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BRYOPHYTE MOLECULAR BARCODING RECORDS. 12

БРИОЛОГИЧЕСКИЕ НАХОДКИ ПО РЕЗУЛЬТАТАМ ДНК-МАРКИРОВАНИЯ. 12

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Abstract

DNA-barcoding revealed/confirmed the range extension of the following bryophytes: *Didymodon abramovae* (Altai Republic and Krasnoyarsk Territory, Siberia), *D. acutus* (Krasnodar Territory and Crimea), *D. borealis* (Belarus; Krasnoyarsk Territory, Siberia), *D. calciphilus* (Kabardino-Balkarian Republic, Caucasus), *D. glaucus* (Perm Territory, Urals; Ingush Republic, Caucasus; Republic Sakha/Yakutia), *D. validus* (Ryazan Province, European Russia), *Chenia leptophylla* (Kabardino-Balkarian Republic, Caucasus and Zabaikalsky Territory, southern Siberia), and *Tortula edentula* (Urup Island, Sakhalinskaya Province, Kuril Islands).

Резюме

С помощью ДНК-баркодинга выявлены или подтверждены находки за пределами основного ареала следующих видов мохообразных: *Didymodon abramovae* (Алтай и Красноярский край), *D. acutus* (Краснодарский край и Крым), *D. borealis* (Беларусь и Красноярский край), *D. calciphilus* (Кабардино-Балкария), *D. glaucus* (Пермский край, Ингушетия и Якутия), *D. validus* (Рязанская область), *Chenia leptophylla* (Кабардино-Балкария и Забайкальский край) и *Tortula edentula* (о. Уруп, Курильские острова).

KEYWORDS: mosses, new records, molecular markers, nrITS, Russia

Introduction

This paper continues the series of brief reports of new findings proved in the course of the bryophyte DNA barcoding studies. It presents various finding where the sequencing either confirms species identities, which are ambiguous by various reasons, or disclose their affinities, or support generic placements of certain taxa that have never been investigated for molecular markers earlier, or have never been barcoded previously, or have been barcoded from different parts of the world. Being obtained in the course of screening rather than special studies of a particular group, such data may remain unsubmitted to DNA databases and stay neglected and not searchable among published materials.

1. ***Didymodon abramovae*** Ignatova & Fedosov

Contributors: E.A. Ignatova, M.S. Ignatov, A.V. Fedorova & V.E. Fedosov

Specimens: RUSSIA: (1) Altai, Chulyshman River 8–10 km upstream Chulcha Creek mouth, 51°00'N – 88°01'E, 550 m alt., rocks at cliff base, 13.VIII.2012 coll. *M.S. Ignatov & E.A. Ignatova 12-607a*, MHA9101361; (2) Krasnoyarsk Territory, SE Taimyr, Kotuyskoe Plateau, vicinity of Kyndyn River Mouth, 70°00'34"N – 102°26'59"E, 550 m alt., calcareous sandstone rock outcrops along the Kotuy River bank, 16.VIII.2011 coll. *V.E. Fedosov 11-1260*, MW9007692.

DNA: Isolates OK4159 (Altai Republic), OK4161 (Krasnoyarsk Territory). GenBank accession numbers:

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[6] – Institute for Biological Problems of Cryolithozone of Siberian Division of Russian Academy of Sciences, 41 Lenin ave., Yakutsk, 677000, Russia. E-mail: bryo.ivanova@yandex.ru

