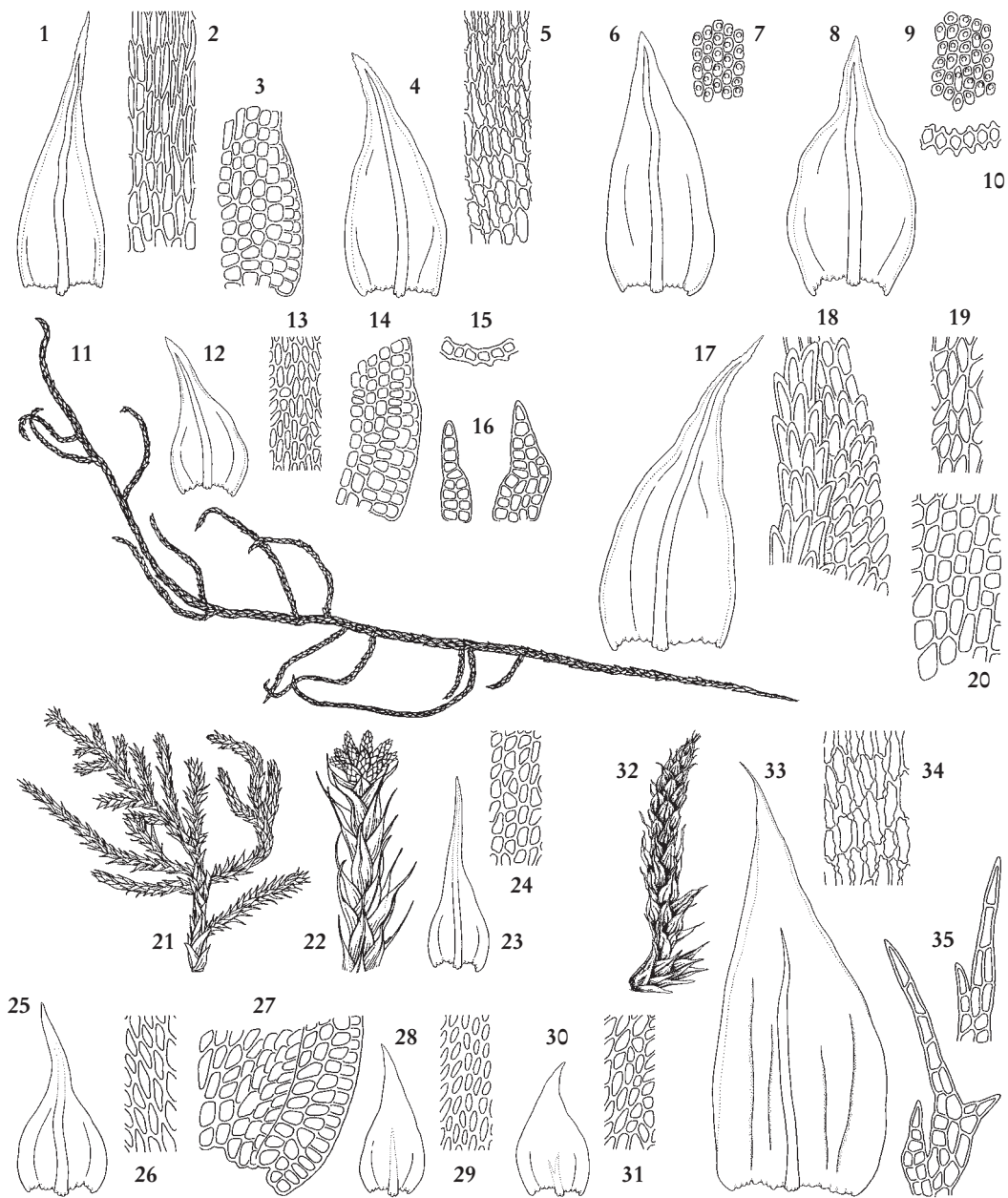


FIGURE 66. 1-3, *Lescurea mutabilis*: 1, leaf; 2, median and basal cells; 3, alar cells. 4-5, *L. saxicola*: 4, leaf; 5, median and basal cells. 6-7, *Leskea polycarpa*: 6, leaf; 7, median cells. 8-10, *Pseudoleskea patens*: 8, leaf; 9, median cells; 10, lamina section. 11-16, *P. incurvata*: 11, habit; 12, leaf; 13, median cells; 14, alar cells; 15, lamina section; 16, paraphyllia. 17-20, *P. radicata*: 17, leaf; 18, nerve on dorsal side; 19, median cells; 20, basal cells. 21-24, *Pseudoleskeella nervosa*: 21, habit; 22, branch with propagules; 23, leaf; 24, basal cells toward nerve. 25-27, *P. rupestris*: 25, leaf; 26, basal cells toward nerve; 27, alar cells. 28-29, *P. catenulata*: 28, leaf; 29, median cells. 30-31, *P. tectorum*: 30, leaf; 31, median cells. 32-35, *Ptychodium plicatum*: 32, habit; 33, leaf; 34, basal cells; 35, paraphyllia. 11 ( $\times 2.5$ ); 21, 32 ( $\times 3.5$ ); 22 ( $\times 15$ ); 1, 4, 6, 8, 12, 17, 23, 25, 28, 30, 33 ( $\times 35$ ); 2, 3, 5, 7, 9, 10, 13, 14, 15, 16, 18, 19, 20, 24, 26, 27, 29, 31, 34, 35 ( $\times 200$ ).

acumen, usually plicate at base, margin entire, recurved at base; laminal cells isodiametric or nearly so, hexagonal or rhomboidal, with one central papilla on both sides, alar cells quadrate or oblate, smooth; nerve stout, nearly reaching the apex. Capsule erect, symmetrical; peristome teeth pale, papillose. Autoicous (fig. 66, 6-7) **L. polycarpa** Hedw.

Plants slender, forming light or brownish green tufts on wet rocks and on trunks by streams, in the lowlands and montane areas, in the northern half of the Peninsula. Esp, Prt.

*Pseudoleskea patens* also has cells with one central papilla, but its leaves have recurved margins from base to apex.

### **Pseudoleskea Schimp.**

Plants small to medium-sized. Stem prostrate, irregularly branched; paraphyllia abundant, filamentous or lanceolate. Leaves acuminate, falciform, with 2, often deep, plicae, margin usually dentate at apex; laminal cells isodiametric to oblong, usually papillose, basal cells predominantly short (1-2:1), not longer than median cells, alar cells all quadrate or intercalated among oblate cells; nerve long, stout. Branch leaves similar to stem leaves. Capsule curved, asymmetrical. Dioicous.

- 1 Laminal cells with 1 central papilla on each side (fig. 66, 8-10)

**P. patens** (Lindb.) Kindb.

**Lescurea patens** Lindb.

Branches straight, rarely curved at apex. Leaves spreading, appressed when dry, ovate, acuminate, margin entirely recurved or recurved at base and also at acumen base; median cells short (1-2:1), rarely longer, apical cells mostly elongate. Forms dark green tufts, often yellowish or brownish below, on rocks, in montane areas and high mountains, in the northern half of the Peninsula. Esp, Prt, And.

- 1 Laminal cells smooth or with distal papillae

2

- 2 Median cells of stem leaves mostly up to 20  $\mu\text{m}$  long; alar cells quadrate, with groups of oblate cells intercalated (fig. 66, 11-16)

**P. incurvata** (Hedw.) Loeske

**Lescurea incurvata** (Hedw.) E. Lawton

Plants sparsely branched; stem and branches with curved tips. Stem leaves ovate, acute or acuminate, falciform, asymmetrical, margin recurved at base and often at acumen base; laminal cells and nerve usually papillose at back above. Forms yellowish green or brownish tufts on rocks, in montane areas and high mountains, in the Peninsula and in Mallorca. Esp, Prt, And, Bl.

- 2 Median cells of stem leaves mostly more than 20  $\mu\text{m}$  long; alar cells quadrate (fig. 66, 17-20)

**P. radicata** (Mitt.) Macoun & Kindb.

**Lescurea radicata** (Mitt.) Mönk.

Plants with abundant branches curved at tips. Leaves ovate, acuminate, falciform, margin recurved from base to apex or only at leaf base and acumen base; median cells elongate, often with groups of shorter cells intermixed, smooth or papillose, upper cells and nerve usually papillose on dorsal side. Forms dark green or yellowish tufts, often brownish in older parts, on acidic rocks in high mountains, in the Pyrenees and Sierra Nevada. Esp, And.

### **Pseudoleskeella** Kindb.

Plants thin, prostrate, often irregularly branched. Stem with lanceolate pseudoparaphyllia, paraphyllia lacking. Leaves concave or with 2 plicae at base, ovate or ovate-lanceolate, acuminate; median cells isodiametric, rhomboidal or elongate, smooth, occasionally prorate; nerve short or long, single or double. Branch leaves similar to stem leaves. Capsule exserted.

- 1 Leaves lanceolate or ovate-lanceolate, twice as long as wide or more; nerve extending at least half way up, usually reaching the apex; laminal cells smooth 2
- 1 Leaves ovate, less than twice as long as wide; nerve not extending half way up, usually shorter; laminal cells smooth or papillose 3

- 2 Plants with propaguliferous branches at tip of ascending branches; cells towards nerve near leaf base mostly  $\pm$  isodiametric (fig. 66, 21-24)

#### **P. nervosa** (Brid.) Nyholm

Plants slender, prostrate with ascending branches, dark green to blackish. Median cells of lamina isodiametric, irregular in shape and size; nerve faint in the upper part, extending 2/3 way up leaf or percurrent. Forms tufts or mats at trees bases or on siliceous rocks in montane areas and high mountains, in the north and northeast of the Peninsula. Esp, And.

- 2 Plants without propaguliferous branches; cells towards nerve near leaf base elongate, usually 2-4:1 (fig. 66, 25-27) **P. rupestris** (Berggr.) Hedenäs & L. Söderstr.

Plants mostly orange or reddish. Median cells of lamina longly elliptical, alar cells oblate; nerve extending 3/4 way up leaf, faint in the upper part. Grows on calcareous rocks, in the Central Pyrenees. Esp.

- 3 Laminal cells thick-walled; nerve extending to half way up leaf, usually shorter, not clearly bifurcate (fig. 66, 28-29) **P. catenulata** (Brid. ex Schrad.) Kindb.

Plants reddish. Leaves ovate, tapered into wide acumen; laminal cells mostly shortly rhomboidal. Grows on shaded, calcareous rocks, in the northern part of the Peninsula, rare in the south, and in Mallorca. Esp, And, Bl.

- 3 Laminal cells thin-walled; nerve extending to 1/3 way up leaf, short and double, occasionally single (fig. 66, 30-31) **P. tectorum** (Funk ex Brid.) Kindb. ex Broth.

Leaves very concave, ovate, abruptly tapered; laminal cells rhomboidal, smooth, occasionally prorate. Forms dense, glossy green to orange tufts on calcareous or siliceous rocks, sporadically on wood, in the northeastern part of the Peninsula. Esp.

### **Ptychodium** Schimp.

Stem prostrate, irregularly branched; paraphyllia abundant, linear-lanceolate to ovate-lanceolate, unbranched or with short branches or teeth at base. Stem leaves about 2,5 mm long, similar to branch leaves, erect or imbricate, ovate-lanceolate, abruptly acuminate, with several deep, longitudinal plicae, margin recurved, entire or denticulate at apex; laminal cells elongate (6-9:1), smooth, thin-walled, basal cells more thick-walled

or porose, alar cells short and wide; nerve long. Capsule curved, asymmetrical (fig. 66, 32-35)

**P. plicatum** (Schleich. ex F. Weber & D. Mohr) Schimp.

**Lescuraea plicata** (Schleich. ex F. Weber & D. Mohr) Broth.

Plants robust. Forms loose, golden green or brownish tufts on shaded, calcareous rocks, in high mountains, in the Pyrenees and Cantabrian Mountains. Esp.

## Fam. Thuidiaceae

### *Abietinella* Müll.Hal.

Plants medium-sized to robust, rigid. Stem ascending, pinnate; paraphyllia abundant on stem and branches, single or branched, papillose. Stem leaves erect or patent, ovate, widely acuminate, plicate, margin recurved, denticulate; laminal cells 1-2 as long as wide, unipapillose; nerve to 3/4 or more way up leaf. Branch leaves smaller, broadly ovate to lanceolate, obtuse to acuminate (fig. 67, 1-5)

**A. abietina** (Hedw.) M. Fleisch.

**Thuidium abietinum** (Hedw.) Schimp.

Forms wefts on dry or moist exposed, calcareous soils, in montane areas and high mountains, in the northern half of the Peninsula. Esp, And.

var. **abietina**: Plants rigid, light green to brownish, branches thin, short; paraphyllia linear, uniseriate, with the terminal cell isodiametric, having 2-4 papillae. Stem leaves imbricate, broad at base, abruptly narrowed in wide, curved apex. Forms wefts on dry, exposed soils, mainly in the northeastern quadrant of the Peninsula (fig. 67, 1-5).

var. **hystriosa** (Mitt.) Sakurai: Plants robust, brownish, with curved branches; paraphyllia lanceolate, curved, irregularly branched, with the terminal cell acute, not papillose. Leaves plicate at base, attenuated in straight, slightly reflexed acumen. Grows on moist soils. Rare in the east of the Peninsula.

### *Thuidium* Schimp.

Plants medium-sized to robust. Stem creeping to ascending, regularly 2-3 pinnate; paraphyllia abundant, single or branched, papillose. Stem leaves ovate or ovate-triangular, acuminate, margin crenulate or denticulate; laminal cells 1-2 times as long as wide, unipapillose; nerve wide, reaching apex or nearly so. Branch leaves small, ovate, acute.

- 1 Apical cell of branch leaves acute, not papillose (fig. 67, 6-9)

**T. tamariscinum** (Hedw.) Schimp.

Plants robust, regularly 3-pinnate, with complanate branches. Forms extensive wefts on wet, shaded rocks and soils and at tree bases, in beechwoods, fir woods and oakwoods, in montane areas and high mountains, in the northern half of the Peninsula. Esp, Prt, And.

- 1 Apical cell of branch leaves obtuse, with 2-3 terminal papillae 2

- 2 Upper cells of stem leaves longer and narrower and more thick-walled than the rest of laminal cells; paraphyllia with terminal or sub-terminal papillae (fig. 67, 10-12)

**T. recognitum** (Hedw.) Lindb.

Stem leaves with reflexed or curved point. Forms  $\pm$  dense, brownish green wefts on usually calcareous soils and rocks and at tree bases in forests of montane areas and high mountains, in the northern half of the Peninsula. Esp.

- 2 Upper cells of stem leaves similar to other laminal cells; paraphyllia with central papillae 3

- 3 Upper part of stem leaves filiform, ending in 2-7 rows of hyaline cells (fig. 67, 13-14)

*T. assimile* (Mitt.) A. Jaeger

*T. philibertii* Limpr.

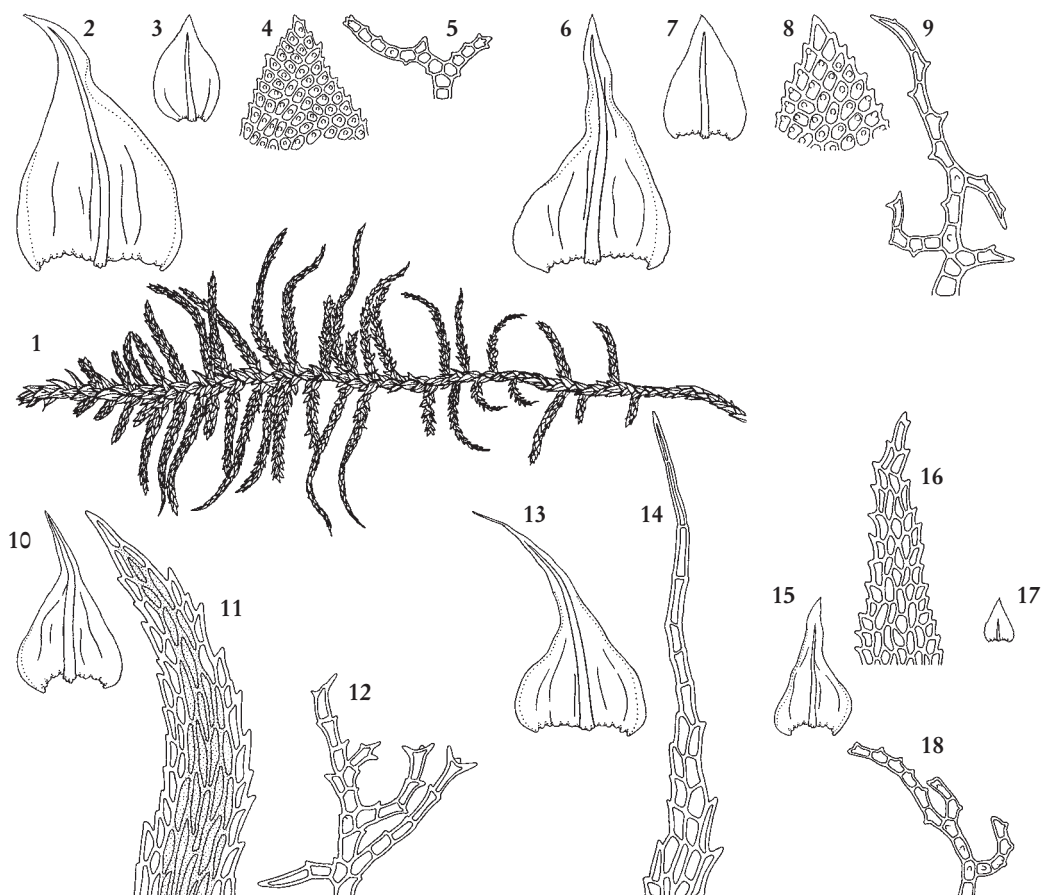


FIGURE 67. 1-5, *Abietinella abietina* var. *abietina*: 1, habit; 2, stem leaf; 3, branch leaf; 4, branch leaf apex; 5, paraphyllium. 6-9, *Thuidium tamariscinum*: 6, stem leaf; 7, branch leaf; 8, branch leaf apex; 9, paraphyllium. 10-12, *T. recognitum*: 10, leaf; 11, leaf apex; 12, paraphyllium. 13-14, *T. assimile*: 13, leaf; 14, leaf apex. 15-18, *T. delicatulum*: 15, stem leaf; 16, stem leaf apex; 17, branch leaf; 18, paraphyllium. 1 ( $\times 2.5$ ); 2, 3, 6, 7, 10, 13, 15, 17 ( $\times 20$ ); 4, 5, 8, 9, 11, 12, 14, 16, 18 ( $\times 200$ ).

Stem leaves with reflexed or curved point. Forms yellowish green wefts on shaded, usually calcareous soils and rocks, in beechwoods, fir woods and oakwoods, in montane areas and high mountains. Mainly in the northern part of the Peninsula. Esp, And.

- 3 Upper part of stem leaves acute or acuminate, not filiform, chlorophyllose (fig. 67, 15-18) **T. delicatulum** (Hedw.) Schimp.

Plants regularly 3-pinnate. Stem leaves appressed when dry, rarely with reflexed acumen. Perichaetial leaves ciliate. Grows on shaded rocks and soils in beechwoods, fir woods and oakwoods, in montane areas and high mountains, in the northern half of the Peninsula and in Mallorca. Esp, And, Bl.

Similar to *T. tamariscinum*, but usually smaller, yellowish green to brownish.

## Fam. Brachytheciaceae

### Brachythecium Schimp.

Plants small to robust. Stem prostrate or ascending, branches usually erect. Stem leaves lanceolate, ovate to triangular, longitudinally plicate or not, concave or flat, decurrent, acute or acuminate; laminal cells linear, alar cells quadrate or rectangular, forming a  $\pm$  distinct group; nerve single, long, extending to 1/2 way up leaf or to the apex, rarely ending in a projecting cell at back. Branch leaves similar to stem leaves, but usually shorter and narrower. Seta smooth or papillose; lid conical. Mostly autoicous.

- 1 Leaves longitudinally plicate 2  
1 Leaves not or only slightly plicate 6

- 2 Group of alar cells ascending up margin, longly and widely decurrent (fig. 68, 1) **B. albicans** (Hedw.) Schimp.

Plants medium-sized, silky, pale green or yellowish. Stem leaves entire or slightly dentate; alar cells quadrate, longly and widely decurrent. Seta smooth. Dioicous. Acidophilous or indifferent, nitrophilous, forms wefts on shaded soils, by roadsides, in the lowlands and montane areas. Widespread throughout the Peninsula and in Mallorca. Esp, Prt, Bl.

- 2 Group of alar cells not ascending up margin, shortly decurrent 3

- 3 Plants golden yellow, rigid; plants of high mountains (fig. 68, 2-7) **B. turgidum** (C. Hartm.) Kindb.

Plants robust, glossy. Stem irregularly branched, with short branches; pseudoparaphyllia rounded. Leaves densely arranged, ovate-lanceolate, margin partially recurved, entire or nearly so; nerve extending to 1/2 way up leaf. Seta smooth. Autoicous. Grows on wet, calcareous soils in high mountains grasslands, in the central Pyrenees. Esp.

- 3 Plants pale green to yellowish, soft; plants of the lowlands or montane areas 4

- 4 Plants irregularly and sparsely branched; stem leaves with twisted and filiform acumen (fig. 68, 8) **B. glareosum** (Bruch ex Spruce) Schimp.



Plants large, glossy yellowish or golden, plumose. Stem long, slightly branched, prostrate, without rhizoids. Leaves with finely denticulate or entire margin; alar cells shortly rectangular, forming a decurrent group. Seta smooth. Dioicous. Forms wefts on dry, calcareous soils, in the lowlands and montane areas. Widespread throughout the Peninsula and in Mallorca. Esp, Prt, And, Bl.

- 4 Plants  $\pm$  regularly pinnately branched; stem leaves lacking a filiform acumen 5

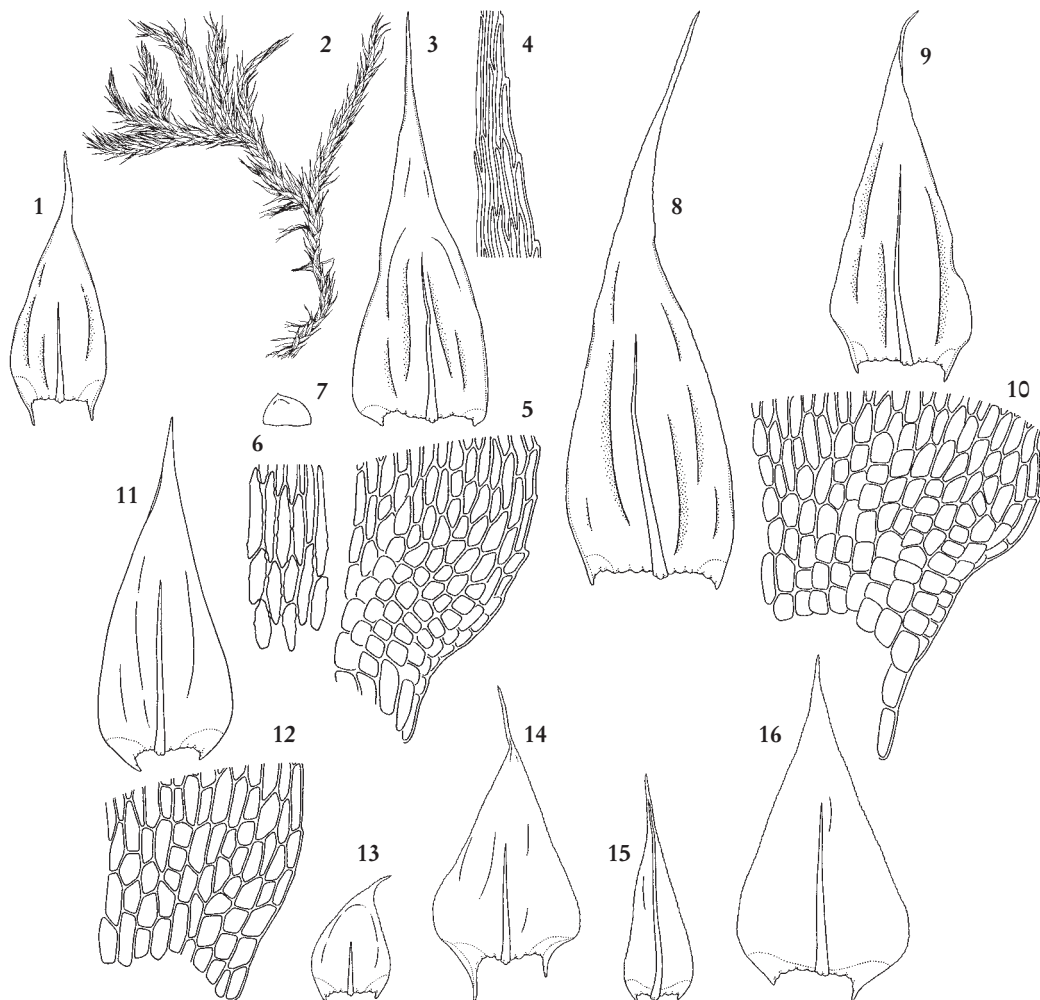


FIGURE 68. 1, *Brachythecium albicans*, leaf. 2-7, *B. turgidum*: 2, habit; 3, leaf; 4, upper marginal cells; 5, alar cells; 6, basal cells; 7, pseudoparaphyllium. 8, *B. glareosum*, leaf. 9-10, *B. salebrosum*: 9, leaf; 10, alar cells. 11-12, *B. mildeanum*: 11, leaf; 12, alar cells. 13, *B. collinum*, leaf. 14, *B. glaciale*, leaf. 15, *B. populeum*, leaf. 16, *B. plumosum*, leaf. 2 ( $\times 2.5$ ); 1, 3, 7, 8, 9, 11, 13, 14, 15, 16 ( $\times 18$ ); 4, 5, 6, 10, 12 ( $\times 160$ ).



- 5 Margin entire to denticulate  $\pm$  from base to apex; median cells of stem leaves 6-9  $\mu\text{m}$  wide; woodland plants (fig. 68, 9-10)

**B. salebrosum** (Hoffm. ex F. Weber & D. Mohr) Schimp.

Plants medium-sized. Stem radiculose; pseudoparaphyllia acute. Stem leaves entire or nearly so; alar cells mostly quadrate, forming a small, decurrent group. Autoicous. Seta smooth. Forms glossy green wefts on acidic soils, rocks and at tree bases, in wet sites of montane areas, in the northern half of the Peninsula and in Sierra Nevada. Esp, Prt.

- 5 Margin usually entire; median cells of stem leaves 7-12  $\mu\text{m}$  wide; plants growing in exposed sites (fig. 68, 11-12)

**B. mildeanum** (Schimp.) Schimp.

Plants robust, yellowish. Stem leaves with basal and alar cells slightly differentiated. Seta smooth. Autoicous or polyoicous. Grows on wet, open soils from montane areas to high mountains. Scattered in the Peninsula. Esp, Prt.

- 6 Branches short, julaceous; leaves concave, imbricate 7

- 6 Branches  $\pm$  long, not julaceous; leaves plane or slightly concave, erecto-spreading or appressed 8

- 7 Plants small; leaves widely ovate, with denticulate or serrate margin; alar cells thin-walled (fig. 68, 13)

**B. collinum** (Schleich. ex Müll.Hal.) Schimp.

\* **Brachytheciastrum collinum** (Schleich. ex Müll.Hal.) Ignatov & Huttunen

Alar cells of stem leaves numerous, quadrate or rectangular. Seta smooth. Autoicous. Forms pale green or yellowish patches in calcareous rock crevices, in high mountains, in the Pyrenees and Sierra Nevada. Esp, And.

- 7 Plants medium-sized; leaves triangular, from wide base, with finely denticulate margin; alar cells  $\pm$  thick-walled (fig. 68, 14)

**B. glaciale** Schimp.

\* **Sciuro-hypnum glaciale** (Schimp.) Ignatov & Huttunen

Stem leaves with recurved margins at base; alar cells numerous, mostly quadrate. Seta papillose. Forms yellowish green patches on wet soils in snow-beds, in high mountains in the Pyrenees. Esp.

- 8 Stem leaves lanceolate or ovate-lanceolate, usually narrow and gradually tapering into long point 9

- 8 Stem leaves ovate, ovate-lanceolate or triangular, wide at base, abruptly or gradually narrowed to long or short acumen 13

- 9 Nerve reaching the leaf apex (fig. 68, 15)

**B. populeum** (Hedw.) Schimp.

\* **Sciuro-hypnum populeum** (Hedw.) Ignatov & Huttunen

Plants small. Stem leaves lanceolate, straight, narrow, margin finely denticulate; alar cells quadrate or rectangular, reaching nerve. Branch leaves strongly denticulate at apex. Seta papillose. Autoicous. Forms glossy green, yellowish or brownish wefts on rocks and at tree bases, in montane areas, in the north of the Peninsula and in Sierra Nevada. Esp, Prt.

