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ON SCIURO-HYPNUM OEDIPODIUM AND S. CURTUM (BRACHYTHECIACEAE, BRYOPHYTA)

О SCIURO-HYPNUM OEDIPODIUM И S. CURTUM (BRACHYTHECIACEAE, BRYOPHYTA)

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Abstract

Sciuro-hypnum curtum has been synonymized with *S. oedipodium*, but the present revision reveals that they are two distinct species although morphological variation is very broad in both of them. However, molecular delimitation of these two species (nrITS) is much more sharp. *Sciuro-hypnum curtum* is a widespread species in boreal forests of Eurasia, and occurs also in North America mainly in its eastern part, with solitary localities in the West. *Sciuro-hypnum oedipodium* is widespread in western North America, totally absent in the eastern part of this continent, and is known in Russia in Caucasus and in Chukotka. *Brachythecium holzingeri* is synonymized with *S. oedipodium.*

Резюме

Sciuro-hypnum curtum был отнесен с синонимы к *S. oedipodium* и последние 25 лет не считался самостоятельным видом, но настоящее исследование установило, что эти два вида довольно далеки друг от друга, несмотря на то, что из-за сильной вариабельности некоторые их морфотипы внешне очень сходны. Молекулярные данные по последовательностям ITS подтверждают их весьма значительные отличия, при том что каждый из них константен на протяжении всего ареала. *Sciuro-hypnum curtum* широко распространен в таежных лесах Евразии, встречается на востоке Северной Америки и в единичных точках на ее западе. *Sciuro-hypnum oedipodium* широко распространен на западе Северной Америки, отсутствует на востоке этого континента, а также выявлен в России на Кавказе и на Чукотке. *Brachythecium holzingeri* отнесен в синонимы к *S. oedipodium.*

INTRODUCTION

The complex of species around *Scuiro-hypnum* (formerly *Brachythecium*) *starkei* is known to be difficult, causing considerable incongruence of species concepts of different authors during the XIX and most of the XX century.

A detailed overview of this history was presented by Piippo (1983), who also selected the neotype of *Hypnum starkei* Brid. and lectotypes of *H. oedipodium* Mitt. and *H. curtum* Lindb., i.e. the taxa in which the indefinite concepts were the main source of taxonomic and nomenclatural confusions.

According to Piippo (1983), this complex includes two species in the Northern Hemisphere, *Brachythecium oedipodium* and *B. starkei* (this group of *Brachythecium* was later transferred to *Sciuro-hypnum* by Ignatov & Huttunen (2002)). Both these species are widespread in northern Europe occurring also in Asia and North America. The concept of Piippo received wide acceptance and was followed in checklists of North America (Anderson et al., 1990), China (Redfearn et al., 1996), Europe (Hill et al., 2006), East Europe and North Asia (Ignatov,Afonina, Ignatova et al., 2006).

The work on the treatment of Brachytheciaceae for the Flora of North America, however, revealed certain difficulties in the application of

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Piippo's (1983) concept. The species identical to widespread European '*oedipodium*' sensu Piippo was found to be more or less widespread in New England and neighboring areas in eastern North America (but with two localities in the Rocky Mountains), while the type of *Hypnum oedipodium* was from the mountains of the West. The type itself comprises poorly developed plants, however very numerous collections from the western states, usually kept in North American herbaria (e.g. in DUKE, MO, NY, US) under '*Brachythecium starkei*', represent a species quite different from '*oedipodium*' sensu Piippo. The type of *Hypnum oedipodium*, as it will be argued below, belongs to this widespread western species, and therefore cannot be applied to the widespread Eurasian and eastern North American species. The earliest species name for the latter species and also the name used for a long time in Europe is '*curtum*', thus this taxon has to be called:

Sciuro-hypnum curtum (Lindb.) Ignatov, **comb. nov.** – *Hypnum curtum* Lindb., Musci Scandinavici 35. 1879 [the validation in Helsingfors Dagblad 1878 (342): 2. 1878 is earlier, but probably has to be ignored as it appeared in a public newspaper, not in scientific literature] – *Brachythecium curtum* (Lindb.) J. Lange & C.O.E.Jensen, Medd. Groenland. 3: 337. 1887.

At the same time, *Sciuro-hypnum starkei* s. str., identical with European and Asian, occurs in North America, although limited in its distribution to the eastern provinces of Canada, occurring in U.S.A. only in Maine, Vermont and Wisconsin.

MORPHOLOGICAL DIFFERENCES BETWEEN *S. CURTUM* AND *S. OEDIPODIUM*

Both species are very variable, so the marginal phenotypes and poorly developed plants of these species (as well as many other Brachytheciaceae) are difficult or even impossible to interpret.

The optimally developed, *S. curtum* (cf. Fig. 1) is a relatively large plant with rather remotely arranged leaves, that are patent and usually somewhat twisted along their length when dry, resulting in a peculiar appearance that has an aspect of terrestrial phenotypes of *Plagiothecium denticulatum*. Branches have an apparent tendency to complanate foliage. Stem leaves are broadly ovate below and are broadest at 1/7–1/10 of leaf length. Decurrencies are long but rather narrow. Mid leaf cells are linear, 60-80 μm long, being 7-12:1. Cells in leaf corners are enlarged, thin-walled and thus pellucid, gradually or rather abruptly delimited from laminal and basal juxtacostal cells. Branch leaves are usually strongly serrate. Seta is distinctly and invariably rough. Capsule is relatively long, and when young is strongly curved with operculum pendent to faced back towards the seta, or ultimately even faced upward, the capsule having made a curve of >270° [there are however exceptions when capsule is relatively short]. The under-developed plants have about the same size of stem and branches, but smaller and more remote leaves.

The optimally developed plants of *S. oedipodium* (e.g. Fig. 2) are rather densely and terete foliate, so the plants have the appearance of *Brachythecium* or of a very large *Sciuro-hypnum glaciale*. Leaves are appressed at their bases, and above are either erect, or gradually reflexed. Leaves are ovate, but compared with *S. curtum* are not that broad and usually have broadest point at 1/6–1/7 of leaf length (not at 1/7–1/10 or occasionally even below the point of insertion in *S. curtum*). Decurrencies are long and conspicuously broad (this is a useful character for identification of smaller phenotypes). Mid-leaf cells are very variable even within one shoot, ranging from 3-4:1 to 7-10:1; an example is shown in Fig. 5. Cells in the leaf corner are subquadrate to shortly rectangular, slightly enlarged, rather numerous along the margin to the broadest point of leaf, with 'normally' thickened cell walls, thus the alar group is conspicuous, but 'not especially pellucid, not especially opaque', usually very gradually transforming into laminal and basal juxtacostal cells. Branch leaves usually serrulate, but variable in this character from subentire to quite serrate. Seta is distinctly rough, although in a few collections only slightly so. Capsule is short, inclined to horizontal, and in many cases looks 'too abruptly' hozirontal for that short shape; more rarely the capsule is somewhat elongate, but at the immature state is never strongly curved. The under-developed plants are smaller and with smaller leaves and the variation from large to small shoots is observed in many collections.