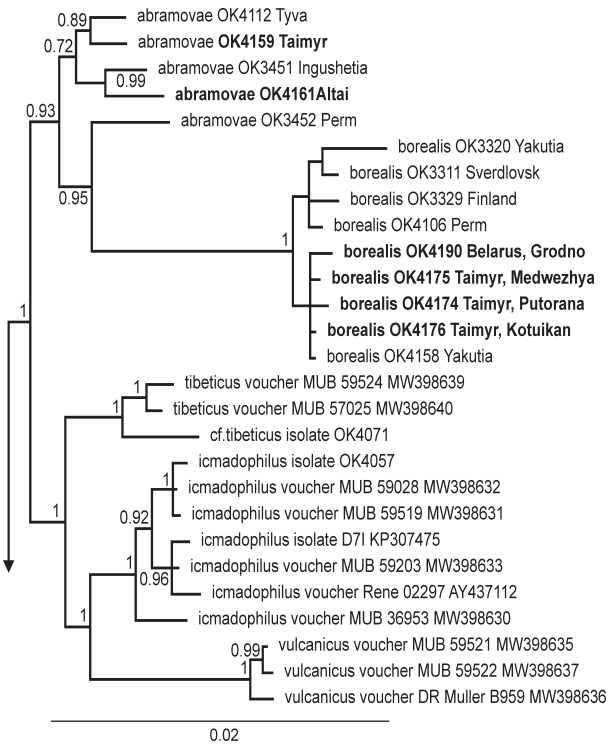

Fig. 1. Phylogenetic ML tree of *Didymodon* abramovae, D. borealis and closely related species based on nrITS and plastid *trn*G sequences. Newly obtained sequences are boldfaced. Bootstrap support > 70 is shown at branches.

PV613691, PV613692 (*trn*G), PV624852, PV624853 (nrITS).

This species was recently described from Dagestan Republic (Ignatova *et al*., 2024); several specimens from Perm Province, Tyva Republic, and Yakutia were also listed. Like many other recently described species, *D. abramovae* remains poorly known for its variability; therefore, several additional specimens identified later as *D. abramovae* were checked with DNA barcoding. Here we first report this species from the xeric part of Altai Mountains and from the southern part of Taimyr District (Fig. 1).

2. ***Didymodon acutus*** (Brid.) K. Saito

Contributors: E.A. Ignatova, M.S. Ignatov, A.V. Fedorova, V.E. Fedosov & A.P. Seregin

Specimens: RUSSIA: (1) Krasnodar Territory, Khosta Distr., Khosta Town, valley of Khosta River 3 km upstream its mouth, left slope, below the road to Vorontsovka, 130 m alt., on the bottow of an owergrown quarry, on fine limestone rubble, 18.IV.2017 coll. *A.P. Seregin M-3918*, MW9112472. (2) Crimea, Balaklava Distr., vicinity of Balaklava Town, 1 km W of Oboronnoe settl., medow on SW hill slope, 5.IV.2003 coll. *A.P. Seregin & I. Privalova (Seregina) M-80*, MW9036050.

DNA: Isolates OK4191 and OK4150. GenBank accession numbers: PV624862, PV789601 (nrITS).

This species was reported from many areas of Russia, but most of the reports later appeared to be erroneous. Its presence in the Caucasus, North Ossetia, was already confirmed (Jiménez, 2006). Here we prove with molecular barcoding the identity of the specimen from Crimea (Fig. 2), where this species was reported earlier by Partyka (2005) and Ignatov *et al*. (2006).

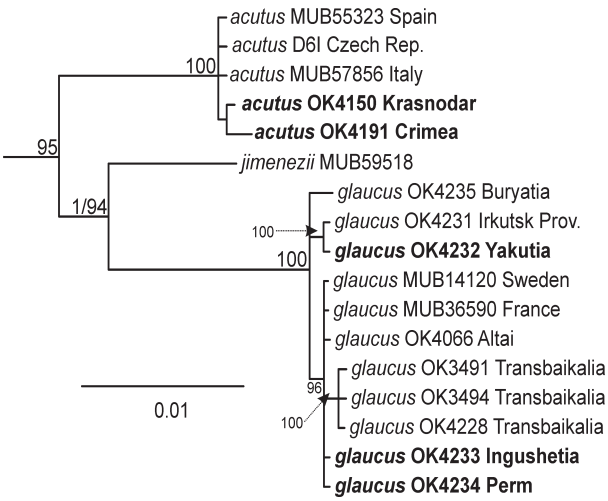

Fig. 2. Phylogenetic ML tree of *Didymodon acutus, D. glaucus* and closely related species based on nrITS and plastid trnG sequences. Newly obtained sequences are boldfaced. Bootstrap support > 70 is shown at branches.

