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MISCELLANEOUS NOTES ON THE GENUS *FORSSTROEMIA* (NECKERACEAE, BRYOPHYTA) IN RUSSIA

ЗАМЕТКИ О РОДЕ *FORSSTROEMIA* (NECKERACEAE, BRYOPHYTA) В РОССИИ

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Abstract

Molecular phylogenetic analysis supports the position on the species known as *Neckera konoi* in the genus *Forsstroemia*, therefore it is transferred to this genus with a new combination, *F. konoi* (Broth.) Enroth, Fedosov & Ignatov. Molecular data also confirm the position of *F. stricta* Laz. described from the Russian Far East in *F. producta*, a pantropical species. *Forstroemia neckeroides* is reported from Russia, Primorsky Territory, for the first time.

Резюме

Молекулярно-филогенетический анализ подтверждает принадлежность *Neckera konoi* к роду *Forsstroemia*; предлагается новая комбинация *F. konoi* (Broth.) Enroth, Fedosov & Ignatov. Молекулярные данные также подтверждают, что *F. stricta* Laz., описанная с российского Дальнего Востока, не отличается от пантропического вида *F. producta*. *Forstroemia neckeroides* впервые приводится для России по образцу, собранному в Приморском крае.

KEYWORDS: mosses, *Neckera*, *Forsstroemia,* taxonomy, East Asia, Russia

INTRODUCTION

Recent revisions of pleurocarpous mosses with molecular phylogenetic methods have brought new insights on the systematics of the group (e.g. Frey & Stech, 2009; Huttunen *et al.*, 2012). Neckeraceae is among the families which underwent one of the most drastic changes, and that work continues (Enroth *et al.*, 2010; Olsson *et al.,* 2009a,b, 2010, 2011, 2016).

The genus *Forsstroemia* Lindb. was monographed worldwide by Stark (1987) and then revised for Russia (Ignatov & Cherdantseva, 1995). However, new observations on the genus continue to appear, especially since a completely new approach to the genus was introduced by Olsson *et al.* (2011). Among others, one common Far Eastern species, *Neckera yezoana* (Besch.) S. Olsson, Enroth & D. Quandt and also a rare species, *N. goughiana* Mitt. were transferred to *Forsstroemia* (Olsson *et al.*, 2010). The genus was in the focus of molecular phylogenetic studies two more times (Olsson *et al.*, 2012; Akiyama, 2016), but some unresolved problems still remains.

The immediate aim of the present paper is to elucidate the species diversity of the genus *Forsstroemia* in Russia, bringing the nomenclature to follow the modern classification of the Neckeraceae, and correcting errors of previous authors.

MATERIAL AND METHODS

The material used in the present study was sampled from MW and MHA and supplemented by sequences available in GenBank. For the molecular phylogenetic study we used two markers, nuclear ITS1,2 and 5.8 rRNA gene and plastid region trnS-F, which were successfully used by Olsson *et al.* (2009a,b, 2011) and thus are available in GenBank for suite of "reference specimens" of *Forsstroemia* and related lineages of the family, involved as outgroups. We added in the dataset some originally studied specimens of *F. cryphaeoides* Cardot, *F. japonica* (Besch.) Paris, *F. noguchi* L.R. Stark, *F. producta* (Hornsch.) Paris and *F. yezoana*, as well as two samples of *Neckera konoi* Broth. Some species, being currently classified in *Neckera* Hedw. s.str., *Exsertotheca* S. Ols-