- 9 Nerve extending to 2/3 way up leaf 10

- 10 Stem leaves ovate-lanceolate; group of alar cells large, reaching nerve or nearly so; branch leaves dentate at base; nerve not ending in a spine-like projection (fig. 68, 16)

**B. plumosum** (Hedw.) Schimp.

\* **Sciuro-hypnum plumosum** (Hedw.) Ignatov & Huttunen

Plants medium-sized. Stem leaves finely denticulate, sometimes falciform; alar cells quadrate or rectangular. Seta papillose above, smooth below. Autoicous. Forms dark green, yellowish or brownish wefts on wet, acidic rocks and by streams, in montane areas, in the northern half of the Peninsula and in Algeciras Mountains. Esp, Prt, And.

- 10 Stem leaves lanceolate; group of alar cells small; branch leaves dentate from base to apex or only at apex; nerve ending in a spine-like projection 11

- 11 Seta smooth; leaves not plicate **B. olympicum** Jur.

\* **Brachytheciastrum olympicum** (Jur.) Vanderp. et al.

Autoicous. Forms compact, yellowish green patches at base of trees and rocks. Scattered, Peninsular distribution poorly known. Esp, And.

Species similar to *B. velutinum*.

- 11 Seta papillose or smooth; leaves slightly longitudinally plicate 12

- 12 Upper nerve with strongly prorate cells on dorsal side; upper lamina with scattered prorate cells; leaf margin broadly recurved, strongly dentate (fig. 69, 1-4)

**B. dieckii** Röhl

\* **Brachytheciastrum dieckii** (Röhl) Ignatov & Huttunen

Plants small, yellowish green or yellowish. Leaves rigid; alar cells thick-walled, forming a large group extending along leaf margin; nerve stout, to 2/3 way up. Distributed in montane areas in the central areas of the western part of the Peninsula. Esp, Prt.

- 12 Upper nerve with scarce prorate cells on dorsal side or prorate cells absent; upper lamina without prorate cells; leaf margin slightly recurved, ± dentate (fig. 69, 5-6)

**B. velutinum** (Hedw.) Schimp.

\* **Brachytheciastrum velutinum** (Hedw.) Ignatov & Huttunen

Plants small, slender, light to dark green. Stem leaves narrowing into fine dentate acumen; alar cells scarce, quadrate. Autoicous. Forms glossy wefts on soils, rocks, bark of trees and at tree bases, in dry or slightly moist, shaded, usually calcareous places, in montane areas. Widespread throughout the Peninsula and in Mallorca and Pithyusic Islands. Esp, Prt, And, Bl.

var. **velutinum**: Nerve to 3/4 way up. Seta papillose (fig. 69, 5-6).

var. **salicinum** (Schimp.) Ochyra & \_arnowiec: Nerve ending below apex. Seta smooth.

- 13 Plants small or medium-sized; stem leaves triangular, ± cordate at base, abruptly tapering into fine acumen; plants growing in high mountains 14

- 13 Plants medium-sized to large; stem leaves widely ovate, ovate-lanceolate or triangular, abruptly or gradually tapering into acute or acuminate point; plants growing in the lowlands and montane areas, rarely in high mountains 15

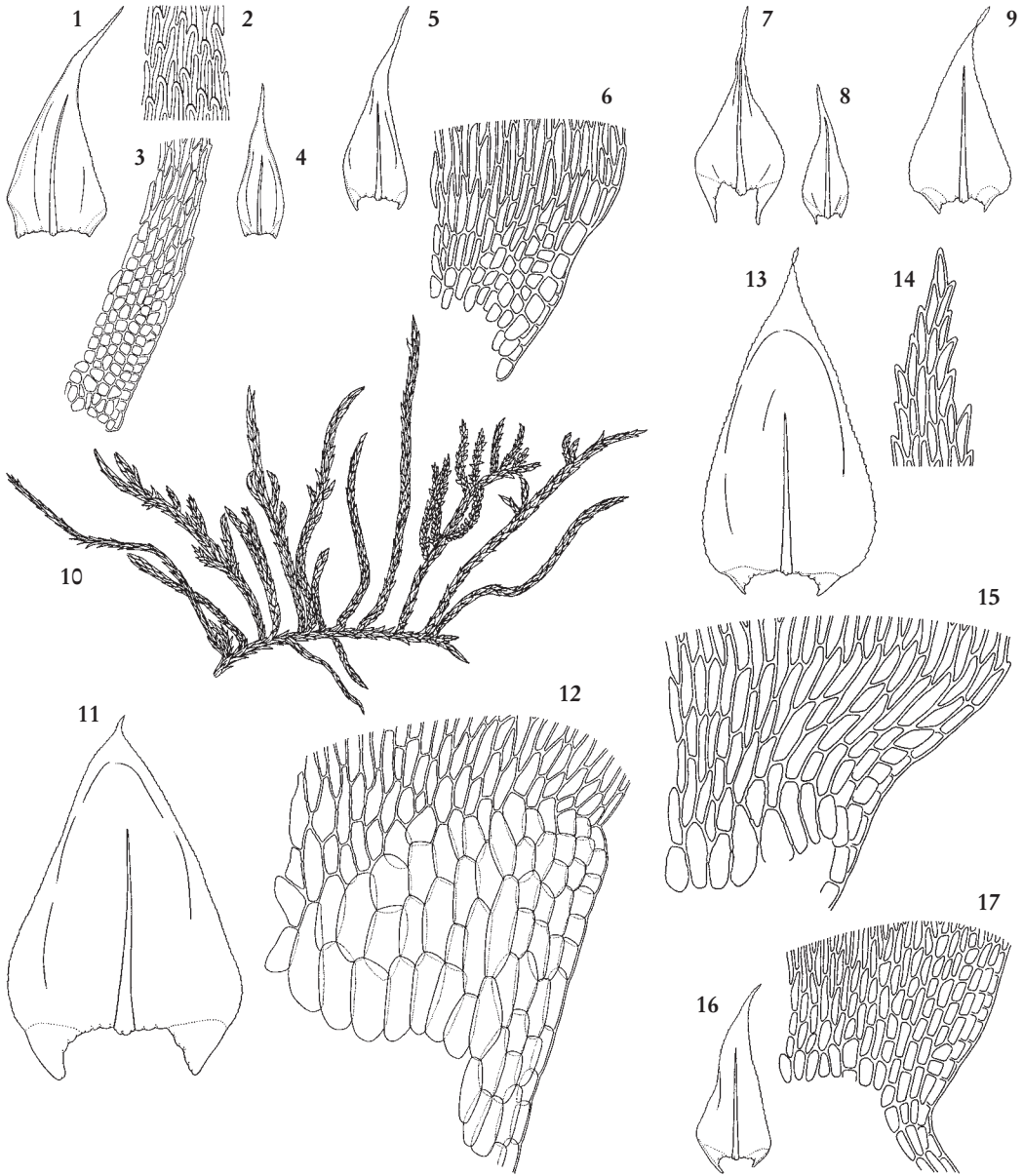


FIGURE 69. 1-4, *Brachythecium dieckii*: 1, stem leaf; 2, upper cells; 3, alar cells; 4, branch leaf. 5-6, *B. velutinum* var. *velutinum*: 5, leaf; 6, alar cells. 7-8, *B. reflexum*: 7, stem leaf; 8, branch leaf. 9, *B. starkei*, leaf. 10-12, *B. rivulare*: 10, habit; 11, leaf; 12, alar cells. 13-15, *B. rutabulum*: 13, leaf; 14, leaf apex; 15, alar cells. 16-17, *B. campestre*: 16, leaf; 17, alar cells. 10 ( $\times 1,2$ ); 1, 4, 5, 7, 8, 9, 11, 13, 16 ( $\times 18$ ); 12 ( $\times 120$ ); 3, 6, 14, 15, 17 ( $\times 160$ ); 2 ( $\times 200$ ).

- 14 Plants small; stem leaves appressed, with long, slightly channelled acumen; alar cells quadrate; nerve reaching leaf apex (fig. 69, 7-8) **B. reflexum** (Starke) Schimp.  
 \* **Sciuro-hypnum reflexum** (Starke) Ignatov & Huttunen  
 Stem leaves finely denticulate; alar cells numerous, quadrate or shortly rectangular, ascending up leaf margin. Branch leaves rough at back due to the projections of the apical parts of cells. Seta papillose. Autoicous. Forms green or yellowish green wefts on shaded soils and on tree bases, in high mountains, in the north of the Peninsula. Esp, And.
- 14 Plants small or medium-sized; stem leaves erecto-spreading; alar cells rectangular; nerve extending to 3/4 way up leaf (fig. 69, 9) **B. starkei** (Brid.) Schimp.  
 \* **Sciuro-hypnum starkei** (Brid.) Ignatov & Huttunen  
 Plants sometimes complanately branched. Stem leaves usually with the acumen twisted 180°; alar cells numerous. Seta papillose. Autoicous. Forms green or yellowish green wefts on shaded soils and at tree bases, in high mountains, in the north and west of the Peninsula. Esp, Prt.
- 15 Alar cells numerous, hyaline, inflated, forming a well delimited group which is widely decurrent (fig. 69, 10-12) **B. rivulare** Schimp.  
 Plants large, glossy light green to yellowish. Stem prostrate, regularly branched, with erect or ascending branches. Stem leaves widely ovate, abruptly narrowed, margin denticulate. Seta papillose. Autoicous or dioicous. Aquatic, on soils and rocks in streams, in montane areas and high mountains. Widespread throughout the Peninsula and in Mallorca. Esp, Prt, And, Bl.
- 15 Alar cells not hyaline or inflated 16
- 16 Leaves with short acumen, abruptly acuminate (fig. 69, 13-15) **B. rutabulum** (Hedw.) Schimp.  
 Stem prostrate or ascending, with erect branches. Stem leaves widely ovate, margin dentate, usually with the acumen twisted 180°; alar cells not inflated, forming a decurrent group ± reaching the nerve. Seta strongly papillose. Autoicous. Forms green or yellowish green wefts on rocks and at tree bases, in wet places, in the lowlands and montane areas. Widespread throughout the Peninsula and in Mallorca and Menorca. Esp, Prt, Bl.
- 16 Leaves with long acumen, gradually acuminate 17
- 17 Leaf margin usually entire; plants growing on wet, open soils from montane areas to high mountains (fig. 68, 11-12) **B. mildeanum** (Schimp.) Schimp.  
 Plants robust, yellowish. Stem leaves elongate triangular, with basal and alar cells slightly differentiated. Seta smooth. Autoicous or polyoicous. Scattered in the Peninsula. Esp, Prt, And.
- 17 Leaf margin denticulate; plants growing in the lowlands and montane areas (fig. 69, 16-17) **B. campestre** (Müll.Hal.) Schimp.  
 Plants medium-sized. Stem leaves with weak longitudinal plicae. Branch leaves broadly ovate-lanceolate, margin usually strongly dentate. Seta papillose or smooth. Autoicous. Forms pale green or yellowish wefts on wet soils. Scattered in the Peninsula. Esp, Prt.

### Cirriphyllum Grout

Plants medium-sized to robust. Stem usually prostrate, pinnate or irregularly branched, with ascending branches. Stem leaves concave, ovate, narrowed at base, abruptly acuminate or tapered into long, fine point, margin entire or serrulate, plane or recurved at base; laminal cells elongate, alar cells quadrate or shortly rectangular, decurrent; nerve extending 1/2-2/3 way up leaf. Branch leaves similar to stem leaves or gradually tapered. Seta papillose; capsule ovoid, curved; lid rostellate to conical. Dioicous.

- 1 Stem leaves  $\pm$  concave, ovate-lanceolate, abruptly acuminate; alar cells quadrate, ascending up margin; branch leaves acuminate (fig. 70, 1-2)

**C. tommasinii** (Sendtn. ex Boulay) Grout

\* **Brachythecium tommasinii** (Sendtn. ex Boulay) Ignatov & Huttunen

Plants yellowish to brownish. Forms glossy wefts on shaded, basic rocks, in montane areas and high mountains, in the north of the Peninsula. Esp.

- 1 Stem leaves strongly concave, ovate, abruptly tapered into long, fine point; alar cells widely rectangular, not ascending up margin; branch leaves similar to stem leaves 2
- 2 Stem irregularly branched; median cells of lamina 5-8  $\mu$ m wide (fig. 70, 3)

**C. cirrosum** (Schwägr.) Grout

Plants robust, glossy golden. Leaves with entire or serrulate margin. Forms wefts on calcareous rocks and wet soils, in montane areas and high mountains, in the northeastern part of the Peninsula. Esp, And.

- 2 Stem pinnately branched; median cells of lamina 10-11  $\mu$ m wide (fig. 70, 4)

**C. piliferum** (Hedw.) Grout

Leaves with finely denticulate margin; alar cells little differentiated. Forms pale green wefts on very wet tree bases, in montane areas and high mountains, in the north of the Peninsula. Esp.

### Eurhynchium Schimp.

Plants small to robust. Stem prostrate or procumbent, irregularly pinnately branched, with erect or ascending branches. Stem and branch leaves similar or not, stem leaves longitudinally plicate or not, plane or slightly concave, ovate to cordate-triangular, acuminate to obtuse, margin denticulate or dentate; laminal cells smooth, median cells usually long and narrow, apical cells shorter, oblong-rhomboidal, alar cells slightly differentiated, forming a small group extending to nerve; nerve single, extending 1/2 way up leaf to near apex, in branch leaves ending in a small projection from back. Seta reddish, smooth or papillose; capsule inclined to horizontal, ovoid or cylindrical, curved or erect; lid obliquely rostrate. Autoicous, synoicous or dioicous.

- 1 Leaves longitudinally plicate; plants robust; seta smooth 2
- 1 Leaves without or with weak longitudinal plicae; plants slender to medium-sized; seta papillose (except in *E. pulchellum*) 3

- 2 Leaves cordate-ovate, with acute, wide acumen, making an angle of more than 45° (fig. 70, 5-6) **E. angustirete** (Broth.) T.J. Kop.  
**E. striatum** (Hedw.) Schimp. subsp. **zetterstedtii** (P. Størmer) Podp.  
 Plants dark green to yellowish green. Grows on humus-rich soils and rocks in firwoods, pinewoods and beechwoods, in montane areas and high mountains, in the Pyrenees. Esp, And.
- 2 Leaves ovate-lanceolate or cordate-lanceolate, with long, narrow acumen, making an angle of less than 40° (fig. 70, 7-9) **E. striatum** (Hedw.) Schimp.  
 Leaves erect or spreading. Forms loose, glossy green or yellowish green patches on soils, slopes, rocks and at tree bases, in wet forests, in montane areas and high mountains, in the northern half of the Peninsula, very rare in the south and in Mallorca. Esp, Prt, And, Bl.
- 3 Seta smooth (fig. 70, 10-12) **E. pulchellum** (Hedw.) Jenn.  
 \* **Eurhynchiastrum pulchellum** (Hedw.) Ignatov & Huttunen  
 Plants small. Stem prostrate, with short, ascending branches. Stem leaves distant, triangular to narrowly oblong-ovate; apical cells of lamina short, 2:1, median cells 50-80 x 5 µm. Branch leaves 0.5-1 mm long, with acute or obtuse point, sometimes concave. Grows on tree bases and rocks, in rock crevices and on wet, calcareous soils, in pinewoods and fir woods, in montane areas and high mountains. Widespread throughout the Peninsula. Esp, Prt, And.  
 var. **pulchellum**: Stem leaves erect-spreading; laminal cells 50-80 µm. Branch leaves with acute apex (fig. 70, 10-11).  
 var. **diversifolium** (Schimp.) C.O.E. Jensen (fig. 65, 21): Stem leaves densely imbricate; laminal cells 36-56 µm long. Branch leaves with rounded, obtuse apex (fig. 70, 12).
- 3 Seta papillose 4
- 4 Stem leaves widely ovate to cordate-triangular, decurrent, branch leaves ovate to lanceolate (fig. 70, 13-17) **E. praelongum** (Hedw.) Schimp.  
 \* **Kindbergia praelonga** (Hedw.) Ochyra  
 var. **praelongum**: Plants dark green or greenish brown. Stem to 15 cm long, irregularly branched with complanate branches, paraphyllia lacking. Stem leaves erect, narrowly decurrent. Branch leaves lanceolate to ovate-lanceolate, with short apical cells, median cells 8-12:1. Forms wefts on wet soils and slopes in forests, mainly in montane areas, rarer in the lowlands. Widespread throughout the Peninsula and in Mallorca. Esp, Prt, Bl (fig. 70, 13-14).  
 var. **stokesii** (Turner) Dixon (fig. 65, 12-14): Plants green, brown or yellowish. Stem procumbent, densely pinnate or bipinnate, with short, ascending branches usually with paraphyllia. Stem leaves patent, with long, squarrose acumen, widely decurrent. Branch leaves ovate-triangular with long apical cells, median cells 5-8:1. Forms soft wefts on rocks, slopes and soils, in chasms and on tree bases, in wet sites, usually in the lowlands. Widespread throughout the Peninsula and in Mallorca, Menorca and Pithyusic Islands. Esp, Prt, And, Bl (fig. 70, 15-17).
- 4 Stem leaves and branch leaves similar, decurrent or not 5
- 5 Leaf apex twisted through 180° (fig. 70, 18) **E. schleicheri** (R. Hedw.) Milde  
 \* **Oxyrrhynchium schleicheri** (R. Hedw.) Röll  
 Plants to 6 cm long. Primary stem creeping, subterranean, the secondary ones erect, regularly branched, with short branches. Leaves densely arranged; median cells 3-5 µm wide. Branch leaves usually complanate, sometimes longitudinally plicate. Dioicous. Grows on wet soils

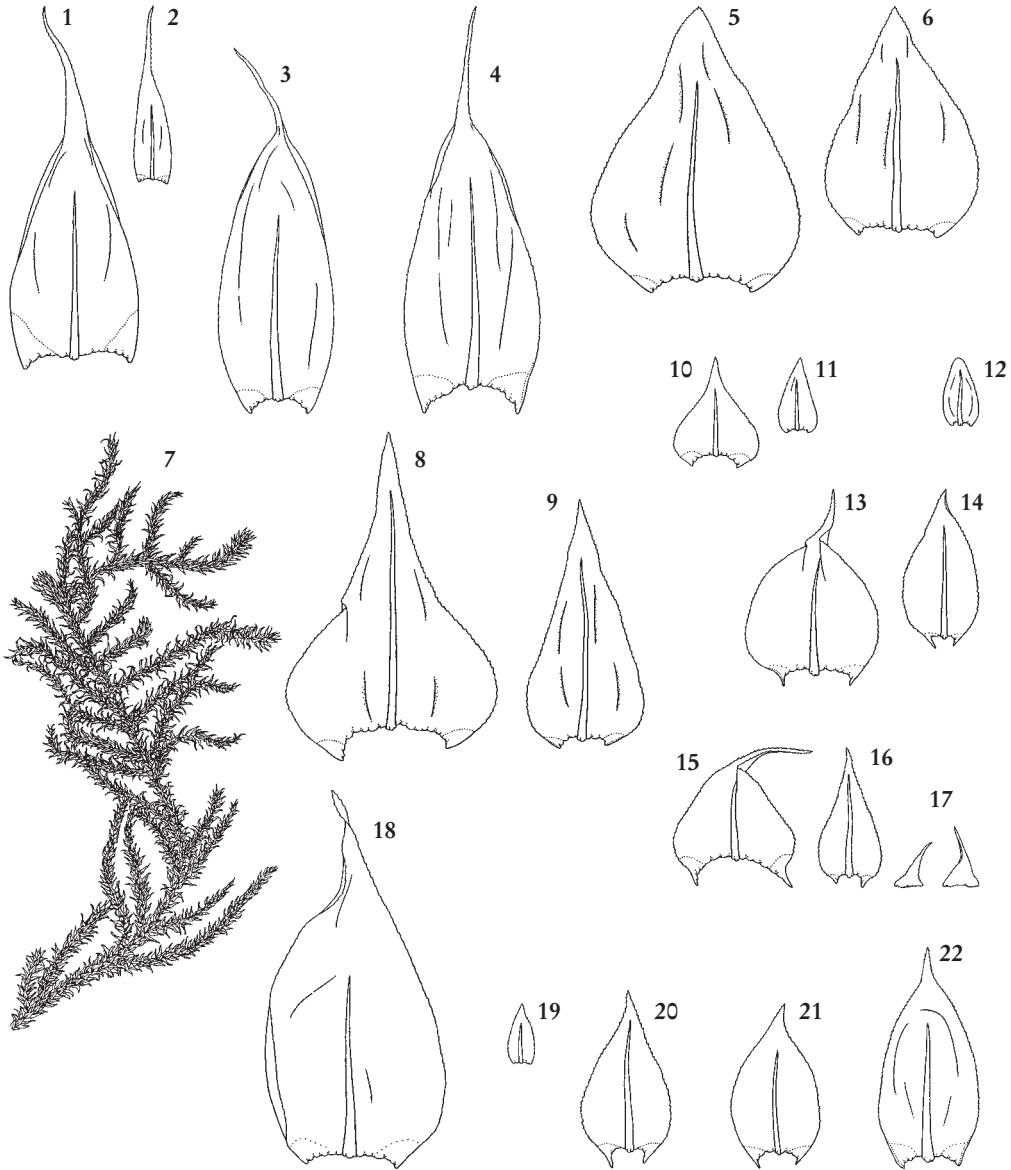


FIGURE 70. 1-2, *Cirriphyllum tommasinii*: 1, stem leaf; 2, branch leaf. 3, *C. cirrosum*, leaf. 4, *C. piliferum*, leaf. 5-6, *Eurhynchium angustirete*: 5, stem leaf; 6, branch leaf. 7-9, *E. striatum*: 7, habit; 8, stem leaf; 9, branch leaf. 10-11, *E. pulchellum* var. *pulchellum*: 10, stem leaf; 11, branch leaf. 12, *E. pulchellum* var. *diversifolium*, branch leaf. 13-14, *E. praelongum* var. *praelongum*: 13, stem leaf; 14, branch leaf. 15-17, *E. praelongum* var. *stokesii*: 15, stem leaf; 16, branch leaf; 17, paraphyllia. 18, *E. schleicheri*, leaf. 19, *E. pumilum*, leaf. 20, *E. speciosum*, leaf. 21, *E. hians*, leaf. 22, *E. crassinervium*, leaf. 7 ( $\times 1.5$ ); 1, 2, 3, 4, 5, 6, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22 ( $\times 18$ ).



and rocks, in montane areas and high mountains. Distributed in the northern half of the Peninsula, rare in the southeast. Esp, Prt.

- 5 Leaf apex plane 6

- 6 Laminal cells 2-5:1; leaves to 0,5 mm long; plants very small (fig. 70, 19)

**E. pumilum** (Wilson) Schimp.

\* **Oxyrrhynchium pumilum** (Wilson) Loeske

Nerve of stem leaves 18-31  $\mu\text{m}$  wide at base. Dioicous. Forms small, dark green patches on calcareous soils and wet slopes, in forests, in the lowlands and montane areas. Widespread throughout the Peninsula and in Mallorca and Menorca. Esp, Prt, Bl.

- 6 Laminal cells 5-15:1; leaves more than 0,5 mm long; plants medium-sized 7

- 7 Branch leaves usually complanate, sparsely arranged, glossy (fig. 70, 20)

**E. speciosum** (Brid.) Jur.

\* **Oxyrrhynchium speciosum** (Brid.) Warnst.

Leaves narrowed at base, longly decurrent; median cells of lamina 40-100  $\times$  5-9  $\mu\text{m}$ ; nerve nearly reaching the apex. Autoicous or synoicous. Forms large, dark green wefts on wet or flushed slopes and rocks, in the lowlands and montane areas. Distributed throughout the Peninsula, but rarer in the west and in the south, and in Mallorca. Esp, Prt, Bl.

- 7 Branch leaves not complanate or glossy 8

- 8 Nerve narrow at base; leaves  $\pm$  flat (fig. 70, 21) **E. hians** (Hedw.) Sande Lac.

**E. swartzii** (Turner) Curn., \* **Oxyrrhynchium hians** (Hedw.) Loeske

Plants rhizomatous, golden green. Stem procumbent; stem leaves lax, widely ovate, decurrence of 1-4 cells; median cells of lamina 40-60(-80)  $\times$  5-9  $\mu\text{m}$ ; nerve extending to 1/2-3/4 way up leaf. Branch leaves 0,8-1,2 mm long, acute, plane, margin strongly dentate. Dioicous. Forms lax patches on wet, base-rich soils, slopes and by streams, in the lowlands and montane areas. Widespread throughout the Peninsula and in Mallorca. Esp, Prt, Bl.

- 8 Nerve very wide at base; leaves concave 9

- 9 Stem leaves widely ovate, strongly concave, similar to branch leaves; nerve extending to 2/3-3/4 way up leaf (fig. 70, 22) **E. crassinervium** (Taylor) Schimp.

\* **Cirriphyllum crassinervium** (Taylor) Loeske & M. Fleisch.

Plants light green to brownish. Median cells of lamina narrow, acuminate, apical cells short, alar cells quadrate, moderately inflated. Capsule oblique, curved. Grows on wet, shaded, mainly calcareous rocks, in montane areas, rarely in the lowlands. Widespread throughout the Peninsula and in Mallorca. Esp, Prt, Bl.

- 9 Stem leaves ovate-lanceolate, concave, branch leaves narrower; nerve extending to 4/5 way up leaf **E. flotowianum** (Sendtn.) Kartt.

**Cirriphyllum reichenbachianum** (Huebener) Wijk & Margad.,

\* **Sciuro-hypnum flotowianum** (Sendtn.) Ignatov & Huttunen

Plants pale green or yellowish. Stem leaves narrowly decurrent. Forms patches on moist, shaded, calcareous rocks in high mountains. Very rare, in the Pyrenees. Esp.



## Homalothecium Schimp.

Plants medium-sized to robust. Stem prostrate, regularly or irregularly branched, with straight or curved branches. Stem leaves similar to branch leaves,  $\pm$  plicate, triangular to triangular-lanceolate, acuminate straight or slightly falciform, margin irregularly denticulate at base, more rarely at apex; laminal cells linear to vermicular, basal cells shorter and wider, alar cells quadrate or irregular in shape; nerve single, long, usually projecting as a dorsal spine. Seta smooth or papillose; capsule erect or inclined. Dioicous.

- 1 Alar cells of branch leaves numerous, quadrate, arranged in 3-4 rows, ascending up margin; capsule inclined (fig. 71, 1-2) **H. aureum** (Spruce) H. Rob.

Plants medium-sized. Stem pinnate, with erect branches, curved when dry, 0.5-1 cm long. Stem leaves triangular to oblong-lanceolate, finely acuminate, slightly plicate, margin recurved from base to apex. Forms golden mats on dry, exposed, acidic or basic soils and rocks, mainly in montane areas. Scattered in the Peninsula and in Mallorca. Esp, Prt, Bl.

- 1 Alar cells of branch leaves irregular in shape, rarely arranged in rows, not ascending up margin; capsule erect or inclined **2**

- 2 Nerve extending to the apex, not projecting as a spine but usually denticulate at back; capsule straight; seta smooth (fig. 71, 3) **H. philippeanum** (Spruce) Schimp.

Plants robust. Stem irregularly branched, with long, erect branches. Leaves triangular, acuminate, with 1-3 decurrent cells at base; nerve stout. Forms glossy green mats, brownish below, on calcareous rocks, in montane areas and high mountains, in the northern half of the Peninsula, rare in the south. Esp.

- 2 Nerve not reaching the apex, usually projecting as a spine; capsule straight or curved; seta papillose **3**

- 3 Plants irregularly branched; branches long, erect when dry; rhizoids basal; branch leaves with 2-4 decurrent cells; capsule inclined (fig. 71, 4)

**H. lutescens** (Hedw.) H. Rob.

**Camptothecium lutescens** (Hedw.) Schimp.

Plants medium-sized to robust, ascending. Leaves triangular, lanceolate or ovate-lanceolate, strongly plicate, apex acuminate, filiform, usually bent, margin finely denticulate, especially at base and apex. Form glossy golden mats on calcareous soils and rocks and in clearings, in montane areas, mainly in the northern half of the Peninsula and in Mallorca, rare in the south of the Peninsula. Esp, Prt, And, Bl.

- 3 Plants regularly branched; branches short, curved when dry; rhizoids along the stem; branch leaves with 4-6 decurrent cells; capsule erect (fig. 71, 5-8)

**H. sericeum** (Hedw.) Schimp.

Plants variable in size, procumbent. Stem leaves ovate-triangular, plicate, apex long and thin, margin serrulate at base, with curved teeth, slightly denticulate at apex. Branch leaves triangular-lanceolate. Forms silky, glossy golden green mats on dry, calcareous, soils, rocks, exposed walls and trunks of trees (slender forms), in the lowlands and montane areas. Widespread throughout the Peninsula and in Mallorca, Menorca and Pityusic Islands. Esp, Prt, And, Bl.

