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Palustriella pluristratosa spec. nov. (Amblystegiaceae, Bryopsida), a new aquatic moss species with pluristratose lamina from Switzerland

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Abstract

Stech M. and Frahm J.-P. 2001. *Palustriella pluristratosa* spec. nov. (Amblystegiaceae, Bryopsida), a new aquatic moss species with pluristratose lamina from Switzerland. Bot. Helv. 111: 139–150.

Palustriella pluristratosa spec. nov. is described from Switzerland as the fourth European species of aquatic pleurocarpous mosses with variously pluristratose laminae. According to a maximum parsimony analysis of a combined data set of cpDNA *trnL* intron and partial nrDNA ITS2 sequences, this species belongs to the Amblystegiaceae and is closely related to *Palustriella commutata*. The *trnL* intron and ITS2 sequences of both species are completely identical. Morphologically, both species are also similar, but *P. pluristratosa* is distinguished by the 2–3-stratose lamina, a stronger ill-defined costa, slightly narrower laminal cells and the lack of paraphyllia.

Key words: *Palustriella pluristratosa* spec. nov.; *trnL*_{UAA} intron; ITS2; Amblystegiaceae.

Introduction

During the annual fieldtrip of the Central European Bryological and Lichenological Working Group (BLAM) in the canton Valais (Switzerland), the second author found an unknown aquatic moss in a stream in the subalpine belt at 1800 m altitude on gneiss rocks, which was conspicuously rigid. It much resembled submerse forms of

Palustriella commutata (Hedw.) Ochyra (*Cratoneuron commutatum* [Hedw.] Roth) growing in fast flowing streams, which had been described as var. *falcata* (Brid.) Ochyra or on species level as *Palustriella falcata* (Brid.) Hedenäs. However, a microscopic examination revealed that the leaves had a pluristratose lamina and a very strong, ill defined costa.

Since the mid 80's, several aquatic pleurocarpous mosses with variously pluristratose laminae and strong costae have been described in mostly monospecific genera, both from Europe (*Ochyraea tatrensis* Váňa from the Tatra Mountains, Slovakia, Váňa 1986; *Gradsteinia torrenticola* from Tenerife, Ochyra et al. 1998; *Platyhypnidium mutatum* Ochyra and Vanderpoorten from the Black Forest, Germany, Ochyra and Vanderpoorten 1999), and from overseas (*Hypnobartlettia fontana* Ochyra from New Zealand, Ochyra 1985a; *Koponenia holoneuron* [Herz.] Ochyra from Bolivia, Ochyra 1985b; *Gradsteinia andicola* Ochyra from Colombia, Ochyra 1990; Table 1). In their first descriptions, these species were called "remarkable" (*Ochyraea*, *Gradsteinia*), "unique" (*Hypnobartlettia*) or "mysterious" (*Platyhypnidium mutatum*), to express their special combination of characters in contrast to other aquatic mosses, which sometimes also have a strong costa, e.g., *Hygroamblystegium noterophilum* (Sull.) Warnst. (see Mönkemeyer 1927, Fig. 162c), but unistratose laminae.

For the genera with variously pluristratose laminae mentioned above, Ochyra (1985a) established the families Donrichardsiaceae (species with partially pluristratose laminae or pluristratose leaf borders, and foliose pseudoparaphyllia), and Hypnobartlettiaceae (species with completely bistratose laminae, filamentous paraphyllia and foliose pseudoparaphyllia). However, the taxonomic status of both families as well as of the monospecific genera remained doubtful due to the absence of sporophytes and the curious distribution patterns of the species, which are all very rare and mostly only known from their respective type localities (Stech and Frahm 2000).

Recent molecular and morphological analyses (Table 2) clearly showed that both families are artificial and have to be rejected, as the species belong to either Amblystegiaceae or Brachytheciaceae. In the case of *Platyhypnidium mutatum*, molecular data (in combination with the finding of sporophytes) were also able to clarify the taxonomic status of the species and to determine its nearest relative. While it was originally intended to describe this moss as a new species of *Donrichardsia*, both DNA sequences and sporophyte morphology supported a close relationship with *Platyhypnidium riparioides* in the Brachytheciaceae (Stech and Frahm 1999), which grows abundantly at the type locality of *P. mutatum*. It was supposed that *P. mutatum* was derived from *P. riparioides* by mutations of genes responsible for the formation of its different gametophytic characters, a broader costa and an irregularly bi- or pluristratose lamina. This study initiated Ochyra and Bednarek-Ochyra (1999) to transfer *Gradsteinia torrenticola* also into *Platyhypnidium*. In contrast, the genera *Hypnobartlettia*, *Gradsteinia* (for *G. andicola*) and *Ochyraea* have to be maintained, because 1) all of these species exhibit different combinations of gametophytic characters and 2) their nearest relatives could not be identified at the molecular level.