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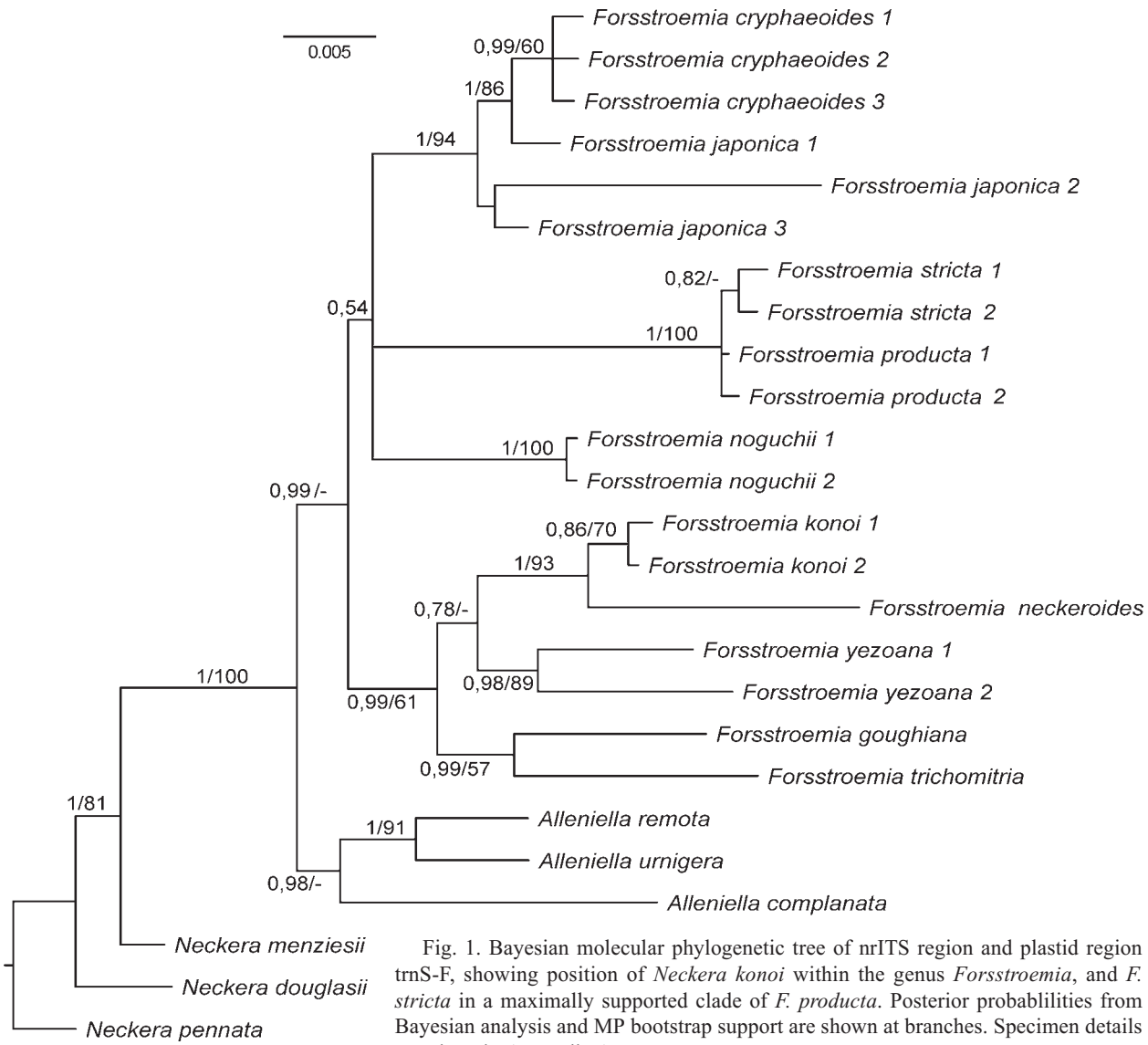


Fig. 1. Bayesian molecular phylogenetic tree of nrITS region and plastid region trnS-F, showing position of *Neckera konoi* within the genus *Forsstroemia*, and *F. stricta* in a maximally supported clade of *F. producta*. Posterior probablilities from Bayesian analysis and MP bootstrap support are shown at branches. Specimen details are given in Appendix 1.

son, Enroth & D. Quandt and *Alleniella* S. Olsson, Enroth & D. Quandt were included as an outgroup. Specimen details and GenBank accession numbers are given in Appendix 1.

