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Contribution to the Knowledge of the Genus *Usnea* (Parmeliaceae, Ascomycota) in Southern Far East Russia

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Abstract Specimens of the lichen genus *Usnea* from the southern part of Far East Russia were examined. As the result of our modern taxonomic studies, following 19 species were confirmed: *Usnea cornuta*, *U. dasaea*, *U. dasopoga*, *U. diffracta*, *U. diplotypus*, *U. fragilescens*, *U. fulvoreagens*, *U. glabrata*, *U. glabrescens*, *U. intumescens*, *U. lapponica*, *U. longissima*, *U. pangiana*, *U. praetervisa*, *U. rubicunda*, *U. rubrotincta*, *U. subfloridana*, *U. trichodeoides* and *U. wasmuthii*, of which *U. cornuta*, *U. dasaea*, *U. intumescens*, *U. pangiana*, *U. praetervisa* and *U. rubrotincta* are new to Russia. Although *U. aciculifera*, *U. articulata*, *U. barbata*, *U. bismolliuscula*, *U. cavernosa* and *U. mutabilis* have been reported from the southern part of Far East Russia, they were not found in our examined specimens, but they were included here in an artificial key to the 25 species recorded for this region.

Key words: Eastern Asia, flora, Jewish Autonomous Region, Khabarovsk, lichen, Primorsky, Sakhalin, taxonomy.

Introduction

The genus *Usnea* (Parmeliaceae, Ascomycota) is characterized by a fruticose thallus with cortex, medulla and a cartilaginous central axis, and the presence of usnic acid in the cortex. It consists of c. 350 species which are widely distributed throughout the world from polar to tropical regions (Kirk *et al.*, 2008; Divakar *et al.*, 2015).

In 2015, the first author had an opportunity to examine 96 specimens of the genus collected from the southern part of Far East Russia (Fig. 1) which were housed in the herbarium of the Pacific Geographical Institute, Vladivostok. Although 20 species were listed for this region (Urbanavichus, 2010), they have not been revised in the light of modern taxonomic studies conducted in related regions (e.g. Ohmura and Kashiwadani, 2000; Ohmura *et al.*, 2000, 2010; Ohmura, 2001, 2002, 2008, 2011, 2012, 2014; Ohmura and Kanda, 2004; Ohmura and Onimaru, 2010; Clerc, 2011). Therefore, the purpose of this study is to contribute to our knowledge of the genus *Usnea* in this region based on herbarium material.

Materials and Methods

This study is based on a total of 110 specimens, 96 of which were mainly collected by the second author between 1959 and 2014 and housed in the Pacific Geographical Institute, Far East Branch of the Russian Academy of Sciences (abbreviated as PGI in the present paper) and 14 specimens housed in the National Museum of Nature and Science, Tsukuba (TNS).

Morphological observations were made using dissecting and light microscopes. Ratio measure-

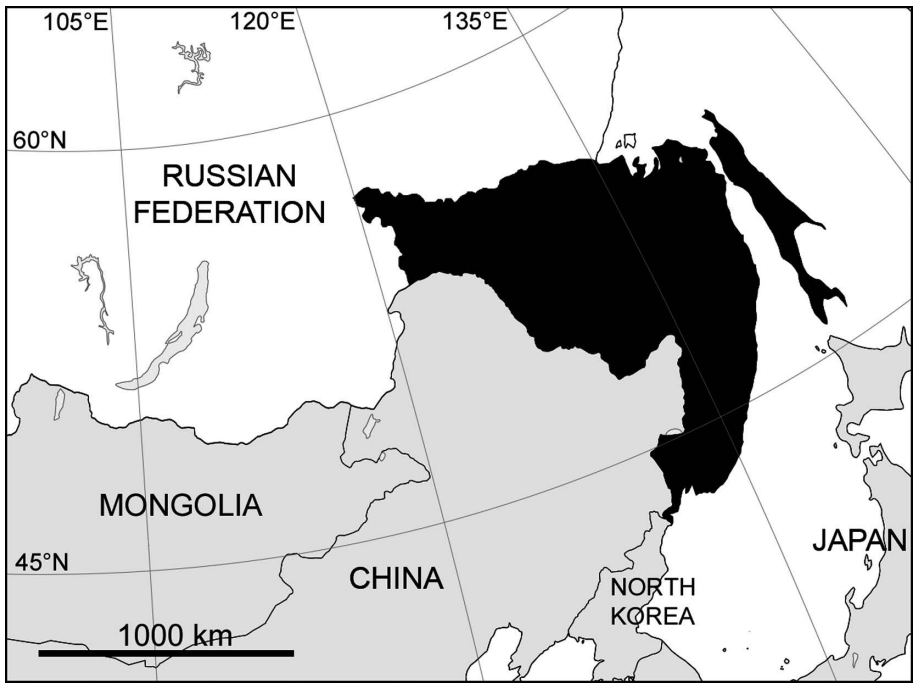

Fig. 1. Map showing the area of southern Far East Russia (black-painted). Modified after Urbanavichus (2010).