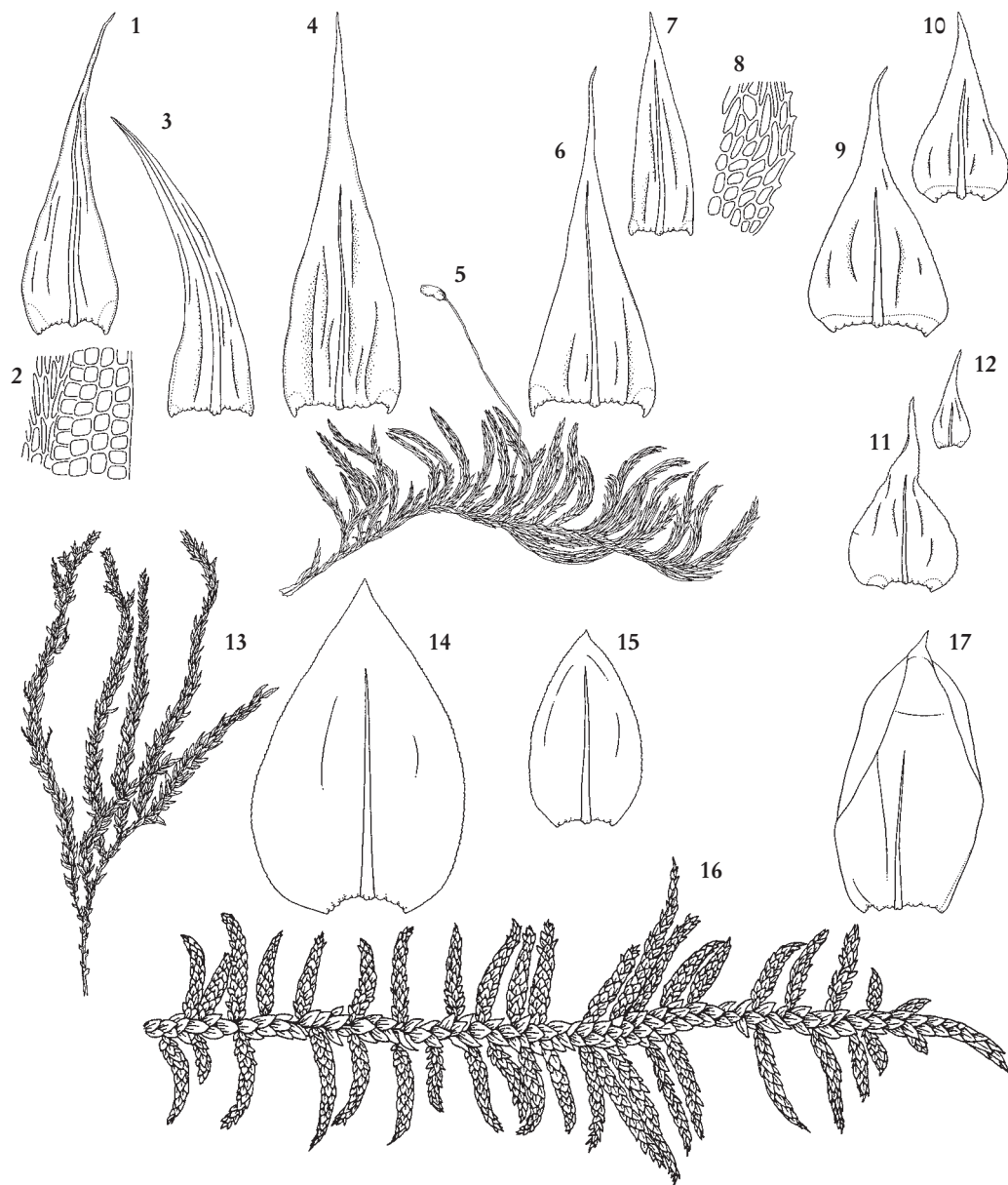


FIGURE 71. 1-2, *Homalothecium aureum*: 1, stem leaf; 2, alar cells of branch leaf. 3, *H. philippeanum*, leaf. 4, *H. lutescens*, leaf. 5-8, *H. sericeum*: 5, habit; 6, stem leaf; 7, branch leaf; 8, alar cells. 9-10, *Plasteurhynchium striatulum*: 9, stem leaf; 10, branch leaf. 11-12, *P. meridionale*: 11, stem leaf; 12, branch leaf. 13-14, *Platyhypnidium riparioides*: 13, habit; 14, leaf. 15, *P. lusitanicum*, leaf. 16-17, *Pseudoscleropodium purum*: 16, habit; 17, leaf. 5, 13, 16 ( $\times 1.5$ ); 1, 3, 4, 6, 7, 9, 10, 11, 12, 14, 15, 17 ( $\times 18$ ); 2, 8 ( $\times 200$ ).

**Plasteurhynchium** M. Fleisch. ex Broth.

Plants robust. Stem prostrate, with erect or ascending branches. Stem leaves longitudinally plicate. Leaves ovate-cordate, with long, narrow acumen, margin denticulate; laminal cells smooth, rhomboidal to linear-rhomboidal, alar cells quadrate, reaching the nerve or forming a small group; nerve extending to 3/4 way up leaf, in branch leaves ending in a small projection from back. Seta smooth; capsule inclined, sub-cylindrical to ellipsoidal; lid obliquely rostrate. Dioicous.

- 1 Alar cells reaching the nerve; laminal cells 3-6:1; leaves erecto-patent (fig. 71, 9-10)  
**P. striatulum** (Spruce) M. Fleisch.  
**Eurhynchium striatulum** (Spruce) Schimp.

Stem with usually curved ascending branches. Stem leaves ovate-lanceolate, with narrow channelled acumen in large forms, widely ovate and acuminate in small forms; basal cells shortly rectangular. Branch leaves lanceolate to ovate-lanceolate, margin denticulate to dentate. Forms dark green to yellow green wefts on moist, shaded, calcareous rocks in montane areas. Distributed in the northern half of the Peninsula, rarer in the south and in Mallorca and Menorca. Esp, Prt, Bl.

- 1 Alar cells forming a small group, not reaching the nerve; laminal cells 8-10:1; leaves spreading (fig. 71, 11-12)  
**P. meridionale** (Schimp.) M. Fleisch.  
**Eurhynchium meridionale** (Schimp.) De Not.

Stem with ascending branches. Stem leaves cordate-triangular, acuminate, squarrose, margin denticulate; basal cells porose. Branch leaves narrower at base. Forms small, glossy yellowish green mats on ledges and dry, calcareous rocks, in the lowlands, rarely in montane areas. Widespread throughout the Peninsula and in Mallorca, Menorca and Pithyusic Islands. Esp, Prt, Bl.

**Platyhypnidium** M. Fleisch.

Plants robust. Stem prostrate, irregularly branched. Stem and branch leaves similar, ovate, concave or nearly flat, margin denticulate or dentate; laminal cells linear or narrowly rhomboidal, smooth, alar cells enlarged but not forming auricles; nerve extending to 3/4 way up leaf, not ending in projecting cell at back. Seta smooth; capsule with rostrate lid.

- 1 Leaves nearly flat, erect to spreading; laminal cells linear (fig. 71, 13-14)  
**P. riparioides** (Hedw.) Dixon  
**Rhynchostegium riparioides** (Hedw.) Cardot

Plants polymorphic, to 15 cm long, usually denudate at base, dark green to glossy blackish. Median cells of lamina 8-13:1, 6-12 µm wide, apical cells short, basal cells short, porose, pale; nerve 65-150 µm wide at base, often bifurcate in the upper part. Rheophilous, on submerged rocks and by streams, from the lowlands to high mountains. Widespread throughout the Peninsula and in Mallorca, Menorca and Pithyusic Islands. Esp, Prt, Bl.

- 1 Leaves concave, appressed; laminal cells narrowly rhomboidal (fig. 71, 15)  
**P. lusitanicum** (Schimp.) Ochyra & Bednarek-Ochyra  
**Rhynchostegium alopecuroides** (Brid.) A.J.E. Sm.

Plants to 7 cm long, with julaceous branches. Median cells of lamina 12-17:1, 4-7  $\mu\text{m}$  wide; nerve 45-80  $\mu\text{m}$  wide at base. Forms glossy dark green wefts on seeping rocks, mainly in the northwestern part of the Peninsula. Esp, Prt.

### **Pseudoscleropodium** (Limpr.) M. Fleisch.

Plants robust. Stem prostrate or ascending, regularly pinnate, branches complanate, stem and branches julaceous. Leaves imbricate, strongly concave, widely ovate or obovate, apex obtuse or rounded and apiculate, margin plane or recurved at apex, finely denticulate to entire; laminal cells linear-vermicular, basal cells shorter than wide, porose, alar cells quadrate to rectangular; nerve extending to 1/2-2/3 way up leaf. Seta smooth (fig. 71, 16-17)

**P. purum** (Hedw.) M. Fleisch.

**Scleropodium purum** (Hedw.) Limpr.

Forms extensive, pale green or brownish green wefts on forest soils, in the lowlands. Widespread throughout the Peninsula and in Mallorca and Menorca. Esp, Prt, And, Bl.

### **Rhynchostegiella** (Schimp.) Limpr.

Plants slender, small. Stems mostly prostrate, with short branches. Leaves lanceolate to oblong-lanceolate, margin entire or denticulate, apex acute or longly acuminate; laminal cells rhomboidal to linear; nerve extending to acumen or at least to 1/2 way up leaf. Seta smooth or papillose; capsule horizontal or inclined; lid rostrate.

1 Leaves linear-lanceolate, longly acuminate, usually with entire margin 2

1 Leaves oblong-lanceolate, shortly acuminate, with finely denticulate margin 4

2 Rhizoids warty-papillose (fig. 72, 1-2) **R. duriei** (Mont.) P. Allorge & Perss.

**Orthothecium duriaci** (Mont.) Besch.

Plants with ascending stems. Leaves subulate; basal cells porose, linear above; nerve faint, short, extending 2/5-1/2 way up leaf, occasionally absent in some leaves. Forms silky, glossy yellowish green mats in crevices and on ledges and acidic soils, in the lowlands and montane areas in the southwestern part of the Peninsula and Menorca. Esp, Prt, Bl.

2 Rhizoids smooth 3

3 Leaves with entire margin; apical cells longer than median cells; nerve reaching acumen; seta smooth; spores 10-15  $\mu\text{m}$  (fig. 72, 3) **R. tenella** (Dicks.) Limpr.

Forms silky, glossy golden wefts in rock crevices and on ledges and slopes, mainly on basic substrata. Widespread throughout the Peninsula and in Mallorca, Menorca and Pithyusic Islands. Esp, Prt, Bl.

3 Leaves with entire or finely denticulate margin; apical cells shorter than median cells; nerve extending to half way up leaf; seta finely papillose; spores 14-22  $\mu\text{m}$  (fig. 72, 4)

**R. litorea** (De Not.) Limpr.

Nerve 20-35  $\mu\text{m}$  wide at base. Forms golden wefts in rock crevices and on slopes, mainly in the lowlands of the Mediterranean region and in Mallorca, Menorca and Pithyusic Islands. Esp, Prt, Bl.

- 4 Nerve thin, 35-50  $\mu\text{m}$  wide at base, vanishing towards middle of the leaf; apical cells 4:1 (fig. 72, 5) **R. curviseta** (Brid.) Limpr.

Leaves erecto-patent; median cells of lamina very long, 8-10:1. Seta mamilllose or papillose. Forms yellowish green to olive green compact patches on moist rocks and slopes, in the lowlands. Widespread in the northern half of the Peninsula and in Mallorca, Menorca and Pithyusic Islands, very rare in the south of the Peninsula. Esp, Prt, Bl.

- 4 Nerve stout, more than 50  $\mu\text{m}$  wide at base, vanishing at leaf acumen; apical cells 5-7:1 (fig. 72, 6) **R. teneriffae** (Mont.) Dirkse & Bouman

**R. teesdalei** (Schimp.) Limpr.

Plants rigid. Leaves patent. Seta mamilllose. Forms olive green wefts on wet rocks, by streams and waterfalls, mainly in montane areas, rarely in the lowlands. Distributed in northern and northeastern part of the Peninsula, rare in the south of the Peninsula and in Menorca. Esp, Prt, Bl.

### **Rhynchostegium Schimp.**

Plants small to robust. Stem prostrate, irregularly branched. Stem and branch leaves similar, ovate-lanceolate to widely ovate, obtuse to acuminate, concave, margin entire to serrate; laminal cells narrowly rhomboidal to linear, smooth, alar cells slightly differentiated from basal ones; nerve extending 1/2-2/3 way up leaf, not ending in projecting cell at back. Seta smooth, reddish; capsule brownish, ovoid, inclined to horizontal; lid rostrate; calyptra cucullate. Autoicous.

- 1 Stem leaves ovate, obtuse and apiculate (fig. 72, 7) **R. murale** (Hedw.) Schimp.

Plants medium-sized, glossy golden green to brownish, with rhizoids along stem. Leaves concave, margin entire or slightly denticulate in the upper part; median cells of lamina 5-8  $\mu\text{m}$  wide, elongate, 7-12:1, alar cells shortly rectangular; nerve extending to 1/2(-2/3) way up leaf. Grows on wet, shaded, basic rocks in montane areas, rarely in high mountains. Widespread in the northern half of the Peninsula. Esp, Prt.

- 1 Stem leaves ovate or oblong, acuminate 2

- 2 Stems attached to substratum for most of their length by rhizoids; leaf apex plane; median cells of lamina 4-7,5  $\mu\text{m}$  wide (fig. 72, 8) **R. confertum** (Dicks.) Schimp.

Plants small, to 3 cm long. Leaves erect to patent, oblong, acuminate, margin denticulate to serrate; nerve extending to 3/4 way up leaf. Forms glossy olive green to golden mats on wet, shaded rocks and at tree bases, in the lowlands and montane areas. Widespread throughout the Peninsula and Mallorca and Menorca. Esp, Prt, Bl.

- 2 Stems attached to substratum only at base; leaf apex twisted 180°; median cells of lamina 6,5-10  $\mu\text{m}$  wide (fig. 72, 9-10)

**R. megapolitanum** (Blandow ex F. Weber & D. Mohr) Schimp.

Plants very polymorphic, to 10 cm long. Leaves erect to patent, with widely ovate base, acuminate, margin denticulate; basal cells shortly rectangular to rhomboidal, extending from nerve to margin; nerve extending to 3/4 way up leaf. Forms green to glossy golden wefts on soils in *Quercus ilex* L. forests, pinewoods and brushwoods, and by roadsides, mainly in the lowlands, rarely in montane areas. Widespread throughout the Peninsula and Mallorca, Menorca and Pithusic Islands. Esp, Prt, Bl.

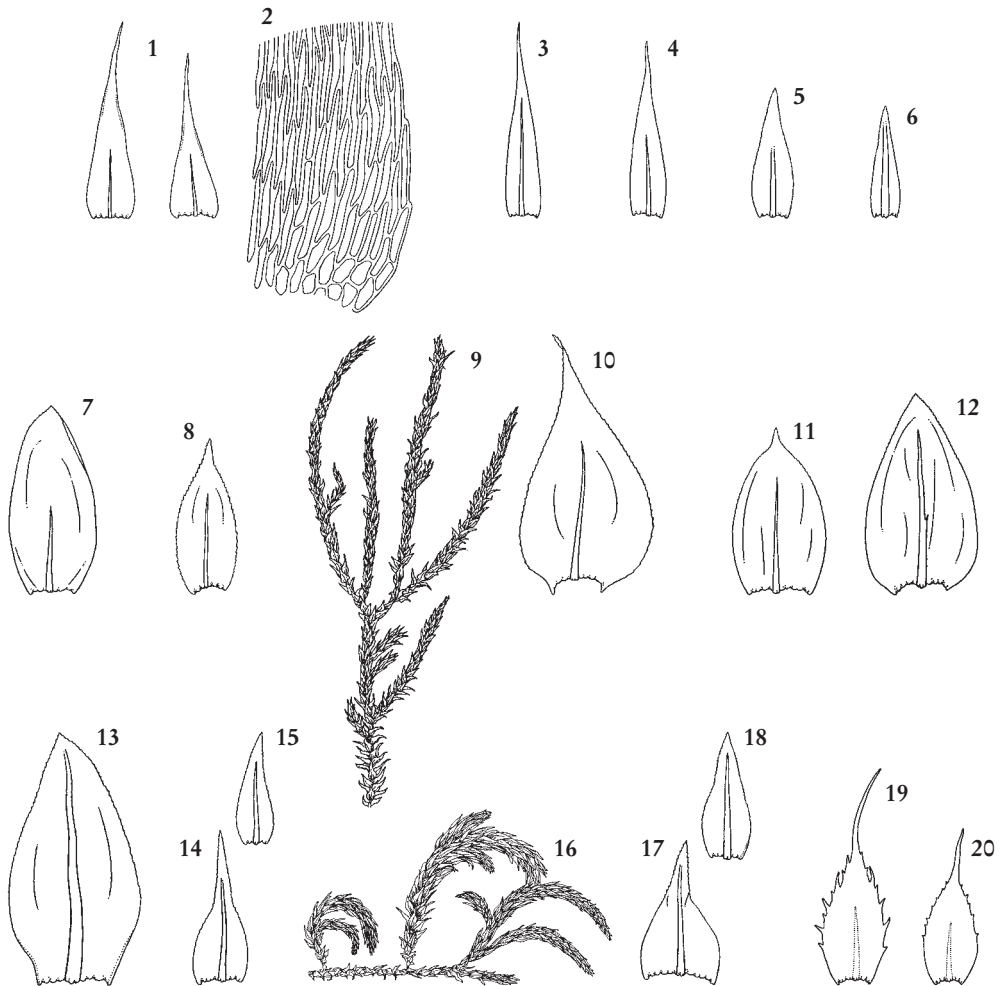


FIGURE 72. 1-2, *Rhynchostegiella duriei*: 1, leaves; 2, basal cells. 3, *R. tenella*, leaf. 4, *R. litorea*, leaf. 5, *R. curviseta*, leaf. 6, *R. teneriffae*, leaf. 7, *Rhynchostegium murale*, leaf. 8, *R. confertum*, leaf. 9-10, *R. megapolitanum*: 9, habit; 10, leaf. 11, *Scleropodium touretii*, leaf. 12, *S. cespitans*, leaf. 13, *Scorpiurium deflexifolium*, leaf. 14-15, *S. sendtneri*: 14, stem leaf; 15, branch leaf. 16-18, *S. circinatum*: 16, habit; 17, stem leaf; 18, branch leaf. 19, *Fabronia pusilla*, leaf. 20, *F. ciliaris*, leaf. 9 ( $\times 1.5$ ); 16 ( $\times 3.5$ ); 1, 3, 4, 5, 6, 7, 8, 10, 11, 12, 13, 14, 15, 17, 18 ( $\times 20$ ); 19, 20 ( $\times 30$ ); 2 ( $\times 200$ ).

### **Scleropodium** Bruch & Schimp.

Plants medium-sized. Stem ascending, irregularly branched; branches short, curved or straight, julaceous, not complanate. Stem leaves imbricate, concave, ovate, not apiculate or fairly gradually narrowed into a short, straight or slightly curved apiculus, margin plane or slightly recurved at base; laminal cells linear, wider and slightly porose at base, alar cells rectangular or quadrate; nerve extending to 1/2-3/4 way up leaf, sometimes bifurcate and short. Branch leaves narrower than stem leaves. Seta papillose. Dioicous.

- 1 Plants with short, curved branches; branch leaves shortly apiculate (fig. 72, 11)  
**S. touretii** (Brid.) L.F. Koch

Stem leaves ovate-oblong, acute, apiculate or not, margin irregularly denticulate in the upper part; nerve extending to 3/4 way up leaf, sometimes short and bifurcate. Branch leaves oblong. Forms glossy green or yellowish green patches on rocky soils and slopes, in clearings and heaths, in the lowlands. Widespread throughout the Peninsula and in Mallorca, Menorca and Pityusic Islands. Esp, Prt, Bl.

- 1 Plants with long, straight branches; branch leaves longly apiculate (fig. 72, 12)  
**S. cespitans** (Wilson ex Müll.Hal.) L.F. Koch

Stem leaves widely ovate, apex obtuse or acute; nerve extending 1/2-2/3 way up leaf. Branch leaves oblong. Forms glossy light green patches on tree bases, rocks and soils near water. Very rare, in the northwest of the Peninsula. Esp, Prt.

### **Scorpiurium** Schimp.

Primary stem prostrate, secondary stems ascending, curved. Stem leaves ovate to triangular, ± acuminate, margin dentate or denticulate, recurved at base. Branch leaves ovate to lanceolate; median cells of lamina smooth, longly rhomboidal, 4-6:1, shorter towards apex, basal cells irregularly quadrate, alar cells quadrate or hexagonal, ascending up margin; nerve ending below apex, stout. Dioicous.

- 1 Plants medium-sized; branches ascending; stem and branch leaves similar in shape, with wide, short acumen, branch leaves loosely imbricate when dry (fig. 72, 13)  
**S. deflexifolium** (Solms) M. Fleisch. & Loeske

Plants denudate in old parts. Leaves ovate-orbicular, narrow at base, margin dentate in the upper half; nerve 68-110 µm wide at base. Forms olive-green mats, blackish below, on acidic substrata, tree stumps, temporarily submerged rocks, by streams, in the lowlands, infrequent in montane areas. Widespread in the western part of the Peninsula, rare in the northeastern part of the Peninsula and in Mallorca and Menorca. Esp, Prt, Bl.

- 1 Plants small; branches ± curved; stem and branch leaves different in shape, stem leaves abruptly narrowed to long acumen, branch leaves densely imbricate when dry 2

- 2 Branches slightly curved, about 0,5 mm wide or less; usually epiphytic (fig. 72, 14-15)  
**S. sendtneri** (Schimp.) M. Fleisch.

Plants minute, slender. Stem leaves ovate-lanceolate, usually falciform, margin nearly entire; nerve to 40 µm wide at base. Branch leaves sub-acute, with denticulate margin in the upper



half; upper laminal cells mostly prorate. Forms dark green mats on trunks of trees, in the southwestern part of the Peninsula. Esp, Prt.

- 2 Branches curved, more than 0,5 mm wide; plants growing on rocks and stony soils (fig. 72, 16-18) **S. circinatum** (Bruch) M. Fleisch. & Loeske  
Plants small. Stem leaves slightly plicate, ovate-triangular, margin serrate; nerve 38-68  $\mu$ m wide at base. Branch leaves ovate to lanceolate, acuminate. Forms green or yellowish green mats on shaded, calcareous rocks and stony soils, in the lowlands and montane areas. Widespread throughout the Peninsula, especially in the Mediterranean region, rare in northwest of the Peninsula. Esp, Prt, Bl.

## Fam. Fabroniaceae

### Fabronia Raddi

Plants small, creeping, irregularly branched. Leaves ovate-lanceolate, longly acuminate, margin dentate to ciliate; median cells elongate rhomboidal, smooth, alar cells quadrate; nerve lacking or faint, extending to 1/2 way up leaf. Seta long; capsule small, ovoid to oblong.

- 1 Leaf margin with long, thin, pluricellular teeth; capsule ovoid (fig. 72, 19) **F. pusilla** Raddi  
Forms wefts with short ascending branches 2-4 mm long, on trunks of trees and rocks, in the lowlands and montane areas, in the Peninsula and in Mallorca. Esp, Prt, Bl.
- 1 Leaf margin entire or irregularly dentate with unicellular teeth; capsule oblong (fig. 72, 20) **F. ciliaris** (Brid.) Brid.  
Forms small wefts with ascending branches about 5 mm long, on oaks and evergreen oaks. Scattered in the Mediterranean region of the Peninsula. Esp.

## Fam. Hypnaceae

### Callicladium H.A. Crum

Stem prostrate, irregularly branched, branches short, julaceous, with thin, slightly curved apex; pseudoparaphyllia wide, foliose. Leaves straight, widely lanceolate, gradually acuminate, concave, margin entire; median cells of lamina linear, alar cells inflated, quadrate or shortly rectangular, hyaline or yellowish, basal cells porose, yellowish, short and wide; nerve thin, short and double **C. haldanianum** (Grev.) H.A. Crum

Forms glossy golden green wefts on humus-rich soils in the Pyrenees. Esp (Extinct).

### Calliergonella Loeske

Plants medium-sized to robust, erect or prostrate. Stem with complanate branches, reddish, with well developed hyaloderm; pseudoparaphyllia broad. Leaves erecto-patent



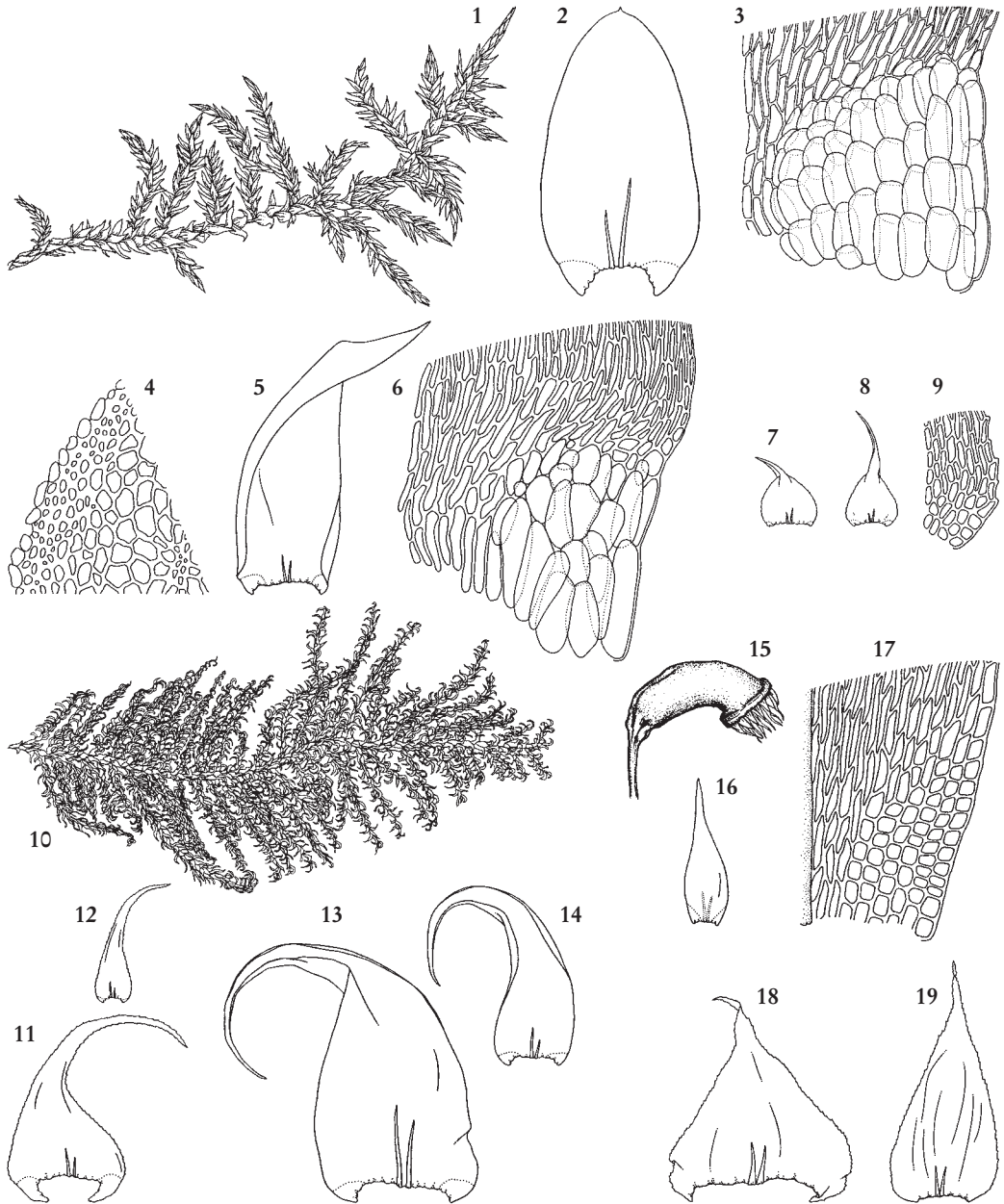


FIGURE 73. 1-3, *Calliergonella cuspidata*: 1, habit; 2, leaf; 3, alar cells. 4-6, *C. lindbergii*: 4, stem section; 5, leaf; 6, alar cells. 7, *Campylophyllum halleri*, leaf. 8-9, *C. calcareum*: 8, leaf; 9, alar cells. 10-12, *Ctenidium molluscum*: 10, habit; 11, stem leaf; 12, branch leaf. 13-14, *C. procerrimum*: 13, stem leaf; 14, branch leaf. 15-17, *Homomallium incurvatum*: 15, capsule; 16, leaf; 17, alar cells. 18-19, *Hyocomium armoricum*: 18, stem leaf; 19, branch leaf. 1, 10 ( $\times 1,6$ ); 15 ( $\times 15$ ); 2, 5, 7, 8, 11, 12, 13, 14, 16, 18, 19 ( $\times 20$ ); 4 ( $\times 120$ ); 3, 6 ( $\times 140$ ); 9, 17 ( $\times 200$ ).

to imbricate, ovate-oblong, obtuse, apiculate or acuminate, margin entire or finely denticulate in the upper part; median cells elongate, alar cells numerous, inflated, hyaline or coloured, forming a distinct group; nerve short, double and faint or lacking

- 1 Stem and branches cuspidate; leaves straight, obtuse or apiculate (fig. 73, 1-3)

**C. cuspidata** (Hedw.) Loeske

Stem  $\pm$  pinnately branched. Forms dense or lax, yellowish green or brownish patches in hollows, wet grasslands, by streams and pools, on calcareous or siliceous substrata, from the lowlands to high mountains. Widespread in the northern half of the Peninsula, rarer in the south and in Mallorca. Esp, Prt, And, Bl.