In this study, the new moss from Switzerland is investigated based on gametophytic characters and molecular data (cpDNA *trnL_{UAA}* intron and nrDNA ITS2 sequences) and compared with the other species of the former Donrichardsiaceae and Hypnobartlettiaceae, with the aim to clarify its familiar and generic placement, and to test the proposal of R. Ochyra, who kindly studied the material, to describe it as a new species of *Platyhypnidium*.

Table 1. Geographic origins, voucher numbers, herbarium locations and GenBank accession numbers of the investigated species. Vouchers are deposited in BONN unless otherwise indicated, with duplicates of the New Zealand species in CHR. Asterisks indicate vouchers of which sequences were either taken from GenBank (*Buck et al. 2000; **Chiang & Schaal 1999) or from ***Vanderpoorten (1999).

Taxon	Geographic origin	Voucher	Accession numbers (trnL-UAA intron/ITS2)
<i>Amblystegium serpens</i> (Hedw.) Bruch & Schimp.	Germany	Stech B980409.1	AF098526/AF152390
<i>Calliergonella cuspidata</i> (Hedw.) Loeske	New Zealand;	Frahm 11.3.1998 (for cpDNA);	AF260913/AF168145
	?	Schofield 100768 (DUKE)***	AF161141/AF168150
<i>Campylium chrysophyllum</i> (Brid.) J. Lange	?	Buck 32532 (NY)*;	
	?	Anderson 26799 (DUKE)***	
<i>Cirriphyllum crassinervium</i> (Tayl.) Loeske & Fleisch.	Germany	Frahm 29.7.1999	AY026904/AY026901
<i>Cratoneuropsis relaxa</i> (Hook. f. & Wils.) Fleisch.	New Zealand	Frahm 11.3.1998	AF098525/AF152391
<i>Cratoneuron filicinum</i> (Hedw.) Spruce	Germany	Stech B900615.1	AF129586/AF231009
<i>Eurhynchium striatum</i> (Hedw.) Schimp.	Germany	Stech B971113.3	AF152381/AF231000
<i>Gradsteinia andicola</i> Ochyra	Colombia	Cleef 8236 (KRAM)	AY012572/AF231007
<i>Hookeria lucens</i> (Hedw.) Sm.	Germany	Stech B880404.8	AF152380/AF230995
<i>Hygroamblystegium tenax</i> (Hedw.) Jenn.	?	Buck 33464 (NY)* (for cpDNA)	AF161140/AF168153
		Murrell & Hall 5827 (DUKE)***	
<i>Hygrohypnum ochraceum</i> (Wils.) Loeske	France	Stech B940717.4	AY012571/AY012570
<i>Hygrohypnum smithii</i> (Sw.) Broth.	Slovakia	Frahm 20.8.1999	AF260914/AF231006
<i>Hylocomium splendens</i> (Hedw.) Bruch & Schimp.	Germany;	1-4957 (herb. Frey, for cpDNA)	AF152385/AJ010434
	USA	Chiang s.n. (MO)**	
<i>Hypnobartlettia fontana</i> Ochyra	New Zealand	Frahm 11.3.1998	AF098524/AF152389
<i>Lopidium concinnum</i> (Hook.) Wils.	New Zealand	92-72 (herb. Frey)	AF033233/AY029369
<i>Ochyraea tatrensis</i> Vána	Slovakia	Vána 30.8.1987	AF260915/AF260916
<i>Palustriella commutata</i> (Hedw.) Ochyra	Slovakia	Frahm 20.8.1999	AF260912/AF231008
<i>Plagiothecium undulatum</i> (Hedw.) Bruch & Schimp.	Germany	Stech B881003.2	AF264045/AF231005
<i>Platyhypnidium mutatum</i> Ochyra & Vanderpoorten	Germany	Vanderpoorten s.n.	AF260909/AF230997
<i>Platyhypnidium riparioides</i> (Hedw.) Dix.	Germany	Frahm 1.9.1997	AF260908/AF230996
<i>Palustriella pluristratosa</i> Stech & J.-P. Frahm	Switzerland	Frahm 17.8.2000	AY026902/AY026899
<i>Rhynchostegiella jacquinii</i> (Garov.) Limpr.	Germany	Frahm 8.2.1998	AF260910/AF231002
<i>Rhynchostegiella pumila</i> (Wils.) E. F. Warb.	Germany	Frahm 7.2.1998	AF260911/AF231001
<i>Rhynchostegium murale</i> (Hedw.) Bruch & Schimp.	Germany	Frahm 15.10.1997	AF129585/AF230998
<i>Rhynchostegium rotundifolium</i> Bruch & Schimp.	Germany	Frahm 7.2.1998	AF260907/AF230999
<i>Sanionia uncinata</i> (Hedw.) Loeske	Germany;	1-4942 (herb. Frey, for cpDNA)	AF071848/AF168148
	Canada	Schofield 95255 (DUKE)***	
<i>Scorpiurium deflexifolium</i> (Solms) Fleisch. & Loeske	Spain	Guerra s.n. (MUB 9985)	AY026903/AY026900

