ON THE TAXONOMY OF MYURELLA–PLATYDICTYA COMPLEX
(PLAGIOTHECIACEAE, BRYOPHYTA)

К ТАКСОНОМИИ КОМПЛЕКСА MYURELLA–PLATYDICTYA
(PLAGIOTHECIACEAE, BRYOPHYTA)

MICHAEL S. IGNATOV & OXANA I. KUZNETSOVA

Abstract

Recently collected specimens of poorly known Siberian taxa of Plagiotheciaceae were studied for DNA sequence data, nuclear ITS1-2 and chloroplastic trnL-F, and morphology. This study has revealed that Bardunovia baicalensis and Myurella acuminata belong to one species which is better to classify in the genus Platydictya, as P. acuminata (Lindb. & Arnell) Ignatov, comb. nov. The Yakutian plants of Platydictya jungermannioides are also discussed and illustrated.

KEYWORDS: mosses, taxonomy, Plagiotheciaceae, Myurella, Platydictya, Siberia, nrITS, trnL-F

INTRODUCTION

Recent literature provides two different circumscriptions of the family Plagiotheciaceae. One of them confines the family volume to the genus Plagiothecium only (Buck & Goffinet, 2000; Goffinet et al., 2009), while Myurella is placed in Pterigynandraceae and Platydictya in Hypnaceae. Other authors include in Plagiotheciaceae also a number of genera characterized by axillary rhizoids, including Platydictya and Myurella (cf. Hedenäs, 1987). Molecular phylogenetic analysis of Pedersen & Hedenäs (2002) demonstrated the close relationship of two latter genera to Plagiothecium and principally the same result has been found in some other analyses, e.g., by Ignatov et al. (2007).

However, some classification problems at the species level remain, and the present paper deals with a group of taxa referred to Myurella, Platydictya, and Bardunovia.

Platydictya was described in the middle of XIX century; however the name was out of use for a long time because Platydictya sprucei (Bruch) Berk., the type of the genus, was treated as a member of Amblystegium or Amblystegiella. The genus Platydictya was resurrected in 1964 when it was turn out that Amblystegiella is an illegitimate name, and all its widespread American species were transferred to Platydictya (Crum, 1964).

Hedenäs (1987) showed that P. jungermannioides (Brid.) H.A. Crum (syn. P. sprucei), is distinct from other widespread Holarctic species,
P. subtilis (Hedw.) H.A. Crum and P. confervoides (Brid.) H.A. Crum, and two latter species were transferred to Serpoleskea (Söderström et al., 1992) or returned to Amblystegium (e.g., Hill et al., 2006).

This approach left in Platystictya one widespread species, P. jangermannioides, and a number of poorly known species with a limited distribution and apparently rare, e.g., Platystictya minutissima (Sull. & Lesq.) H.A. Crum in U.S.A. (Crum & Anderson, 1981), P. fauriei (Cardot) Z. Iwats. & Nog. in Japan (Noguchi, 1992), etc. Seems these species need a placement in other genera, but a revision and likely a molecular analysis will be necessary to solve this problem.

The genus Myurella was established in ‘Bryologia Europaea’ (Bruch et al., 1853) for one species, Myurella julacea (Schwägr.) Bruch et al. It was almost invariably used for this widespread species, and two additional widespread holarctic species, M. tenerima (Brid.) Lindb. and M. sibirica (Müll. Hal.) Reimers were added to it in the end of XIX century. Lindberg & Arnell (1890) described also the fourth species, M. acuminata Lindb. & Arnell, that remained little known until recent progress of study of the flora of Asiatic Russia. It was discussed by Ignatov & Ochyra (1995) and then found by Krivoshapkin and published with expanded description by Afonina & Krivoshapkin (1998). Among others, they noted a great similarity between M. acuminata and Bardunovia baicalensis Ignatov & Ochyra.

The analysis of Pedersen & Hedenäs (2002) found M. acuminata in a basal position in clade of Platystictya, not with other Myurella species, although a support for this position was low, so no taxonomic decisions were made.