- 1 Stem and branches not cuspidate; leaves  $\pm$  falciform, widely acuminate (fig. 73, 4-6)

**C. lindbergii** (Mitt.) Hedenäs

**Hypnum lindbergii** Mitt.

Stem irregularly branched. Forms tufts on wet, peaty soils in montane areas and high mountains. Distributed in the Pyrenees and northeast of the Peninsula, scattered in the north. Esp, And.

### **Campylophyllum** (Schimp.) M. Fleisch.

Plants small or minute, procumbent, pinnate or irregularly branched, with ascending branches. Stem leaves reflexed or squarrose, rarely spreading, ovate or triangular, with cordate base, abruptly narrowed to channelled acumen, margin denticulate or entire; laminal cells elongate, smooth, alar cells small, quadrate or rectangular, not inflated, forming a  $\pm$  distinct group; nerve short or lacking.

- 1 Leaves squarrose, with wide, short acumen (fig. 73, 7)

**C. halleri** (Hedw.) M. Fleisch.

**Campylium halleri** (Hedw.) Lindb.

Plants small. Leaves short, with ovate base, abruptly narrowed into a channelled acumen shorter than the rest of the lamina. Forms pale green or brownish tufts on calcareous soils in wet sites, in montane areas and high mountains, in the northern part of the Peninsula. Esp.

- 1 Leaves spreading or reflexed, with fine, long acumen (fig. 73, 8-9)

**C. calcareum** (Crundw. & Nyholm) Hedenäs

**Campylium calcareum** Crundw. & Nyholm

Plants minute. Stem leaves ovate or triangular, with cordate base, acumen channelled, longer than the rest of the lamina. Forms dense pale green or yellowish tufts on wet, calcareous soils, in forests and grasslands, in the lowlands and montane areas, in the northern half of the Peninsula. Esp.

### **Ctenidium** (Schimp.) Mitt.

Plants small to robust. Primary stem prostrate, secondary stems prostrate to straight, pinnate, plumose. Paraphyllia  $\pm$  lanceolate. Stem leaves cordate, secund, decurrent, tapering into circinate acumen; laminal cells elongate, alar cells differentiated; nerve short and double or lacking. Branch leaves narrower and gradually narrowed towards apex, falcate-sekund.

- 1 Stem leaves cordate, abruptly narrowed, with dentate margin; laminal cells papillose at back, prorate (fig. 73, 10-12) **C. molluscum** (Hedw.) Mitt.

Species very polymorphic. Plants small to medium-sized, bright golden green or brownish. Forms mats on soils and calcareous rocks, from the lowlands to high mountains. Widespread throughout the Peninsula and in Mallorca and Pithyusic Islands. Esp, Prt, And, Bl.

- 1 Stem leaves cordate, gradually narrowed, with entire or finely denticulate margin; laminal cells smooth (fig. 73, 13-14) **C. procerrimum** (Molendo) Lindb.

\* **Hypnum procerrimum** Molendo

Plants medium-sized, brownish or golden green. Stem yellowish or orange. Forms patches on calcareous rocks in montane areas and high mountains. Rare, in the Pyrenees and Basque Mountains. Esp, And.

### **Homomallium** (Schimp.) Loeske

Plants slender. Stem prostrate, with short, irregular, ascending branches, without pseudoparaphyllia. Leaves straight, concave, ovate-lanceolate, attenuated in long acumen, usually secund, margin plane, entire or finely denticulate at apex; median cells of lamina rhomboidal, shorter towards margin and apex, alar cells quadrate, nearly reaching nerve, basal cells rhomboidal, not porose; nerve pale, short and double or lacking. Seta reddish; capsule reddish, inclined to horizontal, curved, asymmetrical; peristome well developed. Autoicous (fig. 73, 15-17) **H. incurvatum** (Schrad. ex Brid.) Loeske

Forms glossy, green or yellowish wefts on wet, calcareous rocks, rarely at tree bases, in montane areas, occasionally in high mountains. Scattered in the northern half of the Peninsula and in Algeciras Mountains. Esp, Prt.

### **Hyocomium** Bruch & Schimp.

Plants small to robust, erect or prostrate. Stem irregularly branched, with short branches. Stem leaves broadly cordate at base, decurrent, shortly tapering into acute or filiform apex, margin strongly and irregularly toothed from base to apex; laminal cells elongate; nerve short and double or lacking. Branch leaves smaller, ovate, acute. Seta purplish red, papillose; capsule ellipsoidal, slightly inclined (fig. 73, 18-19)

**H. armoricum** (Brid.) Wijk & Margad.

Forms golden green or brownish green patches on rocks or tree roots in moist or wet sites, by streams, torrents or waterfalls, in the north and northwestern part of the Peninsula. Esp, Prt.

### **Hypnum** Hedw.

Plants small to robust, green, yellowish or brownish, usually glossy. Stem sparsely to densely branched, sometime pinnately so, pseudoparaphyllia simple or branched, filamentous to foliose, paraphyllia only present in *H. recurvatum*. Stem leaves ovate-lanceolate, acuminate, falciform to circinate, occasionally straight, margin plane or recurved, entire or dentate; median cells of lamina linear, alar cells forming a distinct group; nerve short and double or lacking. Branch leaves similar to stem leaves. Seta reddish; capsule straight or curved, erect to horizontal; lid mamillate to rostrate. Autoicous or dioicous.

- |   |   |   |
|---|---|---|
| 1 | Stem with hyaloderm   | 2   |
| 1 | Stem without hyaloderm  | 3   |
| 2 | Alar cells of leaf subquadrate, forming a small group with 1-2 inflated, hyaline cells at base (fig. 74, 1-3)   | <b>H. hamulosum</b> Schimp.                   |
|   | Plants small. Leaves falciform to circinate. Grows on calcareous soils and rocks in high mountains, in the Central Pyrenees. Esp.   |   |
| 2 | Alar cells forming a large group of inflated, hyaline cells (fig. 74, 4-5)  | <b>H. callichroum</b> Brid.                   |
|   | Plants small. Leaves circinate. Grows on wet soils and shaded rocks, on acidic or slightly basic soils, in montane areas and high mountains, in the Pyrenees. Esp, And.   |   |
| 3 | Alar cells subquadrate to rectangular, fairly homogeneous, occasionally some cells large in the basal margin, forming a flat group; plants small to medium-sized  | 4   |
| 3 | Alar cells heterogeneous, forming a $\pm$ excavate group; plants small to robust  | 7   |
| 4 | Alar cells few, forming a small group with 4-10 cells along the margin; paraphyllia numerous, filiform or narrowly lanceolate (fig. 74, 6-8)  | <b>H. recurvatum</b> (Lindb. & Arnell) Kindb. |
|   | Leaves strongly circinate; median laminal cells 30-60 x 3 $\mu$ m. Autoicous. Grows on calcareous rocks in montane areas and high mountains in the Pyrenees. Esp.   |   |
| 4 | Alar cells numerous, forming a larger group with 8-16(-20) cells along the margin; paraphyllia lacking  | 5   |
| 5 | Leaves strongly dentate, especially the branch leaves; stem leaves 0,6-1 mm long; lid rostrate; plants growing mainly on trunks (fig. 74, 9-10)   | <b>H. pallescens</b> (Hedw.) P. Beauv.        |
|   | Plants small, greenish yellow. Pseudoparaphyllia scarce, lanceolate. Leaves ovate-lanceolate, falciform, recurved at base. Autoicous. Forms dense tufts on trunks of trees. Very rare, in the Cantabrian Mountains and in the Central Pyrenees. Esp.  |   |
| 5 | Leaves $\pm$ entire to dentate; stem leaves more than 1 mm long; lid apiculate; plants growing mainly on rocks or soils   | 6   |
| 6 | Leaves strongly concave, with plane or slightly recurved margin; alar group large, with 10-16(-20) cells along the margin; pseudoparaphyllia $\pm$ rounded (fig. 74, 11-13)   | <b>H. vaucheri</b> Lesq.                      |
|   | Plants medium-sized, green or greenish yellow. Stem irregularly branched to pinnately so, usually with julaceous branches; epidermal cells invaginated. Leaves imbricate, ovate to oblong-lanceolate, falciform; median cells short and wide, 30-50 x 4-5(-6) $\mu$ m; nerve short but somewhat conspicuous, often double. Dioicous. Grows on calcareous soils and rocks, in montane areas and high mountains. Widespread in northern half of the Peninsula, rarer in Mallorca. Esp, And, Bl. |   |
| 6 | Leaves not strongly concave, with recurved margin; alar group small, with 8-15 cells along the margin; pseudoparaphyllia ovate to lanceolate (fig. 74, 14-17)   | <b>H. revolutum</b> (Mitt.) Lindb.            |

Plants small to medium-sized, greenish yellow to brownish. Stem usually regularly pinnate; epidermal cells invaginated. Leaves ovate to lanceolate, falciform. Dioicous. Grows on calcareous rocks, in montane areas to high mountains.

var. **revolutum**: Leaves with strongly revolute margin, plicate. In the Pyrenees and montane areas of the southeast of the Peninsula. Esp (fig. 74, 14-17).

var. **dolomiticum** (Milde) Mönk.: Leaves with plane or slightly recurved margin, little plicate. Very rare, in Sierra Nevada. Esp.

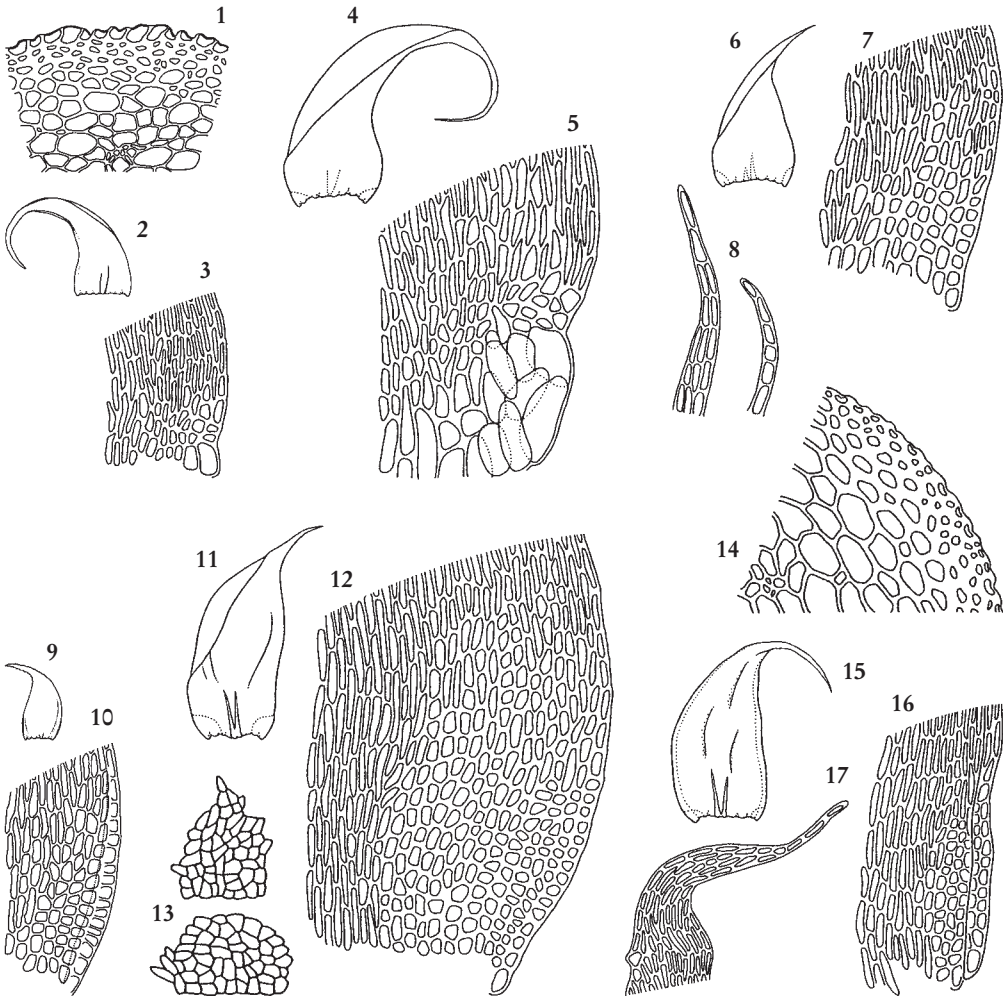


FIGURE 74. 1-3, *Hypnum hamulosum*: 1, stem section; 2, leaf; 3, alar cells. 4-5, *H. callichroum*: 4, leaf; 5, alar cells. 6-8, *H. recurvatum*: 6, leaf; 7, alar cells; 8, paraphyllia. 9-10, *H. pallescens*: 9, leaf; 10, alar cells. 11-13, *H. vaucheri*: 11, leaf; 12, alar cells; 13, pseudoparaphyllia. 14-17, *H. revolutum* var. *revolutum*: 14, stem section; 15, leaf; 16, alar cells on dorsal side; 17, pseudoparaphyllum. 2, 4, 6, 9, 11, 15 ( $\times 20$ ); 13 ( $\times 100$ ); 8, 17 ( $\times 140$ ); 1, 3, 5, 7, 10, 12, 14, 16 ( $\times 180$ ).

- 7 *Pseudoparaphyllia* widely lanceolate or palmate, mostly incised with ciliate points (fig. 75, 1-3) ***H. imponens* Hedw.**  
Plants medium-sized to large, golden-brown to dark brown; stem reddish brown. Stem leaves falciform, strongly serrulate in the upper part; alar group weakly excavate, usually tinted with orange brown, with 5-10 subquadrate cells along the margin. Grows on wet, shaded slopes. Very rare, in the north and northwest of the Peninsula. Esp, Prt.
- 7 *Pseudoparaphyllia* subfiliform to lanceolate, not incised with ciliate points 8
- 8 Leaf margin distinctly denticulate above 9
- 8 Leaf margin weakly denticulate above, subentire or entire 12
- 9 Alar cells few, forming a strongly excavate group, with 3-8 subquadrate cells along the margin 10
- 9 Alar cells numerous, forming a non- or only slightly excavate group, with 7-18 subquadrate cells along the margin 11
- 10 Leaves loosely imbricate, ovate or oblong-lanceolate (fig. 75, 4-5) ***H. jutlandicum* Holmen & E. Warncke**  
Plants medium-sized, pale green. Stem pinnately branched, with flattened branches. Leaves  $\pm$  straight to falciform, usually ending in short acumen, margin distinctly denticulate in the upper half, near the apex very strongly so; median cells of lamina (60-)70-90(-100)  $\times$  3  $\mu$ m. Seta long, 25-40 mm. Grows on siliceous soils and rocks and at tree bases, in the lowlands and montane areas, in the northern half of the Peninsula. Esp, Prt.
- 10 Leaves  $\pm$  densely imbricate, triangular or ovate-triangular, usually widest near leaf base (fig. 75, 6-7) ***H. uncinulatum* Jur.**  
Plants medium-sized, pale green to brownish, more or less regularly densely pinnately branched. Leaves falciform, gradually narrowed to acuminate apex, margin distinctly denticulate in the upper half, near the apex usually more strongly so; median cells 50-70(-80)  $\times$  3-4  $\mu$ m. Grows on tree trunks and decaying logs. Very rare, in Mata do Bussaco and in Algeciras Mountains. Esp, Prt.
- 11 Plants small-sized; median cells of lamina (40-)50-60(-70)  $\times$  4-5(-6)  $\mu$ m; capsule erect; lid mamillate (fig. 75, 8-11) ***H. andoi* A.J.E. Sm.**  
***H. mammillatum* (Brid.) Loeske**  
Stem regularly pinnate-branched. Leaves seemingly imbricate in 2 rows, falcate-secund, margin sharply denticulate in the upper part; alar cells of stem leaves rather heterogeneous, the basal ones enlarged and hyaline, with 7-10(-13) subquadrate cells along the margin. Capsule oblong-cylindrical, nearly symmetrical. Grows on siliceous rocks and trunks of trees, in montane areas and high mountains. Widespread mainly in the north and centre of the Peninsula. Esp, Prt, And.
- 11 Plants medium-sized; median cells of lamina 60-80  $\times$  3-4  $\mu$ m; capsule inclined; lid rostrate (fig. 75, 12-15) ***H. cupressiforme* Hedw. var. *cupressiforme***  
It is the commonest taxon of this genus, very variable in habit and size. Plants green, greenish yellow or brownish yellow, irregularly branched to  $\pm$  pinnate. Leaves falciform, ovate to



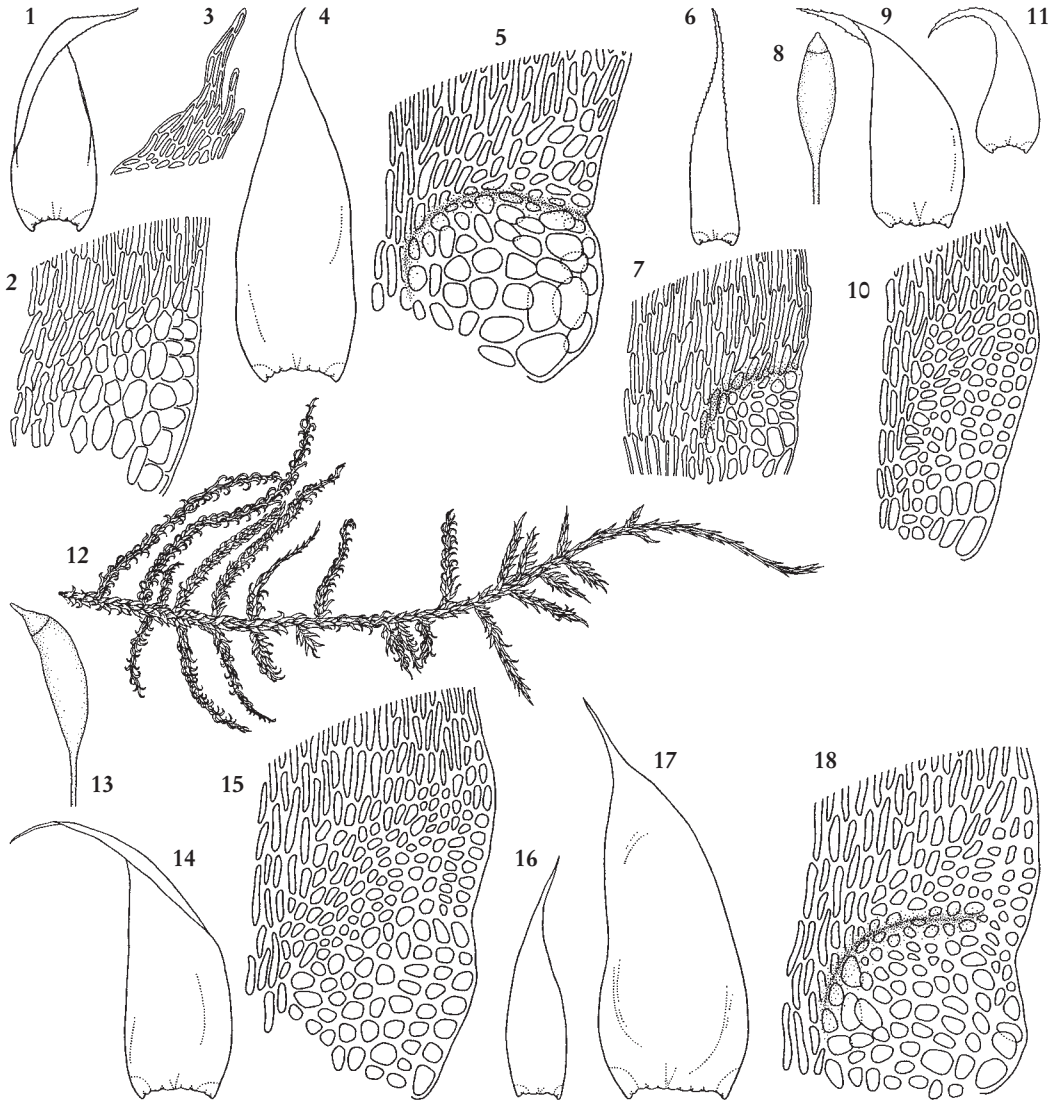


FIGURE 75. 1-3, *Hypnum imponens*: 1, leaf; 2, alar cells; 3, pseudoparaphyllium. 4-5, *H. jutlandicum*: 4, leaf; 5, alar cells. 6-7, *H. uncinulatum*: 6, leaf; 7, alar cells. 8-11, *H. andoi*: 8, capsule; 9, stem leaf; 10, alar cells; 11, branch leaf. 12-15, *H. cupressiforme* var. *cupressiforme*: 12, habit; 13, capsule; 14, leaf; 15, alar cells. 16, *H. cupressiforme* var. *filiforme*, leaf. 17, *H. cupressiforme* var. *lacunosum*, leaf. 18, *H. cupressiforme* var. *subjulaceum*, alar cells. 12 ( $\times 1.6$ ); 8, 13 ( $\times 8$ ); 1, 4, 6, 9, 11, 14, 16, 17 ( $\times 20$ ); 2, 5, 7, 10, 15, 18 ( $\times 180$ ).

oblong-lanceolate, gradually tapering, margin denticulate in the upper part; alar group with 10-18 cells along the margin. Capsule cylindrical. Grows on soils, rocks and at tree bases, from the lowlands to high mountains. Widespread throughout the Peninsula and in Mallorca, Menorca and Pithyusic Islands. Esp, Prt, And, Bl.

- 12 Plants small-sized or slender; branch leaves  $1-1,2 \times 0,3-0,4$  mm 13

- 12 Plants medium-sized to robust; branch leaves  $1,5-2,3 \times 0,4-0,6$  mm 14

- 13 Leaves homomallous, usually abruptly narrowed to a slender point; leaf margin entire **H. cupressiforme** Hedw. var. **resupinatum** (Taylor) Schimp.

**H. resupinatum** Taylor

Plants shiny. Leaves straight or slightly falciform, ovate to oblong-lanceolate; alar group with 10-17 subquadrate alar cells along the margin. Capsule erect, straight or slightly curved; lid distinctly long-beaked. Forms light green patches on trunks, rarely on rocks, in the northern and western part of the Peninsula. Esp, Prt.

- 13 Leaves not homomallous, gradually narrowed to a slender point; leaf margin subentire to slightly denticulate (fig. 75, 16) **H. cupressiforme** Hedw. var. **filiforme** Brid.

Plants light green, with slender, filiform habit. Stem sparsely and irregularly branched. Leaves  $\pm$  straight, rarely falciform, oblong-lanceolate; alar group with 8-13(-17) subquadrate alar cells along the margin. Forms patches on trunks, vertical rocks and tree bases. Widespread throughout the Peninsula, specially in northern half and in Mallorca. Esp, Prt, Bl.

- 14 Plants robust, with swollen branches; leaves abruptly narrowed to a short point; alar group slightly excavate, not distinctly coloured, with 10-20 subquadrate alar cells along the margin (fig. 75, 17) **H. cupressiforme** Hedw. var. **lacunosum** Brid.

**H. lacunosum** (Brid.) Hoffm. ex Brid.

Plants yellowish green to brownish; stem irregularly branched or  $\pm$  pinnate. Leaves straight to slightly falciform, concave, margin subentire to weakly denticulate; median cells  $50-70 \times 4-6$   $\mu$ m. Grows on calcareous or siliceous soils and rocks. Widespread throughout the Peninsula, rare in Mallorca and Menorca. Esp, Prt, And, Bl.

- 14 Plants medium-sized, branches not swollen; leaves gradually narrowed to a long, slender point; alar group strongly excavate and usually brown-coloured, with 8-14 subquadrate alar cells along the margin (fig. 75, 18)

**H. cupressiforme** Hedw. var. **subjulaceum** Molendo

Plants shiny, silky, yellowish-green to brownish; stem regularly or irregularly pinnate-branched. Leaves sometimes homomallous, straight to slightly falciform, concave, margin subentire to weakly denticulate; median cells  $60-70 \times 3-4$   $\mu$ m. Grows on calcareous rocks, occasionally on humus-rich soils, in montane areas and high mountains. Rare, in the north and east of the Peninsula. Esp.

### **Ptilium** De Not.

Stem procumbent to erect, regularly pinnate, with complanate branches; pseudoparaphyllia numerous, wide at base and narrowly acuminate. Stem leaves strongly longitudinally plicate, circinate, widely ovate at base, margin plane finely denticulate above;



laminal cells vermicular, smooth, basal cells shorter, porose, yellowish, alar cells quadrate to shortly rectangular, hyaline, forming a small, decurrent group; nerve short and double. Branch leaves narrower (fig. 76, 1-2)

**P. crista-castrensis** (Hedw.) De Not.

Forms bright green wefts on humus-rich soils in silver fir forests, in high mountains in the Pyrenees. Esp.

### **Pylaisia** Schimp.

Plants small, slender. Stem prostrate, pinnate, without pseudoparaphyllia. Leaves straight, ovate-lanceolate, acuminate, margin plane, entire or denticulate at apex; laminal cells linear, vermicular, more than 10 times as long as wide, alar cells quadrate to oblate, fairly homogeneous, basal cells rectangular, not porose, slightly thick-walled; nerve double and short, pale. Seta reddish; capsule straight, symmetrical. Autoicous (fig. 76, 3-5)

**P. polyantha** (Hedw.) Schimp.

**Pylaisiella polyantha** (Hedw.) Grout

Epiphytic, forming glossy, pale green or yellowish patches on trunks and branches of trees, rarely on rocks, in montane areas and high mountains, in the northern half of the Peninsula. Esp, Prt.

### **Taxiphyllum** M. Fleisch.

Plants small, glossy. Stem prostrate, irregularly branched, with pseudoparaphyllia. Rhizoids smooth, yellowish. Leaves complanate, oblong-lanceolate, symmetrical, apiculate, margin denticulate; laminal cells 6-10  $\mu\text{m}$  wide, 5-8 times as long as wide, alar cells quadrate, green, not decurrent; nerve short and double or lacking (fig. 76, 6-7)

**T. wissgrillii** (Garov.) Wijk & Margad.

Forms wefts on wet, calcareous rocks and soils, roots and at tree bases, in montane areas. Distributed in the north of the Peninsula and in Mallorca. Esp, Bl.

This species may be confused with *Pseudotaxiphyllum elegans*, but this is calcifuge and usually has flagelliform propagules.

## **Fam. Pterigynandraceae**

### **Habrodon** Schimp.

Plants very small. Primary stem creeping, branched. Leaves spreading, appressed when dry, ovate-lanceolate, concave, with long and flexuose or short point, margin plane, entire; laminal cells rhomboidal, more than twice as long as wide, smooth, basal and marginal cells shorter, quadrate; nerve short or lacking (fig. 76, 8-10)

**H. perpusillus** (De Not.) Lindb.

Usually with fusiform, 1-5 celled, brown gemmae on youngest branch parts. Forms wefts on tree trunks, in the lowlands and montane areas of the Mediterranean region of the Peninsula and in Mallorca. Esp, Prt, Bl.

## Heterocladium Schimp.

Primary stem stoloniform, secondary ones pinnate or irregularly branched; paraphyllia scarce, small. Stem leaves ovate-lanceolate, with broad base gradually or suddenly narrowed to a long or short point, margin denticulate; laminal cells papillose,  $\pm$  elongate in mid-leaf, short at margins; nerve short and double or long and single or branched at tip. Branch leaves usually smaller than stem leaves and with shorter acumen.