Table 2. Familial placements of aquatic pleurocarpous mosses with variously pluristratose laminae, which have been recently reinvestigated.

Species	Previous familial placements	Familial placement based on recent molecular and/or morphological data
<i>Donrichardsia macroneuron</i> (Grout) H. Crum & L.E. Anderson	Amblystegiaceae, later Donrichardsiaceae	Brachytheciaceae (own unpublished data)
<i>Richardsiopsis lacustris</i> (Herz. & Rich.) Ochyra	Amblystegiaceae, later Donrichardsiaceae	Amblystegiaceae, included in <i>Drepanocladus perplicatus</i> (Dus.) Roth (Hedenäs 1997)
<i>Gradsteinia andicola</i> Ochyra	Donrichardsiaceae	Amblystegiaceae (Stech and Frahm 2000)
<i>Palustriella pluristratosa</i> Stech & J.-P. Frahm	–	Amblystegiaceae (this paper)
<i>Platyhypnidium mutatum</i> Ochyra & Vanderpoorten	–	Brachytheciaceae (Ochyra and Vanderpoorten 1999; Stech and Frahm 1999)
<i>Gradsteinia torrenticola</i> Ochyra, C. Schmidt & Bültmann	Donrichardsiaceae	Brachytheciaceae, as <i>Platyhypnidium torrenticola</i> (Ochyra and Bednarek-Ochyra 1999)
<i>Hypnobartlettia fontana</i> Ochyra	Hypnobartlettiaceae	Amblystegiaceae (Stech et al. 1999)
<i>Ochyraea tatrensis</i> Váňa	Hypnobartlettiaceae	Amblystegiaceae (Stech and Frahm 2001)

Material and methods

Plant material

Geographic origins, voucher numbers, herbarium locations and GenBank accession numbers of all species are listed in Table 1. Sequences of *Campyllum chrysophyllum*, *Hygroamblystegium tenax* (*trnL* intron, Buck et al. 2000) and *Hylocomium splendens* (ITS2, Chiang and Schaal 1999) were taken from GenBank database, ITS2 sequences of *Calliergonella cuspidata*, *Campyllum chrysophyllum*, *Hygroamblystegium tenax* and *Sanionia uncinata* from Vanderpoorten (1999). Plant material was prepared for DNA extraction through cleaning with water and ultrasonic treatment.

DNA extraction, PCR and sequencing reactions

DNA preparations were carried out following the method of Doyle and Doyle (1990) with the exception of using only 70% (v/v) ethanol to wash the pellets after precipitation with cold isopropanol. PCR reactions (50 µl) were performed in a Biometra thermocycler and contained 1.7 U *Taq* DNA polymerase (Qiagen), 1x buffer (Qiagen), 1.5 mM MgCl₂, 1 mM dNTP-mix of each 0.25 mM dNTPs (Roth), and 10 pmol of primers C/D for cpDNA (modified after Taberlet et al. 1991) or 18F/25R for internal transcribed spacers (after Baldwin 1992), for sequences see Stech and Frahm (1999). PCR protocols were: 5 min 94 °C, 35 cycles (1 min 94 °C, 1 min 55 °C, 1 min 72 °C), 2 min

72 °C for cpDNA and 5 min 94 °C, 35 cycles (45 s 94 °C, 45 s 48 °C, 1 min 72 °C), 4 min 72 °C for nrDNA.