ments of the thicknesses of the cortex, medulla and axis of branches according to the method of Clerc (1984), and lichen substances were determined by thin layer chromatography (TLC) according to Culberson and Johnson (1982). Solvent B system (hexane : methyl tert.-butyl ether : formic acid, 140 : 72 : 18) was used for all TLC analyses. Morphological terminology follows that of Ohmura (2001).

Results and Discussion

The 19 species listed below were confirmed by the results of a taxonomic study based on 110 examined specimens.

1. U. cornuta Körb.

For a detailed description and synonyms, see Clerc (2011).

Chemistry. Three chemotypes were detected in the examined specimens: (1) usnic, norstictic, protocetraric (trace), and salazinic acids; (2) usnic, norstictic, menegazziaic, stictic, and constictic acids; and (3) usnic acid.

New to Russia.

Specimens examined. RUSSIA. Primorsky Krai: Terneiskiy District, upper part of Bol'shaya Ussurka River, north side of the valley, fir-spruce forest, on *Abies nephrolepis*, 1981, *I. F. Skirina 19147* (PGI); Chuguevskiy District, Golets mountain, fir-spruce forest, (1300 m elev.), on *Abies nephrolepis*, *Betula lanata*, and *Picea ajanensis*, 10 July 1991, *I. F. Skirina 13464* (PGI); Kedrovaya Pad Nature Reserve, right side of Kedrovaya River, near the upper part of watershed, 652 m elev., black fir forest, on *Tilia amurensis*, 11 July 1999, *collector unknown 5455* (PGI).

2. U. dasaea Stirt.

For detailed descriptions and synonyms, see Clerc (2011) and Ohmura (2001).

Chemistry. All examined specimens contain usnic, norstictic, protocetraric (trace) and salazinic acids.

New to Russia.

Specimens examined. RUSSIA. Primorsky Krai: Terneiskiy District, Krivoy creek, pine forest, on *Pinus koraiensis*, 30 June 1977, *I. F. Skirina 14649* (PGI); Chuguevskiy District, Upper Ussurian Stationary, test area no. 12, pine forest, on *Pinus koraiensis*, 11 Aug. 1976, *V. A. Efimova & I. F. Skirina 14672* (PGI); Dalnegorskiy District, Medvezh'ya mountain, N slope, fir-spruce forest, on deadwood of *Picea ajanensis*, 28 July 1982, *I. F. Skirina* 14667 (PGI); Dalnegorskiy District, upper part of Krivaya River, fir-spruce forest, on *Pinus koraiensis*, 1 Aug. 1992, *I. F. Skirina 9707* (PGI); Krasnoarmeiskiy District, Serokamenka River, fir-spruce forest, on deadwood, 1980, *I. F. Skirina 14808* (PGI); Lazovskiy District, Lazovskiy Pass, Suchanskiy creek, N side of valley, fir-spruce forest, on *Abies nephrolepis*, *Picea ajanensis*, *Betula lanata* and *Acer barbinerva*, April 1985, *I. F. Skirina 19139* (PGI); Michailovskiy District, Ivanovskiy forestry, fir-spruce forest, on *Abies nephrolepis* and *Picea ajanensis*, 1994, *I. F. Skirina 30495* (PGI); Terneyskiy District, Zacharovskiy creek, fir-spruce forest, on *Abies nephrolepis*, 10 Oct. 1976, *I. F. Skirina 14913* (PGI); Terneiskiy District, Sichote-Alinskiy Nature Reserve, plot of land Blagodatnoe, oak forest, on *Quercus mongolica*, 13 July 1977, *I. F. Skirina 14241* (PGI); Shkotovskiy District, near Shkotovo village, pine-broadleaved forest, on *Pinus koraiensis*, 1976, *collector unknown* (PGI); Sichote-Alinskiy Nature Reserve, Krivoy creek, pine forest, on *Pinus koraiensis*, 30 June 1977, *I. F. Skirina 14630* (PGI); Sichote-Alinskiy Nature Reserve, Tayozjnaya River, fir-spruce forest, on *Picea ajanensis* and *Abies nephrolepis*, 21 July 1980, *I. F. Skirina 28772* (PGI). Jewish Autonomous Region: Bastak Nature Reserve, Kirga River valley, near the Polkovnikova apiary, fir-spruce forest, on *Pinus koraiensis*, 7 Aug. 2002, *I. F. Skirina & V. I. Skirin 14635* (PGI); Bastak Nature Reserve, Kirga River valley, near the Polkovnikova apiary, fir-spruce forest, on *Picea ajanensis*, 7 Aug. 2002, *I. F. Skirina & V. I. Skirin 18946* (PGI); Bastak Nature Reserve, quarter 140, hill near bee-yard, oak forest, tree no. 3, on *Quercus mongolica*, 22 Sept. 2004, *I. F. Skirina 16542* (PGI); Bastak Nature Reserve, valley of Kirga River, pine-broadleaved forest, on *Abies* sp., 2003, *I. F. Skirina 34211* (PGI); Bastak Nature Reserve, right confluence of Bolshoy Sorennak River, near road, swamp with larch, on *Rhododendron davurica*, 13 Aug. 2002, *I. F. Skirina & V. I. Skirin 14640* (PGI).