- 1 Stem leaves squarrose, suddenly narrowed to a filiform point (fig. 76, 11-15)
 

**H. dimorphum** (Brid.) Schimp.

Plants slender, dull green, usually yellowish, pinnately branched. Forms rigid tufts in shaded sites, on rocks, soils and at tree bases, in montane areas. Common in the Pyrenees, it also occurs in the north eastern part of the Peninsula and in Sierra Nevada. Esp, And.
- 1 Stem leaves patent or spreading, gradually narrowed to an acute or acuminate point    2
- 2 Nerve extending 1/2-2/3 way up leaf, usually single or branched at the end (fig. 76, 16-17)
 

**H. wulfsbergii** I. Hagen

**H. heteropterum** (Brid.) Schimp. subsp. **wulfsbergii** (I.Hagen) C.E.O. Jensen & Perss.

Plants slender. Stem leaves not secund, apex usually acute, nerve 30-50  $\mu$ m wide at base. Forms dark green patches on wet, shaded, acidic rock and slopes by streams, in the northwestern part of the Peninsula. Esp, Prt.
- 2 Nerve extending to 1/2 way up leaf, double, occasionally single or absent    3
- 3 Plants slender; branch leaves smaller than stem leaves (fig. 76, 18-19)
 

**H. heteropterum** (Brid.) Schimp.

Plants slender, dull green, rarely yellowish green. Stem leaves often secund, with long tapering point, apex acute to acuminate; nerve to 20  $\mu$ m wide at base. Grows on wet rocks by streams, rarely on soil, in montane areas, in the northern and western part of the Peninsula, rare in the south. Esp, Prt.
- 3 Plants filiform; branch leaves similar to stem leaves
 

**H. flaccidum** (Schimp.) A.J.E. Sm.

Plants with scattered, small leaves. Grows in relatively dry,  $\pm$  basic places, in the north of the Peninsula. Esp.

## Pterigynandrum Hedw.

Plants slender, irregularly branched. Stem and branches prostrate, usually curved. Stem leaves imbricate or erecto-patent, concave, widely ovate or elliptical, acute, obtuse or obtuse and apiculate, margin denticulate in the upper part, recurved at base; laminal cells oblong-rhomboidal, upper cells prorate, alar cells quadrate; nerve single, bifurcate or double, extending to 1/2 way up leaf. Branch leaves smaller. Axillary gemmae frequent, fusiform, of 2-4 cells (fig. 76, 20-23)

**P. filiforme** Hedw.

Plants prostrate. Forms small, dark green, yellowish or brownish mats on wet rocks or at tree bases, in montane areas. Widespread throughout the Peninsula. Esp, Prt, And.

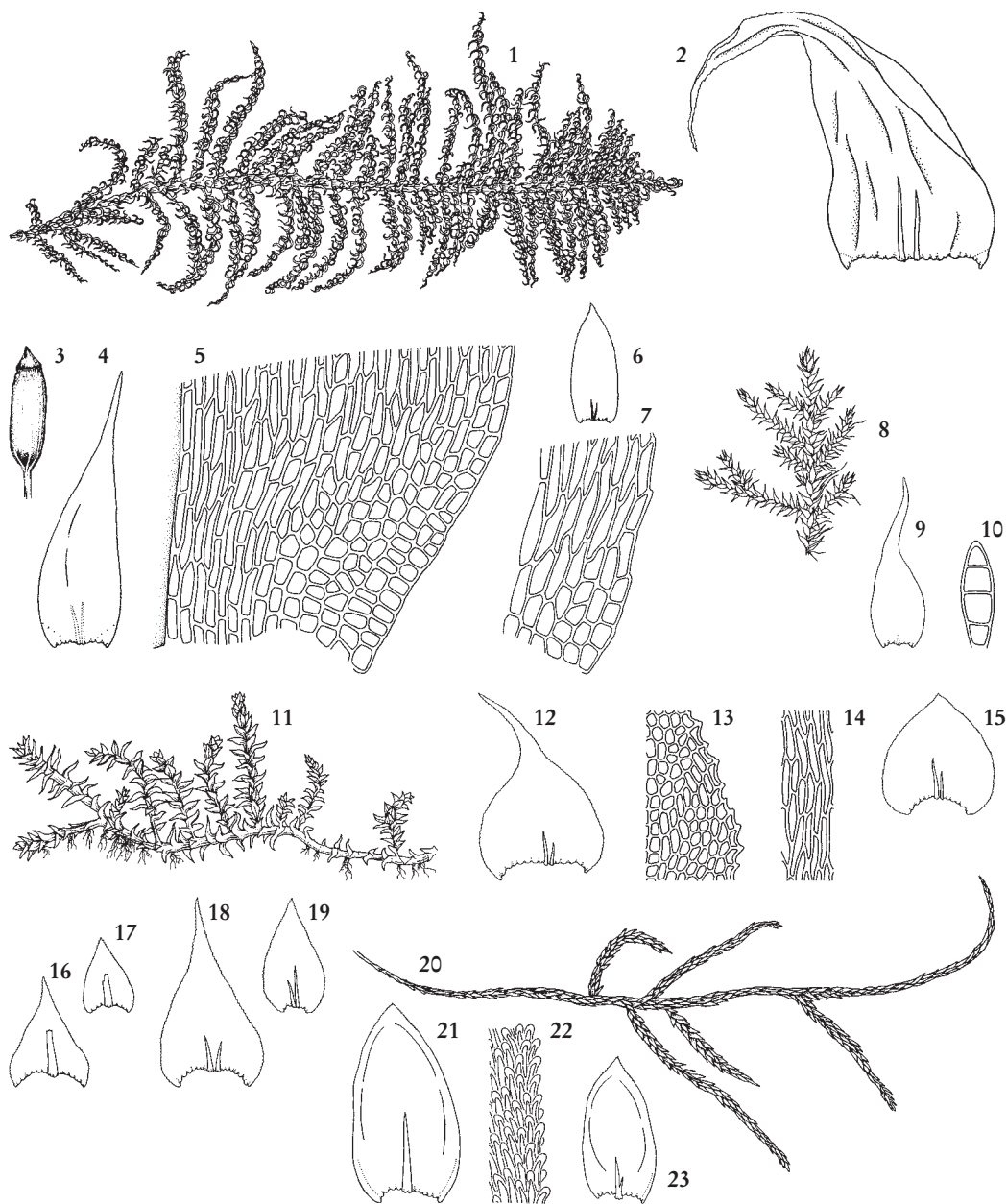


FIGURE 76. 1-2, *Ptilium crista-castrensis*: 1, habit; 2, leaf. 3-5, *Pylaisia polyantha*: 3, capsule; 4, leaf; 5, alar cells. 6-7, *Taxiphyllum wissgrillii*: 6, leaf; 7, alar cells. 8-10, *Habrodon perpusillus*: 8, habit; 9, leaf; 10, gemma. 11-15, *Heterocladium dimorphum*: 11, habit; 12, stem leaf; 13, leaf margin; 14, median cells; 15, branch leaf. 16-17, *H. wulfsbergii*: 16, stem leaf; 17, branch leaf. 18-19, *H. heteropterum*: 18, stem leaf; 19, branch leaf. 20-23, *Pterigynandrum filiforme*: 20, habit; 21, stem leaf; 22, median cells on dorsal side; 23, branch leaf. 1 ( $\times 1,6$ ); 8, 11, 20 ( $\times 4$ ); 3 ( $\times 8$ ); 2, 4, 6 ( $\times 20$ ); 9, 12, 15, 16, 17, 18, 19, 21, 23 ( $\times 35$ ); 5 ( $\times 180$ ); 7, 10, 13, 14, 22 ( $\times 200$ ).

## Fam. Hylocomiaceae

### Hylocomiastrum Broth.

Plants medium-sized to slender. Stem procumbent, irregularly branched or 1-2-pinnate, usually with the annual branches curved, ascending or horizontal, some dendroid; paraphyllia numerous, branched with 2-3 elongated cells, apical cells projecting as spine; pseudoparaphyllia present. Stem leaves erect, concave, strongly plicate, with irregular longitudinal plicae, oblong-ovate, wide at base, gradually or abruptly tapering into short or long, acumens, flexuose and strongly dentate; median cells of lamina linear, basal cells oblong, thick-walled, porose, yellowish, alar cells not differentiated; nerve double or single. Branch leaves similar in form to stem leaves, with single nerve extending to 1/2-3/4 way up leaf, ending in a small projection from back. Dioicous.

- 1 Stem leaves with single nerve, extending to 2/3-3/4 way up leaf; plants sparsely or irregularly branched (fig. 77, 1-2) **H. pyrenaicum** (Spruce) M. Fleisch.

**Hylocomium pyrenaicum** (Spruce) Lindb.

Plants robust. Stem, reddish brown, ascending, branches cuspidate at apex; paraphyllia branched from base, 2-3 cells wide. Leaves ovate, gradually or abruptly tapering into short, twisted point, margin strongly dentate,  $\pm$  recurved at base; laminal cells smooth. Branch leaves smaller than stem leaves. Forms glossy green or yellowish green wefts on rocks, slopes and by streams and lakes, on acidic or basic substrata, in high mountains in the Pyrenees. Esp, And.

- 1 Stem leaves with double nerve extending to 1/4-1/3 way up leaf; plants pinnately branched (fig. 77, 3-4) **H. umbratum** (Hedw.) M. Fleisch.

**Hylocomium umbratum** (Hedw.) Schimp.

Stem reddish-brown, 1-(2)-pinnate, with arcuate branches, dendroid; paraphyllia with branches 2 cells wide. Stem and branch leaves similar, widely ovate, gradually tapering, decurrent, margin strongly dentate, laminal cells smooth. Forms soft, dull dark green or brownish wefts on humus-rich soils in forests, in montane areas and high mountains. Scattered in the northern part of the Peninsula. Esp, And.

### Hylocomium Schimp.

Plants robust, to 20 cm long. Stem procumbent reddish, regularly 2-3-pinnate, usually with the annual branches arcuate, ascending, dendroid, complanate; paraphyllia numerous, divided from base in thin, filiform branches; pseudoparaphyllia present. Stem leaves erect, concave, not or only slightly longitudinally plicate, widely ovate, wide at base, gradually or abruptly narrowed in flexuose acumens; margin dentate in the upper part; leaf cells papillose on dorsal side; median cells of lamina linear, basal cells oblong, thick-walled, porose, yellowish, alar cells not differentiated; nerve double, extending to 1/4-1/3 way up leaf. Branch leaves smaller. Dioicous (fig. 77, 5-8) **H. splendens** (Hedw.) Schimp.

Forms tall, extensive, stratified golden green or olive green wefts on humus-rich soils in forests, in montane areas and high mountains, in the northern half of the Peninsula and in Mallorca. Esp, Prt, And, Bl.

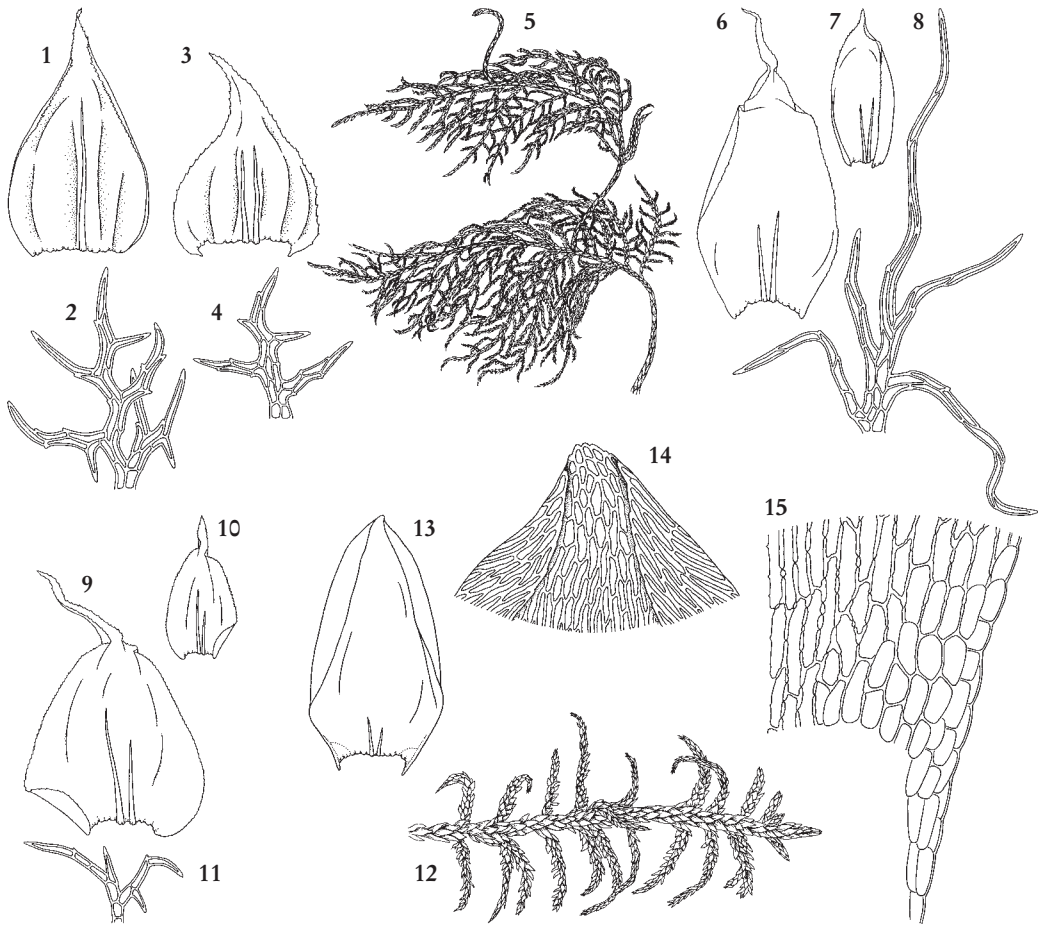


FIGURE 77. 1-2, *Hylocomiastrum pyrenaicum*: 1, leaf; 2, paraphyllium. 3-4, *H. umbratum*: 3, leaf; 4, paraphyllium. 5-8, *Hylocomium splendens*: 5, habit; 6, stem leaf; 7, branch leaf; 8, paraphyllium. 9-11, *Loeskeobryum brevirostre*: 9, stem leaf; 10, branch leaf; 11, paraphyllium. 12-15, *Pleurozium schreberi*: 12, habit; 13, leaf; 14, leaf apex; 15, alar cells. 5, 12 ( $\times 1,4$ ); 1, 3, 6, 7, 9, 10, 13 ( $\times 14$ ); 2, 4, 8, 11, 14, 15 ( $\times 140$ ).

### *Loeskeobryum* Broth.

Plants medium-sized to robust. Stem procumbent, reddish, irregularly branched or 1-(2)-pinnate, usually with the annual branches arcuate or stoloniferous; paraphyllia small, numerous, thin, irregularly branched, divergent at the base, branches of a single row of elongate cells; pseudoparaphyllia present. Lower stem leaves sheathing at base, weakly longitudinally plicate, oblong-ovate, wide at base, abruptly tapering into long acumen, thin, non-decurrent, flexuose, squarrose to recurved and strongly dentate; the rest of stem

leaves narrow and rugose at base of acumen, margin strongly dentate in the upper half of leaf, denticulate at base. Leaf cells smooth, median cells linear, basal cells oblong, thick-walled, porose, yellowish, alar cells not differentiated; nerve double, extending to 1/3-1/2 way up leaf. Branch leaves smaller. Dioicous. (fig. 77, 9-11)

**L. brevirostre** (Brid.) M. Fleisch.

**Hylocomium brevirostre** (Brid.) Schimp.

Forms glossy green or yellowish green to brownish wefts on rocks, humus-rich soils, at tree bases, and in wet sites on acidic substrata, in deciduous forests, in montane areas. Distributed in the northern part of the Peninsula. Esp, Prt (Extinct).

### **Pleurozium** Mitt.

Plants robust, to 15 cm long or more, procumbent or ascending. Stem reddish, pinnate, branches julaceous, attenuate or not,  $\pm$  complanate, without paraphyllia or pseudoparaphyllia. Stem leaves oblong-ovate, strongly concave, decurrent, with rounded to obtuse or apiculate apex, margin crenulate, incurved: median cells of lamina linear, smooth, apical cells shorter, basal cells wider and porose, alar cells oblong, forming a triangular group, orange to brownish; nerve short and double. Branch leaves shorter and narrower (fig. 77, 12-15)

**P. schreberi** (Willd. ex Brid.) Mitt.

Forms high, soft, glossy pale green to yellowish wefts on wet, shaded soils in beechwoods and coniferous forests, rarely in peat bogs, in montane areas and high mountains. Distributed in the northern half of the Peninsula. Esp, Prt, And.

### **Rhytidiadelphus** (Limpr.) Warnst.

Plants robust. Stem rigid, reddish or orange, procumbent, irregularly branched, branches usually arcuate, ascending; without paraphyllia, but often with small, triangular pseudoparaphyllia, wide at base. Stem and branch leaves similar, squarrose, falciform, ovate, gradually or abruptly tapering, acuminate, longitudinally plicate or not, margin denticulate or dentate; laminal cells homogeneous, linear, basal cells short and wide, thick-walled, porose, alar cells non- or poorly differentiated; nerve double or lacking. Dioicous.

- 1 Stem leaves gradually tapering into wide acumen; laminal cells prorate at back (fig. 78, 1-3)

**R. triquetrus** (Hedw.) Warnst.

Plants robust, to 20 cm long, branches not complanate, horizontal to ascending, attenuated at apex. Stem leaves longitudinally plicate, with sheathing, decurrent base, margin plane, dentate at apex; nerve double, extending to 3/4 way up leaf. Branch leaves smaller. Grows on humus-rich soils in forests. Widespread in the northern half of the Peninsula, very rare in the south and in Mallorca. Esp, Prt, And, Bl.

- 1 Stem leaves abruptly tapering into narrow, squarrose or falciform acumen; laminal cells smooth at back

2

- 2 Leaves with irregular longitudinal plicae at base; alar cells slightly differentiated, coloured (fig. 78, 4)

**R. loreus** (Hedw.) Warnst.

Plants robust, to 20 cm long, branches  $\pm$  complanate, arcuate, ascending. Leaves concave, ovate, longly acuminate, with channelled, denticulate acumen; nerve double, extending to 1/4



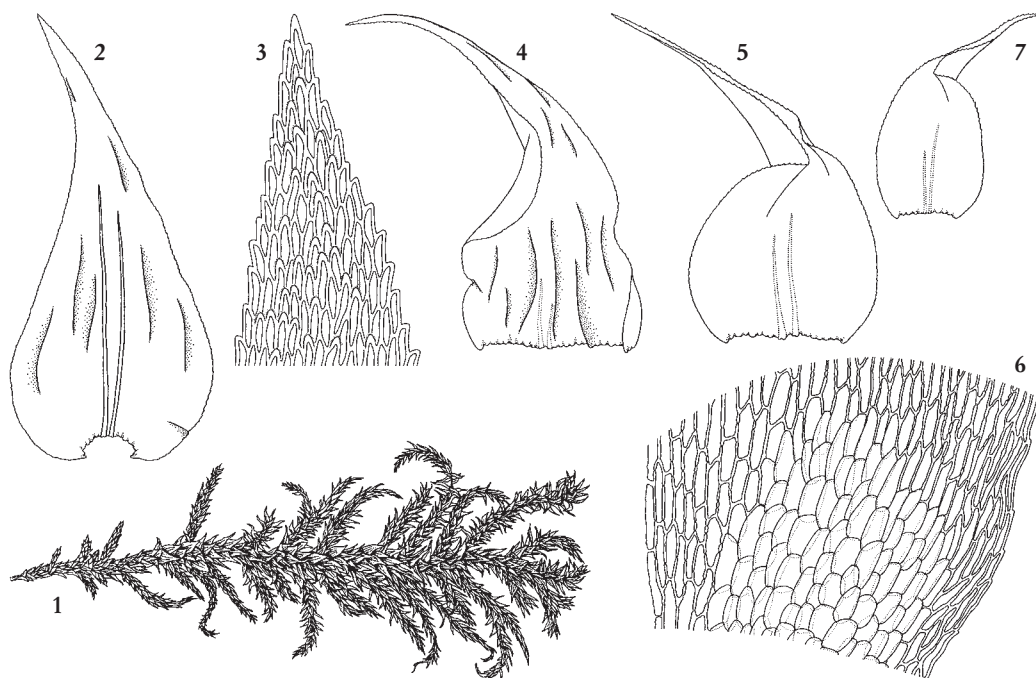


FIGURE 78. 1-3, *Rhytidiadelphus triquetrus*: 1, habit; 2, leaf; 3, leaf apex on dorsal side. 4, *R. loreus*, leaf. 5-7, *R. squarrosus*: 5, stem leaf; 6, alar cells; 7, branch leaf. 1 ( $\times 0.8$ ); 2, 4, 5, 7 ( $\times 14$ ); 3, 6 ( $\times 140$ ).

way up leaf or lacking. Branch leaves smaller than stem leaves. Forms green or yellowish green wefts on wet, acidic soils and rocks, in coniferous forests, in montane areas and high mountains. Distributed in the northern half of the Peninsula. Esp, Prt.

- 2 Leaves not plicate at base; alar cells inflated, pale or hyaline (fig. 78, 5-7)

***R. squarrosus* (Hedw.) Warnst.**

Plants to 10 cm long, branches ascending, attenuated, green or reddish green at apex. Stem leaves squarrose, cordate to ovate, with long, denticulate acumens. Branch leaves narrower at base, with shorter acumens; nerve double, extending to 1/4-1/3 way up leaf. Forms soft, green, brownish or yellowish wefts in exposed, wet grasslands, peat bogs and on forest soils, on acidic substrata, in montane areas and high mountains. Distributed in the north of the Peninsula. Esp, Prt.

## Fam. Rhytidiaceae

### *Rhytidium* (Sull.) Kindb.

Plants robust, to 10 cm long. Stem procumbent or ascending, pale, irregularly branched, branches erect; pseudoparaphyllia lanceolate, subulate. Stem leaves imbricate, ovate,

gradually tapering to acuminate apex, concave, transversely undulate, rugose, falciform, second, margin recurved from base to apex, denticulate in the upper part; laminal cells elliptical, narrow, prorate, basal cells rhomboidal, porose, alar cells numerous, quadrate to trapezoidal, ascending up the margin; nerve single, extending to 1/2-3/4 way up leaf, usually bifurcate above. Branch leaves ovate-lanceolate, smaller (fig. 79, 1)

**R. rugosum** (Hedw.) Kindb.

Forms tall, extensive, pale yellowish green to golden brown wefts on exposed soils, at forest margins, usually on calcareous substrata, in montane areas and high mountains. Distributed in the northern half of the Peninsula. Esp, And.

## Fam. Plagiotheciaceae

### *Herzogiella* Broth

Plants slender, prostrate, irregularly branched, without paraphyllia. Leaves erect to patent, lanceolate or ovate-lanceolate, acuminate, margin plane, denticulate; laminal cells long, narrow, alar cells quadrate to rectangular, hyaline; nerve short and double. Capsule curved; lid conical.

- 1 Laminal cells  $25-40 \times 5-7 \mu\text{m}$ , alar cells rectangular, inflated, decurrent (fig. 79, 2-4)  
**H. striatella** (Brid.) Z. Iwats.

Plants slender, with ascending branches,  $\pm$  complanate. Leaves ovate-lanceolate. Forms glossy light green wefts on rotting stumps of silver firs and humus-rich soils, in high mountains. Rare, in the Pyrenees. Esp.

- 1 Laminal cells  $60-100 \times 6-7 \mu\text{m}$ , alar cells rectangular, not inflated or decurrent (fig. 79, 5-7)  
**H. seligeri** (Brid.) Z. Iwats.

Leaves lanceolate to ovate-lanceolate, falciform, weakly complanate, flexuose when dry. Forms glossy light green wefts on rotting stumps of silver firs, in montane areas and high mountains, in the northern part of the Peninsula. Esp, And.

### *Isopterygiopsis* Z. Iwats.

Plants slender, procumbent. Stem irregularly branched. Leaves  $\pm$  complanate, ovate-lanceolate, abruptly or gradually narrowed, symmetrical, margin entire or nearly so; laminal cells vermicular,  $4-6 \mu\text{m}$  wide, alar cells scarce, poorly differentiated; nerve short and double or lacking; pyriform to cylindrical axillary gemmae usually present.

- 1 Epidermal cells of stem  $16-30 \mu\text{m}$  wide, thin-walled; leaves complanate, non-second, with entire margin; axillary gemmae frequent,  $60-100 \mu\text{m}$  long (fig. 79, 8-10)  
**I. muelleriana** (Schimp.) Z. Iwats.

**Isopterygium muellerianum** (Schimp.) A. Jaeger

Forms glossy pale green wefts on wet slopes, in rock crevices and at bases of shaded, calcareous rocks and trees, in montane areas, in the northern part of the Peninsula. Esp, And.



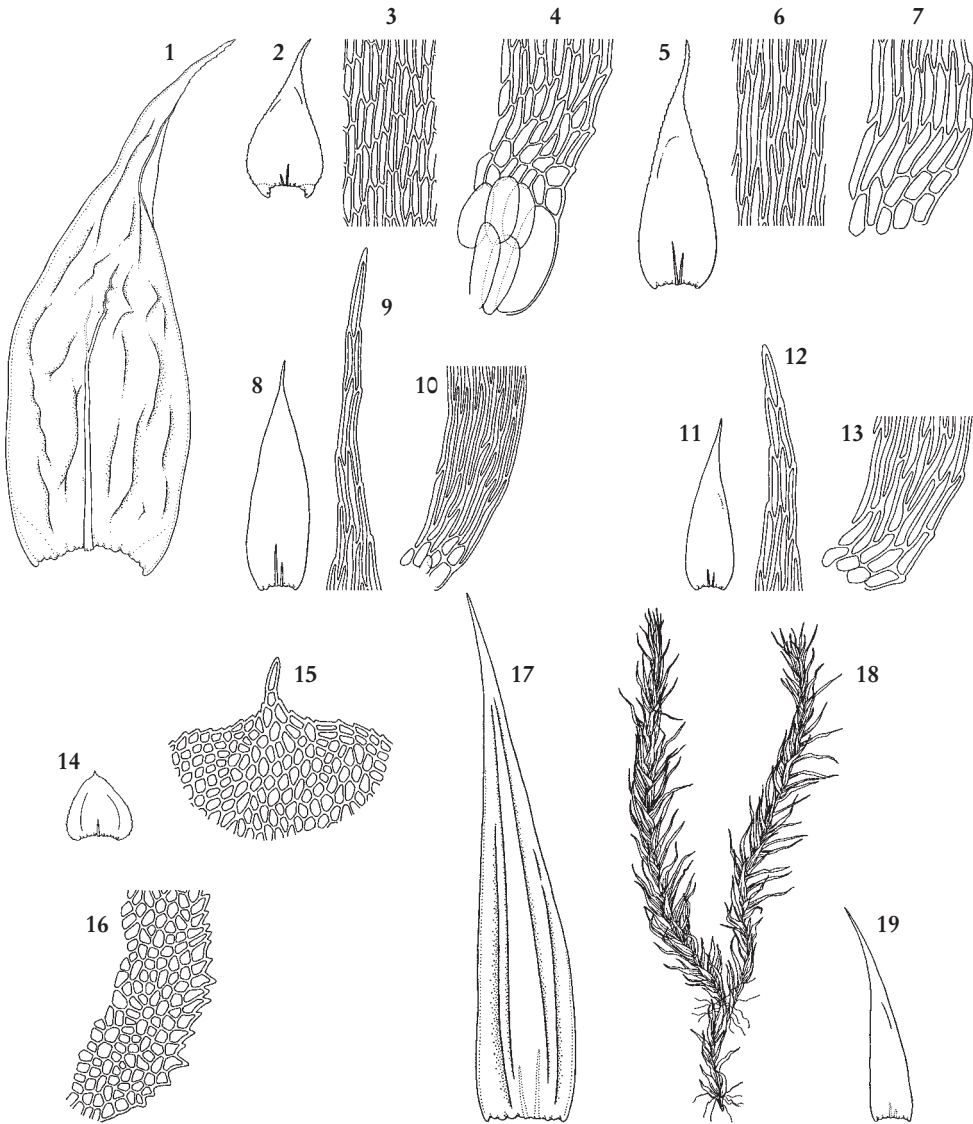


FIGURE 79. 1, *Rhytidium rugosum*, leaf. 2-4, *Herzogiella striatella*: 2, leaf; 3, median cells; 4, alar cells. 5-7, *H. seligeri*: 5, leaf; 6, median cells; 7, alar cells. 8-10, *Isopterygiopsis muelleriana*: 8, leaf; 9, leaf apex; 10, alar cells. 11-13, *I. pulchella*: 11, leaf; 12, leaf apex; 13, alar cells. 14-16, *Myurella julacea* var. *julacea*: 14, leaf; 15, leaf apex; 16, leaf margin at base. 17, *Orthothecium rufescens*, leaf. 18-19, *O. intricatum*: 18, habit; 19, leaf. 18 ( $\times 6$ ); 1 ( $\times 18$ ); 2, 5, 8, 11, 14, 17, 19 ( $\times 20$ ); 3, 4, 6, 7, 9, 10, 12, 13, 15, 16 ( $\times 200$ ).