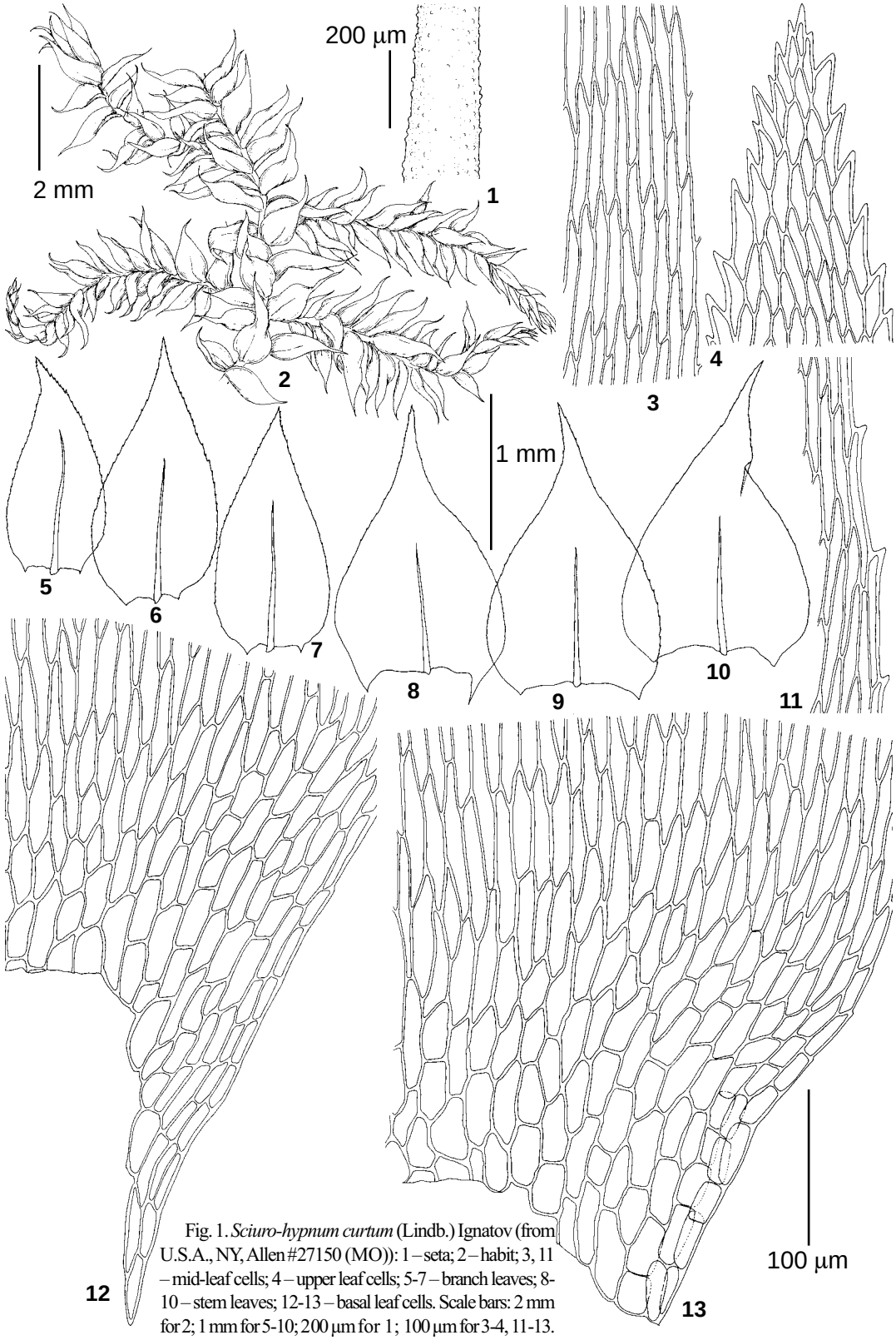

Fig. 1. *Sciuro-hypnum curtum* (Lindb.) Ignatov (from U.S.A., NY, Allen #27150 (MO)): 1 – seta; 2 – habit; 3, 11 – mid-leaf cells; 4 – upper leaf cells; 5-7 – branch leaves; 8-10 – stem leaves; 12-13 – basal leaf cells. Scale bars: 2 mm for 2; 1 mm for 5-10; 200 μm for 1; 100 μm for 3-4, 11-13.

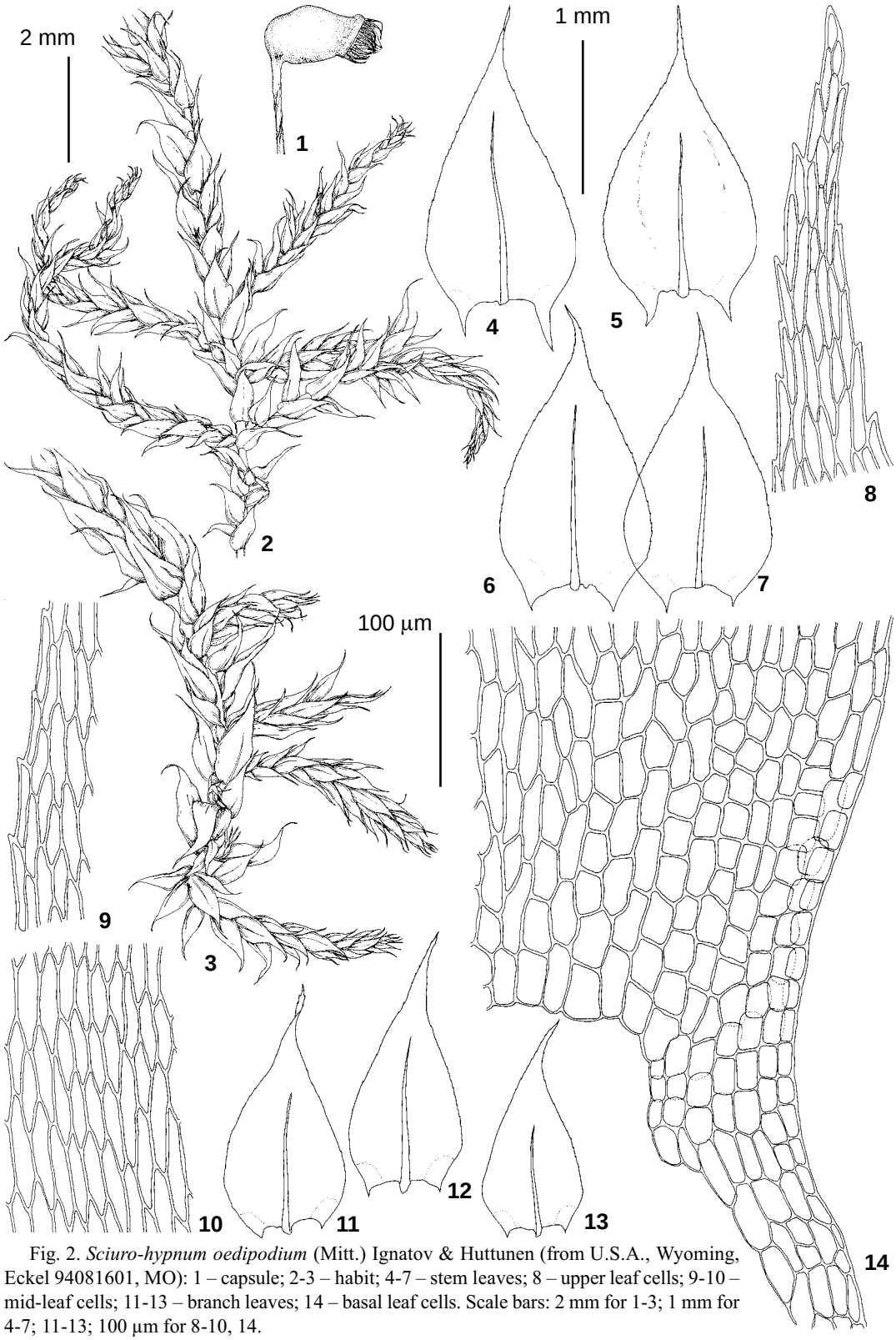

Fig. 2. *Sciuro-hypnum oedipodium* (Mitt.) Ignatov & Huttunen (from U.S.A., Wyoming, Eckel 94081601, MO): 1 – capsule; 2-3 – habit; 4-7 – stem leaves; 8 – upper leaf cells; 9-10 – mid-leaf cells; 11-13 – branch leaves; 14 – basal leaf cells. Scale bars: 2 mm for 1-3; 1 mm for 4-7; 11-13; 100 µm for 8-10, 14.

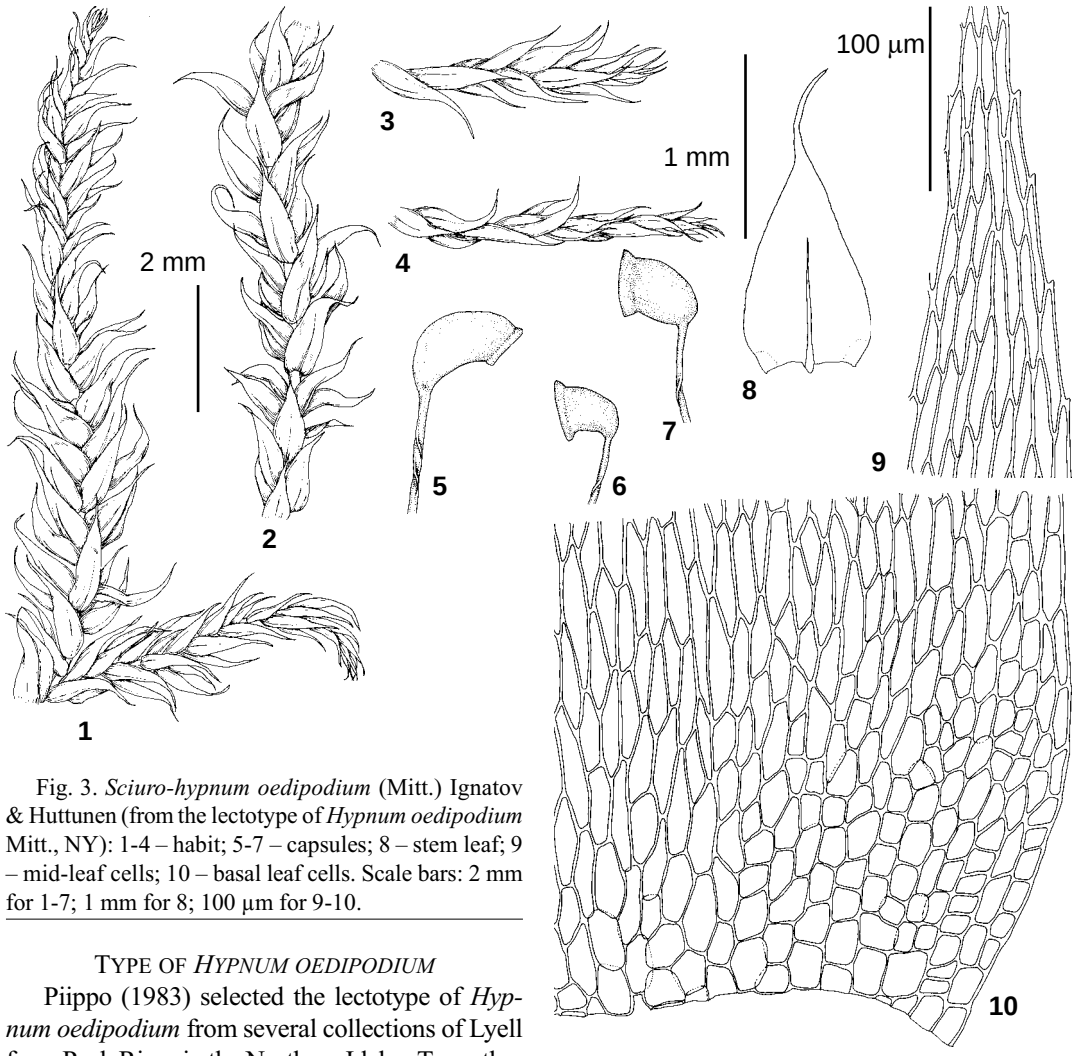

Fig. 3. *Sciuro-hypnum oedipodium* (Mitt.) Ignatov & Huttunen (from the lectotype of *Hypnum oedipodium* Mitt., NY): 1-4 – habit; 5-7 – capsules; 8 – stem leaf; 9 – mid-leaf cells; 10 – basal leaf cells. Scale bars: 2 mm for 1-7; 1 mm for 8; 100 μm for 9-10.