PCR products were purified using the QIAquick PCR purification kit (Qiagen). Cycle sequencing reactions (2 min 94 °C, 35 cycles (30 s 94 °C, 30 s 60 °C, 30 s 72 °C), 1 min 72 °C) were carried out in a Perkin Elmer thermocycler using the SequiTherm Excel II DNA sequencing kit (Epicentre) and primers C/D and 5.8F/25R (ITS2), respectively (each 5'biotin-modified, Roth). Sequencing reactions were separated in the GATC-1500-system, transferred to Nylon membranes (Qiagen, Pall) and visualized applying a standard protocol with Streptavidin-Alkaline Phosphatase (Promega) and BCIP/NBT (Roth) treatment. Sequences were determined manually from the membranes. To verify the results, sequencing reactions were performed on two independent PCR products from each specimen.

Alignment and tree construction

An alignment of the sequences was created manually in the Alignment Editor Align32 (Hepperle 1997). Phylogenetic trees were evaluated according to the maximum parsimony principle with PAUP 4.0b4a (Swofford 2000), using two species of the Hookeriales (*Hookeria lucens*, *Lopidium concinnum*) as outgroups. A heuristic search was performed with the following options: all characters unweighted and unordered, multistate characters interpreted as uncertainties, gaps coded as missing data, performing TBR branch swapping, collapse zero length branches, MulTrees option in effect, random addition sequence with 1000 replicates. Two indels in the *trnL* intron and 7 indels in the ITS2 were coded as additional parsimony informative characters. A heuristic bootstrap search was performed with 1000 replicates, 100 random addition replicates per bootstrap replicate and the same options in effect.

