

## A NEW SPECIES OF *DREPANOCLADUS* (BRYOPHYTA) FROM YAKUTIA

### НОВЫЙ ВИД РОДА *DREPANOCLADUS* (BRYOPHYTA) ИЗ ЯКУТИИ

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Abstract

*Drepanocladus jacuticus* is described as new for science from the Central Yakutia. Superficially this species is similar to a small *Campylium* species, with slightly gradually reflexed leaves. Leaf costae are variable, being double in some leaves and single in others in a way known in *D. polygamus*. However this plant is very small and its alar cells are always small, quadrate, and laminal cells are much shorter than in that species. Molecular phylogenetic data of the nuclear ITS region found the position of this species in *Drepanocladus*-clade, in the basal position sister to all other species of the genus. It occurs in Central Yakutia, in xeric areas where relatively dry grasslands form on somewhat salty permafrost soil.

Резюме

*Drepanocladus jacuticus* описан как новый для науки вид из Центральной Якутии. Внешне он напоминает мелкие виды из рода *Campylium* с постепенно назад отогнутыми листьями. Листья *D. jacuticus* имеют жилку, которая варьирует от короткой двойной до умеренно длинной простой на одном и том же растении, что делает его похожим на *D. polygamus*. Однако растения *D. jacuticus* существенно мельче, клетки в углах основания листа мелкие, квадратные, а не крупные и вздутые, и клетки пластинки листа более короткие, чем у *D. polygamus*. Молекулярно-филогенетические данные, полученные для ядерного участка ITS, ставят *D. jacuticus* в базальное положение в кладе *Drepanocladus*, так что он оказывается сестринским ко всем остальным видам этого рода. Он распространен в Центральной Якутии, в районе с засушливым климатом, где относительно ксерофитные травяные сообщества формируются на засоленных почвах в условиях многолетней мерзлоты.

KEYWORDS: mosses, ITS, *atpB-rbcL*, new species, East Asia

#### INTRODUCTION

In the course of preparation of the Moss flora of Russia we encountered specimens from Yakutia which were difficult to name. They were small, with slightly reflexed leaves, thus having a *Campylium*-like aspect, and somewhat similar to miniature *Drepanocladus polygamus* (Bruch, Schimp. & W. Gümbel) Hedenäs, formerly placed in the genus *Campylium* (Sull.) Mitt. The variable costae, double in some leaves and single in others, a characteristic of *Drepanocladus polygamus*, were also seen in these Yakutian plants. However they were too small to be referred to *D. polygamus* which is a rather robust plant. Moreover, the latter species has large, inflated alar cells, similar to those of *Drepanocladus aduncus* (Hedw.) Warnst., whereas in Yakutian plants the alar cells were small and quadrate, similar to those usually observed in *Amblystegium serpens* (Hedw.) Bruch, Schimp. & W. Gümbel and *Campylophyllopsis sommerfeltii* (Myrin) Ochya. To resolve this problem we invoked a molecular phylogenetic approach. Nuclear ITS and plastid *trnL-F*

regions were used, as they proved to be especially useful for reconstructing phylogeny of the Amblystegiaceae (Vanderpoorten *et al.*, 2002, 2003; Vanderpoorten & Hedenäs, 2009; Hedenäs & Rosborg, 2009; Kučera & Hedenäs, 2019).

#### MATERIAL AND METHODS

The laboratory protocol for DNA extraction, amplification and sequencing were essentially the same as in our previous moss studies, described in detail by, e.g., Gardiner *et al.* (2005). The dataset were built by sequences most similar to Yakutian plans by BLAST search (<https://blast.ncbi.nlm.nih.gov/Blast.cgi>, on March 2002), leaving out repeated identical sequences for the same species. Sequences were aligned in Bioedit (Hall, 1999). Bayesian analysis was performed separately nuclear and plastid *trnL-F* in MrBayes 3.2.6 (Ronquist *et al.*, 2012), with 10 000 000 generations. Maximum parsimony analyses were done in Nona (Goloboff, 1994) in the Winclada shell (Nixon, 1999), with bootstrap calculations for 2000 replications (N searches 100, starting trees per rep 100, max trees 100, do max).