Type of *Hypnum oedipodium*

Piippo (1983) selected the lectotype of *Hypnum oedipodium* from several collections of Lyell from Pack River in the Northern Idaho. Two other collections from the same place were designated as syntypes, and are identical, except the collection from Michigan that belongs to *S. curtum.*

The lectotype is correctly selected, described and illustrated by Piippo (1983). However the collection does not represent plants that are very well developed, thus providing problems with its interpretation. In Fig. 3, *8-10,* one of the stem leaves from a small envelope where Piippo has put leaves used for her drawings is illustrated. Fig. 3, *10* shows alar cells typical for plants widespread in the West, and leaf shape (Fig 3, *8*), mid-leaf cells (Fig. 3, *9*) and short capsules (Fig. 3, *5-7*), as well as non-complanate foliage (Fig. 3, *1-4*). These features demonstrate that the type of *Hypnum oedipodium* and the species widespread in mountains of western North America belong to a single species and therefore the name '*oedipodium*' should be used for it.

What is *Brachythecium holzingeri*?

Grout described this species first as a variety of *Brachythecium collinum* (Grout, 1901), then raised its status up to species level (Grout, 1922), then decided that it was not a member of Brachytheciaceae at all (Grout, 1928), and finally accepted it again as a good species of *Brachythecium* (Grout, 1934). This vacillation might look strange to one who has never worked on taxonomy of Brachytheciaceae, where many species exhibit 'intergradations' 'to all other species'. Note that *Brachytheciastrum (Brachythecium) collinum* is

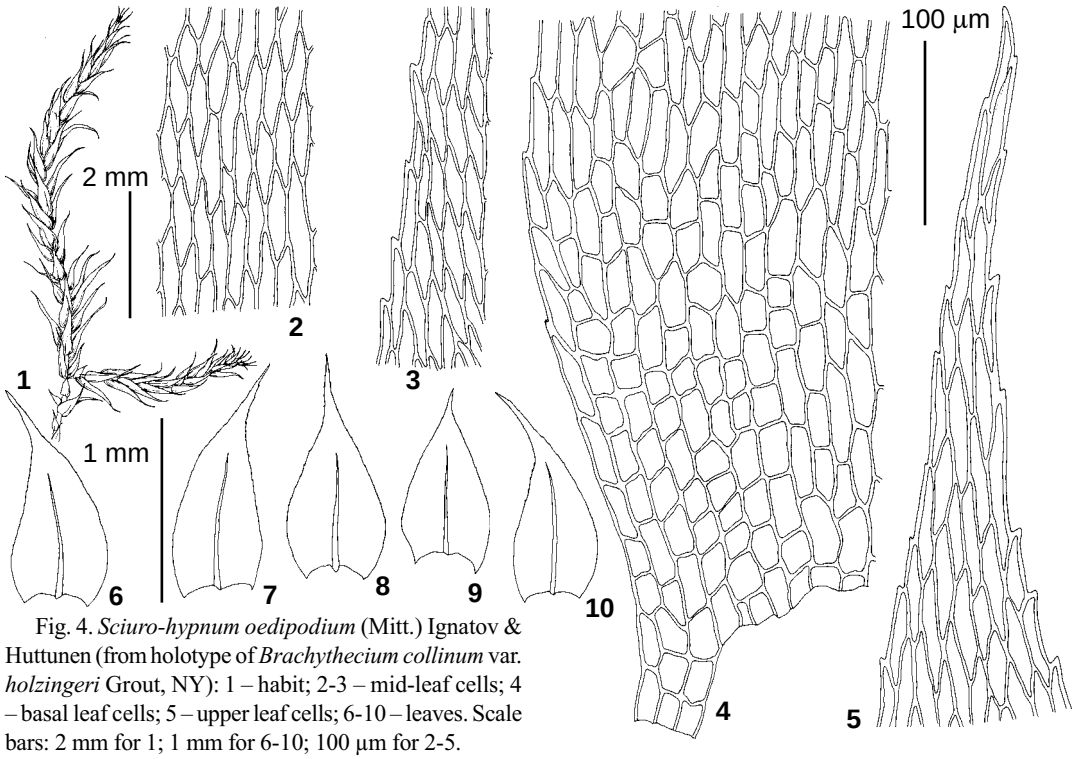

Fig. 4. *Sciuro-hypnum oedipodium* (Mitt.) Ignatov & Huttunen (from holotype of *Brachythecium collinum* var. *holzingeri* Grout, NY): 1 – habit; 2-3 – mid-leaf cells; 4 – basal leaf cells; 5 – upper leaf cells; 6-10 – leaves. Scale bars: 2 mm for 1; 1 mm for 6-10; 100 μm for 2-5.

one of the smallest species of *Brachythecium* s. ampl., while here *B. collinum* var. *holzingeri* is synonymized with *Sciuro-hypnum oedipodium*, one of the largest species of *Brachythcium* s. ampl. This case demonstrates once more the extreme polymorphism of *Sciuro-hypnum oedipodium.*

Sciuro-hypnum oedipodium (Mitt.) Ignatov & Huttunen, Arctoa 11: 270. 2002 [2003]. – *Brachythecium collinum* var. *holzingeri* Grout, Bryologist 4: 236. f. 2a. 1901, syn. nov. – *Brachythecium holzingeri* (Grout) Grout, *Bryologist* 25: 14. 1922.

The holotype of *Brachythecium collinum* var. *holzingeri* in DUKE has a printed label inside the envelope: 'Mosses of North-Western Montana, from the vicinity of lake McDonald, Flathead county, N.-W. Montana. The lake in four miles north of Belton, a station 30 miles east of Kalispell, on the Great Northern Railway. Distributed by J.M. Holzinger. Collected by John M. Holzinger and James B. Blake, July 14-30, 1898, Altitude 3,500–7,000 feet.' Handwritten on this label: 'Base of Sperry glacier, July 25.'

There are three labels glued on the envelope:

1) Rev. N.A.Brachytheciaceae, A.J.Grout, *B. collinum* var. *holzingeri*. Leaves larger and more gradually acuminate than in *B. collinum*. Less serrate leaf, cells broader, [unclear].

2) belong to the *collinum* group

3) type.

[inside there are also two other labels, one with illegible handwriting, second (printed): 'North American Musci Perfecti issued by A.J.Grout, Ph.D.', pencil handwriting of A.J.Grout 'May 1928, This seems to be *Amblystegium Kochii* forma'].

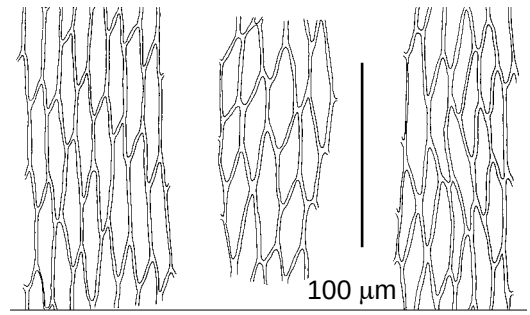

Fig. 5. *Sciuro-hypnum oedipodium* (Mitt.) Ignatov & Huttunen (from Colorado, MO): mid-leaf areolation from different leaves of one shoot, showing variation. Scale bar: 100 μm.

The collection is very poor, comprised mostly of *Polytrichum* with a few thin shoots of a Brachytheciaceae, which exhibit however the main diagnostic characters of *S. oedipodium* (Fig. 4), and therefore is synonymized with this species.

The type of '*holzingeri*' differs from *B. collinum* in the less strong margin serration and less thick-walled cells.

The occurrence of *S. oedipodium* in Eurasia

The circumspription of *S. oedipodium* in North America has helped in the interpretation of several enigmatic specimens from Russia, that were kept in a folder 'to be described'.