3. U. dasopoga (Ach.) Nyl.

For a detailed description and synonyms, see Clerc (2011).

Chemistry. All examined specimens contain usnic and salazinic acids.

Specimens examined. RUSSIA. Khabarovsk Krai: Miao-Chan ridge, 10 km N of Gorniy village, left side of Amur River, fir forest, on *Picea* sp. 1983, *P. V. Elpatyevskiy s.n.* (PGI). Sakhalin Oblast: Timovskiy District, Pilinga River valley, fir-spruce forest, on *Abies sachalinensis*, 17 July 2014, *I. F. Skirina s.n.* (PGI, TNS).

4. U. diffracta Vain.

For a detailed description and synonyms, see Ohmura (2001).

Chemistry. All specimens examined contain usnic, barbatic, diffractaic, baeomycesic (trace) and squamatic acids.

Specimens examined. RUSSIA. Sakhalin Oblast: Mt. Suzuya, 19 July 1932, *Y. Asahina s.n.* (TNS); Toyohara, 12 Aug. 1920, *A. Yasuda s.n.* (TNS); Sakaehama, 21 July 1932, *Y. Asahina s.n.* (TNS); Takinosawa, 31 July 1932, *Y. Asahina s.n.* (TNS); Mt. Tosso, 24 July 1932, *M. Sato s.n.* (TNS); Tinnai, 14 Aug. 1933, *M. Sato s.n.* (TNS); Toyohara, 12 Aug. 1920, *M. Sato s.n.* (TNS).

5. U. diplotypus Vain.

For a detailed description, see Halonen *et al.* (1999).

Chemistry. All specimens examined contain usnic and salazinic acids.

Specimens examined. RUSSIA. Primorsky Krai: Partizanskiy District, Olhovaya mountain, 540 m elev., fir-spruce forest, on *Picea ajanensis*

and *Abies nephrolepis*, 2010, *I. F. Skirina 29423* (PGI). Sakhalin Oblast: Timovskiy District, Pilinga River valley, fir-spruce forest, on *Abies sachalinensis*, 18 July 2014, *I. F. Skirina s.n.* (PGI).

6. U. fragilescens Hav. ex Lynge

For a detailed description and synonyms, see Ohmura (2001).

Chemistry. Two chemotypes were detected in the examined specimens: (1) usnic, norstictic, salazinic and ± protocetraric (trace) acids; and (2) usnic, norstictic and stictic (trace) acids.

Specimens examined. RUSSIA. Primorsky Krai: Chuguevskiy District, valley of Ussury River, Berezoviy Pass, Berezoviy creek, fir-spruce forest, on *Abies nephrolepis* and *Picea ajanensis*, 20 Dec. 2001, *F. V. Skirin s.n.* (PGI); Dalnegorskiy District, headwater of Krivaya River, mixed pine-broadleaved forest, "Chortovi vorota" (Hell's gate), on *Pinus koraiensis*, 6 July 1976, *I. F. Skirina14563* (PGI); Lazovskiy District, Elamovskiy creek, pine-broadleaved forest, on *Abies nephrolepis*, 20 July 2000, *I. F. Skirina 14964* (PGI).

7. U. fulvoreagens (Räsänen) Räsänen

For a detailed description, see Ohmura (2001).

Chemistry. Two chemotypes were detected in the examined specimens: (1) usnic, diffractaic, norstictic and squamatic (trace) acids, and zeorin (trace); and (2) usnic and barbatic (trace) acids, and zeorin (trace).