The laboratory protocol was essentially the same as in previous moss studies, described in detail by, e.g., Gardiner *et al.* (2005). Sequences were aligned using MAFFT v. 7.402 (Katoh & Standley, 2013) with standard settings. At first, ITS (837 bp), and *trn*S-F (1820 bp) were analyzed separately to check congruence of resulting trees. As separate analyses of nuclear and chloroplastic datasets showed subidentical topologies, the concatenated ITS and trnS-F dataset was used for the final analysis (27 taxa, 2657 positions), performed by MrBayes 3.2.6 (Ronquist *et al.*, 2012), on the Cipres Science Gateway (http://www.phylo.org/portal2) on XSEDE with 20 000 000 generations, the chain temperature was set at 0.02. Convergence of each analysis was evaluated using Tracer1.4.1 (Rambaut & Drummond, 2007). Consensus trees were calculated after omitting the first 25% trees as burn-in. Trees were rooted on *Neckera pennata* Hedw., according to the topologies published by Olsson *et al.* (2009a,b, 2011). In addition, maximum parsimony analysis was completed with Nona (Goloboff 1994) within the Winclada shell (Nixon 1999), using the same alignment with a bootstrap calculation with 2000 replications (Parameter: number of search reps 10, starting tree per-rep 10, max tree 100, do max*, Save consensus).

Results

The obtained Bayesian tree resolves the genus *Forsstroemia* as monophyletic (PP=0.99) and sister to *Alleniella*, although MP analysis left subclades of *Forsstroemia* and *Alleniella* unresolved. Within *Forsstroemia,* species are grouped in two clades. The first clade includes species around *F. trichomitria* (Hedw.) Lindb., the type of the genus, and it is well supported (PP=0.99) in Bayesian analysis, although MP bootstrap is low (64). These species are characterized by larger leaves, and have

mostly lustrous plants. It includes, among others, highly sipported clade of *Neckera konoi* and *F. neckeroides* (PP=1, BS=93), otherwise the supported clades are monospecific. The second clade includes three groups, which are all characterized by smaller leaves. It received a very weak support even in Bayesian tree (PP=0.54), but within this clade all three subclades are maximally supported in Bayesian analysis, and have also high MP support: maximal for monospecific clades of (1) *Forsstroemia noguchii* (Chinese and Siberian specimens); (2) *F. producta* + *F. stricta* (Asian and American specimens), and high support (BS=94) from the clade of *F. cryphaeoides* + *F. japonica* (PP=1).

DISCUSSION

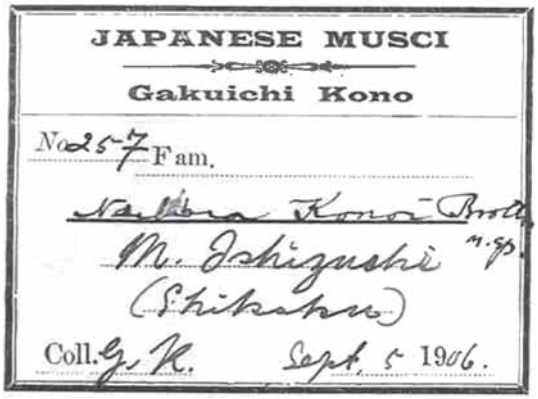
Obtained tree (Fig. 1) in general repeats the topologies published by both Olsson (2009a,b, 2010, 2011) and Akiyama (2016). The position of *Neckera konoi* in *Forsstroemia* is not especially surprising: after the transfer of *Neckera yezoana* and *N. goughiana* to *Forsstroemia* it became clear that the presence of costa is more important than the transversely undulate leaves, which may be totally absent in *Neckera*, e.g. in *N. californica* Hook. & Arn., formely being referred to the monospecific genus *Alsia* Sull.

Neckera konoi expectedly was found among *Forsstroemia*, and again expectedly near a *Forstroemia* with undulate leaves, *F. yezoana*, and therefore has to be transferred to *Forsstroemia* too.

The second problematic species of *Forsstroemia* is *F. stricta*. The species was described by Lazarenko (1941) and then accepted by Ignatov & Cherdantseva (1995) and Ignatov *et al.* (2006). Cherdantseva *et al.* (2018) suggested that this species is not distinct from *F. producta*, but with only brief comments, which will be complemented here.

