Pohlia section Cacodon (Mielichhoferiaceae, Bryophyta) with axillary bulbils in the Iberian Peninsula

by

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Abstract


A taxonomic and descriptive study is presented of the propaguliferous species—with axillary bulbils—of section Cacodon of the genus Pohlia in the Iberian Peninsula. Among the nine species of this section present in the Iberian Peninsula, seven produce axillary propagula (bulbils). The propagulum morphology, seen to be the most relevant gametophyte identification character, is described. Data are provided on the habitat and distribution of the species in the Iberian Peninsula, where they are considered rare or very rare.

Keywords: Pohlia, Pohlia section Cacodon, Bryophyta, Iberian Peninsula.

Introduction

The genus Pohlia Hedw. (1801: 171), which has undergone substantial systematic and taxonomic changes that were summarized by Shaw (1984), has traditionally been included in Bryaceae (e.g. Brotherrus, 1924). However, phylogenetic studies carried out with molecular markers, using plastid, mitochondrial and nuclear DNA sequences (Cox & al., 2000, 2004), place the genus Pohlia closer to Mniaceae. Its exclusion from Bryaceae has been proposed, along with Epipetirgium Lindb. and Mielichhoferia Nees & Hornsch. (cf. Shaw, 2005).

Shaw (1984) considered an infrageneric systematic and taxonomic division with three subgenera: Pohlia, Nyholmiella Shaw and Mnioibryum (Limpr.) Nyholm, the latter with two sections, Mnioibryum and Cacodon Lindb. ex Broth. In Hill & al. (2006) three sections are considered for the genus: Pohlia, Cacodon and Apalo-
dictyon (Müll. Hal.) Ochyra (= Mnioibryum Nyholm, nom. inv.), and the genus Pohlia is included in the family Mielichhoferiaceae, which closely reflects the criteria proposed by Koponen (1988).

The section Cacodon includes 15 species in Europe (cf. Hill & al., 2006), of which 9 (P. andalusica (Höhn.) Broth., P. annotina (Hedw.) Lindb., P. campotracbela (Renaud & Cardot) Broth., P. drummondii (Müll. Hal.) A.L. Andrews, P. filum (Schimp.) Martensson, P. flexuosa Hook., P. lescuriana (Sull.) Ochi, P. ludwigii (Spreng. ex Schwägr.) Broth. and P. proliger (Kindb.) Lindb. ex Broth.) are found in the Iberian Peninsula. Except for P. lescuriana and P. ludwigii, the species of section Cacodon produce propagula in the form of axillary bulbils with their origin in the stem, which, when developed, permit the species to be identified quite easily. None of the species of the section Cacodon has been found with sporophytes in the Iberian Peninsula.
In this article we provide morphological, choro-
logical and ecological data that broaden the knowl-
edge of these propaguliferous species in a territory
where they are infrequent and probably undercol-
clected.

Material and Methods

All the available material (65 specimens) of the stud-
cled species deposited in the Iberian herbaria have been
studied. In addition, all the lectotypes of the species
that it was possible to locate were studied. The bulbs were
photographed with a SPOT INSIGHT U3.5 digital
camera mounted on an OLYMPUS BH2 microscope.
Measurement of the leaves, cells, etc., were made with a
micrometer attached to the same microscope.

Substantial differences exist between the morphol-
ogy of the propagula type in this group of Pohlia,
which, furthermore, tends to change as the bulbs mature (cf. Andrews, 1935; Nyholm, 1958; Wilczek &
Demaret, 1970; Crum, 1976; Townsend, 1995). Al-
though the nomenclature to define the different types
of axillary bulbs is similar in all the recent studies on
the group (Wilczek & Demaret, 1970; Lewis & Smith,
1977, 1978; Demaret & Wilczek, 1979, 1980; Shaw,
1981a, 1981b; Sotiaux & Arts, 1989), in this paper, for
the sake of simplicity, we have only distinguished the
following two types of bulbil. Bulbil A) ovoid, elliptic,
oblong, obconic, subspherical or cylindrical with lam-
inate leaf primordia (Fig. 1 a-k) and B) subspherical or
obconic to vernicular with different degrees of spi-
ralling and with toothlike leaf primordia, that is with
apical teeth (Fig. 1 l-n; Fig. 2 a-o). Not only are the leaf
primordia differences of primary importance, but also
the form and size are important.

Taxonomy

Pohlia Sect. Cacodon Lindb.ex Broth., Nat. Pflanzen-
Fam. 1(3): 547. 1903

Laud.: 125. 1910, nom. nud.

Type: Pohlia erecta Lindb.