3. ***Didymodon borealis*** Ignatova & Ignatov

Contributors: E.A. Ignatova, M.S. Ignatov, A.V. Fedorova & V.E. Fedosov

Specimens: RUSSIA: (1) Krasnoyarsk Territory: SW Taimyr, Putorana Plateau, vicinity of Lama Lake, Vekhikay Creek canyon, 69.37°N – 91.51°E, dry rocky slope, on finesoil, 13.VII.2016 coll. *V.E. Fedosov 16-0145*, MW9079132; (2) SE Taimyr, Kotuyskoe Plateau, vicinity of Medwezhya River Mouth, 71.1541°N – 102.73°E, on ledge of sandstone cliff, on finesoil, 24.VII.2005 coll. *V.E. Fedosov 05-648*, MW9090440; (3) SE Taimyr, Anabar Plateau, Kotuikan River 8 km upstream its mouth, spruce forest, on rotten log, 9.VIII.2011 coll. *V.E. Fedosov 11-1217*, MW9007681. BELARUS, Grodno Province & District, 19 km NW of Grodno City, 1.75 km NW of Sopoyskin Settl., 53°50'30"N – 23°38'10"E, on concrete roof of an old war dugout, 13.X.2006 *A. Seregin, I. Seregina & O. Sozinov M-1882*, MW9036048.

DNA: Isolates OK4174–4176 (Taimyr), OK4190 (Belarus). GenBank accession numbers: PV613694–PV613697 (*trn*G); PV624855–PV624858 (nrITS).

Didymodon borealis was recently described from Yakutia based on the results of morpho-molecular treatment of Russian *Didymodon* s.str. specimens (Ignatova *et al*., 2024). It was also reported for the Ural Mountains and Finland. Further revision of herbarium materials in MW in the course of the 3rd volume of the Moss flora of Russia preparation revealed additional specimens which may represent this taxon. However, since its variability remains insufficiently known, we decided to check these

identifications with the sequence data. The newly presented data (Fig. 1) complement the known species distribution, which is associated mostly with boreal and Subarctic zones of Eurasia. One specimen from Taimyr (OK4176, Kotuikan River lower course) was collected on dry fallen log, expanding our knowledge about the species ecology.

4. ***Didymodon calciphilus*** Ignatova & Ignatov

Contributors: E.A. Ignatova, M.S. Ignatov, A.V. Fedorova & V.E. Fedosov

Specimen: RUSSIA, Kabardino-Balkaria, Chegem River Gorge near waterfalls, 43°25'6"N – 43°13'16"E, 1000 m alt., on boulder, 24.VIII.2005 coll. *M.S. Ignatov, E.A. Ignatova & Z. Kharzinov 05-1529*, MW9036239.

DNA: Isolate OK4162. GenBank accession numbers: PV613711 *(trn*G), PV624876 (nrITS).

Blast search revealed all-three ITS sequences of *D. calciphilus* available in GenBank as the closest to that of OK4162 with the percent identity of 97.90–98.64%, while the plastid *trn*G sequence appeared to be closest to those of OK3457 and OK3489, representing another recently described species, *D. baicalense* (Ignatova *et al*., 2024), and *trn*G sequences of *D. calciphilus* show percent identity of 99.65%.

Didymodon calciphilus was desribed from southern part of the Primorsky Territory; one specimen from the Eastern Caucasus (Dagestan) was also cited (Ignatova *et al*., 2024). Here we present data about the species distribution in the Central Caucasus proved with DNA barcoding.