Forsstroemia noguchii was described by Stark (1983) from Japan, with two paratypes from China and from Siberia. The species is rather rare, thus Stark (1987) reserved a possibility of its identity with *F. tripinnata* (Dixon) Nog. However, Akiyama (2016) found that *F. tripinnata* is closely related neither to *F. noguchi*, nor to the whole genus *Forsstroemia* but belongs to a relatively distant genus in the Neckeraceae, and has to be called *Pseudopterobryum tenuicuspis* Broth. An attempt to include the sequences of this species in the present analysis was given up, as its differences from *Forsstoemia* manifold exceed the differences between e.g. *Forsstoemia* with *Alleniella* and *Neckera*. The present study found that Chinese and Siberian specimens, including sequenced paratype, are genetically closest, thus the unity of disjunct population of *F. noguchii* is proved.

Lazarenko (1941) reported for Russian Far East, near Vladivostok, *Isothecium alopecuroides* (as "*I. viviparum*"), a species of amphiatlantic distribution, reaching in Eurasia to the east Caucasus. In the Middle European Russia all its localities are west of Moscow. We found


JAPANESE MUSCI

Gakuichi Kono

No 257 Fam.

Neckera Konoi Broth.

M. Ishizushi n. sp.

(Shikoku)

Coll. G. K. Sept. 5 1906.

Fig. 2. *Neckera konoi* lectotype label, H-BR 2892007.

that the specimen of Lazarenko from Vladivostok belongs to another species, and interestingly it is the first record of *F. neckeroides* in Russia. Previously this species was known from China, Korea and Japan.

TAXONOMY

1. **Forsstroemia konoi** (Broth.) Enroth, Fedosov & Ignatov, comb. nova – *Neckera konoi* Broth. in Cardot, Bull. Soc. Bot. Gèn., Sér. 2, 3: 277. 1911.

Protologue: "Japon: mont Ishizuchi (G. Kono, Herb. Brotherus); Tsurugizan (n. 1152); Koma-ga-take (n. 3554)".

Lectotype: "Japanese Musci, Gakuichi Kono, No *257, Neckera Konoi* Broth. n. sp., M. Ishizushi (Shikoku), Coll. *G. K.* Sept. 5 1906" (H-BR 2892007!, with sporophytes) (Fig. 2).

Neckera konoi was described from Japan and later reported from Anhui and Sichuan in China (Wu, 2011) and from Primorsky Territory in Russia (Ignatova *et al.*, 2009), with description and illustrations.

Forsstroemia konoi is known in Russia only from a localitity near Benevskie Waterfalls, on cliffs beside waterfall, in a restricted area.

2. **Forsstroemia producta** (Hornsch.) Paris, Actes Soc. Linn. Bordeaux, 9(3): 175. 1895. – *Pterogonium productum* Hornsch., Linnaea 15(1): 138–139. 1841.

Neotype: South Africa (MO, dupl. L), see details in Stark (1987).

Forsstroemia stricta Laz., Bot. Zhurn. (Kiev) 2(1): 84. 1941. Syn. nov.

Holotype: Russia, Primorsky Territory: Shkotovo Distr., Upper Maikhe River, Peishula, on rotten log, 10.X.1933, A. Lazarenko (KW!) [description and illustration of this specimen were provided by Ignatov & Cherdantseva, 1995].

Comment: Ochyra (1988) mentioned this specimen as lectotype. However, only one specimen is cited in the protologue, and Kiew' Institute of Botany (KW) is the main depositarium of Lazarenko collections, thus we designate the specimen as the holotype.