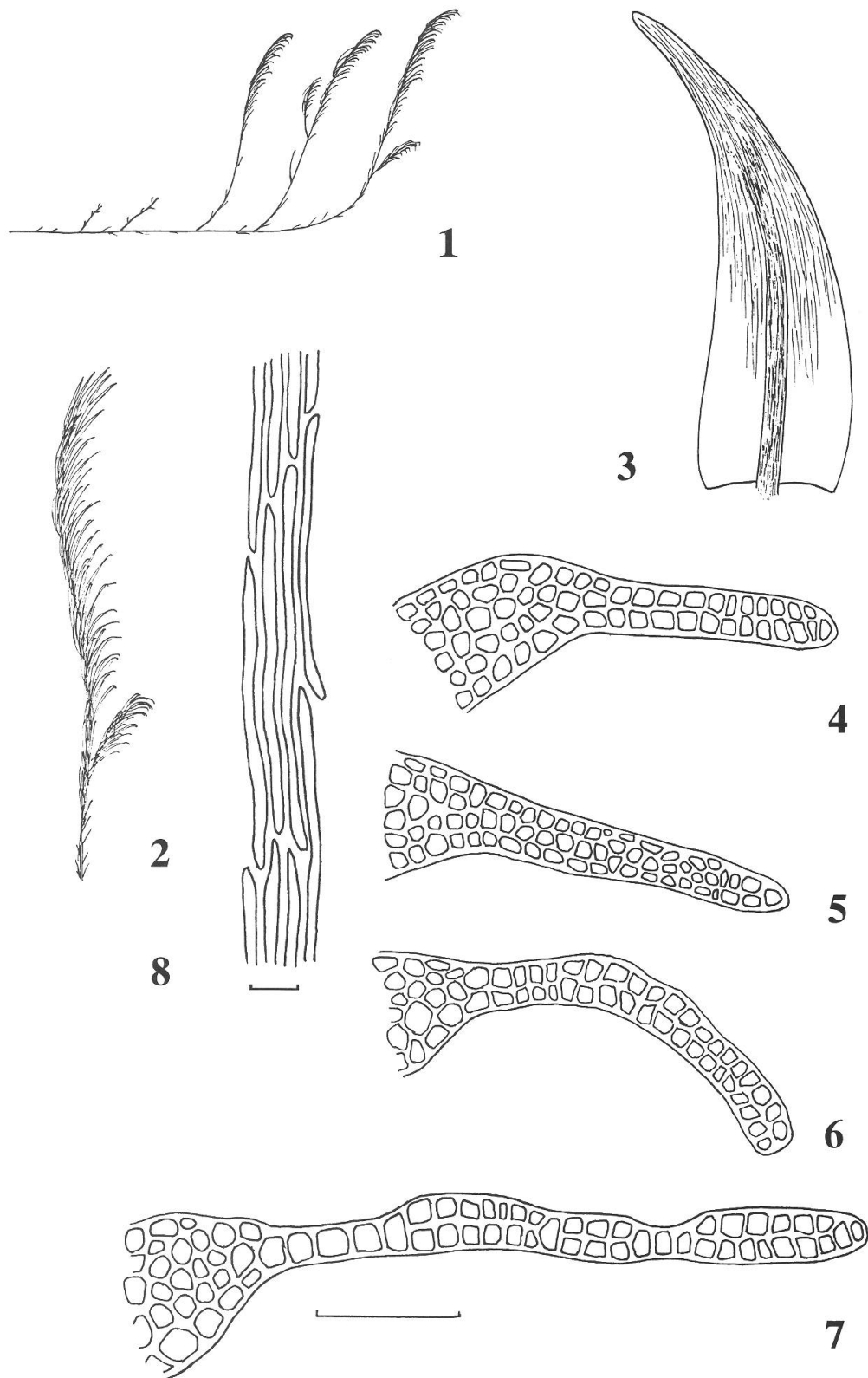
Results

Morphological data

Habit, leaf form, laminal cells and cross sections of the lamina of the new moss from Switzerland are illustrated in Figs. 1–8. Its combination of gametophytic characters is different from those of all other European aquatic species with variously pluristratose laminae (*Ochyraea tatrensis*, *Platyhypnidium mutatum* and *P. torrenticola*), as summarized in Table 3. The moss shares most gametophytic characters with *Palustriella commutata* (and in particular with var. *falcata*), such as the sparsely pinnately to irregularly branched plants, a strong costa, shape of the laminal cells, prorate ends of the basal laminal cells, serrate basal leaf margins, and presence of foliose pseudoparaphyllia, and axillary hairs. However, it differs from *P. commutata* (s.l.) in the 2–3-stratose upper lamina, the lack of paraphyllia, a stronger, ill-defined costa and in slightly narrower laminal cells (4–6 µm in contrast to 5–8 µm in *P. commutata*).

Molecular data

Sequence lengths of the *trnL* intron are quite similar in the ingroup taxa (Hypnales) and range from 264 bp (*Rhynchostegiella jacquinii*) to 280 bp (*Campylium chrysophyllum*), whereas the sequences of *Hookeria lucens* and *Lopidium concinnum* comprise 308 bp and 304 bp, respectively, due to indels in the middle, the most variable part of the intron. The sequences of the moss from Switzerland and of *Palustriella commutata* are both 276 bp long and are completely identical, whereas 6 substitutions and one



Figs. 1–8. *Palustriella pluristratosa*. 1. Plant, size 3 cm. 2. Branch, length 5 mm. 3. Leaf, size 1.8 mm. 4.–7. Transverse sections of parts of leaves in the upper half of the lamina. 8. Upper laminal cells. Scale 10 μ m.

Table 3. Comparison of the new moss from Valais (Switzerland) with the other aquatic pleurocarpous mosses with variously pluristratose laminae described from Europe.

	<i>Palustriella pluristratosa</i>	<i>Ochyraea tatrensis</i>	<i>Platyhypnidium mutatum</i>	<i>Platyhypnidium torrenticola</i>
Costa	strong, covering 1/5 of leaf width, ill defined in the upper part	ill defined, covering most of the leaf width	strong, covering 1/5 of leaf width, sometimes forked	narrow, covering 1/10 of leaf width, sometimes forked
Leaves	lanceolate, curved	oblong ovate, with rounded apex	lanceolate, acute	lanceolate, acute
Lamina	unistratose in the basal part, unistratose with bistratose streaks in the middle, 2–3-stratose in the upper part	almost lacking, (1-)2-3-stratose	uni- to variously 2–3- stratose with 3–5-stratose streaks	irregularly uni- to bistratose, with frequent 3–4-stratose streaks
Pseudo-paraphyllia	few, triangular	foliose, broad triangular	absent	absent
Paraphyllia	absent	few, filamentous	absent	absent
Axillary hairs	rare	scattered	scattered	abundant

indel of 5 bp separate these two species from *Cratoneuron filicinum*, which is next closely related according to the molecular tree (Fig. 9).

The ITS2 could not be determined completely at the 3' end in several species. Approximately, sequence lengths vary between 255 bp (*Rhynchostegiella pumila*) and 288 bp (*Campylium chrysophyllum*). In the identified part of the ITS2, the sequences of the moss from Switzerland and of *Palustriella commutata* are also completely identical.