Plants from middle and upper elevations of Caucasus (Fig. 6) could not be comfortably placed in *S. curtum*, because of too long leaves, opaque rather than pellucid alar cells and relatively short capsule. From ITS sequences it appears to be closest to *S. reflexum*, although strikingly different from the latter in the much bigger size of the plants (like large *Brachythecium salebrosum* or *B. rutabulum*). The ITS sequence differs from that of *S. reflexum* by just one substitution, but that is the same substitution by which *S. reflexum* differs from the American *S. oedipodium* (see below for details).

In general, *S. oedipodium* seems to be rather rare in Caucasus, and so far we have failed to discover it in other Caucasian countries, although it likely occurs in Georgia. This rarity might also correspond to its rarity in Central European mountains. We found no specimens in MW and LE. At the same time, *S. oedipodium* is likely present there, judging from the overall distribution, and from the descriptions of Limpricht (1896). In addition to *Brachythecium curtum,* Limpricht also recognized *Brachythecium strakei*, and the description and illustrations of the latter species are in good agreement with the current concept of *S. oedipodium*. *Sciuro-hypnum starkei*, as it is understood now (cf. Piippo, 1983, and see also below) does not fit any of Limpricht's descriptions, although according to the key to species *'Brachythecium troemsoense* (Kaur. & Arnell) Limpr.' seems to be fairly close to *S. starkei*, as it has a percurrent costa (however the species description indicates a short costa).

In addition, *S. oedipodium* was found in just one collection from Chukotka, where it could be expected, judging from its distribution in the north-west of North America. The Gil'mimliveem Hot Springs, where it was collected, are not far from another hot springs with the only Asian locality of *Plagiothecium undulatum*, a species common in Western North America, also exhibiting disjunction to Europe (Afonina, 2004).

The currently known distribution of S. curtum and S. oedipodium

The main purpose of this paper is to stress the non-identity of *S. curtum* and *S. oedipodium* that was found during revision of North American and Russian material, thus only a few collections from Eurasia outside Russia were revised and included in the list below. Mostly just one specimen per country is cited, except Russia, U.S.A. and Canada, where specimens are cited one per state/province/territory/ or other administrative unit.

SELECTED SPECIMENS EXAMINED:

Sciuro-hypnum curtum

EUROPE: ***RUSSIA***: **Arkhangelsk Prov**.: Kargopol, *Churakova #1238* (MHA); **Bashkiria**: Malyj Iremel Mt., 700 m, *Ignatova #2/65* (MHA); **Belgorod Prov.**: Shebekino Distr., Titovka, 12.VII.2006 *Maslova* (BSU ex MHA); **Bryansk Prov**.: Zhukovka Distr.: between Zhukovka and Trosna, 23.VII.1974 *Makarov* (MHA); **Chuvashia**: Prisursky reserve, V.1999 *Moshkovsky* (MHA); **Kaluga Prov.**: Mechivino, 16.VIII.1911 *Nikolaevskaya* (LE); **Karelia**: Kindo Cape, 29.VI.1994 *Spirina* (MW); **Komi Republic**, 22 km WNW of Syktyvkar, 27.VI.1994 *Zheleznova* (MHA); **Kostroma Prov.**: Sharya Distr., Pechenkino, 17.IX.1990 *Ignatov* (MHA); **Kursk Prov.**: Centralno-Czernozemny Reserve, 13.VIII.1996 *Ignatov* (MHA); **Leningrad Prov**.: Komarovo 26.VII.2007 *Kurbatova* (LE); Lakhta, 4.IX.1919 anonymous (MW); **Mari-El Republic**: Bolshaya Kokshaga Reserve, 15.X.1999 *Bogdanov et al.,* (MHA); **Moscow Prov.**: Taldom Distr., Meldino, 18.VII.1996 *Ignatov & Ignatova* (MHA); **Murmansk Prov.**: Ponoy River, Czernyadjeva 30.VII.1989 (LE); **Nizhny Novgorod Prov**.: Kerzhensky Reserve, 15.X.1998 *Popov #203* (MHA); **Novgorod Prov**.: Valdaj Distr., 1.VIII.1981 *Morozova* (MHA); **Perm Prov.**: Vishera Reserve, 500 m, 30.VI.1994 *Bezgodov #290* (MW); **Pskov Prov.**: Mikhailovskoe, 17.VIII.2005 *Afonina* (LE); **Ryazan Province**: Oksky Reserve, 2.VI.1968 *Bogdanova* (MW); **Smolensk Prov**.: Petrakovo, 16.VII.2004 *Ignatov* (MHA); **Tatarstan**: Volzhsko-Kamsky Reserve, 18.VIII.2003 *Ignatov & Ignatova* (MHA); **Tula Prov.**: Yulskie Zaseki, 27.VI.1971 *Kurnaev* (LE); **Udmurtia**, Votkinsk Distr., Kostovaty, 17.VII.2000 *Munitzyna* (MHA); **Vladimir Prov.**: Gor-

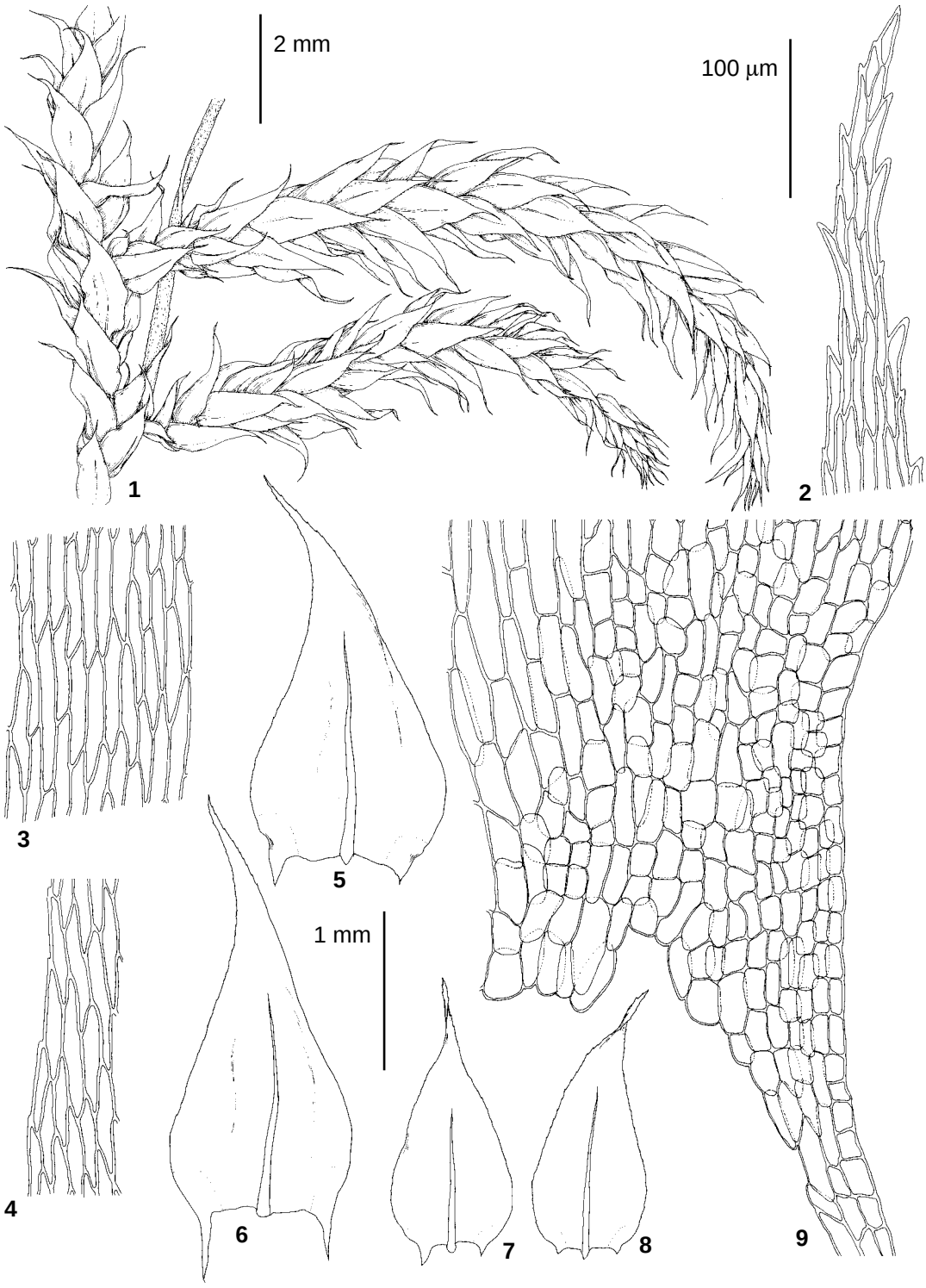

Fig. 6. *Sciuro-hypnum oedipodium* (Mitt.) Ignatov & Huttunen (from Russia, Caucasus, Teberda Reserve, 2100 m alt., Ignatov & Ignatova 06-3038): 1 – habit; 2 – upper leaf cells; 3-4 – mid-leaf cells; 5-6 – stem leaves; 7-8 – branch leaves; 9 – basal leaf cells. Scale bars: 2 mm for 1; 1 mm for 5-8; 100 μm for 2-4, 9.

okhovets Distr.: 32 km NNE of Murom, *Seregin #M-1565* (MHA); **Vologda Prov.**: Sokol Distr., Shorega Creek 22.IX.1990 *Ignatov* (MHA). ***GERMANY****:* Breutel, Flora Germ. Exs. #387 (LE, sub. *Hypnum starkei*). ***POLAND***: Ochyra - Musci Pol. Exs. 878,.1182 (MHA, sub. *Brachythecium oedipodium*). ***SWEDEN***: Stockholm, 25.II.1995 *Ignatov* (MHA). ***BELARUS***: Grodno Prov., *Seregin et al., #M-1673* (MHA); ***UKRAINA***: Kiev, 19.VII.1986 *Virchenko* (MHA); ***ESTONIA***: Keeri-Karijärve Nature Reserve, 31.VIII.2007 *Leis* (MHA).