5. ***Didymodon glaucus*** Ryan

Contributors: A.N. Bersanova, E.A. Ignatova, M.S. Ignatov, E.I. Ivanova, A.V. Fedorova & V.E. Fedosov

Specimens: RUSSIA: (1) Ingushetia, Erzi Nature Reserve, Kkhart, 42°49'51"N – 44°53'42"E, 1343 m alt., hill slope, meadow with scattered trees of *Prunus*, *Pyrus*, and *Juniperus*, on soil, 18.IV.2018 coll. *A.N. Bersanova 18-292*, MW9091157; (2) Perm Territory, Chusovskoy District, left bank of Chusovaya River, 58°16'10"N – 57°59'01"E, limestone outcrops, deep shady grotto, on walls near entrance, 17.VII.2017 coll. *A.G. Bezgodov 235*, MW9090559; (3) Yakutia, Khangalassky Distr., Lenskie Stolby area, Buotama River 6 km downstream Symnaky Creek, 1.VII.2000 coll. *E.I. Ivanova 107005*, MW9078137.

DNA: Isolates OK4233 (Ingushetia), OK4234 (Perm Territory), OK4232 (Yakutia). GenBank accession numbers: PV613703–PV613705 (*trn*G); PV624867–PV624869 (nrITS).

Didymodon glaucus has long time been considered as a rare taxon with a predominantly European distribution (Düll, 1984; Porley, 2005, 2007). This species was first reported from the area of the Soviet Union (contemporary Russia) by Lazarenko (1940) based on two specimens from the southern part of Primorsky Territory. It was consequently reported from Irkutsk Province (Ignatova & Ignatov, 2007), Buryatia (Czernyadjeva & Ignatova, 2017), Transbaikalia (Afonina *et al*., 2017) and, with questionmark, from Khangalassky District of Yakutia (Ivanova *et al*., 2017). Molecular barcoding confirms the identification of several unpublished specimens of this species from other areas, stored in MW, and the Yakutian specimen (Fig. 2). So, the species appears to have a wide distribution in temperate and boreal Eurasia: Western, Northern, and Central Europe, the Caucasus, Urals, Mountains of Southern Siberia and Yakutia, and southern Russian Far East.

5. ***Didymodon validus*** Limpr.

Contributors: E.A. Ignatova, M.S. Ignatov, A.V. Fedorova & V.E. Fedosov

Specimen: RUSSIA, Ryazan Province, Mikhailov Distr., gravely slope along the Pronya River bank, 3.VIII.2009 coll. *L.F. Volosnova s.n.*, MW9035936.

DNA: Isolate OK4192. GenBank accession numbers: PV613709 (*trn*G); PV624874 (nrITS).

Twenty one closest ITS sequences revealed by Blast search (percent identity 98.24–99.72%) represent *Didymodon validus* with closest specimens OK3314 (Ingushetia, Caucasus) and OK3319 (Yakutia). Blast search for closest *trn*G sequences found 6 sequences of *D. validus* as identical with that of OK4192.

Didymodon validus appeared to be widespread in Eurasia; it is a common species in many mountain areas of Russia, while in lowland areas it was known from scattered localities, e.g. in Kursk Province (Ignatova *et al*., 2024). We confirm here its presence in one more locality in lowland European Russia.

6. ***Chenia leptophylla*** (Müll. Hal.) R.H. Zander

Contributors: O.M. Afonina, M.S. Ignatov, E.A. Ignatova & O.I. Kuznetsova

Specimens: RUSSIA: (1) Kabardino-Balkarian Republic, 43°07'N, 43°25.5'E, 1150 m alt., left slope of the Cherek Balkarsky River upstream Verkhnyaya Balkaria settlement, slope to the valley above the ruins of old settlement, outcrops on steppe slope, in rock crevices, 28.VIII.2005 coll. *M.S. Ignatov, E.A. Ignatova & Z.H. Kharzinov 05-1855*, MHA9132132; (2) Zabaikalsky Territory, 55 km WNW of Zabaikalsk Town, Argun Ridge, 50°06'N – 119°33'E, 514 m alt., steep rocky slope with steppe vegetation, on rocks, 26.VII.2005 coll. *O.M. Afonina 5105*, LE.