The combined alignment of the *trnL* intron and partial ITS2 sequences (excluding the 3' end of the ITS2) comprises 640 characters (631 positions and 9 indels coded as informative). 56 positions of the ITS2 were omitted from the phylogenetic analyses due to alignment difficulties. Of the remaining 584 characters (575 positions and 9 indels) used for tree construction, 150 are variable, and 96 of the variable characters are parsimony-informative.

A maximum parsimony analysis (heuristic search) yielded 30 most parsimonious trees (lengths 292 steps, CI = 0.661, RI = 0.757). The strict consensus tree is shown in Fig. 9, with bootstrap values >50% given above the branches. In this tree, the Brachytheciaceae appear as monophyletic with 99% bootstrap support. In contrast, the Amblystegiaceae are divided into two independent clusters, of which the relationships are not completely resolved. The first cluster is well supported by 85% and comprises the moss from Switzerland as well as *Amblystegium*, *Campylium*, *Cratoneuron*, *Cratoneuropsis*, *Gradsteinia*, *Hygroamblystegium*, *Hypnobartlettia* and *Palustriella*, whereas the second (without bootstrap support) comprises *Calliergonella*, *Hygrohypnum*, *Ochyraea* and *Sanionia*.

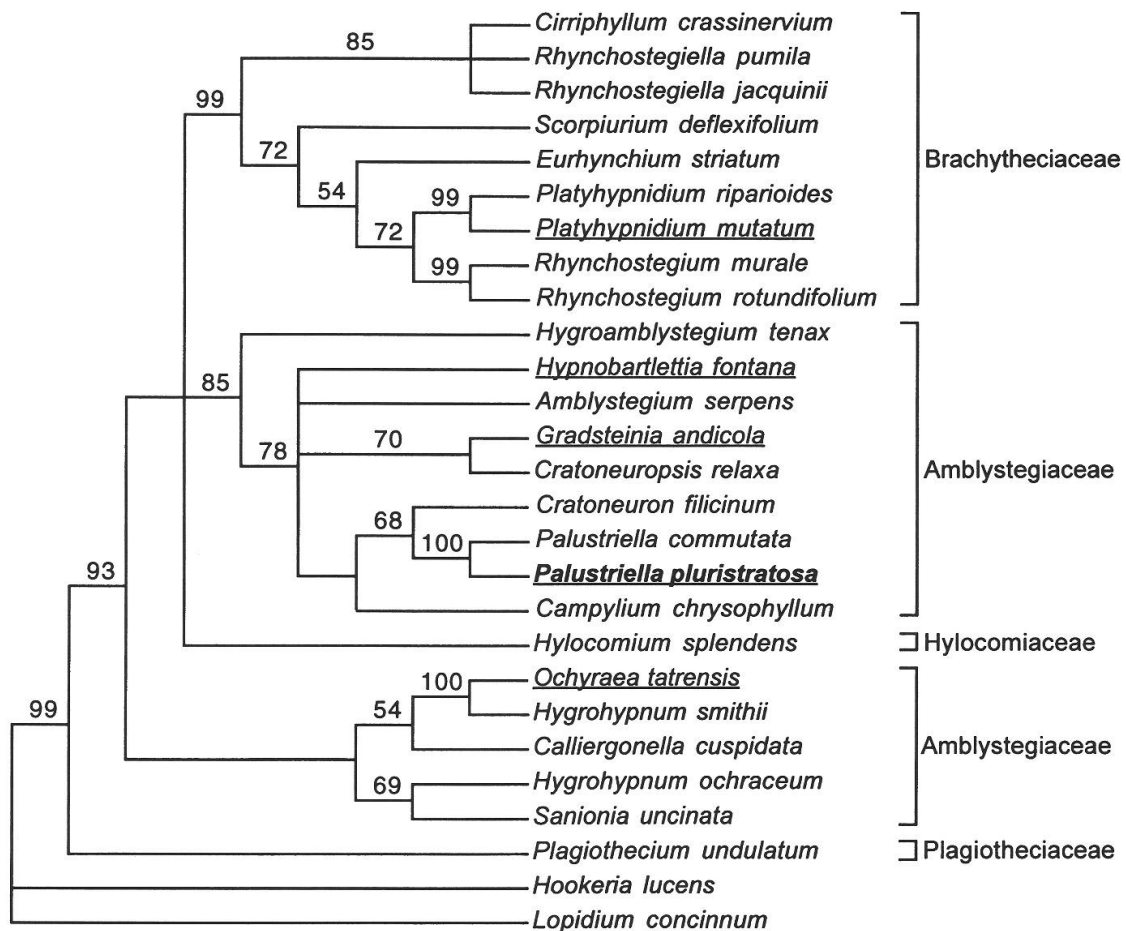


Fig. 9. Maximum parsimony cladogram of 25 species of the Hypnales and *Hookeria lucens*/*Lopidium concinnum* (Hookeriales) as outgroups based on cpDNA *trnL_{UAA}* intron and partial nrDNA ITS2 sequences. Strict consensus tree from 30 most parsimonious trees (lengths 292 steps, CI = 0.661, RI = 0.757) evaluated by a heuristic search with PAUP 4.0b4a. Numbers above branches indicate bootstrap values from 1000 bootstrap replicates with 100 random addition replicates per bootstrap replicate. Species with variously pluristratose laminae are underlined.

Taxonomic treatment

According to the molecular analysis (Fig. 9), the moss from Switzerland clearly belongs to the Amblystegiaceae and might be regarded as a pluristratose form of *Palustriella commutata*, but cannot be described as a species of *Platyhypnidium*, as suggested by Ochyra (pers. comm.). In contrast, its inclusion into *P. commutata* is contradicted by the main gametophytic differences, the 2–3-stratose lamina and especially the lack of paraphyllia. Therefore, at present the best solution is to describe the moss as a new species of *Palustriella*.

Palustriella pluristratosa spec. nov. Amblystegiacearum

Plantae *Palustriella commutata* similes sed folia in parte superiore laminis bi- vel tristratosis, marginibus nec non serratis, cellulis laeves nec non proratis. Costae magis incrassatae, 1/5 folii latitudinem occupantes. Paraphyllia absentia.