ASIA: ***RUSSIA****:* **Altai Republic:** Bolshoye Istyube Creek, 470 m, *Ignatov 18/44, 18/9* (MHA); **Altaisky Territory**: Barnaul, 21.VII.2004 *Ignatov* (MHA); **Amurskaya Prov.**: Zeysky Reserve, 5.VIII. 1980 *L.I. Abramova* (MHA ex IRK); **Buryatia**: Tompuda, 1500 m, 18.VIII.1956 *Bardunov* (MHA ex IRK); **Evenkiya**: Kochumdek Creek, 20.VIII.1991 *Shcherbina* (MW); **Khakassia**: Shirisky Distr.: Yarovoe, 12.VIII.1961 *Kamenetskaya* (MHA ex IRK); **Khanty-Mansijsk Autonomous Area**: Irtysh, 120 km downstream from Tobolsk, 8.VIII.1973 *Iljina & Kobeleva* (MHA ex IRK); **Krasnoyarsk Territory**: Boguchansk Distr., Chuny, 4.VIII.1988 *Kustova* (MHA ex IRK); Kulumys Range, 17.VI.1968 *Bardunov* (MHA ex IRK); Tomsk Prov.: Kaftannikovo, 11.VIII.1913 (LE); **Primorsky Territory**: Shkotovo Distr. 15.IX.947 *Rosenberg* (LE); **Tyumen Prov**.: Berezovsky Distr. 4.X.1950 (LE); **Yakutia**: Lensky Distr., Pilka River 25.VII.1999 *Ivanova* (MHA); **Yamalo-Nenetsky Autonomous Area**: Salemal, Tenguguy River, 28.VIII.1963 *Soldatenkova* (MW).

NORTH AMERICA: ***CANADA***: **Manitoba**, S of Harashville: *Mueller-Dombois #068-13* (MO); **New Brunswick**: *Allen #2144* (MO); **Newfoundland**: R.A.C. Waghorne 1.X.[18]93 (MO); **Nova Scotia**: *Schofield #97254* (MO); **Ontario**: *O.E. & G.K. Jennings s.n.* (MO); **Prince Edwards Island**: Best, Canadian Musci, # 380 (MO); **Quebeck**: *Rolland-Germainn #115* (MO); ***U.S.A.****:* **Colorado**: Grand Co., 2750 m (9000') spruce-fir forest 6 mi W of Fraser, 25 Sept 1963 *Weber et al*. (COLO, B-11091), **Connecticut**: 26.X.1979 *J.A. Allen s.n.* (MO), **Maine**: *Allen #14770* (MO); **Maryland**: Austin herbarium 359 coll. J.D.Smith (NY); **Michigan**: Cronin 76065 (NY); **Montana**, Rocky mountains, Columbia Falls: R.S. Williams, North American Mosses, #259, 19.XI.1896 (NY - two specimes with identical label); **New Hampshire**: 11.VIII.1878 *J.A.Allen* (MO); **New Jersey**: Austin Musci Appalaciani, #323 (NY); Nov 1866 *Austun*, (NY); **New York**: *Allen #27178* (MO); **Pennsylvania**: Moul 4276 (NY); **Vermont**: A.J.Grout North American Musci Pleurocarpi, 62 (as Brachythecium starkei); **West Virginia**: 1.Sept.1922 *Bray* (NY).

Sciuro-hypnum oedipodium

EUROPE: ***RUSSIA***: Caucasus: **Karachaevo-Cherkessia**: Teberdinskij Reserve, *Ignatov & Ignatova #05-3850, 05-3038* (MHA).

ASIA: ***RUSSIA***: **Chukotka**: Gil'mimliveem Hot Springs, 20.VII.1977 *A.E.Katenin* (LE).

NORTH AMERICA: ***CANADA***: **British Columbia**: *Schofield #109936* (MO); **Yukon**: Willians, Noth American Mosses #718 (NY); ***U.S.A.***: **Alaska**: *Darigo #2641* (MO); **Arizona**: Oct 25, 1924 *Bartram* (NY); **Colorado**: *RM King & RMGarvey* #B266 (MO); **Idaho**: Plants of Idaho 1297, coll. Sandberg (MO); **Montana**: 20.X.1896 *R.S. Williams #346*; **New Mexico**: *Buck #39713* (MO); **Utah**: *Flowers #2635, 2749, 4785*; **Washington**: *Schofield & Dube #22352* (MO); **Wyoming**: *Darigo & Darigo #3275* (MO).

Molecular data

The protocol of DNA extraction, PCR and sequencing of ITS data was the same as described in Gardiner et al. (2005). Sequences were aligned manually.

Alignment is presented in the Fig. 7.

Results can be commented on as follow:

1. *Sciuro-hypnum reflexum, S. starkei,* and *S. oedipodium* are very similar in ITS1-2 region, and the former species consistently differ from the two latter species in just one substitution in ITS2 (specific for each of two species).

2. *Sciuro-hypnum curtum* is different from *S. reflexum* in 8 substitutions (3 in ITS1 and 5 in ITS2), and from *S. oedipodium* and *S. starkei* in 9 substitutions. Available ITS2 data of Huttunen on *S. curtum* from Finland, used in the analysis of Huttunen & Ignatov (2004) and not shown in Fig. 7 has the same 5 characteristic substitutions of this species.

3. Five studied specimens of *S. curtum* from Europe, East Asia and eastern North America are almost identical, differing in point mutations in individual species, but never corresponding to other specimens of this species, or to other species.

4. There is only very low variation in the group of species that includes *S. oedipodium, S. reflexum,* and *S. starkei* (and also *S. altaicum, S. latifolium, S. glaciale* – see Ignatov & Milyutina, 2007). Only one substitution differentiates *S. reflexum* (some populations) and *S. starkei*, and similarly, only one substitution differentiates *S. reflexum* (some populations) and *S. oedipodium*.

Fig. 7 (see also next page). Alignment of ITS1 &2 and gene 5.8S RNA of *Sciuro-hypnum* species, demonstrating sharp differentiation of *S. curtum* (8 substitutions, marked by squares) from *S. oedipodium, S. reflexum* and *S. starkei*, that differs from each other by just one substitution (circles). Specimen data are in Table 1.