Small to moderately robust plants. Upper leaves
usually similar to lower not forming conical tufts. Me-
dian laminal cells narrowly hexagonal-rhomboidal to
linear or vernicular. Dioicous. Bulbils usually pre-
sent. Capsule horizontal to pendulous, ovoid to pyri-
form; neck short. Exothecial cells short rectangular,
with evenly thickened, sinuose walls; stomata superfi-
cial or rarely slightly sunken. Annuulus differentiated.
Endostome hyaline; segments well developed and
keeled, rarely imperfect or rudimentary.

KEY TO THE IBERIAN SPECIES

1. Bulbils 1(2) in the axis of leaves, usually longer than 380 μm
long ................................................................. 2
2. Bulbils usually numerous in the axis of leaves, usually shorter
than 380 μm long .................................................. 3
3. Bulbils oblong to cylindrical, with laminate leaf primordia
arising from base to apex ...................................... 1. P. drummondii
4. Bulbils ovoid to elliptical or subospherical, with laminate leaf
primordia arising only at the apex ...................... 2. P. filum
5. Bulbils mainly isodiametric, spherical to short oblong, with 1-
4 toothlike primordia of 1-2(3) cells ........................ 4. P. camptotrachela
6. Bulbils mainly long, obconic, oblong, ovoid or vernicular,
sometimes all three types mixed in the same plant, with lam-
inate leaf primordia of 3-6 cells wide at the base or with
toothlike primordia ............................................... 2
4. Bulbils mainly ovoid, sometimes oblong, reddish to brown-
ish, with laminate leaf primordia of 3-6 cells wide at the base
................................................................. 3. P. andalusica
5. Plants with only vernicular bulbils, toothlike primordia more
than 1/10 of bulbil length ........................................... 5
6. Bulbils vernicular, mainly with 2-4(5) multicellular toothlike
primordia .......................................................... 6. P. annotina
7. Bulbils vernicular, with 1(2) unicellular toothlike primordia .................................................................... 7. P. proliger

1. Pohlia drummondii (Müll. Hal.) A.L. Andrews
Moss Fl. N. Amer. 2: 196. 1935
Bryum drummondii Müll. Hal., Bot. Zeitung (Berlin)
20: 328. 1862, basionym. Lectotype: BM!
(Fig. 1 a-d)

Plants 0.5-4.5(5) cm high, generally growing in loose
turfs, sometimes dense, greenish, sometimes yellowish,
slightly shiny when dry. Leaves appressed to more or
less erect when dry, erect-patent when moist, ovate,
rarely ovate-lanceolate, sometimes carinate, not or
hardly decurrent, 0.8-1.5(1.8) × 0.2-0.5(0.7) mm; apex
acute, sometimes slightly obtuse, not twisted; margins
plane, sometimes slightly recurved at the base, very
slightly denticulate towards the apex, entire in lower
half; upper leaves similar to the lower leaves. Costa 56-
60(70) μm wide near leaf base, ending below apex;
cross section rounded. Upper and middle laminal cells
long-rhomboidal to linear, sometimes long oblong,
35-85(90) × 6-10 μm, walls (0.9)1.2-1.5 μm wide; basal
cells mainly rectangular, sometimes long rhomboidal,
86-100 × (8)12-14 μm; alar cells long-rectangular, 30-50
× 8-10(12) μm. Bulbils 1(2) in the axis of upper leaves,
oblong to cylindrical, (350)400-700(1000) μm long, red
when fresh and alive-- to brownish, opaque, with lam-
inate leaf primordia arising from base to apex.
Fig. 1. *Pohlia drummondii* (MUB 18549): a-d, bulbils. *P. filum* (MUB 21458): e-g, bulbils. *P. andalusica* (MUB 21460): h-k, bulbils. *P. camptotrichela* (MACB 14339): l-n, bulbils. Scale: a, b, d-g = 100 μm; c = 70 μm; h-k = 80 μm; l-n = 30 μm.
Fig. 2. *Pohlia annotina* (MA 7549): a-e, bulbils. *P. proligera* (MUB 1584): f-i, bulbils. *P. flexuosa* (MUB 21471): j-l, vermicular bulbils; m, n, sinuous outline bulbils; o, bulbils angular outline with papillae. Scale: a-e = 35 μm; f-i = 35 μm; j = 25 μm; k, l, n, o = 30 μm; j = 20 μm; m = 12 μm.
Habitat. On sandy, acid and very wet soils on stream banks, in high mountains of the northern Iberian Peninsula. Infrequent in the Iberian Peninsula.