Type: Switzerland, Valais, Finhaut SW Martigny, stream above the village in the sub-alpine belt, 1800 m alt., 46° 05' N, 6° 58' E, leg. J.-P. Frahm 17.8.2000 s.n. (holotype BONN).

Plants 3–4 cm, rarely up to 5 cm long, blackish green, rigid, procumbent with ascending branches, defoliate at base (Figs. 1, 2). Leaves 1.8–2.2 mm long, curved and homomallous, from triangular base lanceolate, ending in an acute apex (Fig. 3). Alar cells large, inflated, hyaline but easily detached and then not visible. Laminal cells narrow, elongate, slightly sinuose, firm-walled, $30\text{--}70 \times 4\text{--}6 \mu\text{m}$ (Fig. 8, measured as lumen + one cell wall), unistratose and prorate (with papillose upper ends) in the lower third, 2–3-stratose and smooth in the upper part (Figs. 4–7), opaque. Costa strong, filling 1/5 of leaf base, ill defined in the upper (pluristratose) part of the leaf, with bistratose streaks reaching down into the basal part. Margins finely serrate along the unistratose part of the lamina, entire in the upper part. Paraphyllia lacking. Pseudoparaphyllia few, triangular. Axillary hairs rare, with one basal cell and two upper cells. Sporophyte not known.

Discussion

Comparison of *trnL* intron and ITS2 sequences as molecular markers clearly allows to determine the systematic placement of all pleurocarpous species with variously pluristratose laminae investigated so far (Stech et al. 1999; Stech and Frahm 1999; 2000; 2001; this paper). Three of them (*Gradsteinia andicola*, *Hypnobartlettia fontana*, *Palustriella pluristratosa*) belong to the Amblystegiaceae “sensu stricto”, which form a well-supported clade in the molecular tree (Fig. 9), whereas *Platyhypnidium mutatum* belongs to the Brachytheciaceae. *Ochyraea tatrensis* is related to genera which are traditionally also placed in the Amblystegiaceae (*Calliergonella*, *Hygrohypnum*, *Sanionia*), but must be excluded from this family according to molecular analyses (Vanderpoorten, pers. comm.).

As far as the taxonomic status of these species is concerned, the most definite statement is possible for *Platyhypnidium mutatum* based on both molecular and morphological (gametophytic and sporophytic) data, i.e., a close relationship to *P. riparioides*, from which *P. mutatum* is probably derived (Stech and Frahm 1999). *Gradsteinia* and *Hypnobartlettia* must still be recognized on genus level in monospecific genera, because their closest relatives have not been determined so far by molecular analyses.