- 1 Epidermal cells of stem 7-12  $\mu\text{m}$  wide, thick-walled; leaves not or little complanate, sometimes secund, with nearly entire margin; axillary gemmae to 60  $\mu\text{m}$  long (fig. 79, 11-13)

**I. pulchella** (Hedw.) Z. Iwats.

**Isopterygium pulchellum** (Hedw.) A. Jaeger

Forms small wefts in rock crevices and on rotting stumps in shaded sites, in montane areas, in the north of the Peninsula, in Serra do Bussaco and in Mallorca. Esp, Prt, And, Bl.

### **Myurella Schimp.**

Plants slender, to 3 cm long, julaceous. Leaves densely imbricate, very concave, widely ovate, acuminate, obtuse or apiculate, margin irregularly dentate or spinulose, especially at base; laminal cells short, rhomboidal or elliptical-rhomboidal, papillose on the dorsal surface; nerve short or lacking (fig. 79, 14-16)

**M. julacea** (Schwägr.) Schimp.

Plants glaucous, yellowish or brownish when old. Isolated or forming small tufts on wet, calcareous soils and ledges and in calcareous rock crevices, in montane areas and high mountains, in the Pyrenees, Cantabrian Mountains and Sierra Nevada. Esp, And.

var. **julacea**: Leaves obtuse or apiculate, margin irregularly dentate (fig. 79, 14-16).

var. **scabrifolia** Limpr.: Leaves acuminate in long apiculus, margin spinulose.

### **Orthothecium Schimp.**

Plants small and slender or robust. Stem prostrate with ascending branches and axillary rhizoids. Leaves lanceolate, concave or longitudinally plicate; laminal cells homogeneous, long, narrow,  $\pm$  porose, basal cells shorter; nerve lacking or very short and double.

- 1 Plants robust, to 10 cm long; leaves strongly longitudinally plicate (fig. 79, 17)

**O. rufescens** (Dicks. ex Brid.) Schimp.

Leaves 3-4 mm long, triangular-lanceolate, acuminate, rigid, straight when dry, margin recurved. Forms glossy golden green to reddish wefts in springs, by streams, on humus-rich slopes and wet, shaded walls, mainly on basic substrata, in montane areas and high mountains, in the north of the Peninsula. Esp.

- 1 Plants small and slender, to 4 cm long; leaves concave, not longitudinally plicate (fig. 79, 18-19)

**O. intricatum** (C. Hartm.) Schimp.

Leaves 0.5-2 mm long, secund, lanceolate, longly and finely acuminate, appressed when dry, margin plane. Forms small, bright pale green patches in sheltered, wet, calcareous rock crevices, in the entrance of caves and karstic chasms, in montane areas and high mountains, in the north and northeastern part of the Peninsula, very rare in the south and in Mallorca. Esp, Bl.

### **Plagiothecium Schimp.**

Plants glossy, light to dark green, growing on wet, shaded, acidic substrata. Stem prostrate, simple or irregularly branched. Leaves complanate, rarely imbricate, ovate or ovate-lanceolate, abruptly or gradually tapering, obtuse and apiculate or piliferous, symmetrical or asymmetrical, flat or concave, margin plane or recurved, entire or dentate

at apex; laminal cells smooth, median cells linear, linear-rhomboidal or hexagonal, apical cells shorter, alar cells decurrent, hyaline, rectangular, rounded or quadrate, basal cells wider and shorter; nerve short and double or lacking. Capsule cylindrical, straight or curved, erect or inclined.

- 1 Leaves abruptly tapering to long, fine point (fig. 80, 1) **P. piliferum** (Sw.) Schimp.  
Plants small, light green. Capsule erect or slightly inclined. Forms wefts on slopes and wet, acidic rocks, in montane areas. Rare, in the north of the Peninsula. Esp, Prt.
- 1 Leaves not abruptly tapering to long, fine point 2
- 2 Leaves about 4 mm long, transversely undulate (fig. 80, 2-3)  
**P. undulatum** (Hedw.) Schimp.  
**Buckiella undulata** (Hedw.) Ireland  
Plants robust, light green, sparsely branched. Capsule curved, inclined. Forms wefts on shaded, wet rocks and acidic slopes, in the lowlands and montane areas. Widespread in the north of the Peninsula. Esp, Prt.
- 2 Leaves less than 4 mm long, not transversely undulate 3
- 3 Median cells of leaf linear, less than 10 µm wide 4
- 3 Median cells of leaf elliptical, rhomboidal or hexagonal, more than 10 µm wide 5
- 4 Plants slender, median cells of leaf 5-7 µm wide; capsule straight, slightly inclined (fig. 80, 4-5) **P. laetum** Schimp.  
Forms glossy wefts on rotten stumps, slopes and acidic rocks, in montane areas, in the northern part of the Peninsula. Esp, Prt, And.
- 4 Plants medium-sized, median cells of leaf 6-9 µm wide; capsule curved, inclined (fig. 80, 6-7) **P. curvifolium** Schliepf. ex Limpr.  
Leaves concave, irregularly ovate. Forms glossy green wefts on wet, acidic soils and slopes, in montane areas, in the northern part of the Peninsula. Esp.
- 5 Decurrent cells of leaf quadrate or rounded, prominent in the margin (fig. 80, 8-10) **P. denticulatum** (Hedw.) Schimp.  
Leaves clearly asymmetrical, with plane, denticulate apex; decurrent cells arranged in 2-8 vertical rows. Seta reddish brown; capsule curved, horizontal. Forms glossy wefts on soils, slopes, wet rocks and at tree bases, in coastal areas, montane areas and high mountains, in the northern half of the Peninsula and in Sierra Nevada. Esp, Prt, And.  
var. **denticulatum**: Plants not julaceous. Leaves not undulate (fig. 80, 8-10).  
var. **obtusifolium** (Turner) Moore: Plants with julaceous branches. Leaves rounded, concave. Rare, in the Pyrenees.  
var. **undulatum** R. Ruthe ex Geh. (= *P. ruthei* Limpr.): Leaves ± transversely undulate.
- 5 Decurrent cells of leaf longly rectangular, sometimes with some quadrate in the margin 6

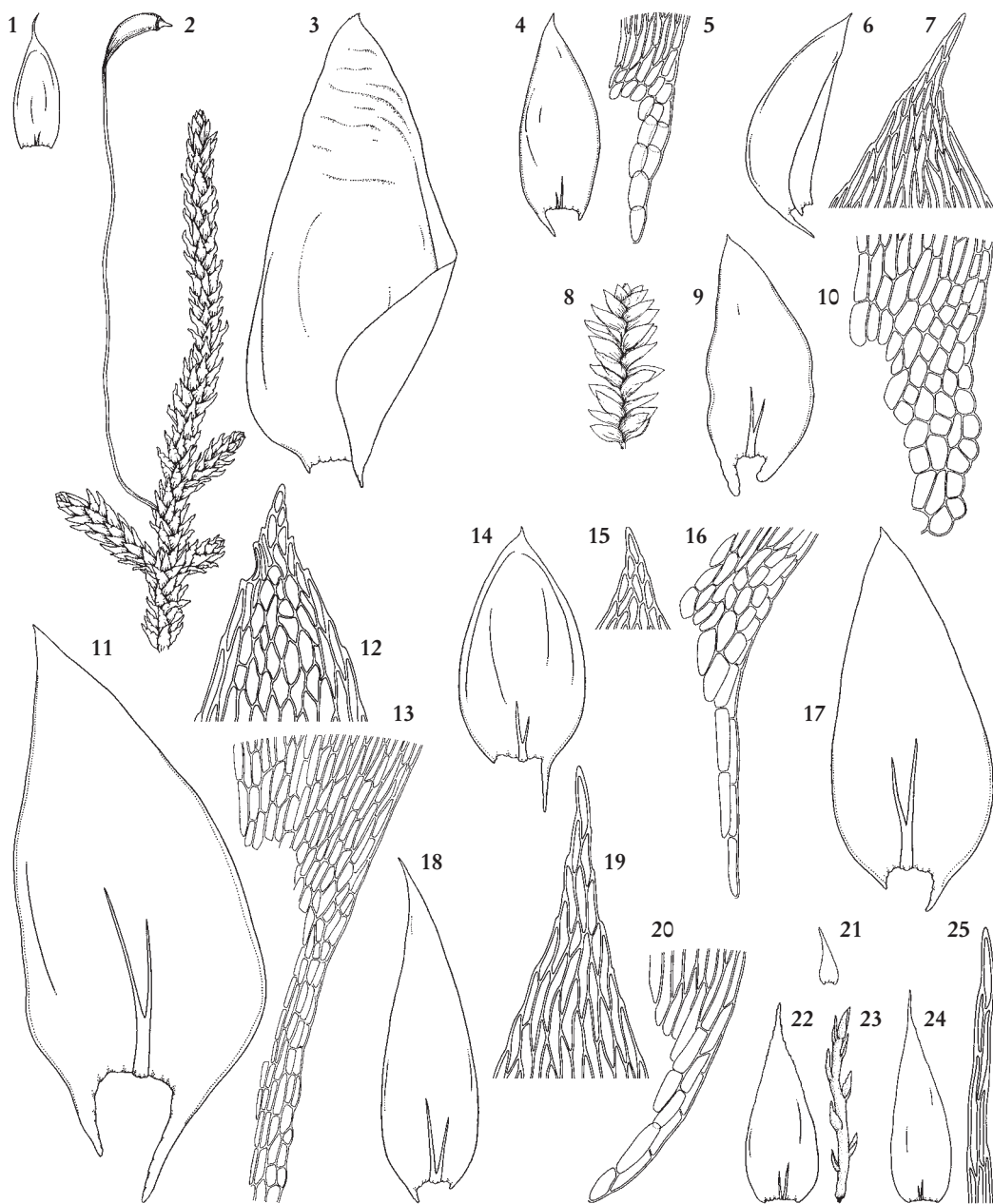


FIGURE 80. 1, *Plagiothecium piliferum*, leaf. 2-3, *P. undulatum*: 2, habit; 3, leaf. 4-5, *P. laetum*: 4, leaf; 5, decurrent cells. 6-7, *P. curvifolium*: 6, leaf; 7, leaf apex. 8-10, *P. denticulatum* var. *denticulatum*: 8, habit; 9, leaf; 10, decurrent cells. 11-13, *P. platyphyllum*: 11, leaf; 12, leaf apex; 13, decurrent cells. 14-16, *P. cavifolium*: 14, leaf; 15, leaf apex; 16, decurrent cells. 17, *P. nemorale*, leaf. 18-20, *P. succulentum*: 18, leaf; 19, leaf apex; 20, decurrent cells. 21, *Platydictya jungermannioides*, leaf. 22-23, *Pseudotaxiphyllum elegans*: 22, leaf; 23, propagule. 24-25, *P. laetevirens*: 24, leaf; 25, leaf apex. 2 ( $\times 1,6$ ); 8 ( $\times 2,6$ ); 1, 3, 4, 6, 9, 11, 14, 17, 18, 21, 22, 24 ( $\times 20$ ); 23 ( $\times 40$ ); 13 ( $\times 60$ ); 5, 10, 16, 20 ( $\times 100$ ); 7, 12, 15, 19 ( $\times 160$ ); 25 ( $\times 200$ ).

- 6 Decurrent cells of leaf rectangular, some quadrate; upper cells of leaf shorter than median cells (fig. 80, 11-13) ***P. platyphyllum*** Mönk.  
Forms glossy wefts at tree bases and on acidic soils, in montane areas of the northern half of the Peninsula. Esp.
- 6 Decurrent cells of leaf all rectangular; upper cells of leaf similar to median cells 7
- 7 Leaves concave, obtuse and apiculate; plants with julaceous branches (fig. 80, 14-16) ***P. cavifolium*** (Brid.) Z. Iwats.  
***P. roeseanum*** Schimp.  
Capsule straight. Forms glossy wefts on acidic slopes and in wet rock crevices, in montane areas and high mountains, in the northern half of the Peninsula. Esp, Prt.
- 7 Leaves plane, acute or acuminate; plants with complanate branches 8
- 8 Leaves acute, shrunken when dry; median cells of lamina 4-6:1 (fig. 80, 17) ***P. nemorale*** (Mitt.) A. Jaeger  
***P. sylvaticum*** (Brid.) Schimp., ***P. neglectum*** Mönk.  
Seta reddish; capsule inclined. Forms glossy yellowish green to dark green wefts on wet, acidic slopes rocks, at tree bases and by streams, from the lowlands to high mountains. Widespread throughout the Peninsula. Esp, Prt, And.
- 8 Leaves acuminate, not or moderately shrunken when dry; median cells of lamina 6-10:1 (fig. 80, 18-20) ***P. succulentum*** (Wilson) Lindb.  
Leaves with obtuse and apiculate apex, with a point longer than in *P. nemorale*; nerve bifurcate, stout at base. Capsule inclined. Forms dense, glossy, silky wefts on acidic soils and wet rocks, in montane areas. Distributed in the northern half of the Peninsula, sporadically in the southeastern part. Esp, Prt.

### ***Platydictya*** Berk.

Plants very small and slender, irregularly branched. Stem with red, papillose rhizoids. Leaves less than 0,5 mm long, straight to sub-secund, lanceolate, acute, often narrower at insertion, margin denticulate, especially near base; laminal cells shortly oblong-rhomboidal, smooth, alar cells quadrate or shortly rectangular, scarcely differentiated, with a row of 3-7 cells ascending up margin; nerve lacking (fig. 80, 21)

***P. jungermannioides*** (Brid.) H.A. Crum

***Amblystegium jungermannioides*** (Brid.) A.J.E. Sm.

Plants very variable in stem leaves and margin denticulation. Forms loose green or dull yellowish green patches on soils, rocks, walls of caves, in rock crevices and at tree bases near streams, on calcareous substrata, in montane areas and high mountains, in the northern part of the Peninsula. Esp.

### ***Pseudotaxiphyllum*** Z. Iwats.

Plants slender. Stem irregularly branched; epidermal cells 7-12 µm wide, thick-walled, yellowish. Rhizoids reddish brown, finely papillose. Leaves complanate, ovate-

lanceolate, acuminate, margin plane, denticulate near apex or entire; laminal cells fusiform, basal cells shorter and wider, alar cells poorly differentiated; nerve short and double. Axillary propagules flagelliform, caducous, 0,7-1,5 mm long, with small primordial leaves.

- 1 Leaves complanate or curved downwards; apical cells of leaf 10-20(-30)  $\mu\text{m}$  long (fig. 80, 22-23) **P. elegans** (Brid.) Z. Iwats.

**Isopterygium elegans** (Brid.) Lindb.

Laminal cells 50-100  $\mu\text{m}$  long, basal cells shorter and wider, alar cells poorly differentiated. Forms small, glossy wefts at tree bases and on wet, shaded siliceous rocks, in montane areas and high mountains, in the north and west of the Peninsula. Esp, Prt, And.

- 1 Leaves complanate or pointing in all directions; apical cells of leaf 35-60  $\mu\text{m}$  long (fig. 80, 24-25) **P. laetevirens** (Dixon & Luisier ex F. Koppe & Düll) Hedenäs

Laminal cells 90-180  $\mu\text{m}$  long. Grows in exposed or shaded crevices. Very rare, in Algeciras Mountains. Esp, Prt.

## Fam. Entodontaceae

### Entodon Müll.Hal.

Plants robust, prostrate or ascending. Stem pinnate, with short,  $\pm$  complanate branches. Leaves concave, with rounded, obtuse or apiculate apex, margin plane or recurved at base; alar cells quadrate to shortly rectangular, green or hyaline, median cells linear; nerve short and double or lacking.

- 1 Stem prostrate; leaves apiculate; group of alar cells unistratose (fig. 81, 1)

**E. cladorrhizans** (Hedw.) Müll.Hal.

Plants light green to yellowish, with ascending branches. Leaves imbricate when dry, elliptical, apical margin entire or denticulate. Forms glossy golden green to reddish wefts on wet soils in beech forests and alder forests. Scattered in the Pyrenees and northeastern part of the Peninsula. Esp.

- 1 Stem prostrate or ascending; leaves obtuse, non-apiculate; group of alar cells 2-3-stratose (fig. 81, 2-5)

**E. concinnus** (De Not.) Paris

Stem golden brown to pinkish. Leaves appressed when dry, concave, elliptical, slightly decurrent, with obtuse apex, usually cucullate, margin entire; alar cells quadrate to shortly rectangular, green or hyaline. Forms glossy yellowish or pale brown wefts on humus-rich soils and calcareous rocks, in montane areas. Scattered in the northern part of the Peninsula. Esp.

This species may be confused with *Pleurozium schreberi*, but this has red stems, leaves decurrent and alar cells oblong and orange brown.

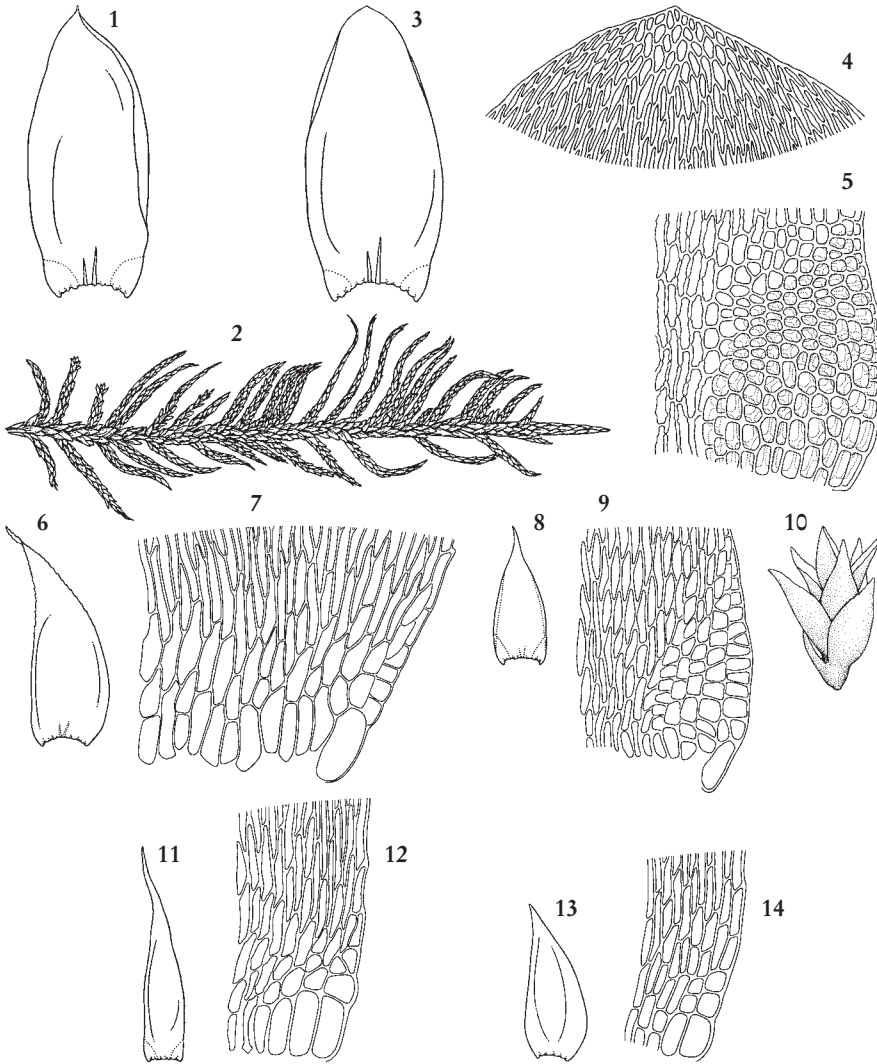


FIGURE 81. 1, *Entodon cladorrhizans*, leaf. 2-5, *E. concinnus*: 2, habit; 3, leaf; 4, leaf apex; 5, alar cells. 6-7, *Isopterygium tenerum*: 6, leaf; 7, alar cells. 8-10, *Platygryium repens*: 8, leaf; 9, alar cells; 10, propaguliferous branchlet. 11-12, *Sematophyllum substrumulosum*: 11, leaf; 12, alar cells. 13-14, *S. demissum*: 13, leaf; 14, alar cells. 2 ( $\times 1,6$ ); 1, 3, 6, 8, 11, 13 ( $\times 20$ ); 10 ( $\times 50$ ); 4, 5, 7, 9, 12, 14 ( $\times 180$ ).



## Fam. Pylaisiadelphaceae

### *Isopterygium* Mitt.

Plants medium-sized, shiny, yellow green to golden brown. Stem irregularly branched; pseudoparaphyllia filiform. Leaves spreading to erect-spreading, complanate, sometimes asymmetrical, ovate-lanceolate, gradually tapering into long acumen, which is often twisted and flexuose, margin denticulate in the upper half; laminal cells linear, alar cells few, enlarged, yellowish; nerve short and double. Seta brown to reddish; capsule horizontal to pendulous, curved and asymmetrical, constricted below mouth when dry (fig. 81, 6-7)

***I. tenerum*** (Sw.) Mitt.

***Sematophyllum bottinii*** (Breidl.) Podp.

Forms glossy, golden wefts on wet slopes. Localized in Algeciras Mountains. Esp.

### *Platygyrium* Schimp.

Plants small. Stem prostrate, without pseudoparaphyllia, with ascending or straight branches. Stem leaves erect, ovate-lanceolate, acuminate, margin entire, partially narrowly recurved; laminal cells elongate, elliptical, basal cells narrowly rhomboidal, not porose, alar cells distinctly differentiated, quadrate-trapezoidal or shortly rectangular, ascending up margin; nerve absent or short and double. Small, deciduous, axillary, propaguliferous branchlets present on erect branches. Seta brownish red; capsule straight, symmetrical. Dioicous (fig. 81, 8-10)

***P. repens*** (Brid.) Schimp.

Corticolous, in the lowlands. Very rare, in the north of the Peninsula. Esp.

## Fam. Sematophyllaceae

### *Sematophyllum* Mitt.

Plants slender. Stem prostrate, 3-5 cm long, irregularly branched, without paraphyllia. Leaves erect to patent, stem and branch leaves similar, minute, lanceolate to ovate-lanceolate, with short or long acumen, margin entire; median cells of lamina linear-rhomboidal, alar cells inflated; nerve lacking or very short and double. Seta purplish; capsule inclined to horizontal, constricted below mouth after dehiscence; lid longly rostrate; peristome double.

- 1 Leaves narrowly lanceolate, with long, filiform apex; alar group large, with 4-6 inflated cells (fig. 81, 11-12) ***S. substrumulosum*** (Hampe) E. Britton  
Alar cells yellowish or hyaline. Forms compact, silky, glossy golden green mats on rotten trunks. Distributed in the western part of the Peninsula, rare in the south, north and in Mallorca and Menorca. Esp, Prt, Bl.
- 1 Leaves ovate-lanceolate, with shortly acuminate apex; alar group small, with 2-4 inflated cells (fig. 81, 13-14) ***S. demissum*** (Wilson) Mitt.  
Alar cells hyaline. Forms glossy yellowish green mats on wet, rocky slopes in the lowlands. Scattered localities in the north of the Peninsula. Esp.



**Fam. Cryphaeaceae****Cryphaea D. Mohr**

Plants medium-sized, densely or sparsely branched. Primary stem creeping, secondary stems erect. Leaves imbricate, ovate, obtuse, acute or acuminate, concave, margin entire, plane or recurved at base; median cells of lamina rounded or elliptical, 1,5:1, smooth, thick-walled, basal cells towards nerve longer; nerve extending to 3/4 way up leaf. Capsule ellipsoidal, immersed, borne unilaterally along the secondary stems.

- 1 Branch leaves acute to acuminate; margin recurved at base (fig. 82, 1-2)

**C. heteromalla** (Hedw.) D. Mohr

Stem creeping,  $\pm$  densely branched, branches erect. Forms dark green wefts on trunks of trees and bushes, more rarely on rocks, in the lowlands and montane areas. Widespread throughout the Peninsula but commoner in the north and west. Esp, Prt.

- 1 Branch leaves obtuse; margin plane (fig. 82, 3-4) **C. lamyana** (Mont.) Müll.Hal.

\* **Dendrocryphaea lamyana** (Mont.) P. Rao

Stem creeping, simple or sparsely branched, branches erect or curved when dry. Grows on rocks, at tree bases and submerged in streams, in the west and southwest of the Peninsula. Esp, Prt.

**Fam. Leucodontaceae****Antitrichia Brid.**

Plants glossy dark green. Leaves ovate to ovate-lanceolate,  $\pm$  longitudinally plicate, apex acute or acuminate, with reflexed teeth, especially in branch leaves, margin narrowly recurved; laminal cells smooth, 2-3 times as long as wide, thick-walled, basal cells shorter, rounded; nerve long, extending to 3/4 way up leaf or more. Capsule ellipsoidal, inclined; peristome double.

- 1 Leaves ovate-lanceolate, acuminate, with large, irregular teeth at apex, with 1-2 lateral nerves at base distinct and short (fig. 82, 5-6)

**A. curtipendula** (Hedw.) Brid.

Plants robust, irregularly branched. Forms wefts at tree bases and on siliceous rocks, in montane areas. Scattered in the Peninsula, more frequent in the northern half and in Mallorca. Esp, Prt, Bl.

- 1 Leaves ovate, acute, with fine teeth at apex, lateral nerves absent or indistinct (fig. 82, 7)

**A. californica** Sull.

Plants slender,  $\pm$  regularly branched. Forms wefts on trunks and rocks in montane areas, in the centre and south of the Mediterranean region of the Peninsula and in Mallorca. Esp, Prt, Bl.

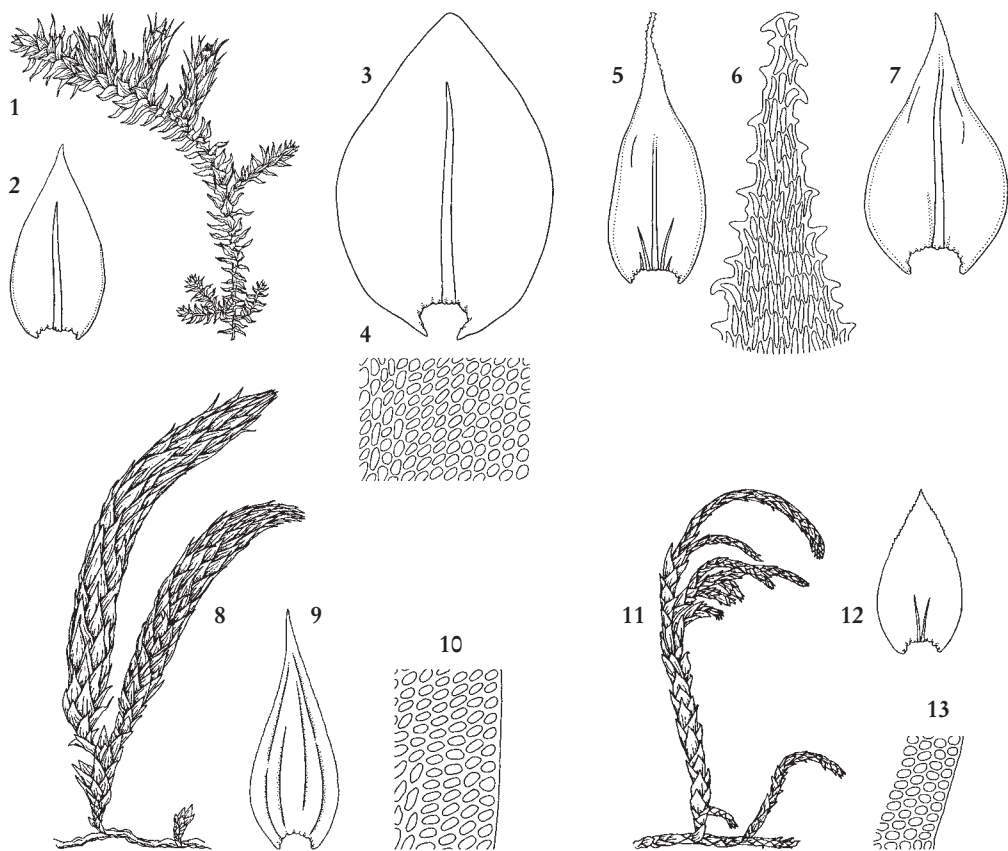


FIGURE 82. 1-2, *Cryphaea heteromalla*: 1, habit; 2, leaf. 3-4, *C. lamyana*: 3, leaf; 4, median cells. 5-6, *Antitrichia curtipendula*: 5, leaf; 6, leaf apex. 7, *A. californica*, leaf. 8-10, *Leucodon sciuiroides* var. *sciuiroides*: 8, habit; 9, leaf; 10, lower marginal cells. 11-13, *Pterogonium gracile*: 11, habit; 12, leaf; 13, lower marginal cells. 8, 11 ( $\times 3,5$ ); 1 ( $\times 4$ ); 2, 3, 5, 7, 9, 12 ( $\times 20$ ); 6 ( $\times 140$ ); 4, 10, 13 ( $\times 200$ ).