(Fig. 1 e-g)

Plants 1.5-5(6) cm high, growing generally in loose turfs, sometimes dense, greenish, sometimes yellowish or orange, slightly shiny when dry. Leaves mainly appressed, sometimes erect when dry, erect to erect-patent when moist, ovate or ovate-lanceolate, usually carinate, decurrent, very pronounced on lower leaves, (1)1.2-1.8(1.9) × 0.2-0.5(0.7) mm; apex acute, very rarely obtuse in young leaves, not twisted; margins plane, sometimes slightly recurved at the base, slightly denticulate towards the apex; entire in lower half; upper leaves similar to rest. Costa (25)30-35 μm wide near leaf base, ending below apex; cross section rounded. Upper and middle laminar cells long rhomboidal to linear-rectangular, sometimes short-vermicular, (40)50-80(90) × 6-8(10) μm; walls 0.8-1.2 μm wide; basal cells mainly oblong, (20)40-50(54) × 8-10(12) μm; alar cells mainly short rectangular, 30-40 × 8-10 μm. Bulbils (1)2-3(4) in the axils of upper leaves, rarely in lower leaves, mainly oblong, sometimes oblong-obovate, (200)400-500(600) μm long, reddish to brownish, opaque to semi-transparent, with laminate leaf primordia of 3-6 cells wide at the base, arising only at the apex.

Habitat. Acid soils, sometimes calcareous, on talus and in bare patches in pastures and meadows, generally shaded, humid sites in high and medium mountains. Relatively frequent in the Iberian Peninsula.

Observations. Obconic bulbils, with leaf primordia arising only in the apex is a characteristic of *Pohlia andalusica* and therefore useful for identification purposes.


(Fig. 1 l-n)

Plants 0.3-0.8(1.2) cm high, growing in loose turfs or gregariously in tufts, greenish-yellow, sometimes reddish at base, slightly or not all shiny when dry. Leaves erect when dry, erect to erect-patent when moist, ovate, rarely ovate-lanceolate, sometimes slightly carinate, hardly decurrent, 0.7-0.8(0.9) × 0.3-0.4(0.5) mm; apex acute, sometimes slightly twisted; margins plane, sometimes slightly recurved at the base and in upper third, denticulate towards the apex, entire in lower half; upper leaves similar to the rest. Costa (25)30-35 μm wide near leaf base, ending below apex; cross section rounded. Upper and middle laminar cells long rhomboidal to linear-rectangular, sometimes short-vermicular, (40)50-80(90) × 6-8(10) μm; walls 0.8-1.2 μm wide; basal cells mainly rectangular, (30)40-50(54) × 8-10(12) μm; alar cells mainly short rectangular, 30-40 × 8-10 μm. Bulbils (12-3-4) in the axils of upper leaves, rarely in lower leaves, mainly oblong, sometimes oblong-obovate, (200)400-500(600) μm long, reddish to brownish, opaque to semi-transparent, with laminate leaf primordia of 3-6 cells wide at the base, arising only at the apex.

Habitat. On sandy, acid and very wet soils on stream banks, in high mountains of the northern Iberian Peninsula. Infrequent in the Iberian Peninsula.

Observations. Obconic bulbils, with leaf primordia arising only in the apex is a characteristic of *Pohlia andalusica* and therefore useful for identification purposes.


(Fig. 1 h-k)
diametric, spherical to slightly oblong, (100)125-150(200) μm long, greenish to yellowish, transparent, with 1-4 toothlike primordia of 1-2(3) cells, occasionally laminate primordia with age.

Habitat. Acid soils, on taluses and on bare ground in pastures and meadows, shaded, wet sites generally near streams and springs. Relatively frequent in the Iberian Peninsula. Near streams and springs. Relatively frequent in the pastures and meadows, shaded, wet sites generally near streams and springs. Relatively frequent in the Iberian Peninsula.

Observations. Pohlia annotina may occasionally produce similar bulbils to those of P. camptotrichela, but are mixed with typical bulbils of the species, and never spherical to oblong, so there need be no confusion.