Forsstroemia stricta was described from a small spec-

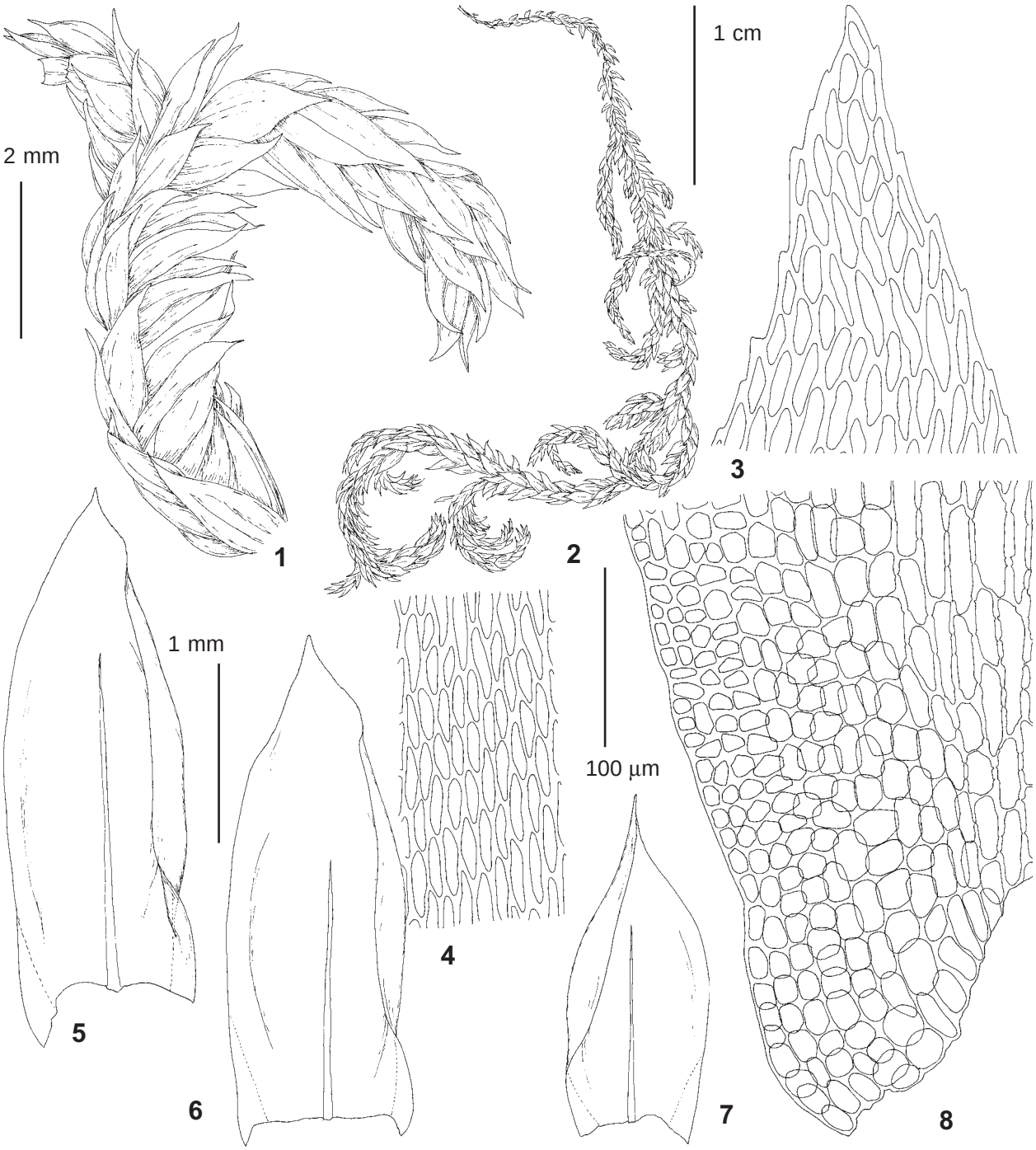


Fig. 3. *Forsstroemia neckeroides* Broth. from Okeanskaya, Lazarenko 1935 (KW): 1–2: habit; 3: upper leaf cells; 3: middle leaf cells; 5–7: leaves; 8: basal leaf cells. Scale bars: 1 cm for 2; 2 mm for 1; 1 mm for 5–7; 100 µm for 3, 4, 8.

imen, and male gemetangia were not found by Lazarenko, so the species was assumed to be dioicous. Ignatov & Cherdantseva (1995) confirmed this. However, subsequently we found this species in two localities and richer material showed an autoicous sexual condition in all collections. Quite many plants, either collected or seen in forest, had sporophytes.