Although Clerc (2011) treated this taxon under the synonym of *U. glabrescens*, *U. fulvoreagens* has deeply excavated soralia (as seen in *U. lapponica*) and constantly contains zeorin. In contrast, *U. glabrescens* has discrete soralia with slightly excavated surface and lacking zeorin. Therefore, *U. fulvoreagens* is treated as a distinct taxon in the current paper.

Specimens examined. RUSSIA. Primorsky Krai: Krasnoarmeiskiy District, Dal'niaya River, Porojistiy creek, fir-spruce forest, on *Abies nephrolepis*, 8 Aug. 2014, *I. F. Skirina & F. V. Skirin s.n.* (PGI). Sakhalin Oblast: Timovskiy District, Pilinga River valley, fir-spruce forest, on *Abies nephrolepis*, 18 July 2014, *I. F. Skirina s.n.* (PGI).

8. U. glabrata (Ach.) Vain.

For detailed descriptions, see Ohmura (2001) and Clerc (2011).

Chemistry. Two chemotypes were detected in the examined specimens: (1) usnic and salazinic acids; and (2) usnic, barbatic, 4-*O*-demethylbarbatic (trace), ± norstictic and ± protocetraric (trace) acids.

Specimens examined. RUSSIA. Primorsky Krai: Dalnegorskiy District, Eldorado mountain (1300 m elev.), fir-spruce forest, on deadwood of *Picea ajanensis*, 1982, *I. F. Skirina 14323* (PGI); Terneiskiy District, Dal'niy mountain ridge, fir-spruce forest, on *Abies nephrolepis*, 22 June 1977, *I. F. Skirina 14314* (PGI); Terneiskiy District, Solontsoviy creek, pine forest, on *Abies nephrolepis*, 7 July 1977, *I. F. Skirina 14665* (PGI); Terneiskiy District, estuary of Serebrianka River, *Chosenia* forest, on *Chosenia arbutifolia*, 11 July 1977, *I. F. Skirina 28605* (PGI); Terneiskiy District, Sichote-Alinskiy Nature Reserve, Tayozhnaya River, fir-spruce forest, on *Abies nephrolepis* and *Picea ajanensis*, 21 July 1980, *I. F. Skirina 28773* (PGI); Partizanskiy District, near Olhovaya mountain, Vetvistiy creek, 700 m elev., fir-spruce forest, on *Picea ajanensis* and *Betula lanata*, 19 Aug. 2006, *I. F. Skirina 29587* (PGI); Partizanskiy District, 25 km N of Sergeevka village, Sergeevskoe (Suchano-Malazskoe) plateau, 875 m elev., swamp with larch, on *Larix cajanderi*, 14 July 2002, *E. P. Kudryavceva 14354* (PGI); Partizanskiy District, spur of Skalistaya mountain, 1000 m elev., pine-broadleaved forest, area no. 10, tree no. 1 (N43°07′82.2″, E132°59′18.9″), on *Pinus koraiensis*, 25 Aug. 2012, *I. F. Skirina & F. V. Skirin 31979* (PGI).

9. U. glabrescens (Nyl. ex Vain.) Vain.

For descriptions and synonyms, see Halonen *et al.* (1999) and Ohmura (2001).

Chemistry. Usnic and norstictic acids were detected in the single specimen examined.

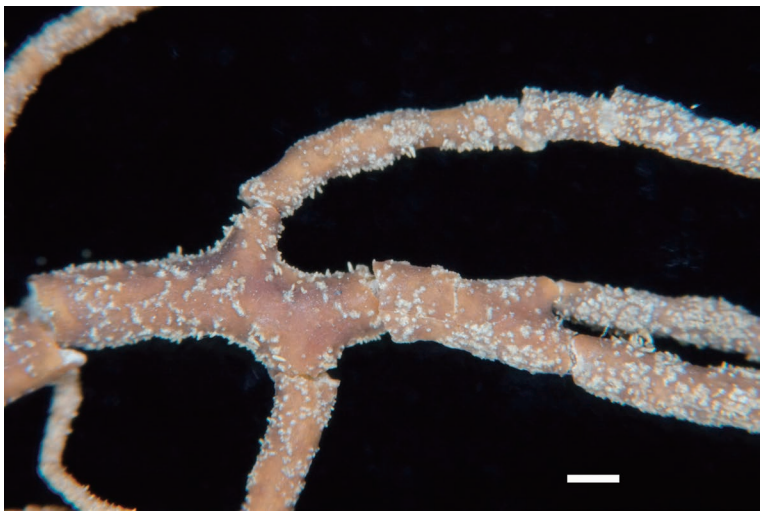

Fig. 2. *Usnea intumescens* (*Demenshina 14995*, fragment in TNS) showing punctiform soralia and the broadened base of branches. Scale = 0.5 mm.