5. Pohlia flexuosa Hook. f., Icon. Pl. 1, pl. 19, f. 5. 1836


(Fig. 2 j-o)

Plants 1.5-2 cm high, growing in loose turfs, yellowish green to green pale, sometimes orangey at base, not shiny when dry. Leaves erect when dry, erect to erect-patent when moist, ovate-lanceolate, non carinate, strongly decurrent, 0.8-0.9(1.2) × 0.4-0.5 mm; apex acute, not twisted; margins more or less recurved, slightly denticulate towards apex, entire in lower two-thirds; upper leaves broader than rest. Costa 42-50(55) μm wide near leaf base, ending below apex or subpercurrent; cross section rounded. Upper and middle laminal cells long rhomboidal, more or less linear near the margins, 45-75(95) × (6)8-14(20) μm, walls 1.2-1.8 μm wide; basal cells rectangular to long rhomboidal, (35)40-60(65) × (8)14-15 μm, alar cells long rectangular, 60-70 × 8-9 μm. Bulbils usually numerous, normally in axils of middle and lower leaves, ovoid or shortly oblong, some more or less sinuous outline, brownish, transparent to almost opaque, others angular in outline, with small papillose protuberances, 90-100(110) μm long, hyaline, and a third type generally in the axils of upper leaves, vermicular, (150)200-300(350) μm long, brownish, more or less transparent, with 1-2 unicellular toothlike primordia very short, not reaching 1/10 of bulbil length.

Habitat. Acid soils, sometimes calcareous on humid and shaded taluses.

Observations. Probably the most frequent occurring species of those studied here.


(Fig. 2 a-e)

Plants 1.2 cm high, growing in loose turfs, yellowish to slightly orange or reddish at the base, slightly shiny when dry. Leaves erect-patent to spreading when dry, patent to spreading when moist, lanceolate to ovate-lanceolate, non carinate, non or slightly decurrent, (1.2)1.4-1.5 × 0.3-0.4(0.45) mm; apex acute, sometimes twisted; margins plane, sometimes slightly recurved at the base, sinuous-denticulate in upper third, entire in lower half; upper leaves narrower and shorter than rest. Costa 50-60 μm wide near leaf base, ending below the apex or percurrent, cross section rounded to semicircular. Upper and middle laminal cells mainly linear, sometimes vermicular, (60)80-120(130) × 6-8(11) μm, walls 1.5-2 μm wide; basal cells long rhomboidal to rectangular, (30)35-55 × 7.5-8(8.5) μm; alar cells long rectangular to short linear, 50-65 × 7.5-8 μm. Bulbils usually numerous, in axils of middle and upper leaves, vermicular, oblongic, 50-100(250) μm long, almost hyaline to yellowish, transparent, with 2-4(5) multicellular toothlike primordia, sometimes in axils of middle leaves or mixed, bulbils oblong or oblongic, non vermicular, 50-60 μm long, yellowish, transparent, with 2-3(4) generally multicellular toothlike primordia.

Habitat. Acid soils, sometimes calcareous on humid and shaded taluses.

Observations. Probably the most frequent occurring species of those studied here.


(Fig. 2 f-i)
Plants 0.3-1(2.5) cm high, growing in loose turfs, greenish to reddish at the base, shiny when dry. Leaves erect to patent when dry, erect-patent when moist, narrowly lanceolate to slightly ovate-lanceolate, carinate near the base, non decurrent, 0.9-1.2(1.5) × (0.2)0.25-0.3 mm; apex acute, sometimes very slightly twisted; margins plane, sometimes slightly recurved at the base, denticulate near the apex, entire to sinuous-denticulate in lower third; upper leaves slightly longer and broader than rest. Costa (24)28-34 μm wide near base, ending below apex, percurrent or slightly on oldest leaves, cross section plane to convex.

Upper and middle laminal cells long rhomboidal to linear-vermicular, (60)74-90(100) × (4)5-9(10) μm, walls 1-1.25 μm wide; basal cells long rhomboidal to rectangular, (38)40-60 × 8-9(10) μm; alar cells long rectangular to linear, 80-90 × 4-6 μm. Bulbils usually numerous, in axils of upper leaves, vermicular, subcylindrical, 50-100(250) μm long, hyaline, with 1(2) unicellular toothlike primordia.

Habitat. Acid soils, sometimes calcareous on wet and shaded taluses, frequently covered with herbaceous vegetation. *Pohlia proligera* is a much more northern species, and in the Iberian Peninsula only appear at higher elevations compared to *P. annotina*.

Observations. The bulbils of this species are characteristic, although they may resemble those *Pohlia annotina* in the early stages of development. It is therefore necessary to observe a considerable number of bulbils to avoid confusion. Another character to distinguish *P. proligera* from *P. annotina* is the very shiny leaves of *P. proligera*, which permits a distinction even when bulbils are lacking.

Conclusions

To date, a group of seven species of *Pohlia* from the section *Cacodon* can be characterized in the Iberian Peninsula according to differences in size, number, morphology, etc. of their axillary bulbils. Species of this group are very similar to one another in such features as habit, size, leaf sheen, shape, leaf cell size and shape. In most cases species are not easily recognizable in the absence of bulbils. Table 1 summarises the most relevant differentiating characteristics of all the species studied.