DNA analysis of two specimens from two localities resolved them it an a clade with *F. producta* from Mexico and U.S.A., confirming their identity. *Forsstroemia producta* is a pantropical and subtropical species, and the name has numerous~~many~~ synonyms used for plants from Asia, Africa, North America and Australia (Stark, 1987).

3. **Forsstroemia neckeroides** Broth., Rev. Bryol. Lichénol. 2: 7. 1929.

Lectotype (selected by Stark, 1987): [China] "Mandschuria, prope stantionem Hantoheva (Handahoedzi) viae ferrafiae, ad rupes", coll. Litvinov s.n., 20 Jun 1903 (H-

BR 1742008!; isolectotypes H-BR 1742011!, H.BR 1742012!).

Description: Plants robust, in loose brownish-green, somewhat lustrous tufts. Secondary stems up to 2 cm long, curved, densely terete foliate, remotely and irregularly pinnately branched, branches up to 8 mm long, curved, similarly foliate as secondary stems. Stem leaves ovate to ovate-lanceolate, shortly acuminate, concave, 1.8–2.8 mm long, 0.7–1.1 mm wide; margin plane, entire to minutely crenulate; costa reaching 0.4–0.7 the leaf length; lamina cells ovate-elongate, 20–45 × 7–11 μm. Autoicous. Perigonia and perichaetia present. Sporophytes not available in Russian collection [Capsules immersed (Stark, 1987)].

Differentiation: The concave leaves of *F. neckeroides* with "oily luster" resemble *F. trichomitria*, but in that species the shoots are not so much curved, the leaves are less concave, not plicate, the costa reaches only 0.2–0.4(–0.5) the leaf length, and the commonly present sporophytes are exserted. Sympatric species of Lembophyllaceae that resemble *F. neckeroides*, i.e. *Dolichomitriopsis diversiformis* (Mitt.) Nog., *Dolichomitra cymbifolia* (Lindb.) Broth. and *Isothecium hakkodense* Besch. have a still longer costa, 0.6–0.8 the leaf length, not conspicuously curved shoots, and all of them are dioicous.

Specimen examined: [Russia, Primorsky Territory] Okeanskaya, Koreisakaya Sopka ["Corean Hill"], 6 Aug 1930, coll. A.S. Lazarenko, KW #12964.

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LITERATURE CITED

AKIYAMA, H. 2016. A re-examination of the identities of *Forsstroemia japonica* (Besch.) Paris and *Pseudopterobryum tenuicuspis* Broth. (Neckeraceae, Musci). – *Bryological Research* **11**(6): *157–166*.

CHERDANTSEVA, V.YA., O.YU. PISARENKO, M.S. IGNATOV, E.A. IGNATOVA, V.E. FEDOSOV, S.V. DUDOV & V.A. BAKALIN. 2018. Mosses of the southern Russian Far East, an annotated check-list. – *Botanica Pacifica* **7**(2): *53–81*.

ENROTH, J., S. OLSSON, S. HE, J.R. SHEVOCK & D. QUANDT. 2010. When morphology and molecules tell us different stories, part 2: *Pinnatella homaliadelphoides* (Neckeraceae), a new moss species from China and India. – *Tropical Bryology* **31**: *67–75*. https://doi.org/10.11646/bde.31.1.12

FREY, W. & M. STECH. 2009. Bryophyta (Musci, mosses). – *In: Frey, W. (ed.). Syllabus of plant families A. Engler's Syllabus der Pflanzenfamilien. Part 3. Bryophytes and seedless vascular plants. 13th ed.. Gebr. Borntraeger Verlagsbuchhandlung, Stuttgart, Germany: 116–257.*

GARDINER, A., M. IGNATOV, S. HUTTUNEN & A. TROITSKY. 2005. On resurrection of the families Pseudoleskeaceae Schimp. and Pylaisiaceae Schimp. (Musci, Hypnales). – *Taxon* **54**: *651–663*.