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Fig. 1. **A.** Bayesian tree of the Amblystegiaceae based on nuclear ITS sequences. Posterior probabilities and / MP bootstrap supports are shown at branches.

Newly sequenced specimens data are in Appendix.

**B.** *Drepanocladus* clade, scheme of strict consensus MP tree based on plastid *trnL*-F dataset, showing poorly resolved relationships of species; in the *trnL*-F alignment, *D. jacuticus* differs from *D. polygamus* in 1 substitution, from *D. trifarius* in 2, from any other *Drepanocladus* species in fig 'B' and *Vittia* in 3 substitutions.

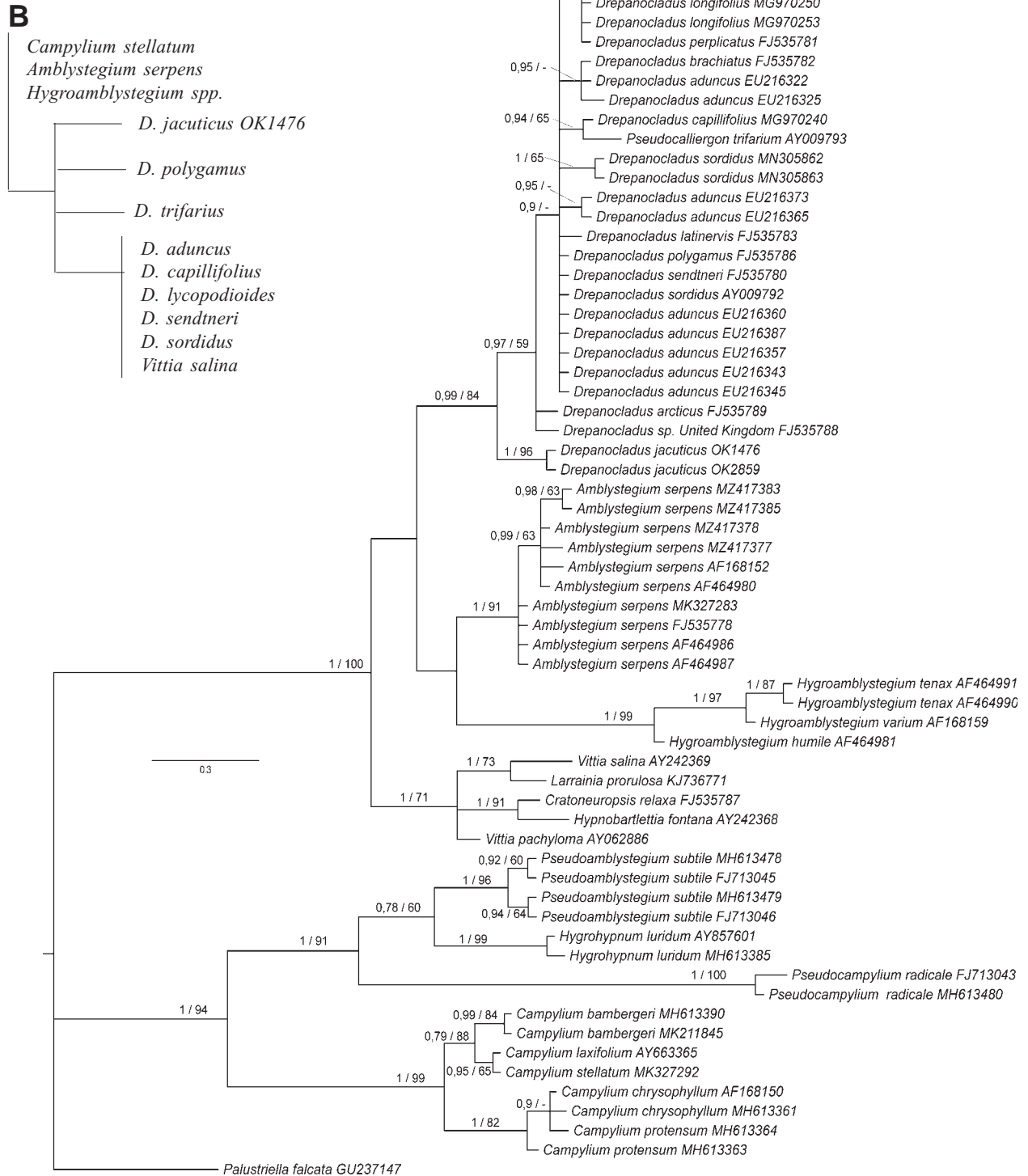




Fig. 2. Habitat of *Drepanocladus jacuticus* near Ulakhan-An: ‘bulgunyakhs’ (local name for permafrost hummocks) at the edge of *Larix* forest (along the road, a mildly cow pastured area). Soil is salty, which is indicated by *Glaux maritima* (red color in photos).