See also *U. fulvoreagens* above for the differences.

Specimen examined. RUSSIA. Sakhalin Oblast: Timovskiy District, Pilinga River valley, fir-spruce forest, on *Abies nephrolepis*, 20 July 2014, *I. F. Skirina s.n.* (PGI).

10. U. intumescens Asahina

For a description and synonyms, see Ohmura (2001).

Chemistry. Usnic, psoromic and 2′-*O*-demethylprosormic acids were detected.

New to Russia. This species was previously known only from central Japan (Ohmura, 2001). However, the features of the Russian material [i.e. broadened base of branches, punctiform soralia (Fig. 2), and the presence of psoromic or salazinic acid as the major substance] coincide well with those seen in *U. intumescens* (see Ohmura, 2001).

Specimen examined. RUSSIA. Primorsky Krai: Khasanskiy District, Pos'et Bay, Sosnovaya Cove, pine forest, on *Pinus densiflora*, 5 Aug. 1980, *Demenshina 14995* (PGI).

11. U. lapponica Vain.

For descriptions and synonyms, see Clerc (2011) and Mark *et al.* (2016).

Chemistry. All specimens examined contain usnic and salazinic acids; a trace amount of zeorin was also detected in one specimen.

Usnea lapponica is morphologically difficult to distinguish from *U. fulvoreagens*.

Specimens examined. RUSSIA. Primorsky Krai: Partizanskiy District, Olhovaya mountain, 1500-1600 m elev. and Olchoviy creek (540 m elev.), fir-spruce forest, on *Abies nephrolepis*, *Picea ajanensis* and *Betula costata*, 27 July 2007, *I. F. Skirina & F. V. Skirin 29636* (PGI); Partizanskiy District, Postishevka River valley, 353 m elev., pine-broadleaved forest, area no. 2, tree no. 1 (N43°09′53.0″, E132°59′28.9″), on *Salix caprea*, 24 Aug. 2012, *I. F. Skirina & F. V. Skirin 31976* (PGI); Partizanskiy District, Olhovaya mountain, 540 m elev., fir-spruce forest, on *Picea ajanensis* and *Abies nephrolepis*, 2 July 2007, *I. F. Skirina & F. V. Skirin 29643* (PGI); Partizanskiy District, Olhovaya mountain, fallen fir, on *Abies nephrolepis*, 4 July 2007, *I. F. Skirina & F. V. Skirin 31121* (PGI). Sakhalin Oblast: Timovskiy District, Pilinga River valley, fir-spruce forest, on *Abies sachalinensis*, 18 July 2014, *I. F. Skirina*, *s.n.* (PGI, TNS); Timovskiy District, Timovsk city, on *Populus* sp., 18 July

2014, *O. E. Chrapko s.n.* (PGI); Timovskiy District, Pilinga River valley, fir-spruce forest, on *Abies sachalinensis*, 18 July 2014, *I. F. Skirina s.n.* (PGI).

12. U. longissima Ach.

For a description and synonyms, see Ohmura (2001).

Chemistry. Two chemotypes were detected in the examined specimens: (1) usnic, barbatic (trace), diffractaic, baeomycesic and squamatic acids; and (2) usnic and evernic acids. Ohmura (2001) also reported a further chemotype (usnic and barbatic acids) found in northern Hokkaido of Japan, and further investigation would no doubt find the chemotype in Far East Russia.

Specimens examined. Sakhalin Oblast: Timovskiy district, Pilinga River valley, fir-spruce forest, on *Abies sachalinensis*, 20 July 2014, *I. F. Skirina s.n.* (PGI); Takinosawa. 30 July 1932, *Y. Asahina s.n.* (TNS); *ibid*., 31 July 1932, *Y. Asahina 2503* (TNS); Sakaehama, 21 July 1932, *Y. Asahina s.n.* (TNS); *loc. non cit*., 1923, *O. Kikuchi s.n.* (herb. *Y. Asahina 2506*) (TNS); Aikawa (Picecharomai), 28 Feb. 1930, *O. Kikuchi s.n.* (TNS).

13. U. pangiana Stirt.

For a description and synonyms, see Ohmura (2001).

Chemistry. Two chemotypes were detected in the examined specimens: (1) usnic and salazinic acids; and (2) usnic acid. Although barbatic acid is also commonly detected in eastern Asian material (Ohmura, 2001), it was not detected in the examined specimens in this study.

New to Russia.