Bardunovia baicalensis was described by one poor specimen from Baikal region of South Siberia. In the original description, it was compared with Myurella acuminata, as a morphologically closest species. The analysis of Pedersen & Hedenäs (2002) found this taxon in a highly supported clade with Platystictya jangermannioides, thus the genus was synonymized with Platystictya and the single species of Bardunovia was transferred to Platystictya, as P. baicalensis (Hedenäs & Pedersen, 2002). Note, however, that they used for their analysis the specimen of Bardunovia from Yakutia, far from the type locality of B. baicalensis.

Recent years have yielded in a number of new collections of Myurella acuminata from Yakutia, which allow better understanding of this still very rare species. Present paper deals with taxonomy of this group, involving, in addition to morphology, also molecular markers of nuclear ITS and chloroplastic trnL-F.

MATERIAL AND METHODS

Laboratory protocol was essentially the same as in some of our previous analyses (e.g., Gardner et al., 2005). Maximum parsimony analysis and jackknifing was performed in Nona (Golboff, 1994) under Winclada shell (Nixon, 1999). The specimen details and GenBank accession numbers are given in Appendix 1.

The trees was rooted on Hookeria lucens and include representatives of all northern genera of Plagiotheciaceae and also Fabronia that sometimes appeared to be closely related to Plagiotheciaceae in molecular analyses (Ignatov et al., 2007). It also includes the sequences from the holotype of Bardunovia baicalensis (shown in trees as Myurella acuminata Irkutsk).

One trnL-F short inversion region of 3 nucleotides exhibits strong variation (CCT – AGG), so it was omitted in the analysis according to the suggestion of Quadt & Stech (2005).

RESULTS

Strict consensus tree of trnL-F (Fig. 1) has a polytomy with clades representing Myurella (M. tenerima, M. julacea, M. sibirica), Orthotheicum (O. chryseon (Schwägr.) Bruch et al., O. intricatum (Hartm.) Bruch et al., O. rufescens (Dicks. ex Brid.) Bruch et al., O. strictum Lorentz), Isopterygiopsis (I. alpicola (Lindb. & Arnell) Hedenäs, I. pulchella (Hedw.) Z. Iwats.), Platystictya (3 of 5 specimens of P. jangermannioides) and Struckia+Plagiothecium. However two specimens of Isopterygiopsis muelleiana (Schimp.) Z.Iwats. form a separate clade, while one of two specimens of I. pulchella was found in unresolved polytomy, not with another specimens of I. pulchella and I. alpicola. The unresolved polytomy includes Platystictya jangermannioides (2 of 5 specimens used in analysis), Myurella acuminata, species of Herzogella, Pseudotaxiphyllum, and Fabronia.

ITS is more variable in this group and it gives the better resolved strict consensus tree (Fig. 2A).
On the taxonomy of Myurella–Platydictya complex

and some clades get a statistical support (Fig. 2B), although mostly quite low.

The basal grade in the strict consensus tree (Fig. 2A) includes Fabronia, Pseudotaxiphyllum and Orthothecium clade.

The terminal clade includes two subclades. One is formed by Herzogiella spp., Isopterygiopsis muelleriana, Platydictya and Myurella acuminata, while another one by Plagiothecium + Struckia, Isopterygiopsis alpicola + I. pulchella, and Myurella (including three widespread species, but excluding M. acuminata).

The strict consensus supports the monophyly of Plagiothecium + Struckia, Isopterygiopsis alpicola + I. pulchella, and Myurella (including three widespread species, but excluding M. acuminata).

A high value of Jackknife support has been found for Plagiothecium+Struckia-clade (97), Orthothecium-clade (82) and Herzogiella-clade (79). Other clades got only a moderate support, including those formed by a single species: Myurella tenerrima (57); Isopterygiopsis muelleriana (69), I. pulchella (68). The clade of Platydictya jugermannioides + Myurella acuminata got a support of 67, and five specimens of the latter species formed a clade with support 64 nested within Platydictya polytomy.