## RESULTS

Two separate analyses for ITS and *trnL*-F datasets were done because the content of their datasets was not identical. The Bayesian analysis of the ITS dataset (Fig. 1A) resolved the genus *Drepanocladus* monophyletic with a sufficient, albeit not maximal support (PP=0.99, BS=84). Within this clade, the first branch is formed by two Yakutian specimens (PP=1.0, BS=96), while all other species of the genus form a clade with low support (PP=0.97, BS=56). This latter clade comprises a polytomy of species or small monospecific clades with high support or small non-monospecific clades with low support. Only one clade with several species appeared to be moderately supported: the species sometimes segregated to the genus *Pseudocalliergon* (Limpr.) Loeske (*D. lycopodioides* (Brid.) Warnst., *D. angustifolius* (Hedenäs) Hedenäs & Rosborg, *D. turgescens* (T. Jensen) Broth., *D. trifarius* (F. Weber & D. Mohr) Broth.) and, among them, the GenBank accession of *Gradsteinia andicola* Ochyra [the position of *G. andicola* within *Drepanocladus* was also found by Vanderpoorten & Hedenäs (2009)]. Plastid *trnL* is less variable, thus its clades are not sufficiently supported. In MP strict consensus tree (shown in part in Fig. 1B) however one Yakutian plant is in basal position to the main content of the genus.

## DISCUSSION

The order of genera arranged by relationships to *Drepanocladus* according to phylogenetic tree in Fig. 1 is consistent with the orders found in other analyses (Vanderpoorten *et al.*, 2003; Vanderpoorten & Hedenäs, 2009; Huttunen *et al.*, 2012), which ensures that the resolve of the position of Yakutian plants is likely reliable. The high support of the clade of *Drepanocladus* including Yakutian plants and at the same time the low support of the clade of all other *Drepanocladus* without Yakutian plants support its position within this genus. We found no existing names for Yakutian plants, and therefore, describe it below as a new species.

## TAXONOMY

***Drepanocladus jacuticus*** Ignatov & Ignatova, species nova. Fig. 3.

**Type:** Russia. Republic Sakha/Yakutia, Tattinsky District, 62°20'28"N, 133°32'22"E, 154 m alt., surroundings of Ityk-Kyuel Settlement, permafrost hummock, on soil. 27 Jul 2016 Ignatov & Ignatova 16-1596 (MHA9100592) (Holotype MHA!, isotype MW!)(DNA Isolate OK2859, ITS: ON678000).

**Diagnosis:** *Drepanocladus jacuticus* is similar to *D. polygamus* in having variable costae: simple, forked or double in leaves from the same plant, but differs from it in smaller size of plants; smaller leaves, 0.6–0.9×0.3–0.4 mm vs. 1.7–3.5×0.6–0.9(–1.1) mm; and alar cells small, subquadrate to transversely rectangular, firm-walled vs. large, oval, thin-walled in *D. polygamus*.

**Description:** Plants small, green or yellowish-green, in dense low tufts, weakly glossy. Stems ca. 1 cm long, irregularly branched, densely foliate, terete; branches 2–5 mm long, terete-foliate; axillary hairs 2-celled, with upper cell ca. 60 µm long; proximal branch leaves of branch primordia subulate to triangular. Leaves loosely appressed to erect, with erect or slightly recurved acumina, 0.6–0.9×0.3–0.4 mm, straight or weakly curved, from triangular-ovate or ovate base gradually tapered into long, narrow triangular acumina, gradually narrowed to the insertions, slightly concave; costae variable, simple, forked or double, to 0.2–0.5 the leaf length; margins entire or finely serrulate at leaf base; cells elongate-rhomboidal, 18–37×6–9 µm, cell length, µm/ leaf length, mm ratio 30–41:1, with moderately thickened, non-porose walls; alar cells quadrate and transversely rectangular, firm-walled, in moderately delimited alar groups. Dioicous? Gametangia and sporophytes unknown.