Selected specimens studied

*Pohlia drummondii*


*Pohlia filum*

SPAIN. Huesca: entre los ibones y el Pico de la Renclusa, hendiduras de rocas rezumantes cerca de un nevero, 2350 m, Guerra (MUB 21458). Pyréneés, Maladetta, Zetterstedt s.n. (UPS). Pyréneés, Maladetta, Jones s.n. (BM).

Table 1. Diagnostic characters of *Pohlia* section *Cacodon* in the Iberian Peninsula.

<table>
<thead>
<tr>
<th>Species</th>
<th>Leaf shape</th>
<th>Shape &amp; width of median laminal cells</th>
<th>Bulbil shape</th>
<th>Costa width (μm)</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>P. drummondii</em></td>
<td>Ovate, rarely ovate-lanceolate</td>
<td>Long rhomboidal to linear, sometimes long oblong / 6-8 μm</td>
<td>Oblong to cylindrical, with laminar leaf primordia arising from base to apex</td>
<td>56-60(70)</td>
</tr>
<tr>
<td><em>P. filum</em></td>
<td>Ovate to ovate-lanceolate</td>
<td>Long rhomboidal to linear / (7)10-12(14) μm</td>
<td>Ovoid to eliptical or subshperical, with laminar leaf primordia arising only in the apex</td>
<td>(48)50-60(65)</td>
</tr>
<tr>
<td><em>P. andalusica</em></td>
<td>Ovate, rarely ovate-lanceolate</td>
<td>Long rhomboidal to linear-rectangular, sometimes short vermicular / 6-8(10) μm</td>
<td>Obconic, sometimes oblong, with laminar leaf primordia arising only in the apex</td>
<td>(25)30-35</td>
</tr>
<tr>
<td><em>P. camptotrichela</em></td>
<td>Ovate-lanceolate</td>
<td>Long rhomboidal to linear, sometimes short vermicular / 6-7(8) μm</td>
<td>Spherical to short oblong, with 1-4 toothlike leaf primordia of 1-2(3) cells</td>
<td>(28)30-35(40)</td>
</tr>
<tr>
<td><em>P. flexuosa</em></td>
<td>Ovate-lanceolate</td>
<td>Long rhomboidal / (6)8-14(20) μm</td>
<td>Vermicular with 1-2 unicellular toothlike primordia, or ovoid to oblong, more or less sinuous outline or papillae</td>
<td>42-50(55)</td>
</tr>
<tr>
<td><em>P. annotina</em></td>
<td>Lanceolate to ovate-lanceolate</td>
<td>Mainly linear, sometimes vermicular / 6-8(1) μm</td>
<td>Vermicular, rarely obconic with 2-4(5) multicellular toothlike primordia</td>
<td>50-60</td>
</tr>
<tr>
<td><em>P. proligera</em></td>
<td>Narrowly lanceolate to slightly ovate-lanceolate</td>
<td>Long rhomboidal to linear-vermicular / (4)5-9(10) μm</td>
<td>Vermicular to subcylindrical, with 1(2) unicellular toothlike primordia</td>
<td>(24)28-34</td>
</tr>
</tbody>
</table>
**Poblia andalusica**

ANDORRA: Port de Cabús, 2350 m, Casas (MA 20255).

SPAIN. Granada: Sierra Nevada, Rams (MUB 18578). Huesca: Benasque, ibones de la Rencusa, 2280 m, Guerra (MUB 21460). Pyrénées centrales, Port de Venasque, Zetterstedt s.n. (UPS). Lérida: Esterrí de Cardós, 1000 m, Casas (MUB 21466).

**Poblia camptotraceba**


**Poblia flexuosa**

SPAIN. Huesca: Valle de Hecho, Selva de Oza, talud en un camino, Guerra (MUB 21471).

**Poblia annotina**

PORTUGAL. Serra da Estrela, entre Gouveia y Manteigas, 1350 m, talud en el borde de un arroyo, Guerra et al. (MUB 22534).


**Poblia proligera**

SPAIN. Albacete: Campamento de San Juan, Sierra del Calar del Mundo, 1200, talud ácido protegido por herbáceas, Jiménez & Ros (MUB 1584). Almería: Sierra de los Filabres, Bacares, Barranco del Pino, García-Zamora & Ros (MUB 8645). Almería, Sierra de Filabres, Bacares, Barranco de Julián, 1600-1700 m, tierra acumulada en un muro muy protegido, García-Zamora & Ros (MUB 8557). Guadalajara: hayedos de Cantalojas, 1500 m, Riestra (MACB s.n.).

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**References**