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                         5        15        25        35        45        55        65        75        85        95       105       115
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curtum New York          CACACACAAG TTGCAGCCAA CCCGCGGCGA ACGAACACAT TGTCCCCCCT TCGGCGGGTC GTGGCGCCCT CGCGGCGTCG CGGCCGGCCG TCTCCCCTCG TCACGAGCGC GAGCTTCGTG
curtum Kamchatka         CACACACAAG TTGCAGCCAA CCCGCGGCGA ACGAACACAT TGTCCCCCCT TCGGCGGGTC GTGGCGCCCT CGCGGCGTCG CGGCCGGCCG TCTCCCCTCG TCACGAGCGC GAGCTTCGTG
curtum Vologda           CACACACAAG TTGCAGCCAA CCCGCGGCGA ACGAACACAT TGTCCCCCCT TCGGCGGGTC GTGGCGCCCT CGCGGCGTCG CGGCCGGCCG TCTCCCCTCG TCACGAGCGC GAGCTTCGTG
reflexum Khabarovsk      CACACACAAG TTGCAGCCAA CCCGCGGCGA ACGAACACAT TGTCCCCCCT TCGGCGGGTC GTGGCGCCCT CGCGGCGTCG CGGCCGGCCG TCACCCCTCG TCACGAGCGC GAGCTTCGTG
reflexum Kamchatka       CACACACAAG TTGCAGCCAA CCCGCGGCGA ACGAACACAT TGTCCCCCCT TCGGCGGGTC GTGGCGCCCT CGCGGCGTCG CGGCCGGCCG TCACCCCTCG TCACGAGCGC GAGCTTCGTG
reflexum Altai           CACACACAAG TTGCAGCCAA CCCGCGGCGA ACGAACACAT TGTCCCCCCT TCGGCGGGTC GTGGCGCCCT CGCGGCGTCG CGGCCGGCCG TCACCCCTCG TCACGAGCGC GAGCTTCGTG
reflexum Vologda         CACACACAAG TTGCAGCCAA CCCGCGGCGA ACGAACACAT TGTCCCCCCT TCGGCGGGTC GTGGCGCCCT CGCGGCGTCG CGGCCGGCCG TCACCCCTCG TCACGAGCGC GAGCTTCGTG
oedipodium Canada        CACACACAAG TTGCAGCCAA CCCGCGGCGA ACGAACACAT TGTCCCCCCT TCGGCGGGTC GTGGCGCCCT CGCGGCGTCG CGGCCGGCCG TCACCCCTCG TCACGAGCGC GAGCTTCGTG
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oedipodium Alaska        CACACACAAG TTGCAGCCAA CCCGCGGCGA ACGAACACAT TGTCCCCCCT TCGGCGGGTC GTGGCGCCCT CGCGGCGTCG CGGCCGGCCG TCACCCCTCG TCACGAGCGC GAGCTTCGTG
oedipodium Wyoming       CACACACAAG TTGCAGCCAA CCCGCGGCGA ACGAACACAT TGTCCCCCCT TCGGCGGGTC GTGGCGCCCT CGCGGCGTCG CGGCCGGCCG TCACCCCTCG TCACGAGCGC GAGCTTCGTG
starkei Buryatia         CACACACAAG TTGCAGCCAA CCCGCGGCGA ACGAACACAT TGTCCCCCCT TCGGCGGGTC GTGGCGCCCT CGCGGCGTCG CGGCCGGCCG TCACCCCTCG TCACGAGCGC GAGCTTCGTG
starkei Tatarstan        CACACACAAG TTGCAGCCAA CCCGCGGCGA ACGAACACAT TGTCCCCCCT TCGGCGGGTC GTGGCGCCCT CGCGGCGTCG CGGCCGGCCG TCACCCCTCG TCACGAGCGC GAGCTTCGTG
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curtum New York          GCGTCGGGTT TCCACACGAT GCATCACCCG AATGACTGAG TCCCGAATAC TTGGATGGAG GAGTGGGTGC GTGTTCCGTC CCCTCGAGCG AGCTTGCGAA CTCGAGGCGC GCCGCGCGCG
curtum Kamchatka         GCGTCGGGTT TCCACACGAT GCATCACCCG AATGACTGAG TCCCGAATAC TTGGATGGAG GAGTGGGTGC GTGTTCCGTC CCCTCGAGCG AGCTTGCGAA CTCGAGGCGT GCGGCGCGCG
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reflexum Kamchatka       GCGTCGGGTT TCCACACGAT GCATCACCCG AATGACTGAG TCCCGAATAC TTGGATGGAG GAGTGGGTGC GTGTTCCGTC CCCTCGAGCG AGCTTGCGAA CTCGAGGCGT GCGGCGCGCG
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reflexum Vologda         GCGTCGGGTT TCCACACGAT GCATCACCCG AATGACTGAG TCCCGAATAC TTGGATGGAG GAGTGGGTGC GTGTTCCGTC CCCTCGAGCG AGCTTGCGAA CTCGAGGCGT GCGGCGCGCG
oedipodium Canada        GCGTCGGGTT TCCACACGAT GCATCACCCG AATGACTGAG TCCCGAATAC TTGGATGGAG GAGTGGGTGC GTGTTCCGTS CCCTCGAGCG AGCTTGCGAA CTCGAGGCGT GCGGCGCGCG
oedipodium Caucasus      GCGTCGGGTT TCCACACGAT GCATCACCCG AATGACTGAG TCCCGAATAC TTGGATGGAG GAGTCGGTGC GTGTTCCGTC CCCTCGAGCG AGCTTGCGAA CTCGAGGCGT GCGGCGCGCG
oedipodium Alaska        GCGTCGGGTT TCCACACGAT GCATCACCCG AATGACTGAG TCCCGAATAC TTGGATGGAG GAGTGGGTGC GTGTTCCGTC CCCTCGAGCG AGCTTGCGAA CTCGAGGCGT GCGGCGCGCG
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starkei Buryatia         GCGTCGGGTT TCCACACGAT GCATCACCCG AATGACTGAG TCCCGAATAC TTGGATGGAG GAGTGGGTGC GTGTTCCGTC CCCTCGAGCG AGCTTGCGAA CTCGAGGCGT GCGGCGCGCG
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starkei Caucasus         GCGTCGGGTT TCCACACGAT GCATCACCCG AATGACTGAG TCCCGAATAC TTGGATGGAG GAGTGGGTGC GTGTTCCGTC CCCTCGAGCG AGCTTGCGAA CTCGAGGCGT GCGGCGCGCG

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reflexum Altai           CCGGTTACCT TACGACGAGT TGAAACATAA CCAAAAACCA ACTCTCAGCA ACGGATATCT TGGCTCTTGC AACGATGAAG AACGCAGCGA AATGCGATAC GTAGTGTGAA TTGCAGAATT
reflexum Vologda         CCGGTTACCT TACGACGAGT TGAAACATAA CCAAAAA-CA ACTCTCAGCA ACGGATATCT TGGCTCTTGC AACGATGAAG AACGCAGCGA AATGCGATAC GTAGTGTGAA TTGCAGAATT
oedipodium Canada        CCGGTTACCT TACGACGAGT TGAAACATAA CCAAAAA-CA ACTCTCAGCA ACGGATATCT TGGCTCTTGC AACGATGAAG AACGCAGCGA AATGCGATAC GTAGTGTGAA TTGCAGAATT
oedipodium Caucasus      CCGGTTACCT TACGACGAGT TGAAACATAA CCAAAAA-CA ACTCTCAGCA ACGGATATCT TGGCTCTTGC AACGATGAAG AACGCAGCGA AATGCGATAC GTAGTGTGAA TTGCAGAATT
oedipodium Alaska        CCGGTTACCT TACGACGAGT TGAAACATAA CCAAAAA-CA ACTCTCAGCA ACGGATATCT TGGCTCTTGC AACGATGAAG AACGCAGCGA AATGCGATAC GTAGTGTGAA TTGCAGAATT
oedipodium Wyoming       CCGGTTACCT TACGACGAGT TGAAACATAA CCAAAAA-CA ACTCTCAGCA ACGGATATCT TGGCTCTTGC AACGATGAAG AACGCAGCGA AATGCGATAC GTAGTGTGAA TTGCAGAATT
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starkei Tatarstan        CCGGTTACCT TACGACGAGT TGAAACATAA CCAAAAA-CA ACTCTCAGCA ACGGATATCT TGGCTCTTGC AACGATGAAG AACGCAGCGA AATGCGATAC GTAGTGTGAA TTGCAGAATT
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Fig. 7. continued from the previous page.

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curtum Maine      CCGCGAATCA TCGAGTCTTT GAACGCAAGT TGCGCCCGAG GCTTGTCCGA GGGCATTTCC GCTAGAGCGT CACCGCGCCC CCCACCGATC CACTCTCGCC GCGAGGCGCC AGTCGGGTCG
curtum New York   CCGCGAATCA TCGAGTCTTT GAACGCAAGT TGCGCCCGAG GCTTGTCCGA GGGCATTTCC GCTAGAGCGT CACCGCGCCC CCCACCGATC CACTCTCGCC GCGAGGCGCC AGTCGGGTCG
curtum Kamchatka  CCGCGAATCA TCGAGTCTTT GAACGCAAGT TGCGCCCGAG GCTTGTCCGA GGGCATTTCC GCTAGAGCGT CACCGCGCCC CCCACCGATC CACTCTCGCC GCGAGGCGCC AGTCGGGTCG
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starkei Buryatia  CCGCGAATCA TCGAGTCTTT GAACGCAAGT TGCGCCCGAG GCTTGTCCGA GGGCATTTCC GCTAGAGCGT CACCGCGCCC CCCACCGATC CACTCTCGCC GCGAGGCGCC AGTCGGGTCG
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starkei Caucasus  CCGCGAATCA TCGAGTCTTT GAACGCAAGT TGCGCCCGAG GCTTGTCCGA GGGCATTTCC GCTAGAGCGT CACCGCGCCC CCCACCGATC CACTCTCGCC GCGAGGCGCC AGTCGGGTCG

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curtum Maine      AGTGCAAGTG GCCGTCCCGG TGGAGCGGCC TCCTTCACG AGGAGGCCGT ACTCAGAAGG GTCGGCTGAA ATGGATGGAA TCGGGCCGCC GTGGTGACAC AGTCCGCGAT CGGGTGATTT
curtum New York   AGTGCAAGTG GCCGTCCCGG TGGAGCGGCC TCCTTCACG AGGAGGCCGT ACTCAGAAGG GTCGGCTGAA ATGGATGGAA TCGGGCCGCC GTGGTGACAC AGTCCGCGAT CGGGTGATTT
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starkei Buryatia  AGTGCAAGTG GCCGTCCCGG TGAAGCGGCC TTCTTCACG AGGAGGCCAT ACTTAGAAGG GTCGGCTGAA ATGGATGGAA TCGGGCCGCC GTGGTGACAC AGTCCGCGAT CGGGTGATTT
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starkei Caucasus  AGTGCAAGTG GCCGTCCCGG TGAAGCGGCC TTCTTTCACG AGGAGGCCAT ACTTAGAAGG GTCGGCTGAA ATGGATGGAA TCGGGCCGCC GTGGTGACAC AGTCCGCGAT CGGGTGATTT