**Other specimens examined:** Republic Sakha/Yakutia, Khangalassky District, 61°20'40"N, 128°21'21"E, ~230 m alt., between settlements Ulakhan-An and Bestyakh, in larch forest on old rotten log, 2 Aug 2016 Ignatov & Ignatova 16-

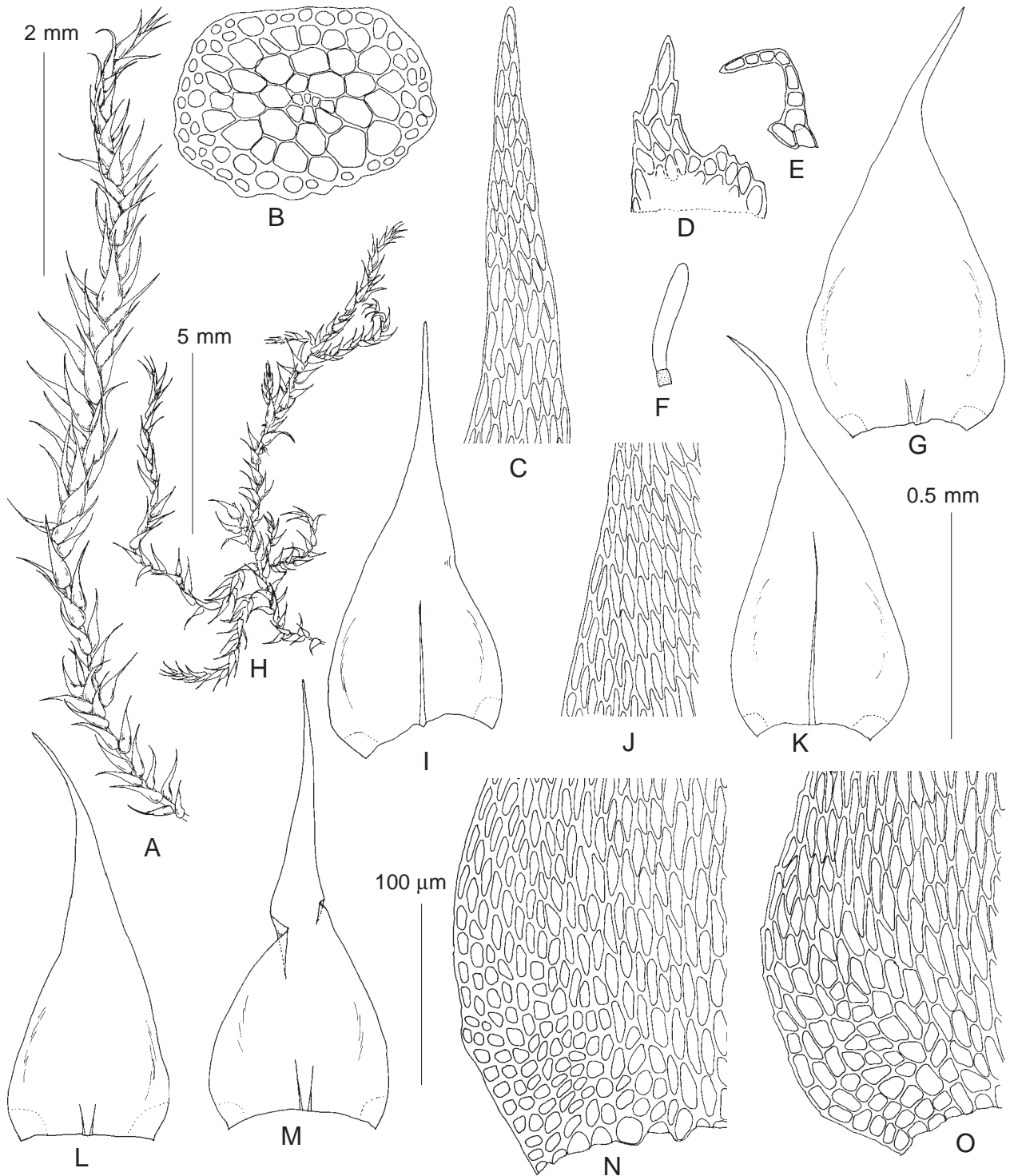


Fig. 3. *Drepanocladus jacuticus* Ignatov & Ignatova (A–F, H–J, L–N – from holotype; G, K, O – from Russia, Yakutia, Khangalassky Distr., Ignatov & Ignatova 16-253, MHA9021822). A, H: habit, dry; B: stem transverse section; C: upper leaf cells; D, E: proximal branch leaves; F: axillary hair; G, I, K–M: leaves; J: mid-leaf cells; N, O: basal leaf cells. Scale bars: 5 mm for H; 2 mm for A; 0.5 mm for G, I, K–M; 10 µm for B–F, J, N–O.

244 (MHA9131511); near previous locality, 61°21'48"N, 128°27'01"E, ~190 m alt., low-grass meadow, on soil, 3 Aug 2016 Ignatov & Ignatova 16-253 (MHA9021822).

**Differentiation:** *Drepanocladus jacuticus* was placed into the genus *Drepanocladus* as a result of molecular

phylogenetic evidence. In aspect it resembles depauperate *Campyllum chrysophyllum* or *Amblystegium serpens*. However, the former species have more widely spreading to recurved leaves, while the former never has leaves with double costae. Differences of *D. jacuticus* from *D. poly-*

*amus* is given in the diagnosis; *D. arcticus*, another species with variable costae, is also a much larger plant, with larger leaves and U-shaped outline of leaf insertion.

*Drepanocladus cardotii* (Thér.) Hedenäs, known only from the type collection in high mountains in USA, Montana, is also a small plant with bifid costa and leaves similar to *D. jacuticus*. It differs from *D. jacuticus* in still larger leaves, 1.0–1.4×0.7–0.8 mm vs. 0.6–0.9×0.3–0.4 mm; ratio of medial laminal cell length (µm) to leaf length (mm) 23.6 vs. 30–41:1 in specimens of *D. jacuticus* (data on *D. cardotii* are given according to Hedenäs, 2014).