DISCUSSION

The previous descriptions of Myurella acuminata (Lindberg & Arnell, 1890; Ignatov & Ochyra, 1995) and description of Bardunovia baicalensis by Ignatov & Ochyra (1995) were based on only two and one specimens respectively, which does not allow fully understand the variation of these taxa. It seems that small plant size, variable foliage and leaf shape in different shoots, growth in a small quantity, and also quite fragile plants have led to one misinterpretation for the latter species. The heterophylly was considered as an important character of Bardunovia; however, some larger leaves (0.7 mm long) illustrated in Figs. 28-3, 28-4 and 29-1 by Ignatov & Ochyra (1995) were taken likely from slender shoots of Campylium sommerfeltii entangled with the type material of Bardunovia. A total re-study of the type collection of Bardunovia baicalensis indicates the absence of leaves longer than 0.5 mm in plants that have axillary rhizoids and axillary gemmae, a characteristic of Bardunovia.

Another problem concerns the analysis of Pedersen & Hedenäs (2002). The sampling for molecular analysis has been done among specimens labeled by Ignatov as Bardunovia baicalensis. However Siberian phenotypes of Platydictya
Fig. 2. Maximum parsimony trees based on nrITS sequences:

A (upper, right) – strict consensus tree of 12 shortest trees (L=298, CI=0.75, RI=0.72) obtained in analysis of ITS1-2 nuclear region.

B (lower, left) – jackknife tree for 100 replications.
jungermannioides are sometimes very difficult to separate from B. baikalensis (cf. Figs. 3-4). East Siberian specimens of P. jungermannioides often have more strongly serrate margin with prominent ‘compound’ teeth (formed by projection of upper end of cell and lower end of next cell above along margin). This character seems to be strongly overestimated as a diagnostic for Myurella acuminata and Bardunovia baikalensis, as such teeth are rarely seen in European populations of P. jungermannioides, and this caused a number of misidentifications. We resequenced the specimens ‘Yakutia 00-37’, used for the analysis of Pedersen & Hedenäs (2002) and studied also its ITS. This revealed that the conclusion of the position of Bardunovia in Platydictya has been based on a specimen different from the type of Bardunovia (‘Myurella acuminata Irkutsk’ in Figs. 1-2), but according to present analysis, especially of ITS, belonging to P. jungermannioides. At the same time, the type of B. baikalensis appears in the clade with four studied specimens of Myurella acuminata. This new sorting based on molecular data also agree with morphological characters, however changing the values of characters, increasing, e.g., that of leaf concavity and describing the importance of, e.g., ‘compound teeth’.

The results of the phylogenetic analysis (Figs. 1-2) indicate that Myurella acuminata does not belong to the genus Myurella and has to be placed in Platydictya, as a separate species, P. acuminata, with Bardunovia baikalensis being its synonym. Thus, the suggestion to synonymize the latter genus with Platydictya (Hedenäs & Pedersen, 2002) is supported. This however expands the circumscription of Platydictya, including in the genus plants with julaceous foliage (at least at places), strongly concave leaf base, prominent ‘compound’ marginal teeth, and cells strongly prorate at lower end (cf. SEM photographs in Ignatov & Ochyra, 1995).

The main differences between Platydictya and Myurella s. str. (i.e. without M. acuminata) include a common presence of non-concave leaves in the former, but never in the latter, as well as the papillosity pattern of the laminal cells: smooth or papillose (‘prorate’) at its lower angle in the former, while with conspicuous papillae either over cell lumen or in the upper cell end in the latter.

Nomenclatural consequence at species level is as follow:


Plants in lax soft mats, light green to yellowish-brownish-green, very fragile. Stems 5-8 mm long, moderately densely julaceous foliate to remotely arranged, sparsely and irregularly branched, branches almost undifferentiated from stem; central strand absent or indistinct, of solitary smaller cells, outer cell layer almost undifferentiated; rhizoids axillary, purplish, finely papillose. Leaves erect (when foliage is dense) to spreading (especially when foliage is remote), (0.15-)0.25-0.45(-0.55)×(0.05-)0.10-0.20(-0.25) mm wide, ovate to ovate-lanceolate, acuminate, basal part strongly concave; margin serrate at base, mostly with ‘compound’ teeth (formed by projected upper end of lower cells and lower end of next upper cell), subentire to serrate above (with simple or more rarely ‘compound’ teeth); costa absent; laminal cells 20-40×7-10 μm, at base shorter, to 15 μm long, in alar region isodiametric, 10-14 μm; lower and middle laminal cells prorate on abaxial side by projections of lower cell ends, cell in upper third of leaf nearly smooth. Dioicous. Perichaetia rather frequent; perichaetial leaves 0.3-0.45×12-0.17 mm, non-plicate, ovate-lanceolate, gradually narrowed into acumen, serrate; cells in the middle of the lamina large and elongate, 40-60×10-15 μm, near margins smaller, 25-40×7-10 μm, in basal leaf corners subisodiametric.