### *Leucodon* Schwägr.

Plants robust, dark green. Primary stem creeping, secondary stems simple or sparsely branched, pendulous, curved or straight. Leaves spreading, imbricate when dry, ovate-lanceolate, longitudinally plicate, acuminate, margin plane, entire or denticulate at apex; laminal cells long, narrow, smooth, marginal cells short, oblong at base; nerve lacking. Capsule ovoid to ellipsoidal or cylindrical (fig. 82, 8-10)

*L. sciuiroides* (Hedw.) Schwägr.

Usually with groups of propaguliferous shootlets at branch apex. Forms extensive tufts on trees and rocks in montane areas. Widespread in the Peninsula and in Mallorca. Esp, Prt, And, Bl.

var. **sciuroides**: Secondary stems to 2 cm long, branched. Capsule ovoid to cylindrical (fig. 82, 8-10).

var. **morensis** (Schwägr.) De Not.: Secondary stems to 6 cm long, sparsely branched. Leaves longly acuminate. Capsule cylindrical.

### **Pterogonium Sw.**

Plants medium-sized. Primary stem creeping, secondary stems erect, secund, often with flagelliform branches. Branch leaves spreading, imbricate when dry, ovate, concave, acute, margin plane, dentate at apex; laminal cells rhomboidal, papillose on dorsal side, basal cells towards nerve elongate, marginal cells rounded, quadrate or oblate, forming several rows; nerve short, forked or double. Capsule ovoid-cylindrical (fig. 82, 11-13)

**P. gracile** (Hedw.) Sm.

Forms loose, dark green patches on rocks and trunks of trees, in montane areas. Widespread throughout the Peninsula and in Mallorca. Esp, Prt, Bl.

## **Fam. Neckeraceae**

### **Homalia Brid.**

Stem prostrate, irregularly branched. Leaves complanate, oblong to spatulate, with rounded, dentate apex, margin plane; laminal cells rhomboidal in the upper part, gradually narrower and longer towards leaf base; nerve single, faint, extending 1/2-4/5 way up leaf.

- 1 Nerve extending 3/4-4/5 way up leaf; leaf apex strongly dentate; stem with pseudoparaphyllia; dioicous (fig. 83, 1-4) **H. lusitanica** Schimp.

Forms glossy, golden green mats on wet, shaded rocks and slopes, by streams and on walls of caves, in the lowlands near coastal areas, in the east, west and south of the Peninsula and in Mallorca. Esp, Prt, Bl.

- 1 Nerve extending 1/2-3/4 way up leaf; leaf apex moderately dentate; stem without pseudoparaphyllia; autoicous (fig. 83, 5-6) **H. trichomanoides** (Hedw.) Brid.

Forms loose wefts at tree bases and on wet, calcareous soils and rocks, in the lowlands and montane areas in the north of the Peninsula. Esp, Prt.

### **Neckera Hedw.**

Plants mostly large. Secondary stems pinnate, bipinnate or irregularly branched, often with propaguliferous flagelliform branches. Leaves complanate, oblong, asymmetrical, plane or transversely undulate, apex rounded to acuminate, margin entire or denticulate at apex; nerve thin, single or double, or absent; laminal cells elongate, gradually shorter towards apex and leaf base. Capsule ovoid or ellipsoidal, emergent or exserted; peristome double.

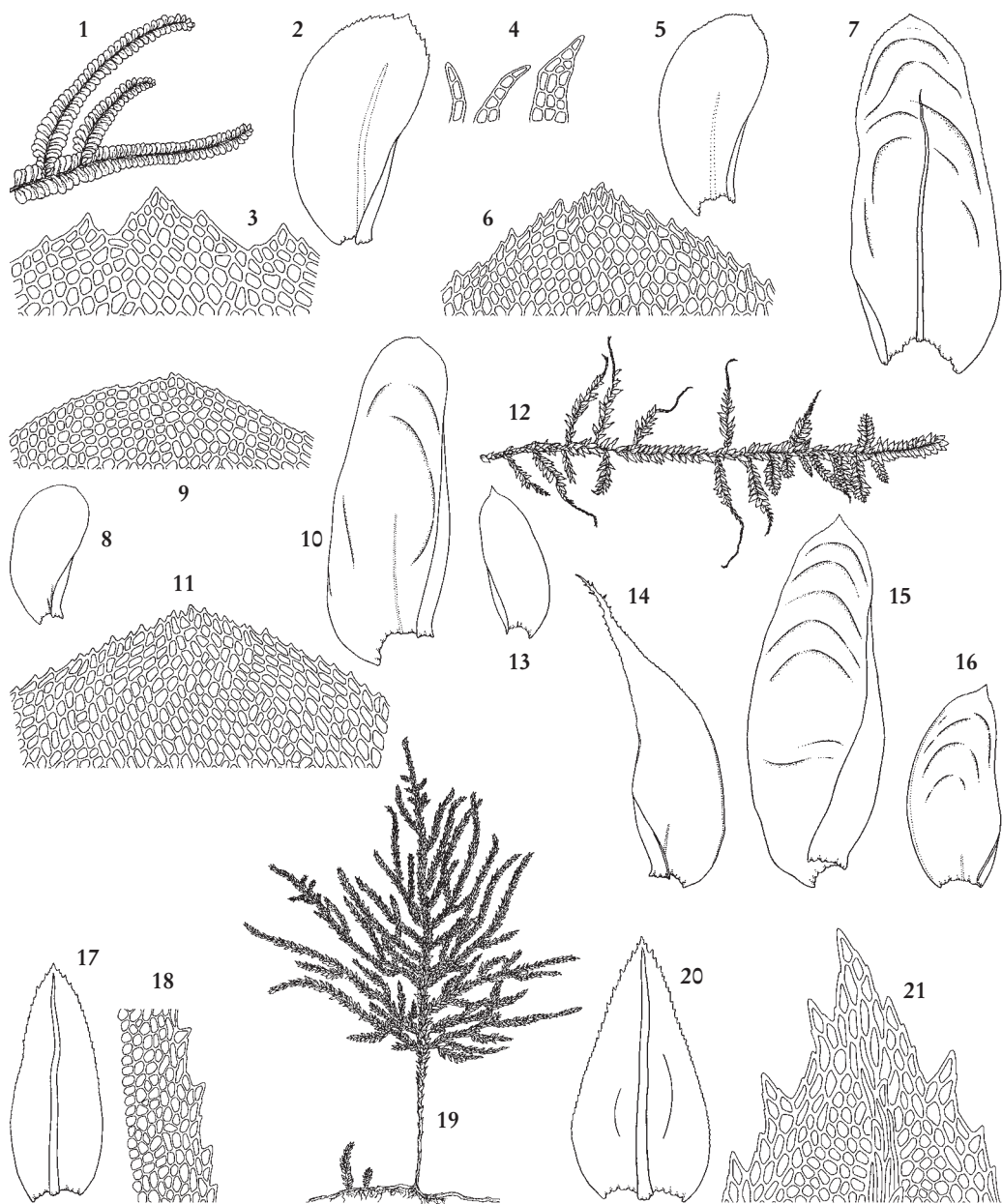


FIGURE 83. 1-4, *Homalia lusitanica*: 1, habit; 2, leaf; 3, leaf apex; 4, pseudoparaphyllia. 5-6, *H. trichomanoides*: 5, leaf; 6, leaf apex. 7, *Neckera menziesii*, leaf. 8-9, *N. bessi*: 8, leaf; 9, leaf apex. 10-11, *N. intermedia*: 10, leaf; 11, leaf apex. 12-13, *N. complanata*: 12, habit; 13, leaf. 14, *N. cephalonica*, leaf. 15, *N. crispa* var. *crispa*, leaf. 16, *N. pumila*, leaf. 17-18, *Thamnobryum maderense*: 17, leaf; 18, margin in the middle of leaf. 19-21, *T. alopecurum*: 19, habit; 20, leaf; 21, leaf apex. 19 ( $\times 0.8$ ); 1, 12 ( $\times 1.4$ ); 2, 5, 7, 8, 10, 13, 14, 15, 16, 17, 20 ( $\times 18$ ); 3, 4, 6, 9, 11, 18, 21 ( $\times 160$ ).

- 1 Nerve single, extending to 3/4 way up leaf (fig. 83, 7) **N. menziesii** Drumm.  
**Metaneckera menziesii** (Drumm.) Steere  
 Plants about 15 cm long, golden green, darker below. Stem irregularly branched, with paraphyllia, often with flagelliform branches. Leaves oblong, transversely undulate, obscurely complanate, apex obtuse. Forms pendulous, loose patches in wet, deep, calcareous rock crevices, in montane areas. Scattered in the Peninsula. Esp, Prt (Extinct).
- 1 Nerve single, extending to 1/2 up leaf, short and double or lacking 2
- 2 Leaf apex rounded, entire or slightly denticulate 3
- 2 Leaf apex apiculate or acuminate, dentate or denticulate 4
- 3 Leaves plane when dry or moist (fig. 83, 8-9) **N. besseri** (Lobarz.) Jur.  
 Plants small. Stem regularly pinnate, mostly with flagelliform branches. Nerve short and double or lacking. Forms bright green patches on trunks and branches, mainly on *Buxus sempervirens* L., in montane areas in the northeast of the Peninsula and in Mallorca. Esp, And, Bl.
- 3 Leaves transversely undulate when dry, plane when moist (fig. 83, 10-11) **N. intermedia** Brid.  
 Plants large. Stem irregularly branched, without flagelliform branches. Nerve faint, short or ending half way up leaf. Epiphyte. Very rare, in Algeciras Mountains. Esp.
- 4 Leaves plane 5
- 4 Leaves transversely undulate 6
- 5 Leaves apiculate; margin finely denticulate at apex (fig. 83, 12-13) **N. complanata** (Hedw.) Huebener  
 Stem regularly branched, with numerous flagelliform branches. Seta long. Forms glossy light green patches on trunks of trees and on rocks, in montane areas, in the northern and western half of the Peninsula and in Mallorca. Esp, Prt, And, Bl.
- 5 Leaves acuminate; margin irregularly dentate at apex (fig. 83, 14) **N. cephalonica** Jur. & Unger  
 Stem irregularly branched, without flagelliform branches. Seta short. Grows on rocks and bark of trees. Very rare, in Algeciras Mountains. Esp.
- 6 Plants robust, 5-20 cm long; leaves 3-5 mm long, with plane margin and obtuse, apiculate apex (fig. 83, 15) **N. crispa** Hedw.  
 Plants glossy golden brown. Stem regularly or slightly branched. Seta long. Forms loose, pendulous patches on calcareous rocks, trunks of trees and branches of *Buxus sempervirens* L., in montane areas in the Peninsula and in Mallorca. Esp, Prt, And, Bl.  
 var. **crispa**: Leaves straight, strongly undulate (fig. 83, 15).  
 var. **falcata** Müll.Hal.: Leaves falciform, not very undulate.
- 6 Plants small, 2-5 cm long; leaves to 1,5 mm long, with recurved margin and obtuse apex or attenuated in acute point (fig. 83, 16) **N. pumila** Hedw.

Seta short; capsule emergent. Forms dark green to pale green wefts on trunks of branches, rarely on rocks, in the lowlands and montane areas, in the north and west of the Peninsula. Esp, Prt.

### **Thamnobryum Nieuwl.**

Plants robust. Primary stem creeping, the secondary ones erect and dendroid. Branch leaves of the first or second order erecto-patent, imbricate when dry, margin plane, strongly dentate in the upper half; laminal cells short, smooth or slightly papillose, marginal cells longer; nerve long, nearly reaching the apex.

- 1 Branches complanate; stem leaves ovate; median cells of lamina isodiametric or a little longer than wide,  $8-23 \times 6-13 \mu\text{m}$  (fig. 83, 17-18)

**T. maderense** (Kindb.) Hedenäs

Grows on wet, shaded acidic soils. Very rare, in the west of the Peninsula and in Algeciras Mountains. Esp, Prt.

- 1 Branches not complanate; stem leaves ovate-triangular; median cells of lamina longer than wide,  $9-40 \times 6-9 \mu\text{m}$  (fig. 83, 19-21)

**T. alopecurum** (Hedw.) Gangulee

Forms lax, dark green patches on shaded, usually water-splashed rocks by streams or in chasms, in the lowlands and montane areas of the Peninsula and in Mallorca and Menorca. Esp, Prt, Bl.

## **Fam. Leptodontaceae**

### **Leptodon D. Mohr**

Plants medium-sized. Primary stem prostrate, adhering to substratum, secondary stems ascending or decumbent, with pinnate branches, circinate when dry. Leaves ovate, rounded at apex, spreading, appressed when dry, margin recurved on one side, entire, dentate or denticulate at apex; laminal cells ovate, short, smooth, thick-walled; nerve single, hardly extending beyond 1/2 way up leaf. Seta short; capsule ellipsoidal (fig. 84, 1-3)

**L. smithii** F. Weber & D. Mohr

Usually with straight propaguliferous branches. Forms lax, dark green to black patches on trunks of trees and basic rocks. Common in the Peninsula, although rarer in the centre and northwest, and in Mallorca, Menorca and Pithyusic Island. Esp, Prt, And, Bl.

## **Fam. Lembophyllaceae**

### **Isothecium Brid.**

Plants small to robust. Primary stem prostrate, secondary stems decumbent to erect, irregularly branched, often dendroid. Stem leaves imbricate, concave, ovate to ovate-triangular, acuminate, acute or obtuse and apiculate, margin denticulate, at least in the upper part or entire; laminal cells linear-rhomboidal, shorter towards margin and apex,

basal cells shorter or rectangular, alar cells small, opaque, yellowish to brownish, thick-walled; nerve single, extending beyond 1/2 way up leaf, usually bifurcate in the upper part, occasionally short and double. Branch leaves ovate to lanceolate. Seta reddish, smooth; capsule inclined. Dioicous.

- |   |                            |   |
|---|----------------------------|---|
| 1 | Apical cells to 3:1        | 2 |
| 1 | Apical cells more than 4:1 | 3 |

- 2 Alar cells quadrate, forming a distinctly delimited group; stem leaves apiculate, with denticulate margin in upper part (fig. 84, 4-5)

**I. alopecuroides** (Lam. ex Dubois) Isov.

**I. myurum** Brid.

Plants very variable in size but usually robust. Secondary stems procumbent, irregularly branched, with straight or curved branches. Stem leaves ovate-oblong, margin incurved in the middle of leaf; nerve faint, extending to 1/2 way up leaf. Branch leaves narrower, apiculate, nerve single or forked above. Capsule erect. Forms dark green wefts on wet rocks and at bases of trees, in montane areas and high mountains, in northern half of the Peninsula and in Mallorca, very rare in the south of the Peninsula. Esp, Prt, Bl.

- 2 Alar cells rounded, forming a large triangular group indistinctly delimited; stem leaves acuminate, with entire margin (fig. 84, 6-7)

**I. algarvicum** W.E. Nicholson & Dixon

Plants small, slender. Stem and branches curved when dry, branches often attenuated, flagelliform branches common. Stem leaves ovate, margin plane, group of alar cells gradually narrowing upwards along margin, extending 1/3-1/4 way up leaf. Branch leaves concave, oblong-ovate, margin revolute at base, denticulate in the upper part with scattered upper cells prorate dorsally; nerve stout, extending 1/2 way up leaf. Forms green, yellow-green or brownish wefts on sheltered, acidic rocks and at tree bases, in montane areas. Rare, in the south of the Peninsula. Esp, Prt.

- 3 Leaves with long, narrow point, margin dentate from base to apex or only in the upper part

**I. myosuroides** Brid.

Plants slender. Secondary stems sub-dendroid or irregularly branched, with straight or curved branches, attenuated at tips. Stem leaves ovate, ovate-oblong or cordate-triangular; alar cells shortly rectangular or rhomboidal; nerve long or short, bifurcate in the upper part. Capsule inclined. Forms yellowish green to brownish wefts on rocks and at tree bases in wet, shaded sites, in montane areas and high mountains.

var. **myosuroides**: Stem leaves ovate to cordate-triangular, margin dentate from base to apex. Branch leaves smaller than stem leaves Widespread in the northern half of the Peninsula, rare in the south. Esp, Prt (fig. 84, 8-9).

var. **brachythecioides** (Dixon) Braithw.: Stem leaves ovate-oblong, margin dentate in the upper part. Branch leaves shorter than stem leaves. Very rare, in montane areas in the northwest of the Peninsula. Esp.

- 3 Leaves with short point, margin denticulate in the upper part (fig. 84, 10-11)

**I. holtii** Kindb.

Plants medium-sized to robust, dendroid, with ascending, julaceous secondary branches, longer than in *I. myosuroides*. Stem leaves ovate to cordate-triangular; alar cells shortly



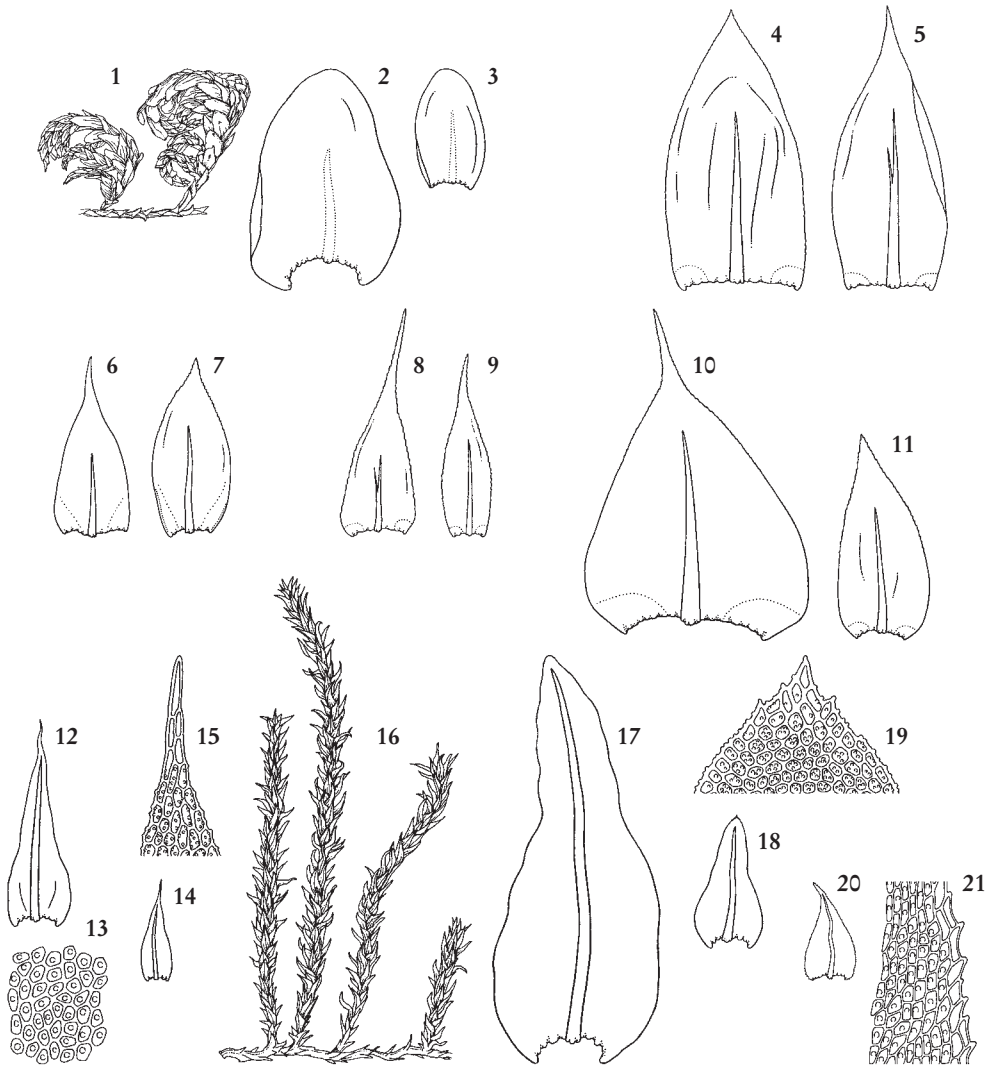


FIGURE 84. 1-3, *Leptodon smithii*: 1, habit when dry; 2, stem leaf; 3, branch leaf. 4-5, *Isoetecium alopecuroides*: 4, stem leaf; 5, branch leaf. 6-7, *I. algarvicum*: 6, stem leaf; 7, branch leaf. 8-9, *I. myosuroides* var. *myosuroides*: 8, stem leaf; 9, branch leaf. 10-11, *I. holtii*: 10, stem leaf; 11, branch leaf. 12-13, *Anomodon longifolius*: 12, leaf; 13, laminal cells. 14-15, *A. rostratus*: 14, leaf; 15, leaf apex. 16-17, *A. viticulosus*: 16, habit; 17, leaf. 18-19, *A. attenuatus*: 18, leaf; 19, leaf apex. 20-21, *Claopodium whippleanum*: 20, leaf; 21, margin in the middle of leaf. 16 (x2); 1 (x4); 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 14, 17, 18, 20 (x20); 13, 15, 19, 21 (x240).



rectangular; nerve broad, stout, extending to 1/2 way up leaf. Capsule inclined. Forms flat, light or dark green to orange wefts on periodically flushed rocks and by mountains streams, in the northern half of the Peninsula, very rare in the south. Esp, Prt.

## Fam. Anomodontaceae

### *Anomodon* Hook. & Taylor

Plants slender to robust. Primary stem stoloniferous, secondary stems simple or irregularly branched,  $\pm$  erect or pendent. Leaves of secondary stems and branches similar, ovate, lanceolate or lingulate, acuminate to obtuse, margin entire, crenulate or sparsely dentate; laminal cells short, papillose; nerve nearly reaching the apex.

- 1 Laminal cells with one conical, low, rounded papilla (fig. 84, 12-13)

**A. longifolius** (Schleich. ex Brid.) C. Hartm.

Plants slender. Stem with filamentous or foliose pseudoparaphyllia, branches fasciculate or irregularly pinnate, often attenuated or flagelliform. Leaves ovate-lanceolate, longly acuminate. Forms yellowish green tufts on rocks in beechwoods and oakwoods in the north of the Peninsula. Rare. Esp.

- 1 Laminal cells with 2-3, often branched papillae 2

- 2 Leaf apex acuminate, elongate in hyaline point (fig. 84, 14-15)

**A. rostratus** (Hedw.) Schimp.

Stem profusely and irregularly branched, branches julaceous, erect. Leaves ovate-lanceolate, acuminate, less than 0,8 mm long. Forms dense, glaucous or yellowish green tufts on calcareous walls or vertical rocks and as an epiphyte in deciduous forests in montane areas, in the Pyrenees and in the Basque Mountains. Esp.

- 2 Leaf apex obtuse, acute or apiculate, not elongate in hyaline point 3

- 3 Plants robust; branches 1,3 mm wide when dry or more; leaves more than 2 mm long (fig. 84, 16-17)

**A. viticulosus** (Hedw.) Hook. & Taylor

Plants with branched stems, 6-8 cm long. Leaves falciform-secund, apex obtuse, rarely acuminate; laminal cells papillose. Forms erect to pendulous tufts on calcareous rocks and as an epiphyte in deciduous forests in montane areas, in the north and east of the Peninsula, very rare in the west, and in Mallorca. Esp, Prt, And, Bl.

- 3 Plants variable in size; branches up to 1 mm wide when dry; leaves less than 2 mm long (fig. 84, 18-19)

**A. attenuatus** (Hedw.) Huebener

Plants to 3 cm long, irregularly pinnate, branches complanate, often flagelliform. Leaves with obtuse apex, apiculate or not, margin often sparsely dentate near apex; apical cell smooth, long, translucent. Forms dense, dull yellowish green tufts on basic soils or calcareous rocks and as an epiphyte in deciduous forests in montane areas, in the northeastern part of the Peninsula. Esp.

**Claopodium** (Lesq. & James) Renauld & Cardot

Plants small, creeping, slightly radiculose, irregularly pinnately branched. Paraphyllia few or lacking. Stem leaves ovate-lanceolate, gradually longly acuminate, margin strongly dentate; laminal cells rhomboidal, 6-7  $\mu\text{m}$  wide, usually 2:1, with a central papilla, marginal cells elongate, usually without chlorophyll; nerve stout, nearly reaching apex. Branch leaves smaller and more shortly acuminate than stem leaves (fig. 84, 20-21)

**C. whippleanum** (Sull.) Renauld & Cardot

Forms dark green mats on shaded, acidic soil, slopes, banks, rocks and at tree bases, in the western part of the Peninsula. Esp, Prt.

## GLOSSARY

- acrocarpous** Erect mosses producing perichaetia and later the sporophyte at the tip of the stem [fig. 29, 6].
- acumen** Long and tapering point forming an angle less than 45°.
- acuminate** Ending in an acumen [fig. A, 3].
- acute** Tapering to a point forming an angle 45°-90°, [fig. A, 3].
- alar cells** Cells at basal angles of leaf, which usually differ from other leaf cells in their shape or colour [fig. B, 4].
- androecium** Antheridia and surrounding bracts.
- annual** Moss that completes its life cycle in less than one year.
- annulus** One or more rings of differentiated cells between the urn and lid, which assist in the dehiscence, then peels off or remains attached to the capsule mouth.
- antheridium / antheridia (pl.)** Male reproductive organ containing the antherozoids.
- apical** At apex or tip; referring to the apex.
- apiculate** Ending in an apiculus [fig. A, 3].
- apiculus / apiculi (pl.)** Short abrupt point.
- apophysis / apophyses (pl.)** Swollen upper part of seta, beside the base of the capsule [fig. C, 3].
- appendiculate** Having short, thin, transverse projections, as on the cilia of the inner peristome in some species of *Bryum* [fig. 52, 16].
- applied** Close to the organ where it is inserted.
- appressed** Closely applied, as the leaves against the stem [fig. A, 1].
- archegonium / archegonia (pl.)** Female reproductive organ containing an ovum.
- arista / aristae (pl.)** Long, thin, rigid point.
- articulate** Having thickened transverse joints.
- articulation** The point of connection between two parts or rigid segments, usually thickened.
- 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.
- autoicous** Monoicous plant, having archegonia and antheridia in separate inflorescences on the same plant [fig. C, 2].
- axil** The angle between a stem and the upper surface of a leaf or any other structure which is growing out of that stem.
- axillary** 1. Referring to the axil. 2. Located in an axil.
- axillary hair.** Uniseriate hair found in the leaf axils, generally inconspicuous and well concealed by the leaf bases [fig. 34, 11; 36, 4].
- basal** At the base of a structure; referring to the base.
- basal cells** Cells at the base of leaf, located between the margin and the nerve [fig. B, 4].
- basal membrane** Cylindrical membrane at the base of the endostome of some mosses [fig. 44, 12].

- bifurcate** Forked into  $\pm$  equal halves.
- bipinnate** Twice-pinnately branched.
- border** Cells along a leaf margin that differ from other leaf cells in their shape, size, colour or wall thickening.
- bordered** Having a border [fig. B, 2].
- bulbiform** Resembling a bulb, as mosses with a very short stem and leaves concave and closely attached [fig. 33, 3].
- bulbil** Axillary propagule resembling a small bulb [fig. 55, 22].
- caducous** Falling off early.
- calyptra** A membranous covering of haploid tissue over the developing sporophyte [fig. C, 5].
- campanulate** Bell-shaped [fig. C, 5].
- capitate** Forming a head.
- capitulum / capitula (pl.)** Group of crowded, short branches on the tip of the stem of *Sphagnum* species [fig. 4, 9].
- capsule** Terminal part of the sporophyte, usually differentiated into *lid*, *urn* and *neck*.
- carinate** Longitudinally folded forming a keel [fig. C, 1].
- central strand** Longitudinal cylinder of small, thin-walled cells at the centre of the stem [fig. 73, 4].
- channelled** Groove-shaped, U-shaped in cross-section [fig. C, 1].
- chlorophyllose** With chloroplasts.
- ciliate** Having cilia.
- cilium / cilia (pl.)** Fine hairs, usually unicellular and unbranched, at the margin of a structure or alternating with the segments of the endostome.
- circinate** Curved in a circle [fig. A, 2].
- cladautoicous** Monoicous plant, having archegonia and antheridia in separate branches.
- clavate** Club-shaped.
- cleistocarpous** Indehiscent capsule, that has no lid.
- columella** Central column of sterile tissue of the urn.
- comal tufts** A tuft of leaves at tip of a stem or branch [fig. 52, 14].
- commissure** In *Sphagnum*, the junction between hyaline cells and green cells [fig. 2, 7].
- complanate** Apparently, flattened into one plane, referring to leaf arrangement [fig. A, 1].
- conduplicate** Longitudinally folded along the middle, as *Fissidens* leaves [fig. 23, 9].
- confluent** Merging together.
- conical** Cone-shaped.
- constricted** Abruptly narrowed.
- contorted** Irregularly bent or twisted.
- convolute** Longitudinally rolled [fig. 34, 7].
- cordate** Heart-shaped [fig. B, 1].
- cordiform** Heart-shaped.
- cortex** Outermost layer or layers of cells of a stem or branch.
- cortical** Referring to the cortex.
- corticulous** Growing on bark.
- crenulate** With minute, rounded teeth along the margin [fig. B, 2].
- cribrose** Finely perforated [fig. 19, 14].
- crisped** Strongly curled and twisted.
- cupulate** Hood-shaped; in calyptra split along one side only; in leaves with the apex strongly concave and curved inwards [fig. C, 5].
- cushion** Life form with more or less erect, tightly clustered and radiating stems.
- cuspidate** Ending in a stout point; in stems and branches this point is formed by imbricate leaves [fig. A, 1; B, 3].
- cyathiform** Cup-shaped.
- cygneous** Strongly curved like the neck of a swan [fig. 20, 4].