DNA: Isolates OK3867 (Kabardino-Balkaria), OK3962 (Zabaikalsky Territory). GenBank accession numbers: PV765591, PV765592 (nrITS).

Chenia leptophylla is sporadically distributed throughout the world, mainly in tropical and temperate regions. Zander (2007) referred it to the "mundivagant group" of species, which are associated with disturbed habitats. In Europe, it is spreading (Frahm, 2000), reaching now Hungary and Poland (Fudali *et al.*, 2009; Hodgetts & Lokhart, 2020), and it was recently collected in Georgia in a man-made habitat, on concrete base of a bridge (Ellis *et*

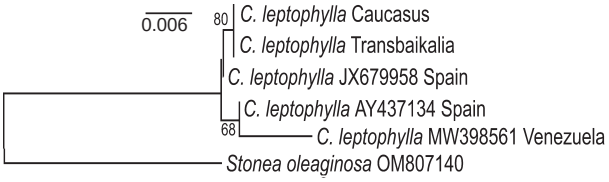

Fig. 3. Phylogenetic ML tree of *Chenia leptophylla* based on nrITS sequences. Bootstrap support > 60 is shown at branches.

al., 2024). Here we present its first records from Russia, based on previously unidentified collections of 2005 in Republic of Kabardino-Balkaria, Caucasus and Zabaikalsky Territory, southern Siberia. In both localities it grew in xeric steppe habitats. Siberian locality is only moderately far from Jilin and Shaanxi Provinces of China, where the species is known, while the Caucasian one might be a result of invasion form Europe; so we tested their affinities with nrITS marker (Fig. 3), but found that two Russian populations are likely monophyletic with a moderate support.

7. ***Tortula edentula*** Ignatova & Ignatov

Contributors: A.S. Kartasheva & A.V. Fedorova

Specimens: RUSSIA: Kuril Islands, Urup Island, cape Kastrikum, 46.227735°N – 150.568375°E, on moist wall of an abandoned building, 31.VIII.2021. coll. *A.S. Kartasheva U-70n*, MHA9132131.

DNA: Isolate OK4209. GenBank accession number PV763578.

Blast search revealed the only ITS sequence of *T. edentula* available in GenBank as the closest to that of OK4209 with the percent identity of 99.15%.

Tortula edentula was recently described from Shikotan Island (South Kuril Islands); later it was collected on Kommander Islands, Bering Island (Fedosov *et al*., 2012). Here we first report it from Urup Island. This species is still known only from island part of the Russian Far East.

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LITERATURE CITED

[AFONINA, O.M., I.V. CZERNYADJEVA, E.A. IGNATOVA & YU.S. MAMONTOV.] АФОНИНА, О.М., И.В. ЧЕРНЯДЬЕВА, Е.А. ИГНАТОВА, Ю.С. МАМОНТОВ. 2017. *Мхи Забайкальского края.* – [*Mosses of Zabaikalsky Territory*] *СПб, ЛЭТИ* [*St-Pb., LETI*], *301 pp.*

[CZERNYADJEVA, I.V. & E.A. IGNATOVA] ЧЕРНЯДЬЕВА И.В., Е.А. ИГНАТОВА. 2017. Мхи Ушканьего архипелага и островов Чивыркуйского залива (Забайкальский национальный парк, Бурятия). – [Mosses of the Ushkaniy Archipelago and islands of Chivyrkujsky Bay (Zabaikalsky National Park, Buryatia)] *Ботанический журнал* [*Botanicheskij Zhurnal* **102**(9): *1203–1218*. https://doi.org/10.1134/S0006813617090010

DÜLL, R. 1984. Taxonomy and distribution of some critical taxa of the genus *Didymodon* in Europe.– *Journal of the Hattori Botanical Laboratory* **55**: *259–266*.