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curtum Maine      TGTCTCAAGC CTCCTTCGGG AGGTTCTTGG TGAATTTTTC TAAGTGCTTG GCTGCGTCCC CCAGTTGGCT CGGGTTACCT CATGCAGGTC GAGCGCGCCC CCGCGGCGCG CGTCACGCAT
curtum New York   TGTCTCGAGC CTCCTTCGGG AGGTTCTTGG TGAATTTTTC TAAGTGCTTG GCTGCGTCCC CCAGTTGGCT CGGGTTACCT CATGCAGGTC GAGCGCGCCC CCGCGGCGCG CGTCACGCAT
curtum Kamchatka  TGTCTCGAGC CTCCTTCGGG AGGTTCTTGG TGAATTTTTC TAAGTGCTTG GCTGCGTCCC CCAGTTGGCT CGGGTTACCT CATGCAGGTC GAGCGCGCCC CCGCGGCGCG CGTCACGCAT
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starkei Caucasus  TGTCGCGAGC CTCCTGCGGG AGGTTCGTGG TGAATTTTTC TAAGTGCTTG GCTGCGTCCC CCAGTTGGCT CGGGTTACCT CATGCAGGTC GAGCGCGCCC CCGCGGCGCG CGTCACGCAT
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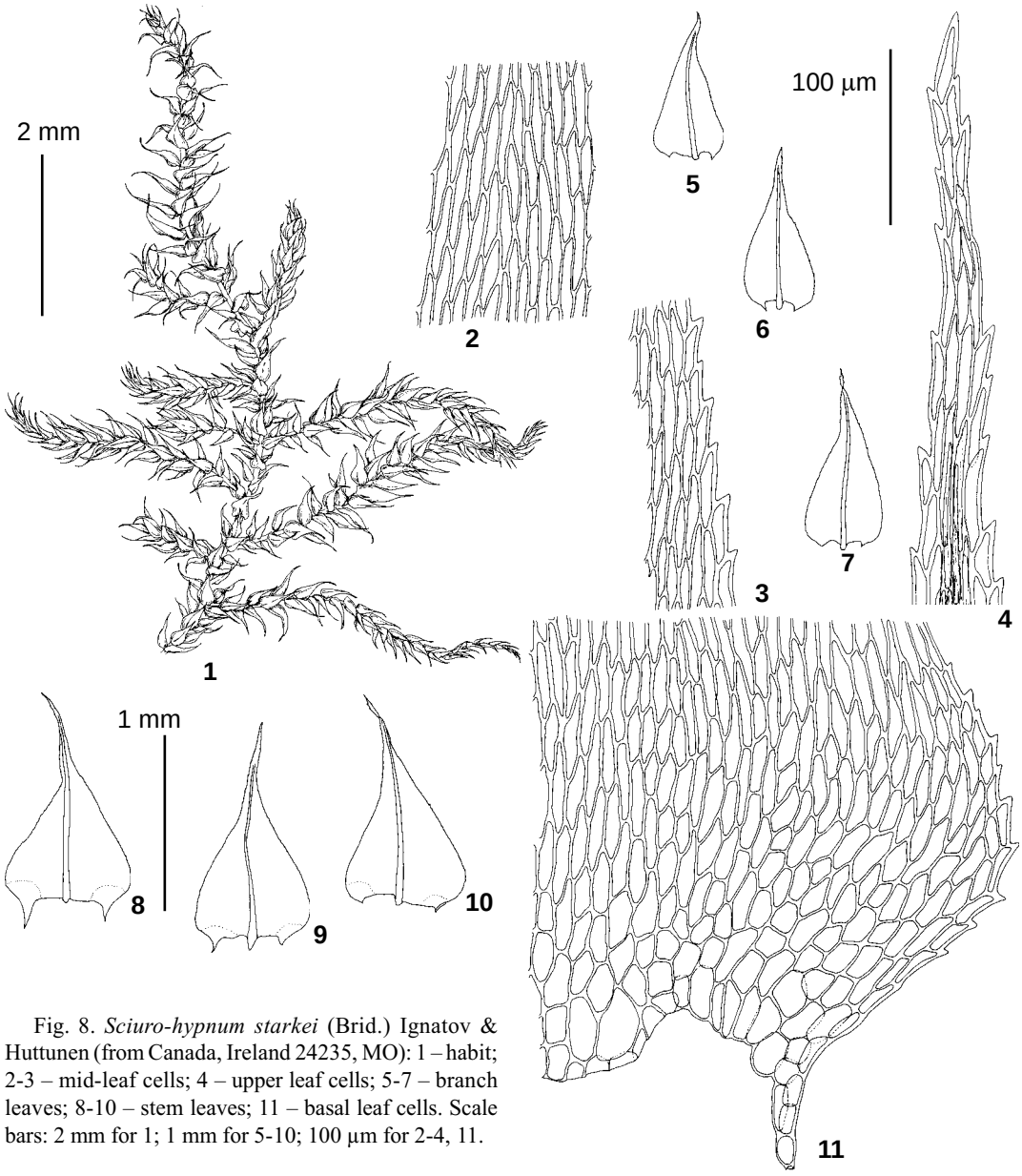

Fig. 8. *Sciuro-hypnum starkei* (Brid.) Ignatov & Huttunen (from Canada, Ireland 24235, MO): 1 – habit; 2-3 – mid-leaf cells; 4 – upper leaf cells; 5-7 – branch leaves; 8-10 – stem leaves; 11 – basal leaf cells. Scale bars: 2 mm for 1; 1 mm for 5-10; 100 μm for 2-4, 11.

Although the difference is small and includes the only substitution between *S. reflexum* and *S. starkei*, and between *S. reflexum* and *S. oedipodium*, these differences are consistent with species morphology and constant in the territory of the ca. 4 000 km for *S. starkei*, and all around Holarctic for *S. oedipodium.*

WHAT IS *SCIURO-HYPNUM STARKEI*?

As most of collections of *S. oedipodium* and *S. curtum* are still deposited in herbaria (especially in North America) under '*Brachythecium starkei*', and this species is considered to be a common one by, e.g. Lawton (1971), a brief comment on *S. starkei* is necessary (for standard description see Ignatov & Milyutina, 2007).

Sciuro-hypnum starkei is a medium-sized moss that has relatively regular pinnate branching, with rigidly spreading branch leaves and sometimes also stem leaves. Stem leaves are lanceolate-triangular to ovate-triangular, grad-

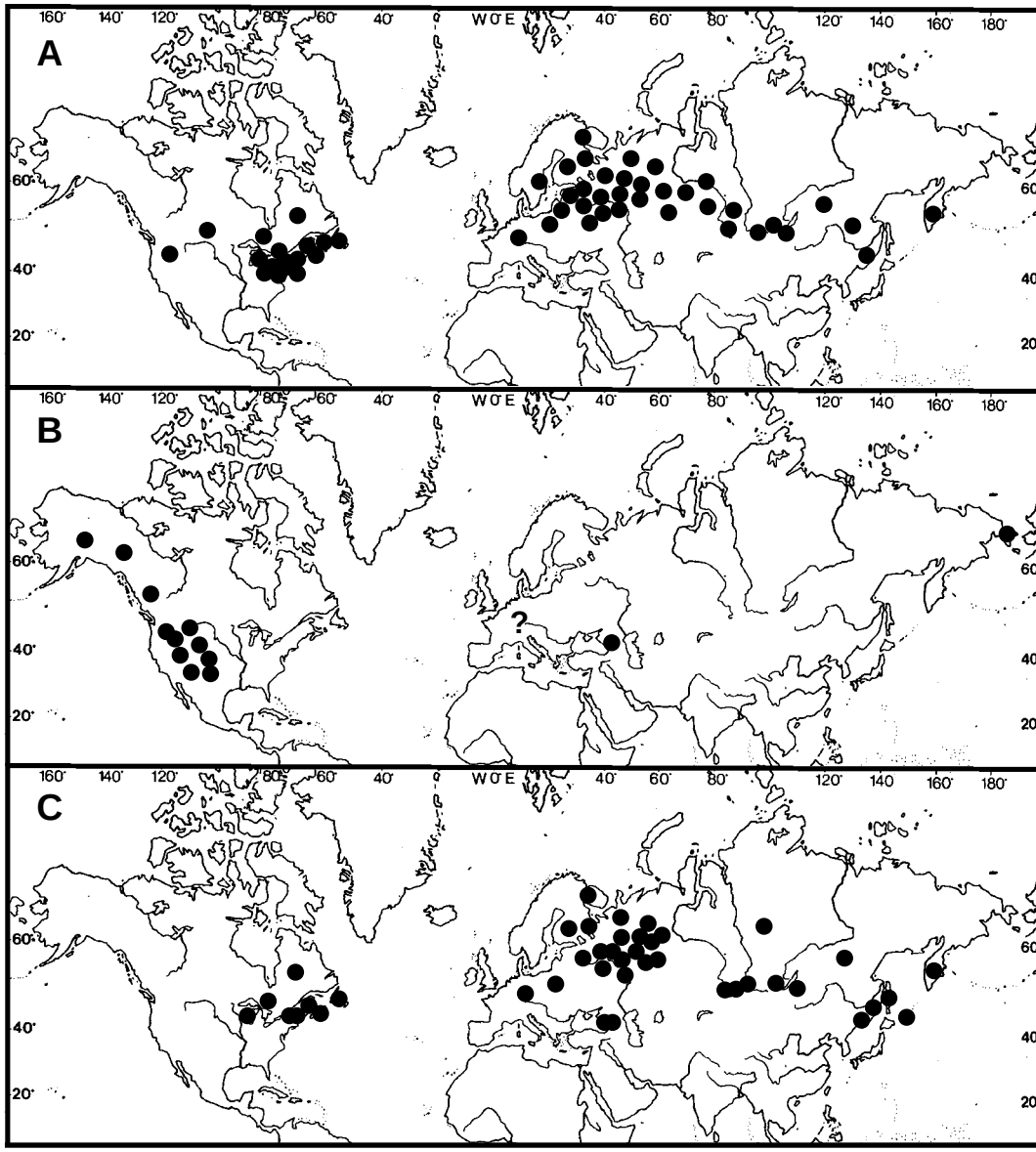

Fig. 9. Distribution of *Sciuro-hypnum curtum* (**A**)*, S. oedipodium* (**B**) and *S. starkei* (**C**), basing on revised specimens. Mapping is somewhat schematical, with just one dot per country, except Russia, U.S.A. and Canada, where mapping was up to level of state/province or else administrative units.