GOLOBOFF, P. A. 1994. NONA: A Tree Searching Program. – *Program and documentation. Argentina, Tucumán, published by the author.*

HUTTUNEN, S., N. BELL, V.K BOBROVA, V. BUCHBENDER, W.R. BUCK, C.J COX, B. GOFFINET, L. HEDENÄS, B.-C. HO, M.S IGNATOV, M. KRUG, O. KUZNETSOVA, I.A MILYUTINA, A. NEWTON, S. OLSSON, L. POKORNY, J.A. SHAW, M. STECH, A. TROITSKY, A. VANDERPOORTEN & D. QUANDT. 2012. Disentangling knots of rapid evolution: origin and diversification of the moss order Hypnales. – *Journal of Bryolpgy* **34**: *187–211.*

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.*

IGNATOV, M.S. & V.YA. CZERDANTSEVA. 1995. The families Cryphaeaceae, Leucodontaceae and Leptodontaceae (Musci) in Russia. – *Arctoa* **4**: *65–104*

IGNATOVA, E.A., M.S. IGNATOV & V.YA. CHERDANTSEVA. 2009. The genus *Neckera* (Neckeraceae, Bryophyta) in the Russian Far East. – *Arctoa* **18**: *177–188.*

KATOH, K. & D.N. STANDLEY. 2013. MAFFT Multiple sequence alignment software version 7: improvements in performance and usability. – *Molecular Biology and Evolution* **30** (4): *772–780*.

[LAZARENKO, A.S.] ЛАЗАРЕНКО А.С. 1941. Листяні мохи Радянського Далекого Сходу. I–IV. – [Mosses of the Soviet Far East. I–IV]. *Ботанічний Журнал АН УРСР* [*Botanichny Zhurnal Akadtmii Nauk Ukr. RSR*] Pt. II: *51–95.*

NIXON, K.C. 1999. *Winclada (BETA) ver. 0.9.9*. available at http://www.cladistics.com/about_winc.html.

OCHYRA, R. 1988. New taxa and new combinations of mosses proposed by Andrey S. Lazarenko. – *Journal of the Hattori Botanical Laboratory* **64**: *335–346.*

OLSSON, S., V. BUCHBENDER, J. ENROTH, S. HUTTUNEN, L. HEDENÄS & D. QUANDT. 2009a. Evolution of the Neckeraceae: resolving the backbone phylogeny. – *Systematics and Biodiversity* **7**: *419–432*. https://doi.org/10.1017/S1477200009990132

OLSSON, S., V. BUCHBENDER, J. ENROTH, L. HEDENÄS, S. HUTTUNEN & D. QUANDT. 2009b. Phylogenetic analyses reveal high levels of polyphyly among pleurocarpous lineages as well as novel clades. – *The Bryologist* **112**: *447–466.* https://doi.org/10.1639/0007-2745-112.3.447

OLSSON, S., V. BUCHBENDER, J. ENROTH, L. HEDENÄS, S. HUTTUNEN & D. QUANDT. 2010. Phylogenetic relationships in the "Pinnatella" clade of the moss family Neckeraceae (Bryophyta). – *Organisms, Diversity & Evolution* **10**(2): *107–122.* https://doi.org/10.1007/s13127-010-0017-z

OLSSON, S., J. ENROTH, V. BUCHBENDER, L. HEDENÄS, S. HUTTUNEN & D. QUANDT. 2011. *Neckera* and *Thamnobryum* (Neckeraceae. Bryopsida): Paraphyletic assemblages. – *Taxon* **60**(1): *36–50*.

OLSSON, S., J. ENROTH, S. HUTTUNEN & D. QUANDT. 2012. *Forsstroemia* Lindb. (Neckeraceae) revisited. – *Journal of Bryology* **34**(2): *114–122*.

OLSSON, S., J. ENROTH, S. HUTTUNEN & D. QUANDT. 2016. Phylogeny of *Neckeropsis* and *Himantocladium* (Neckeraceae, Bryophytina). – *Bryophyte Diversity and Evolution* **38**(2): *53–70*.