**Ecology:** *Drepanocladus jacuticus* was collected in mesic or xero-mesic meadows, some being flat or other being ‘hummocky’ from permafrost raisings (Fig. 2). In all localities soil was somewhat salty (indicated by abundant *Glaux maritima* L. and occasionally present *Sueda* sp.); the area has very low precipitation, 200–250 mm per year, and forest exists only due to permafrost melting (mean annual temperature in Yakutsk is 8.8°C below zero). **Admixture species:** in MHA9131511 (on rotten log): *Sanionia uncinata* (Hedw.) Loeske, *Pohlia nutans* (Hedw.) Lindb., *Ceratodon purpureus* (Hedw.) Brid., *Tomentypnum involutum* (Limpr.) Hedenäs & Ignatov; in MHA9021822 (on soil): *Abietinella abietina* (Hedw.) M. Fleisch., *Pterygoneurum kozlovii* Laz., *P. sessile* (Brid.) Jur., *Didymodon* cf. *validus* Limpr. (worth mentioning that in similar permafrost hummocks are common *Aloina rigida* (Hedw.) Limpr. and *Pterygoneurum ovatum* (Hedw.) Dixon, and once found *Hilpertia velenovskiyi* (Schiffn.) R.H. Zander).

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APPENDIX: Voucher specimens and GenBank accessions.

#### *Drepanocladus jacuticus*:

Holotype (Isolate OK2859). ITS: ON678000. Yakutia, *Ignatov & Ignatova 16-1596*, MHA9100592.

Isolate OK1476. ITS: ON677999; *trnL*–F: ON646248. Yakutia, *Ignatov & Ignatova 16-244*, MHA9131511.

#### SUPPLEMENTARY MATERIAL:

MP tree based on *trnL*

[https://kmkjournals.com/journals/Arctoa/Arctoa\\_30\\_017\\_021\\_SM\\_Drepanocladus\\_trnL-F.pdf](https://kmkjournals.com/journals/Arctoa/Arctoa_30_017_021_SM_Drepanocladus_trnL-F.pdf)