ually tapered to apex or sometimes shortly acuminate above, narrowly decurrent. Costa is vanishing in the narrow part of acumen or often percurrent, occasionally ending shortly below acumen. Cells at mid-leaf are 40-60 μm, but usually with lengh to width ratio ca. 10:1, so looking very narrow and somewhat flexuose; cells in upper part of branch leaves (occasionally in stem leaves also) are prorate on the dorsal side. Alar cells are enlarged and thin-walled, forming a pellucid group just proximal to the decurrency. Seta is always rough; capsules are relatively short. Under-developed plants differ in more remote and more narrow leaves, retaining however their rigidly spreading appearance.

Rigidly spreading leaves and prorate laminal cells of *S. starkei* result in an apprearance quite

similar to *Kindbergia praelonga*; the latter is different however in broader decurrencies, laminal cell proportions 4-8:1 (vs. 8-15:1 in *S. starkei*), dioicous sexual condition and longly rostrate operculum.

SELECTED SPECIMENS EXAMINED:
Sciuro-hypnum starkei

EUROPE: ***RUSSIA:*** **Arkhangelsk Prov**.: Onega Distr., Ponga, 4.VII.2000 *Churakova #80* (MHA); **Bashkiria**: Malyj Iremel Mt., *Ignatova #2/111* (MHA); **Chelyabinsk Prov.,** Miass Distr., Novoandreevskaya, 26.VII. 1995 *Muldashev #109* (MW); **Chuvashskaya Republic:** Prisursky Nature reserve, 12.VIII.2000 *Sultanova* (MW); **Karelia**: Olonetsky Distr., Obninsky Forestry Unit, 12.VIII.1984 *Volkova* (LE); **Kirov Prov.**: Khalturin Distr., between Aksenovka and Bakulikha (26 km from Nurashi Station) 23.IX.1928 *Kolokolnikov* (LE); **Komi Republic:** Pechoro-Ilych Nature Reserve, 27.VI.2000 *Bezgodov* (Herb. Perm Ped. Univ.); **Kostroma Prov.**: Manturovo Distr., Khalbuzh 6.VII.1997 *Lazareva* (MHA); **Moscow Prov.**: Khimki Distr., Yurlovo 5.VIII.1986 *Ignatov* (MHA); **Murmansk Prov.**, Polar-Alpine Botanical Garden, 500 m, 31.VII.1998 *Ignatov & Ignatova* (MHA); **Nizhniy Novgorod Prov.**: Kerzhensky Reserve, 100 m, 18.IX.1999 *Ignatov* (MHA); **Novgorod Prov.**: Valdai Distr., 25.VII.1981 *Vaulina* (MHA); **Perm Prov.:** Vishera State Reserve, 20.VII.1994 *Bezgodov* (MHA); Sverdlovsk Prov.: Kirovgrad Distr., Visimsky Nature Reserve, 9.VII.2005 *Smirnova* (MW); **Tatarstan**, Volzhsko-Kamsky Reserve, Saraly, *Ignatov & Ignatova #05-2131* (MHA); **Tver Prov.**: Centralno-Leskoj Reserve, 200 m, 28.VIII.1989 *Minaeva* (MHA); **Udmurtia**: Votkinsk Distr., Kostovaty 17.VII.2000 *Munitsyna* (MHA); **Vladimir Prov:** Aleksandrovo Distr., *Seregin & Privalova #M-388* (MW); **Vologda Prov**.: Sokol Distr., Shorega Creek, 22.IX.1990 *Ignatov* (MHA); **Yaroslavl Prov**.: Pleshcheevo Lake, 20.VIII.2001 *Ignatov & Ignatova* (MHA). CAUCASUS: **Karachaevo-Cherkessia**: Teberdinsky Reserve, 2850 m, 8.IX.2005 *Ignatov & Ignatova* (MHA); **Krasnodar Territory**: Caucasian Nature Reserve, Abago Mt., 1850 m, 20.VII.1960 *Artamonova* (MW). ***GEORGIA***: South Osetia, Dzava Distr., 13.VIII.1955 *Dombrovskaya* (MW). ***GERMANY***: Bayrisches Wald, 20.X.1918 *Paul* (MW). ***POLAND***: Zarnowiec & al.: Musci Macroregioni Merid. Poloniae Exs. #302 (MHA).

ASIA: *RUSSIA:* **Altai Territory**: Riddera, 25.VIII.1947 *Polyakov* (MHA); **Altai Republic**: Kairu-Bazhi Peak, 2050 m, *Ignatov #13/105* (MHA); **Amurskaya Territory**: Zeya Nature Reserve, 15.VIII.1980 *L.Abramova #126* (MW); **Buyatia**: Khamar-Daban, Vydrinnaya, 15.VIII.1989 *Kazanovsky* (MHA ex IRK); **Evenkiya**: 62°09'N,91°09'E, 19.VIII.1992 *Szerbina* (MW); **Irkutsk Prov**.: Ulkan, 1.VII.1976 *Bardunov* (MHA ex IRK); **Kamchatskaya Prov**.: Kozyrevsk, 220 m, 12.VIII.2004 *Czernyadjeva #64* (LE); **Kemerovo Prov.**: Tisulsky Distr., Kiya River, 400 m, 7.IX.1971 *Vasiliev* (MHA ex IRK); **Khabarovsk Territory**: De Castri Bay, 18.VI.1854 *Maximovicz* (LE); **Primorsky Territory**: Lazo Distr., Olkhovaya Mt., 1650 m, 2.X.2006 *Ignatov, Ignatova & Cherdantseva #06-2200* (MHA); **Sakhalinskaya Prov**.: Sakhalin, Dui, V-1861 *Glehn* (LE); Kunashir, Saratovka, *Ignatov #06-1387* (MHA).

NORTH AMERICA: ***CANADA***: New Brunswick: Ireland 13008 (MO); Labrador: R.A.C.Waghorne 1.X.[18]93 (MO); Ontario: Ireland 24235 (MO); Prince Edwards Island: J. Macoun Canadian Mosses # 293 (MO); Quebeck: Redfearn 37440 (MO); ***U.S.A.****:* Maine: Allen 14774, 24555 (MO); Vermont: E.C.Taylor S-697 (NY); Wisconsin: Pursell 6120 (MO).

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Table 1. Specimen data of the genus *Sciuro-hypnum* used in analysis, and Genbank accession numbers.

species	specimen	GenBank #
curtum Kamchatka	Asian Russia, Kamchatka, Czernyadjeva 48-07 (MHA)	EU715332
curtum Maine	U.S.A., Maine, Allen 14770 (MO)	EU715330
curtum New York	U.S.A., New York State, Allen 27178 (MO)	EU715331
curtum Tatarstan	European Russia, Tatarstan, Ignatov & Ignatova 18.VIII.2003 (MHA)	EU715329
curtum Vologda	European Russia, Vologda, Ignatov & Ignatova 19-8-2001 (MHA)	EU715333
oedipodium Caucasus	Russia, Caucasus, Ignatov & Ignatova 05-3038 (MHA)	EU715345
oedipodium Alaska	U.S.A., Alaska, Darigo 2641 (MO)	EU715346
oedipodium Wyoming	U.S.A., Wyoming, Darigo 3275 (MO)	EU715347
oedipodium British Columbia	Canada, British Columbia, Schofield 109936 (MO)	EU715344
reflexum Kamchatka 39	Asian Russia, Kamchatka, Chernyadjeva 5.VIII.2002 #39 (MHA)	EU715351
reflexum Khabarovsk	Asian Russia, Khabarovsk Territory, Ignatov 97-177 (MHA)	EU715352
reflexum Vologda	European Russia, Vologda Province, Ignatov & Ignatova 19.VIII.2001 (MHA)	EU715353
reflexum 'pacificum' Altai	Asian Russia, Altai, Ignatov 0/442 (MHA)	EU715354
starkei Tatarstan	European Russia, Tatarstan, Ignatov & Ignatova 05-2027 (MHA)	EU715348
starkei Caucasus	Russia, Caucasus, Onipchenko 31-8-1983 #37-83 (MHA)	EU715350
starkei Buryatiya	Asian Russia, Buryatia, Kazanovsky 16.VIII.1989 (MHA)	EU715349

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