For *Ochyraea* and *Palustriella pluristratosa*, the molecular data alone support a close relationship to other species, *Hygrohypnum smithii* from Slovakia (this species seems to be not monophyletic according to molecular data, Stech and Frahm 2001) or *Palustriella commutata*, respectively, of which *Ochyraea* and *P. pluristratosa* might be derived similar to *Platyhypnidium mutatum*/*P. riparioides*. However, these molecular relationships are contradicted by the presence/absence of paraphyllia (present in *Ochyraea* but absent in *Hygrohypnum*, present in *Palustriella commutata* but absent in *P. pluristratosa*). Paraphyllia are traditionally regarded as very important for the classification of pleurocarpous mosses, although it could equally well be argued that the combination of identical base sequences of *Palustriella commutata* and *P. pluristratosa*, their close relationship in the molecular tree, their morphological similarity and their anatomical identity of the basal laminal cells with prorate cells and serrate margins might weight more than the presence/absence of paraphyllia. If paraphyllia turn out to be not valuable for assessing systematic relationships after further investigations,

Palustriella pluristratosa could be regarded as another case of a mutation of an aquatic moss, here of *P. commutata*. A more definite solution of this problem could be reached if sporophytes of *Palustriella pluristratosa* are found, as in the case of *Platyhypnidium mutatum*, and if additional molecular studies are performed.

Another problem is that nothing is known about the mechanisms which produce single populations of aquatic mosses with variously pluristratose laminae. Probably more than one mechanism exists causing this characteristic morphological difference of the species described in the former Donrichardiaceae and Hypnobartlettaceae, because they show very different aberrations: 1) costa filling almost the whole leaf (*Koponenia holoneuron*, *Ochyraea tatrensis*), 2) costa strong, lamina at least in the upper part completely bistratose (*Hypnobartlettia fontana*, *Palustriella pluristratosa*), 3) costa strong and sometimes forked, lamina 1–2-stratose with 3–4-stratose streaks (*Platyhypnidium mutatum*, *P. torrenticola*), 4) costa indistinct and hardly distinguishable from the pluristratose streaks of the lamina (*Gradsteinia andicola*).

In addition, several mainly aquatic acrocarpous/cladocarpous moss species with pluristratose laminae have been recently described:

- *Racomitrium lusitanicum* Ochyra and Sérgio from Portugal (Ochyra and Sérgio 1992), which resembles *R. heterostichum* but has a 2–4-stratose lamina,
- *Racomitrium lamprocarpum* (C. Müll.) Jaeg., an austral moss with a disjunct occurrence in Portugal (Ochyra et al. 1988),
- *Racomitrium hespericum* Sérgio, Muñoz and Ochyra, a newly described moss from Portugal (Sérgio, Muñoz and Ochyra 1995) which morphologically and ecologically resembles *R. aciculare*, and grows in mixed stands with the latter, but is distinguished by a pluristratose lamina,
- *Cinclidotus bistratosus* from Turkey (Kürschner and Lübenau-Nestle 2000), which differs from all other species of the genus by the strongly papillose laminal cells,
- *Dicranum crassifolium* Sérgio, Ochyra and Seneca (1995) described from the Iberian Peninsula and the Toscana, which resembles *D. scoparium* morphologically and ecologically, but has completely or partly bistratose laminae.

All these species produce sporophytes and are, with the exception of *Cinclidotus bistratosus*, known from a comparably small but wider range than the pleurocarpous species. This does not exclude the possibility that these species are also mutants, but shows that they have successfully established.

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Zusammenfassung

Palustriella pluristratosa spec. nov. wird aus dem Wallis (Schweiz) neu beschrieben. Es handelt sich um die dritte in Europa an aquatischen Standorten gefundene pleurokarpe Laubmoosart mit mehrschichtiger Lamina. Eine Maximum-Parsimony-Berechnung eines kombinierten Datensatzes aus Sequenzen des *trnL*-Introns der

cpDNA und des ITS2 der nrDNA zeigt, daß diese Art zu den Amblystegiaceae gehört und nah mit *Palustriella commutata* verwandt ist, da die Sequenzen beider Arten identisch sind. Auch morphologisch ähneln sich beide Arten, *P. pluristratosa* unterscheidet sich jedoch durch die 2-3-schichtige Lamina, eine breitere undeutlich begrenzte Rippe, etwas schmalere Laminazellen und das Fehlen von Paraphyllien.

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