Specimens examined. RUSSIA. Primorsky Krai: Ussuriyskiy Reserve, on slope of watershed of Mironov creek, pine-broadleaved forest, on *Betula platyphylla*, 9 June 1974, *E. Semenova 32888* (PGI); Khasanskiy District, Kedrovaya Pad Reserve, right side of Kedrovaya river, 652 m elev., black fir-spruce forest, on *Tilia amurensis*, 11 July 1999, *I. F. Skirina 18651* (PGI); Khasanskiy District, Kedrovaya Pad Nature Reserve, Kedrovaya River, right side, 562 m elev., near the watershed, black fir forest, on *Tilia amurensis*, 11 July 1999, *I. F. Skirina 19120* (PGI); Khasanskiy District, Riazanovka railway station, near FEFU Biological Station, on hill slope, oak forest, on *Tilia amurensis*, 18 July 1984, *E. Shparko 14312* (PGI).

14. U. praetervisa (Asahina) P. Clerc

For a detail description, see Clerc (2004).

Chemistry. All examined specimens contain usnic and norstictic acids.

New to Russia.

Specimens examined. RUSSIA. Primorsky Krai: Sichote-Alinskiy Nature Reserve, Krivoy creek, east side of the valley, larch forest, scree, on *Rhododendron* sp., 1 July 1977, *I. F. Skirina s.n.* (PGI); Sichote-Alinskiy Nature Reserve, Listvenichniy island, estuary of Serebrianka River, birch forest, on *Betula platyphylla*, 14 June 1985, *I. F. Skirina 5419* (PGI). Sakhalin Oblast: Timovskiy District, Pilinga River valley, fir-spruce forest, on *Abies sachalinensis*, 18 July 2014, *I. F. Skirina s.n.* (PGI). Jewish Autonomous Region: Bastak Nature Reserve, mixed pine-broadleaved forest, on *Tilia amurensis*, 14 Aug. 2002, *I. F. Skirina & V. I. Skirin 14637* (PGI).

15. U. rubicunda Stirt.

For a detail description and synonyms, see Ohmura (2001).

Chemistry. Usnic, norstictic, menegazziaic, stictic and constictic acids were detected.

Specimen examined. RUSSIA. Primorsky Krai: Muraviev-Amurskiy Peninsula, Bogataya griva ridge, on *Fraxinus rinchophilla*, 14 Sept. 1959, *Vokueva 28901* (PGI).

16. U. rubrotincta Stirt.

For a detail description and synonyms, see Ohmura (2001).

Chemistry. All specimens examined contain usnic, norstictic, protocetraric (trace) and salazinic acids.

New to Russia.

Specimens examined. RUSSIA. Primorsky Krai: Shkotovskiy District, near Novaya Moskva village, the upper reaches of the Tigroviy creek, fir-spruce forest, on *Abies nephrolepis*, *Taxus kuspidata*, *Picea ajanensis* and *Acer* sp., 1 Sept. 2002, *I. F. Skirina 14865* (PGI); Shkotovskiy District, Livadiyskaya mountain, Pryamoi creek, fir-spruce forest, on *Abies nephrolepis*, 12 June 2003, *I. F. Skirina 30257* (PGI); Shkotovskiy District, Livadiyskaya mountain, Pryamoi creek, fir-spruce forest, on *Picea ajanensis*, 12 June 2003, *I. F. Skirina 34207* (PGI); Kedrovaya Pad Nature Reserve, near small hut, on *Pinus koraiensis*, 13 Sept. 1959, *Vasil'eva 34229* (PGI); Khasanskiy District, Gamova Peninsula, near Marine Experimental Station, oak forest with *Rhododendron*, on *Quercus mongolica*, 24 May 1988, *A. Mikulin 10687* (PGI); Khasanskiy District, Kedrovaya Pad Nature Reserve, near small hut, pine forest, on deadwood of *Pinus koraiensis*, 16 Aug. 1975, *I. F. Skirina & L. A. Knyazheva 18306* (PGI).

17. U. subfloridana Stirt.

For a detail description and synonyms, see Ohmura (2001).

Chemistry. Two chemotypes were detected in the examined specimens: (1) usnic and squamatic acids; and (2) usnic and thamnolic acids.