**Specimens examined** (other than types): Taimyr Autonomous District, Anabar, 4 July 2009, Fedosov s.n. (MW); Yakutia, Yana River, 10 July 2009, Isakova #82 (MHA ex SASY); Yakutia, Ust-Mayak Dist., Yudoma River, Ignatov #00-257 (MHA). (See also Fig. 5).
Differentiation: *Platydictya acuminata* differs from *P. jungermannioides* in concave leaves and tendency to julaceous foliage, which is usually apparent in more developed plants at least in some shoots. Also in the former species leaves are usually larger, more strongly serrate at margin and with laminal cells more strongly prorate.

It should be noted however, that *Platydictya jungermannioides* is probably a heterogeneous taxon and additional studies are needed for understanding if it represents one polymorphic species or a complex of cryptic species. Yakutian plants of *P. jungermannioides* (Fig. 4) have rather dense foliage, larger leaves with well developed marginal teeth, i.e. they are variable in characters differentiating the most widespread phenotype of this species from *P. acuminata*. ‘Compound’ marginal teeth are common in Yakutian *P. jungermannioides* (Fig. 4), while they are at best very rare in European and North American collections, at least they are not illustrated by European (Nyholm, 1965) and American authors (Crum & Anderson, 1981; Lawton, 1971).
On the taxonomy of Myurella–Platydictya complex

ACKNOWLEDGEMENTS
We are grateful to A. Ivanova for correcting English, and to E. Ignatova for illustrations. The work was partly supported by 10-04-00678 and Biodiversity Program of RAS.

LITERATURE CITED


Appendix 1. Studied specimen data and GenBank accessions numbers.