RAMBAUT, A., & A.J. DRUMMOND. 2007. Tracer. – Computer program and documentation distributed by the author, website http://beast.bio.ed.ac.uk/Tracer

RONQUIST, F, M. TESLENKO, P. MARK, Van der, D.L. AYRES, A. DARLING, S. HÖHNA, B. LARGET, L. LIU, M.A. SUCHARD & J.P. HUELSENBECK. 2012. MrBayes 3.2: efficient Bayesian phylogenetic inference and model choice across a large model space. – *Systematic Biology* **61**: *539–542.*

STARK, L.R. 1983. A new species of *Forsstroemia* from eastern Asia. – *Miscellanea Bryologica et Lichenologica* **9**: *181–183.*

STARK, L.R. 1987. A taxonomic monograph of *Forsstroemia* Lindb. (Bryopsida: Leptodontaceae). – *Journal of the Hattori Botanical Laboratory* **63**: *133–218*.

WU, P.-C. 2011. Neckeraceae. – *In: He. S. (ed.) Moss Flora of China. English Version. Vol. 5. Erpodiaceae–Climaciaceae. Science Press & Missouri Botanical Garden, Beijing, New York & St. Louis: 319–368.*

Appendix 1. Specimens used in the molecular phylogenetic analysis, ITS / trnS-F (for newly generated ones, the specimen voucher information is added).

Alleniella complanata JF690788 / AM990413; *A. remota* FM161171 / AM990415; *A. urnigera* FM161174 / AM990416; *Forsstroemia goughiana* FM161162 / FM210300; *F. trichomitria* FM161103 / AM990365; *F. yezoana* (Russia, Kuril Islands, Kunashir, Ignatov 06-1333 MHA, isolate AnomF15) MN011954 / MN031374; *F. yezoana* FM161177 / FM210312; *F. konoi* (Russia, Primorskiy Terrritory, 6.IX.2013, Ignatov, s.n. MHA, isolate OK587) MN011955 / MN031375; *F. konoi* (Russia, Primorskiy Terrritory, 5.IX.2013, Ignatov, s.n. MW 9049684, isolate NF62) MN011956 / MN031376; *F. neckeroides* FN868972 / FN868963; *F. producta* (Russia, Primorskiy Terrritory, 16.X.2008, Ignatov. MW9039963, isolate AnomF5) MN011957 / MN031377; *F. stricta* (Russia, Primorskiy Terrritory, 6.IX.2006, Ignatov, s.n. MW9039961, isolate AnomF6) MN011958 / MN031378; *F. producta* (USA, Arkansas, W. R. Buck 37442 NY00586485, isolate OK538) MN011959 / MN031379; *F. producta* 539 (Mexico, C. Delgadillo Moya 7390 NY01475937, isolate OK539) MN011960 / MN031380; *F. noguchii* (Russia, Buryatia, East Sayans, 13.VI.1962, Bardunov. MHA 9033172, isolate AnomF10) MN011961 / MN031381; *F. japonica* 1 LC041112 / LC041071 & LC041097; *F. japonica* 2 (Russia, Primorskiy Terrritory, 1.IX.2006, Ignatov, s.n. MW9039960, isolate AnomF4) MN011962 / MN031382; *F. cryphaeoides* 1 (Russia, Primorsky Territory, Ignatov 08-244 MHA 9033134, isolate AnomF12) MN011963 / MN031383; *F. cryphaeoides* 2 (Russia, Primorskiy Territory, Ignatov & Ignatova 06-3416 MHA 9033133, isolate AnomF14) MN011965 / MN031385; *F. cryphaeoides* 3 (Russia, Primorskiy Territory, Ignatov 08-214 MHA 9033118, isolate AnomF13) MN011964 / MN031384; *F. cryphaeoides* 4 FN868970 / FN868967; *Neckera menziesii* FM161167 / FM210305; *N. douglasii* FM161161 / FM210299; *N. pennata* (Austria, Kučera. SBFS 16367, isolate NF45) MN010515 / MN031368.