Specimens examined. RUSSIA. Khabarovsk Krai: Lazo District, Nelta River valley, right inflow of Muchen River, upper and middle flowing, 400-500 m elev., fir-spruce forest, on *Abies nephrolepis*, 29 March 2003, *I. F. Skirina s.n.* (PGI); Lazo district, Nelta River valley, right inflow of Muchen River, upper and middle flowing, 400-500 m elev., fir-spruce forest, on *Abies nephrolepis*, 29 March 2003, *I. F. Skirina s.n.* (PGI). Primorsky Krai: Ussuri Nature Reserve, pine-broadleaved forest, on fallen *Pinus koraiensis*, 7 Aug. 1974, *E. Semenova s.n.* (PGI); Partizanskiy District, Olhovaya mountain, fir-spruce forest, on *Picea ajanensis*, 4 July 2007, *I. F. Skirina & F. V. Skirin 31126* (PGI); Partizanskiy District, Postishevka River valley, 353 m elev., pine-broadleaved forest, area no. 2, tree no. 1 (N43°09′53.0″, E132°59′28.9″), on *Salix caprea*, 24 Aug. 2012, *I. F. Skirina & F. V. Skirin 31977* (PGI); Terneyskiy District, Djigitovka River, Zolotaya polyana village, north slope, oak forest, on *Quercus mongolica*, 1982, *I. F. Skirina 14809* (PGI); Terneyskiy District, Sichote-Alinskiy Nature Reserve, Blagodatnoe, Sukhoy creek, pine-broadleaved forest, on stones, 1982, *I. F. Skirina s.n.* (PGI); Terneyskiy District, Sichote-Alinskiy Nature Reserve, Blagodatnoe, oak forest with larch, on *Larix cajanderi*, 15 June 1985, *I. F. Skirina 5417* (PGI); Terneyskiy District, near Terney village, watershed, oak forest with larch, on *Larix cajanderi*, 15 June 1985, *I. F. Skirina 5437* (PGI); Partizanskiy District, Olhovaya mountain, on fallen *Picea ajanensis*, 4 July 2007, *I. F. Skirina & F. V. Skirin 31120* (PGI); Dalnegorskiy District, Rudnaya River valley, upper part of Novitskogo, watershed, on *Rhododendron davurica*, *Betula davurica* and *B. platyphylla*, 1981, *I. F. Skirina 10903* (PGI). Sakhalin Oblast: Timovskiy District, Pilinga River valley, fir-spruce forest, on *Abies sachalinensis*, 18 July 2014, *I. F. Skirina s.n.* (PGI, TNS); 10 km N of Buyukhli village, larch forest, on *Larix cajanderi*, 11 July 2014, *I. F. Skirina s.n.* (PGI); Timovskiy District, near Uskovo village, larch forest, on *Larix cajanderi*, 17 July 2014, *I. F. Skirina s.n.* (PGI); Timovskiy District, Pilinga River valley, fir-spruce forest, on *Abies sachalinensis*, 18 July 2014, *I. F. Skirina s.n.* (PGI).

18. U. trichodeoides Vain.

For a detail description and synonyms, see Ohmura (2001).

Chemistry. Atranorin, and fumarprotocetraric and usnic (trace) acids were detected. Ohmura (2001) also reported another chemotype (usnic and salazinic acids); since it was found in northern Hokkaido of Japan, further investigation no doubt detect the chemotype in Far East Russia.

Specimen examined. RUSSIA. Primorsky Krai: Khasanskiy District, Kedrovaya Pad Reserve, test area no. 6, behind small hut, pine forest, on *Pinus koraiensis*, 16 Aug. 1980, *L. A. Kniazsheva 14787* (PGI).

19. U. wasmuthii Räsänen

For a detail description and synonyms, see Ohmura (2001).

Chemistry. All specimens examined contain usnic and salazinic acids.

Specimens examined. RUSSIA. Primorsky Krai: Partizanskiy District, Olhovaya mountain, Olchoviy creek, 540 m elev., fir-spruce forest, on *Picea ajanensis* and *Abies nephrolepis*, 2 July 2007, *I. F. Skirina 29615* (PGI); Partizanskiy District, Olhovaya mountain, 540 m elev., fir-spruce forest, on *Picea ajanensis* and *Abies nephrolepis*, 2 July 2007, *I. F. Skirina 29404* (PGI); Partizanskiy District, Skalistaya mountain, watershed, 430–475 m elev., pine-broad-leaved forest, on *Picea ajanensis* and *Abies nephrolepis*, 24 Aug. 2012, *I. F. Skirina & F. V. Skirin 31978* (PGI); Terneiskiy District, Zakharovskiy creek, fir-spruce forest, on *Abies nephrolepis*, 10 Oct. 1976, *I. F. Skirina 15014* (PGI); Terneiskiy District, Zakharovskiy creek, fir-spruce forest, on *Abies nephrolepis*, 10 Oct. 1976, *I. F. Skirina 15021* (PGI).