**cylindrical** Cylinder-shaped, e.g. capsule in many species [fig. C, 3].

**deciduous** Falling off.

**decumbent** Prostrate but with ascending tips.

**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. B, 1]; the hyaline point of a leaf extending down its margin.

**dehiscent** Capsule that opens regularly by means of a lid or valves.

**dendroid** Branched like a tree [fig. 60, 12].

**dentate** With teeth [fig. B, 2].

**denticulate** Finely dentate [fig. B, 2].

**dentiform** Shaped like a tooth.

**denudate** Stem with leaves worn away or lost.

**depauperate** Poorly developed.

**dioicous** Producing archegonia and antheridia on separate plants [fig. C, 2].

**distal** Away from the base or point of attachment (opposite of *proximal*).

**distichous** Leaves arranged in two opposite rows [fig. A, 1].

**dorsal** Said of the back or lower surface of a leaf (opposite of *ventral*).

**ellipsoidal** Solid with a elliptical outline [fig. C, 3].

**elliptical** Ellipse-shaped [fig. A, 2].

**emarginate** Broadly notched at apex.

**emergent** Referring to the capsule, only partly projecting beyond the tips of perichaetial leaves [fig. 48, 16].

**endostome** The inner peristome when the peristome is double [fig. 52, 16].

**entire** Smooth on the margin; lacking teeth.

**ephemeral** Short-lived.

**epiphragm** Membrane positioned horizontally over the capsule mouth and below the lid, disintegrating at maturity.

**epiphyte** A plant growing on another plant, usually a tree or a shrub.

**epiphytic** Growing on another plant.

**erect** Vertical [fig. A, 1].

**erecto-patent** Posture between erect and patent, leaves making an angle with the stem of 45° or less.

**erose** Margin irregularly notched or ragged, as if gnawed.

**evanescent** Vanishing or disappearing.

**excavate** Abruptly concave or hollowed out.

**excurrent** Nerve that extends beyond the leaf apex [fig. B, 3].

**exostome** The outer peristome when the peristome is double [fig. 52, 16].

**exothecium** The capsule epidermis or the outermost layer of cells in the capsule [fig. 18, 1].

**exserted** When the capsule is raised high above the perichaetial leaves [fig. 50, 8].

**falcate** Curved like a sickle.

**falcate-secund** Strongly curved and turned to one side.

**falciform** Sickle-shaped [fig. A, 2].

**fascicle** Cluster of branches originating at the same point on a stem [fig. 5, 12].

**fasciculate** Bunched together, in bundles or fascicles.

**fibrillose** With fibrils.

**fibrils** Fine, fibre-like wall thickenings of the *Sphagnum* hyaline cells [fig. 2, 3].

**fimbriate** Fringed, generally with radiating cell walls of partly eroded marginal cells [fig. 3, 9].

**flexuose** Slightly wavy, irregularly bent.

**furrow** Groove.

**fusiform** Spindle-shaped [fig. 49, 15].

**gametophyte** The haploid, gamete-producing generation; in bryophytes, the dominant generation.

**geminate** Arranged in pairs [fig. 56, 7].

**gemma / gemmae (pl.)** Propagulum globose, ellipsoidal, cylindrical or filamentous, uni- or pluricellular [fig. 34, 12; 24, 26; 41, 28].

**gibbous** Swollen or bulging on one side [fig. C, 3].

**glabrous** Not hairy, smooth.

**glaucous** Having a somewhat glaucous appearance or nature; becoming glaucous.

**glaucous** With a whitish, greyish, or bluish bloom.

**globose** Spherical [fig. C, 3].

**gregarious** Growing close together but not densely.

**guide cells** Cells with large lumen, thin-walled and longitudinally arranged, found in a median layer across the nerve of many mosses [fig. C, 1].

**habit** General appearance of a plant.

**hair-point 1.** Filiform appendix. **2.** Long, fine point often formed by the excurrent nerve.

**hairy** Covered by hairs, having abundant hairs.

**high mountains** Referring to land above c. 1800 m.

**homomallous** Pointing the same way.

**humus** Soil substratum forming by decomposing organic material.

**hyaline cells** Large, empty, water-storage cell as in leaves of *Sphagnum* and *Leucobryum* [fig. 2, 7].

**hyaline** Colourless and transparent or translucent.

**hyaloderm** Uni- or pluristratose cortex of comparatively large, thin-walled, colourless cells [fig. 2, 2; 2, 4].

**hydrophilous** Growing in or by water.

**hygrophilous** Growing in moist places.

**imbricate** Closely appressed and overlapping, like shingles on a roof [fig. A, 1].

**immersed 1.** Referring to a capsule exceeded by the perichaetial leaves [fig. 33, 25]. **2.** Referring to the stomata below the epidermis of capsule [fig. 48, 10].

**imperforate** Not pierced through.

**inclined** Capsules that are between the erect and horizontal positions [fig. C, 3].

**incrassate** Thick-walled.

**incurved 1.** Curved inward and upward; e.g., peristome teeth curved over the capsule mouth; **2.** Applied to a leaf margin curved towards the ventral side (opposed to *recurved*) [fig. C, 1].

**indehiscent** Lacking distinct opening mechanism; said of the capsule that, at maturity, opens by irregular rupture or wall breakdown [fig. 41, 3].

**inflexed** Bent upward (ventrally) and weakly inward; e.g., leaf margins or leaves on a stem bent or turned abruptly inward, or towards the stem, as some leaf apex.

**innovation** In some mosses, a branch formed below perianth.

**insertion** The point of attachment of a structure; applied to leaves and branches on a stem.

**julaceous** Stem or branch with cylindrical appearance, because of the strongly imbricate, concave leaves [fig. A, 1].

**keeled** Sharply folded along the middle, like the keel of a boat; V-shaped in cross-section.

**lamella / lamellae (pl.) 1.** Small lamina. **2.** Ridges or plates along a leaf blade or nerve [fig. 8, 14]. **3.** In the genus *Bryum*, exostome enlargement joining the transverse articulations.

**lamina / laminae (pl.)** The flat blade of a leaf not including the nerve.

**lanceolate** Lance-shaped [fig. A, 2].

**lax** Loose, parts distant from each other.

**leaf** A photosynthetic, laminal outgrowth from the stem.

**lenticular** Shaped like a double-convex lens.

**lid** The cover of a moss capsule, which opens during the dehiscence [fig. C, 4].

**linear** Long, narrow and with parallel sides, applied to leaves and cells [fig. A, 2; B, 4].

**lingulate** Tongue-shaped [fig. A, 2].

**lobate** Divided into lobes.

**lowlands** Referring to land up to c. 800 m.

- lumen / lumina (pl.)** The cell cavity inside the cell walls.
- macronema / macronemata (pl.)** Large, branched, rhizoids produced around branch insertions and leaf axils.
- mamilla / mamillae** Protuberance from cell surface into which cell lumen projects.
- mamillate** Convex to hemispherical with a blunt central projection.
- mamillose** With mamillae [fig. B, 4].
- margin** The edge of a laminal structure.
- marginal** At the margin, especially as applied to a leaf.
- mats** A densely interwoven, horizontal growth form; e.g., *Brachythecium*, *Hypnum*.
- median cells** Cells located between the upper and lower parts of a leaf [fig. B, 4].
- median** Middle or central.
- Mediterranean Region** [fig. 1].
- micronema / micronemata (pl.)** Thin, sparsely branched rhizoids produced on stem between leaves.
- mitriform** Regularly lobed at base, referring to calyptra [fig. C, 5].
- monoicous** With antheridia and archegonia on the same plant [fig. C, 2], including *autoicous*, *paroicous* and *synoicous*.
- montane areas** Referring to land c. 800-1800 m.
- mouth** Opening of the capsule.
- mucro** A short, abrupt point.
- mucronate** Ending in mucro [fig. B, 3].
- muticous** Without arista, hair or hyaline point.
- neck** The sterile basal portion of a capsule [fig. C, 3].
- nerve** Longitudinal midrib of a leaf, always more than one cell thick.
- nodulose** Cell wall with short knob-like thickenings in the inner side.
- oblate** Wider than long, applied to cells [fig. 66, 27].
- oblong** Rectangular with rounded corners or ends, applied to cells and leaves [fig. A, 2 and B, 4].
- obovate** Egg-shaped with apex broader than base [fig. A, 2].
- obovoid** An obovate solid.
- obtuse** Broadly pointed, more than 90° [fig. A, 3].
- operculate** With a lid.
- orbicular** Circular in outline [fig. A, 2].
- ovate** Outline of an egg with base broader than apex [fig. A, 2].
- ovoid** An egg-shaped solid [fig. C, 3].
- papilla / papillae (pl.)** Small protuberance of a cell, by a local thickening of the cell wall [fig. B, 4].
- papillose** Having papillae.
- paraphyllum / paraphyllia (pl.)** Small, filiform or laminar outgrowths, sometimes branched, scattered on the stem [fig. 77, 2].
- paraphysis / paraphyses (pl.)** Hyaline, usually uniseriate, hair intermixed among antheridia or archegonia.
- paroicous** Monoicous plant with the antheridia just below the archegonia but in separated inflorescences [fig. C, 2].
- patent** In leaves, spreading from stem at an angle of 45° or more [fig. A, 1].
- pedicellate** Stalked.
- pellucid** Transparent or translucent.
- pendulous** Drooping and inclined like the capsules of *Bryum* [fig. C, 3].
- percurrent** Extending to the apex but not beyond [fig. B, 3].
- perforate** Pierced through.
- perichaetial** Referring to the perichaetia.
- perichaetium / perichaetia (pl.)** Cluster of ± modified leaves enclosing the archegonia.
- perigonal** Referring to the perigonium.
- perigonium / perigonia (pl.)** Cluster of ± modified leaves enclosing the antheridia [fig. 43, 15].

- peristome** A circular structure, generally divided into teeth, arranged in a single or double row around the mouth of the capsule [fig. 52, 16]. See also *endostome* and *exostome*.
- persistent** Not falling, remaining attached.
- piliferous** Having hair-point.
- pinnate** With numerous, spreading branches on opposite sides of the stem [fig. 76, 1].
- pleurocarpous** Moss with stems usually prostrate, producing perichaetia and sporophytes laterally [fig. 71, 5].
- plica / plicae** longitudinal furrow or pleat.
- plicate** With longitudinal furrows or pleats [fig. 63, 13].
- plumose** 1. Closely and regularly pinnate. 2. Feathery.
- polyoicous** Said of a species, in which there coexists the dioicous form with any type of monoicous form.
- pore** 1. A small aperture in the wall of some cells; e.g., in leaf hyaline cells and hyalodermis of *Sphagnum* [fig. 2, 2-4]. 2. In leaves, pit or hole in the wall opening to the wall of an adjacent cell [fig. B, 4].
- porose** Having pores [fig. B, 4].
- primary stem** The main stem, often creeping and prostrate or rhizome-like.
- primordium / primordia** An organ in its earliest stage of differentiation.
- prismatic** Shaped like a prism.
- procumbent** Laying flat on the ground but not attached by rhizoids.
- propagule / propagules (pl.)** Body serving for vegetative reproduction of the plant, with the appearance of a reduced bud, branch, or leaf [fig. 66, 22; 42, 3]. See also *bulbil* and *gemma*.
- propaguliferous** Having propagules.
- prorate** Having papillae or mamillae borne at the tips of cells, or formed by projecting cell ends [fig. B, 4].
- prostrate** Lying flat on the ground; creeping.
- protonema / protonemata (pl.)** The juvenile stage of the gametophyte, a filamentous or thalloid structure resulting from spore germination.
- proximal** Near the base or point of attachment (opposed to *distal*).
- pseudoparaphyllium / pseudoparaphyllia (pl.)** Small, unistratose, filiform or foliose outgrowths, restricted to the areas of the stem around branch primordia or branch base [fig. 74, 17].
- pseudopodium** In *Sphagnum* and *Andreaea*, an elongation of the stem serving the function of a seta.
- pyriform** Pear-shaped [fig. C, 3].
- radiculose** Covered with rhizoids.
- recurved** 1. Curved downward and backwards. 2. In leaves, referring to margins curved backwards (opposed to *incurved*).
- reflexed** Bent down and inwards, generally referring to leaf margins or leaves on a stem [fig. A, 1].
- reniform** kidney-shaped.
- resorption** Disappearance or erosion of parts of cell walls, e.g., the hyaline cells of *Sphagnum* leaves.
- reticulate** Forming a network.
- retort cells** In *Sphagnum*, elongated, flask-shaped, hyalodermis cells with a short projecting distal neck terminating in a pore [fig. 4, 2].
- revoluble** Rolling away, referring to an annulus that falls in a broken ring.
- revolute** Rolled downwards and backwards, referring to a leaf margin [fig. C, 1].
- rheophilous** Living in running water.
- rhizoidal** Referring to the rhizoids.
- rhizoids** Branched, root-like, slender filaments that arise from stem and usually anchor the gametophyte to the substratum.
- rhizomatous** Having a slender underground stem, horizontal and creeping.
- rhizome** A horizontal, subterranean stem giving rise to erect secondary stems.



- rhomboidal** Shaped like a rhombus [fig. B, 4].
- ringed** Having a thickened ring surrounding a pore; e.g., *Sphagnum*.
- riparian** Growing by rivers and streams.
- rosette** A compact cluster of leaves that surrounds the stem tip [fig. 54, 16].
- rostellate** Ending in a short point, like a small beak [fig. C, 4].
- rostrate** Narrowed into a slender, long point, like a long beak [fig. C, 4].
- rudimentary** Incompletely developed.
- rugose** With transverse wrinkles or undulations [fig. 79, 1].
- saxicolous** Growing on rocks.
- scabrous** Rough.
- secondary stems** Stems branching from primary stem.
- secund** Said of leaves or branches strongly turned to one side [fig. A, 1; 82, 11].
- segment** The main division of the endostome.
- septate** Having partitions.
- septum / septa (pl.)** Thin lamina dividing a cell [fig. 3, 13].
- serrulate** Minutely serrate.
- sessile** Without stalk.
- seta / setae (pl.)** Part of sporophyte holding the capsule.
- setaceous** Bristle-like.
- sheath** A widened leaf base that surrounds the stem [fig. 8, 13].
- sheathing** Surrounding and clasping the stem.
- sigmoid** Doubly curved in opposite directions, S-shaped [fig. 11, 2].
- sinuose** Wavy or uneven, applied to leaf margins or cell walls [fig. B, 4].
- spathulate** Spatula-shaped, narrow at base and gradually broad above [fig. A, 2].
- spinose** With sharp, pointed teeth; also very high, sharp leaf cell papillae or mamillae.
- spinule / spinulae (pl.)** Small spine.
- spinulose** Minutely spiny, having short, sharp teeth.
- 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 of 45° or more with the stem [fig. A, 1].
- squarrose** Leaves spreading at right angles, strongly curved back at an angle of 90° or more [fig. A, 1].
- stellate** Star-shaped.
- stem** The main axis in mosses.
- stereids** Cells thick-walled and with small lumen found in groups (stereid bands) in the nerve or stem cortex of some mosses [fig. C, 1].
- stolon** Horizontal, main stem, having erect secondary stems or branches, arching and rooting at points touching the substrate.
- stoloniferous** Producing stolons.
- stoloniform** Referring to stoloniferous stems [fig. 84, 16].
- stoma / stomata (pl.)** Minute, epidermal opening of the capsule, usually at base, surrounded by two kidney-shaped cells. The Funariaceae have single cells with opening in the centre [fig. 48, 30].
- stria / striae (pl.)** Fine ridges or lines.
- striate** Having striae [fig. 21, 4].
- strumose** Capsule with a swelling (struma) at one side of its base [fig. C, 3].
- sub-** Prefix meaning “nearly”, “almost”, or “somewhat”.
- subula / subulae (pl.)** A conic, long, slender point. In leaves, it is often mainly occupied by the nerve.
- subulate** Ending in a subula [fig. A, 3].
- sulcate** Strongly plicate, with deep longitudinal furrows or grooves.
- sulcus / sulci (pl.)** A groove or furrow.
- synoicous** Monoicous plant with antheridia and archegonia mixed in the same inflorescence [fig. C, 2].
- terricolous** Growing on soil.

**thalloid** Flattened, resembling a thallus.

**tomentose** Woolly, densely radiculose.

**tomentum / tomenta (pl.)** A felt-like covering made up of abundant rhizoids.

**tooth / teeth (pl.)** 1. Sharp, small projections on margin of leaf. 2. The divisions of either a single peristome or of the exostome of a double peristome.

**triangular** In the shape of a triangle [fig. A, 2].

**trigones** Triangular or circular intracellular wall thickenings, found at the point where three or more cells meet.

**tristichous** With leaves arranged in 3 rows [fig. 21, 7].

**truncate** Abruptly cut off at the apex.

**tuft** Growth form with stems erect but radiating at the edges, e.g., *Orthotrichum*.

**turbinate** Shaped like a spinning top, narrow at base and wide above [fig. C, 3].

**turf** Growth form with stems erect, parallel and close together; often covering extensive areas.

**turgid** Plump or swollen.

**urceolate** Urn-shaped; applied to capsules constricted below a wide mouth and abruptly narrowed to the seta.

**urn** Spore bearing portion of a capsule [fig. C, 3].

**vaginula** Minute sheath surrounding the base of the seta, derived from the wall of the archegonium, remaining after the separation of the calyptra [fig. 48, 9].

**ventral** The upper leaf surface (opposed to *dorsal*).

**ventricose** Bulging on one side below.

**vermicular** Worm-shaped, long, narrow and wavy; usually applied to cells [fig. B, 4].

**verrucose** Warty or roughened.

**wart** A small, ± rounded elevation or protuberance.

**warty** Covered with small wart-like protuberances.

**wefts** A loosely interwoven, often ascending growth form, e.g. *Thuidium*.

**xerophilous** Growing in dry places.

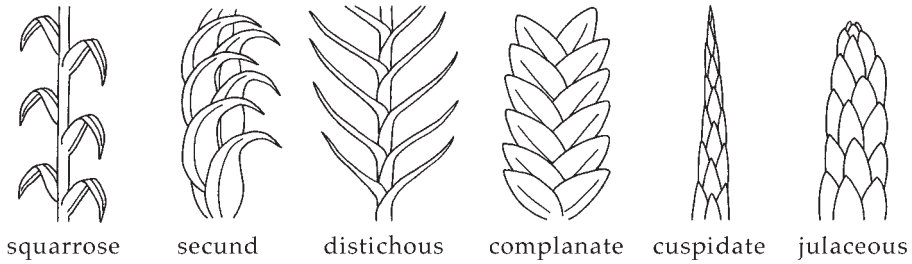
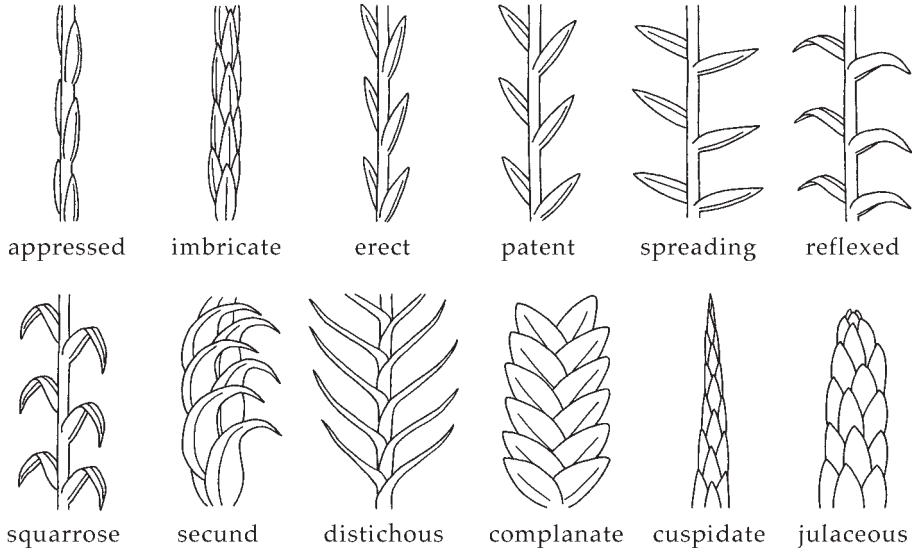
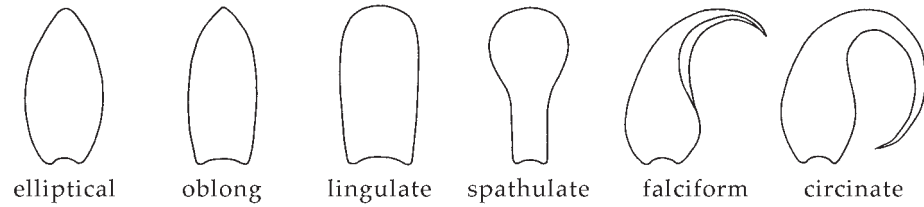
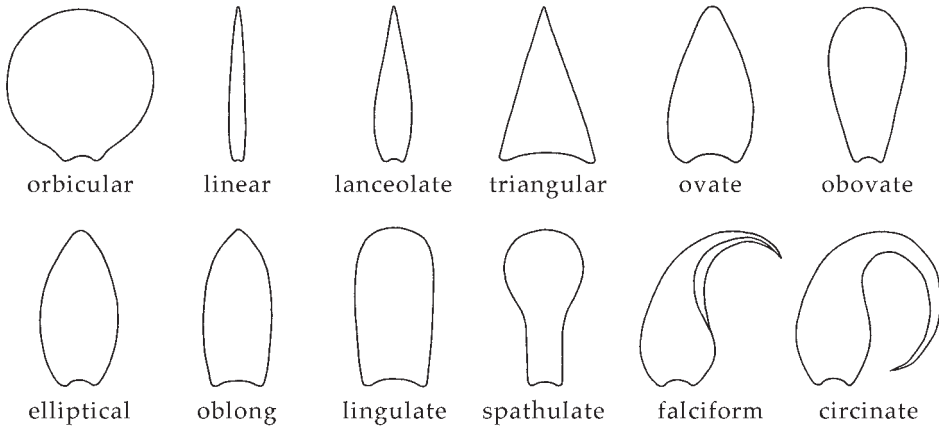
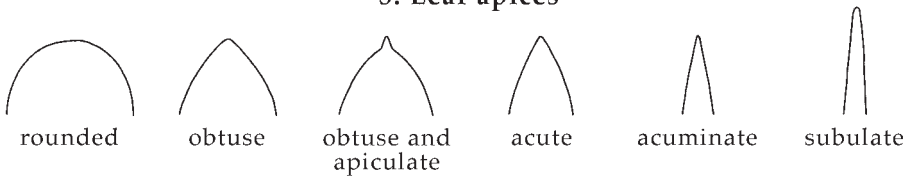
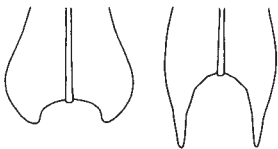
**1. Leaf arrangements****2. Leaf shapes****3. Leaf apices**

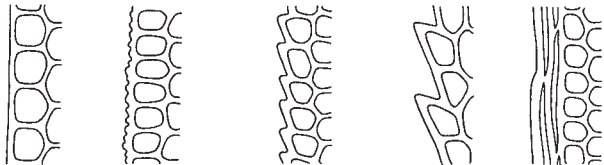
FIGURE A

1. Leaf bases



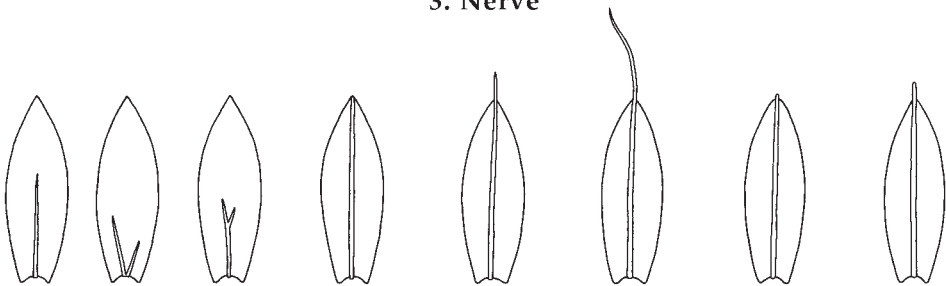
cordate      decurrent

2. Leaf margins



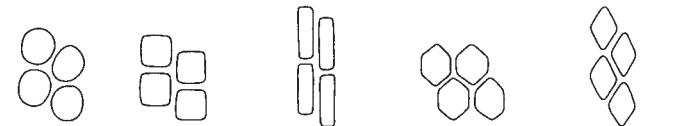
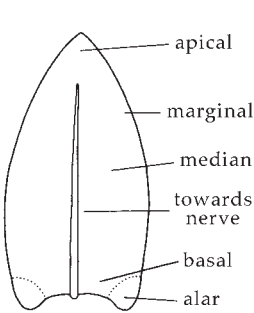
entire      papillose-crenulate      denticulate      dentate      bordered

3. Nerve



single      double      furcate      percurrent      excurrent      excurrent in hair point      mucronate      cuspidate

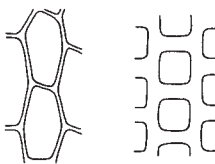
4. Cells



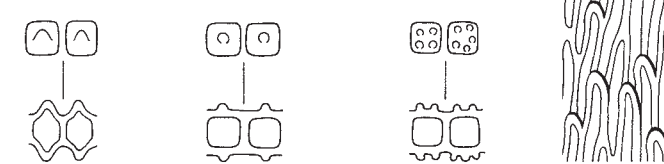
rounded      quadrate      rectangular      hexagonal      rhomboidal



oblong      linear      vermicular      sinuose      porose



thin-walled      thick-walled



mamilllose      unipapillose      pluripapillose      prorate

FIGURE B

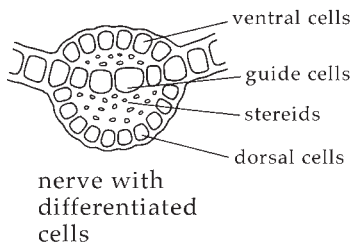
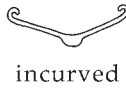
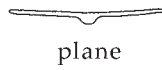
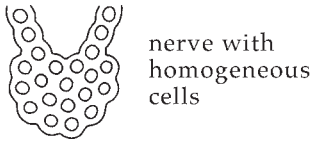
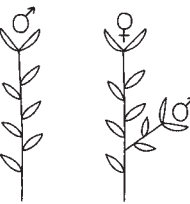
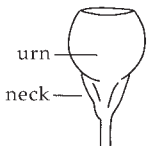
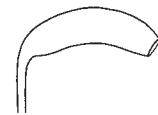
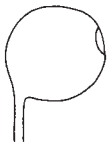
**1. Leaves in section****2. Distribution of gametangia****3. Capsules****4. Capsule lids****5. Calyptras**

FIGURE C



# 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. Annual plants, which complete their cycle between winter and spring, are characteristic of exposed soils in the lowlands.

Specimens should be collected as complete as possible; the ideal would be sporophyte-bearing material but in the Iberian Peninsula many species are never or only rarely found with sporophytes. 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. Annual species develop rapidly and always complete their life cycle; they should be collected with mature sporophytes for determination.

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 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. 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, especially in nerve and stem sections.

**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. Most species have no conservation problems but some may be attacked by insects and for this reason periodic fumigation is recommended.



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IECentanys19072007



ISBN 84-7283-865-X



9 788472 838659