A. Newly obtained sequences (for some specimens sequences are old, started not from JQ)

<table>
<thead>
<tr>
<th>species</th>
<th>specimen</th>
<th>trnL-F</th>
<th>ITS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Isopterygiopsis alpicola</td>
<td>Russia, Khabarovsk, Bureya River,</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Khabarovsk 97-459 Ignatov #97-459(MHA)</td>
<td>JQ247743 JQ247726</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Isopterygiopsis alpicola</td>
<td>Russia, Khabarovsk, Bureya River,</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Khabarovsk 97-734 Ignatov #97-734(MHA)</td>
<td>JQ247744 JQ247727</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Isopterygiopsis muelleriana</td>
<td>Russia, Primorsky Territory, Ignatov #07-296(MHA)</td>
<td>JN896318</td>
<td></td>
</tr>
<tr>
<td>Isopterygiopsis pulchella Mexico</td>
<td>Plantas de Mexico, Cardenas #3942(MHA)</td>
<td>JQ247745 JQ247728</td>
<td></td>
</tr>
<tr>
<td>Myurella acuminata Anabar</td>
<td>Russia, Taimyr Autonomous District, Anabar, 4 July 2009, Fedosov s.n. (MW)</td>
<td>JQ247747 JQ247729</td>
<td></td>
</tr>
<tr>
<td>Myurella acuminataIrkutsk</td>
<td>Russia, Irkutsk Prov., 1 July 1983, Bardunov (MHA)</td>
<td>JQ247748 JQ247730</td>
<td></td>
</tr>
<tr>
<td>Myurella acuminata Yakutia Yana</td>
<td>Russia, Yakutia, Yana River, 10 July 2009, Isakova #82 (MHA ex SASY)</td>
<td>JQ247749 JQ247731</td>
<td></td>
</tr>
<tr>
<td>Myurella acuminata Yakutia, Yudoma 1</td>
<td>Russia, Yakutia, Ust-Mayaya Distr., Yudoma River, Ignatov #00-257 (MHA)</td>
<td>JQ247750 JQ247732</td>
<td></td>
</tr>
<tr>
<td>Myurella acuminata Yakutia, Yudoma 2</td>
<td>Russia, Yakutia, Ust-Mayaya Distr., Yudoma River, Ignatov #00-257 (MHA) [another extraction of Yudoma1]</td>
<td>JQ247751 JQ247733</td>
<td></td>
</tr>
<tr>
<td>Myurella julacea</td>
<td>Russia, Anabar, Fedosov #07-216 (MW)</td>
<td>AF472460 JQ247734</td>
<td></td>
</tr>
<tr>
<td>Myurella sibirica</td>
<td>Russia, Sakhalin, Ignatov #06-108 (MHA)</td>
<td>JQ247752 AJ288415/ AJ277227</td>
<td></td>
</tr>
<tr>
<td>Myurella tenerrima 2 Orulgan</td>
<td>Russia, Yakutia, Orulgan, Ignatov #11-1001 (MHA)</td>
<td>JQ247753 JQ247736</td>
<td></td>
</tr>
<tr>
<td>Myurella tenerrima 3 Suntar-Khayata</td>
<td>Russia, Yakutia, Suntar-Khayata Range, 19 June 1999, Ivanova &amp; Krivoshapkin s.n. (MHA)</td>
<td>JQ247754 JQ247737</td>
<td></td>
</tr>
<tr>
<td>Myurella tenerrima 4 Anabar</td>
<td>Russia, Anabar, Fedosov #06-292 (MW)</td>
<td>—</td>
<td>JQ247735</td>
</tr>
<tr>
<td>Orthothecium strictum</td>
<td>Russia, Taimyr, 3 Aug 2008, Fedosov s.n. (MW)</td>
<td>JQ247755 JQ247738</td>
<td></td>
</tr>
<tr>
<td>Platydictya jungermannioides Altai</td>
<td>Russia, Altai, Ignatov #0/455 (MHA)</td>
<td>JQ247756 JQ247739</td>
<td></td>
</tr>
<tr>
<td>Platydictya jungermannioides AnabarRussia, Anabar, Fedosov #04-15 (MW)</td>
<td>JQ247757 JQ247740</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Platydictya jungermannioides Yakutia 00-30</td>
<td>Russia, Yakutia, Lenskie Stolby, Ignatov 00-30 (MHA)</td>
<td>JQ247758 JQ247741</td>
<td></td>
</tr>
<tr>
<td>Platydictya jungermannioides Yakutia 00-37</td>
<td>Russia, Yakutia, Lenskie Stolby, Ignatov 00-37 (MHA)</td>
<td>JQ247759 JQ247742</td>
<td></td>
</tr>
</tbody>
</table>

B. Previous sequences used in the present analysis (trnL-F|||ITS1-2 or ITS1/ITS2)

| Fabronia ciliaris                  | AY527128|||AY528883; Herzogiella seligeri Ryazan AY683585|||AY695758/AY695764; Herzogiella seligeri Slovakia AF472453|||AY999174; Herzogiella turfacea Kunashir —|||JN896315; Hookeria lucens AF215906|||JN896317; Isopterygiopsis muelleriana Yakutia AY527138|||AY528882; Isopterygiopsis pulchella Yakutia AY683568|||AY695751/AY695770; Myurella tenerrima 1 AF472461; —; Orthothecium chryseum AF472462; —; Orthothecium intricatum AF472463; —; Orthothecium rugescens AF472464; —; Orthothecium euryphyllum —|||AJ288577; Plagiothecium euryphyllum —|||AJ288577; Plagiothecium latebrocila AF472468; —; Plagiothecium neckeroides AF472469; —; Plagiothecium nemorale AF472470; —; Plagiothecium denticulatum AY527131|||AY528892/AY528893; Plagiothecium undulatum AF230990|||AF231005; Plagiothecium jungermannioides Nowray AY857568|||AY857610; Pseudotaxiphyllum fauriei —|||AF231007; Pseudotaxiphyllum elegans AF472473; —; Struckia argentata Nepal DQ836728|||DQ836733; Struckia argentata Yunnan DQ836729|||DQ836734; Struckia enervis Altai DQ836730|||DQ836735; Struckia enervis Sichuan DQ836731|||DQ836736/DQ836737.