Key to *Usnea* taxa in southern Far East Russia

The taxa in squared parentheses [ ] have been reported from southern Far East Russia, but not found in our examined specimens. Therefore this key includes such species possibly occurring in this region.

1. Red pigment present in the cortex 2
1. Red pigment absent in the cortex 3
2. Terminal and subterminal branches elongated; sorediate fibrils abundant on branches; soralia present both on fibrils and thick branches; salazinic acid present (or very rarely stictic acid could be present) ..... **U. rubrotincta** Stirt.
2. Terminal and subterminal branches not elongated; fibrils sparse and sorediate fibrils very rare on branches; soralia present mainly on thick branches; stictic acid present ..... **U. rubicunda** Stirt.
3. Cortex fragile on main branches, decorticated or areolate-corticated; thallus "fish-bone" like in appearance with numerous perpendicular fibrils on elongated branches 4
3. Cortex stable, consistent on the branches; thallus not as above 5
4. Branches terete, without longitudinal-furrows on the surface; diffractaic, barbatic (or possibly evernic) acids present ..... **U. longissima** Ach.
4. Branches flattened in well-developed thallus with longitudinal-furrows on the surface; fumarprotocetraric or salazinic acid present ..... **U. trichodeoides** Motyka
5. Annular-pseudocyphellae distinct on the segments of branches (bamboo-like appearance); thallus isotomic-dichotomous branching ..... **U. diffracta** Vain.
5. Annular-pseudocyphellae absent; thallus anisotomic- or isotomic-dichotomous branching 6
6. Medulla wine-red ..... [**U. mutabilis** Stirt.]
6. Medulla white 7
7. Branches foveolate and/or ridged 8
7. Branches not foveolate nor ridged 9
8. Soralia absent ..... [**U. cavernosa** Tuck.]
8. Soralia present, punctiform, ± plane to slightly stipitate ..... [**U. barbata** (L.) F.H. Wigg.]
9. Main branches inflated and segmented (sausage-like) ..... [**U. articulata** (L.) Hoffm.]
9. Branches do not form sausage-like segments 10
10. Thallus with jet black base 11
10. Thallus with concolorous to dark brown base 19
11. Soralia convex 12

11. Soralia concave 15
12. Squamatic or thamnolic acid present ..... **U. subfloridana** Stirt.
12. Salazinic or norstictic acid present 13
13. Norstictic acid present ..... **U. praetervisa** (Asahina) P. Clerc
13. Salazinic acid present 14
14. Thallus usually pendulous; terminal branches elongated ..... **U. dasopoga** (Ach.) Nyl.
14. Thallus shrubby; apical parts often sinuous ..... **U. diplotypus** Vain.
15. Soralia deeply excavated nearly into central axis 16
15. Soralia slightly excavated and never reaching to central axis 17
16. Salazinic acid present; norstictic acid absent ..... **U. lapponica** Vain.
16. Norstictic acid present; salazinic acid absent ..... **U. fulvoreagens** (Räsänen) Räsänen
17. Branches glossy on the surface, constricted at the ramification points ..... **U. fragilescens** Hav.
17. Branches mat on the surface, not constricted at the ramification points 18
18. Soralia discrete, rounded; norstictic acid present ..... **U. glabrescens** (Nyl. ex Vain.) Vain.
18. Soralia confluent, elliptic; norstictic acid absent ..... **U. wasmuthii** Räsänen
19. Branches inflated, constricted at the ramification points 20
19. Branches not inflated, not constricted at the ramification points 25
20. Soralia concave, cortical margin reflexed ..... **U. glabrata** (Ach.) Vain.
20. Soralia convex to flat 21
21. Stictic acid present 22
21. Stictic acid absent 23
22. Perforations present on thicker branches ..... [**U. bismolliuscula** Zahlbr.]
22. Perforations absent on thicker branches ..... **U. cornuta** Körb.
23. Lateral branches broadened at the base (Fig. 2) ..... **U. intumescens** Asahina
23. Lateral branches constricted at the base 24
24. Main branches inflated and segmented as sausage-like; soralia (usually cited as pseudocyphellae) punctiform and sparse; galbinic acid absent, fumarprotocetraric acid present or absent .... [**U. articulata** (L.) Hoffm.]
24. Branches do not form sausage-like segments; soralia irregular in shape which are developed from scars of detached fibrils; galbinic acid present or absent, fumarprotocetraric acid absent .... **U. dasaea** Stirt.
25. Base of thallus continuous or irregularly cracked; stictic acid present ..... [**U. aciculifera** Vain.]
25. Base of thallus distinctly annularly cracked; salazinic acid present ..... **U. pangiana** Stirt.

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