ELLIS, L.T., H.B. M. ALIA, M. ALATAŞ, J. ÁLVAREZ, A.M. APONTE, O.M. AFONINA, J. J. ATWOOD, G. BACILLIERE et al. 2024. New national and regional bryophyte records, 76. – *Journal of Bryology* **46**(1): *51–74*.

JIMÉNEZ, J. A. 2006. Taxonomic revision of the genus *Didymodon* Hedw. (Pottiaceae, Bryophyta) in Europe, North Africa, and Southwest and Central Asia. – *Journal of the Hattori Botanical Laboratory* **100**: *211–292*.

FEDOSOV, V.E., E.A. IGNATOVA, M.S. IGNATOV, A.I. MAKSIMOV & V.I. ZOLOTOV. 2012. Moss flora of Bering Island (Commander Islands, North Pacific). – *Arctoa* **21**: *133–164*.

FRAHM, J.-P. 2002. Zur aktuellen Verbreitung von *Phascum leptophyllum* in Deutschland. – *Bryologische Rundbriefe* **55**: *1–8*.

FUDALI, E., M. SZCZEPAŃSKI, A. RUSIŃSKA, S. ROSADZIŃSKI & G. J. WOLSKI. 2009. The current distribution in Poland of some European neophytic bryophytes with supposed invasive tendencies. – *Acta Societatis Botanicorum Poloniae* **78**: *73–80*.

HODGETTS, N.G. & N. LOCKHART. 2020. Checklist and country status of European bryophytes – update 2020. – *Irish Wildlife Manuals* **123**: *214 pp*.

IGNATOV, M.S., O.M. AFONINA & E.A. IGNATOVA (eds.). 2006. Check-list of mosses of East Europe and North Asia. – *Arctoa* **15**: *1–130*.

IGNATOVA, E.A, V.E. FEDOSOV, O.I. KUZNETSOVA, A.V. FEDOROVA & M.S. IGNATOV. 2024. On the genus *Didymodon* s. str. (Pottiaceae, Bryophyta) in Russia. – *Arctoa* **33**: *129–155*.

IGNATOVA, E.A. & M.S. IGNATOV. 2007. Didymodon glaucus Ryan (Pottiaceae, Musci), the first record from Siberia. – *Arctoa* **16**: *139–143*.

IVANOVA, E.I., V.G. ISAKOVA, M.S. IGNATOV & E.A. IGNATOVA. 2017. On the moss flora of Khangalassky District (Republic of Sakha/Yakutia, East Siberia). – *Arctoa* **26**(1): *47–57*.

JIMÉNEZ, J.A. 2006. Taxonomic revision of the genus *Didymodon* Hedw. (Pottiaceae, Bryophyta) in Europe, North Africa, and Southwest and Central Asia. – *Journal of the Hattori Botanical Laboratory* **100**: *211–292*.

[LAZARENKO, A.S.] ЛАЗАРЕНКО А.С. 1940. Листяні мохи Радянського Далекого Сходу. І. – [*Mosses of the Soviet Far East. I*]. *Бот. Журн. АН УРСР* [*Botanichesky Zhurnal Akademii Nauk Ukrainskoy RSR*] **1**(3–4): *59–100.*

[PARTYKA, L.Ya.] ПАРТЫКА Л.Я. 2005. Бриофлора Крыма. – [*Bryoflora of Crimea*] *Киев, Институт ботаники НАН* [*Kiev, N.G. Kholodny' Inst. Bot. NAN*]*, 170 pp.*

PORLEY, R.D. 2005. The conservation of *Didymodon glaucus* Ryan in Britain. – *Boletín de la Sociedad Española de Briología* **26**–**27**: *55–58*.

PORLEY, R.D. 2007. Threatened bryophytes: *Didymodon glaucus*. – *Field bryology* **93**: *16–22*.

ZANDER, R.H. 2007. Pottiaceae. – *In: Flora of North America Editorial Committee (eds.) Flora of North America North of Mexico. Vol. 27. Oxford University Press, New York: 476–481.*

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