

## Suillus grevillei and S. clintonianus (Gomphidiaceae), two boletoid fungi associated with Larix

MAURI KORHONEN, JAAKKO HYVÖNEN and TEUVO AHTI

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*Suillus clintonianus* (Peck) Kuntze, earlier regarded as a dark red-brown form of *S. grevillei* (Klotzsch: Fr.) Singer, is shown to possess other distinctive morphological characters as well, and to have a wide distribution in Eurasia and North America. It is here proposed as a separate species. Both *S. grevillei* and *S. clintonianus* are ectomycorrhizal fungi of *Larix*, and often grow together, but the total distributions are different. *S. grevillei* f. *badius* (Singer) Singer is included in *S. clintonianus*.

Key words: Boletes, Finland, *Larix*, *Suillus*, taxonomy

Mauri Korhonen, Botanical Museum, P.O. Box 47, FIN-00014 University of Helsinki, Finland

Jaakko Hyvönen and Teuvo Ahti, Department of Botany, P.O. Box 47, FIN-00014 University of Helsinki, Finland

### Introduction

The pilei of the widespread bolete *Suillus grevillei* (Gomphidiaceae) range in colour from light lemon yellow to dark reddish-brown. Although this variation is generally recognized, it is usually interpreted as an infraspecific variation not deserving of taxonomic recognition (e.g. Slipp & Snell 1944, Smith & Thiers 1964, Watling 1970). This view has been supported by the observation that dark reddish-brown and the normally light yellow pilei are sometimes found at the same site. Further corroboration is provided by the observation that a dark reddish-brown "form" is prevalent in the Russian Far East and gradually the "typical" yellow *S. grevillei* becomes more common as one approaches Europe (K. Kalamees, pers. comm.). A similar trend has been noted in North America, where the yellow form is replaced by the dark reddish one in the western part of the continent (Miller 1978). The reddish variant has occasionally been recognized at varietal level, e.g. as *S. grevillei* "var. *badius* Singer" (e.g. Kallio &

Heikkilä 1992), but generally it has been ignored.

In Finland, especially in the northern parts of the country, the two colour variants frequently grow together. They are easily distinguished in the field and microscopic studies reveal additional, essential differences, as described below. We are therefore proposing that the two variants be recognized as distinct species, *S. grevillei* and *S. clintonianus*.

### Material and methods

Most of the material was collected in Finland. Many of the specimens were photographed at the original site. In addition, herbarium material from various countries was studied, both material deposited Helsinki (H), and material from other herbaria (C, K, LE, NYS, OULU, S, TUR, TURA, UME, UPS, VPI).

The microscopical study of specimens was done with a Leitz Dialux microscope equipped with a Pl Apo Oel 100/1.32 oil immersion lens. Spores, cystidia, pileipellis, etc. were drawn with a Leitz drawing tube at a magnification of 2 000. All measurements are based on the drawings.

All the preparations were mounted in pure water without use of any softening or colour media. This allowed

observation of the natural colour of the structures. The ratio of length to width was measured in individual spores, and the mean spore volume was calculated according to the formula of an ellipsoid:  $4\pi/3abc$  (Breitenbach & Kränzlin 1991). The spore volume was based on the material as cited in Fig. 6.

### 1. *Suillus grevillei* — Figs. 1, 2, 5a–d, 6

*Suillus grevillei* (Klotzsch : Fr.) Singer, Farlowia 2:259. 1945. — *Boletus grevillei* Klotzsch, Linnaea 7:198. 1832, 'grevillii': Fr., Syst. Mycol. 3 (Index) 59. 1832, nom. superfl. for *Boletus flavus* With. 1792, but because sanctioned, not automatically typified by that name (Art. 7.13). — Type: Sine loco, Herb. Klotzsch (K!; lectotype by Singer, see Palm & Stewart 1986: 327).

*Boletus flavus* With., Bot. Arr. Brit. Pl. 3:415. 1792. — *Suillus flavus* (With.) Singer, Farlowia 2:260. 1945. — Type: [England], Bolton, Hist. Fung. Halifax 4: Tab. 169. 1792 (lectotype, by Dörfelt 1984: 61).

*Boletus elegans* Schumacher, Enum. Pl. Saell. 2:374. 1803, nom. illeg., non *Boletus elegans* Bolton 1788. — *Cricunopus elegans* P. Karsten, Rev. Mycol. 3:16. 1881. — *Suillus elegans* (P. Karsten) Snell in Slipp & Snell, Lloydia 7:27. 1944. — Type: not designated.

*Pileus* 5–16(–22) cm, pale lemon yellow, yellow, golden, apricot or greyish ochre brown (the variation in colour is well presented by Kallenbach 1928: plate 17). Young pileus hemispheric, adhering by the margins to the annulus which tightly covers the tubes. Mature pileus with thick context in the centre, gradually convex, thin at the sharp margins, becoming essentially plane with age. Pileipellis with thick layer of slime, viscid when wet, slightly shiny when dry, easily removed when fresh. *Stipe* 5–15 cm long, 1.5–3.5 cm thick, essentially equal, viscid; with thick, floccose, and gelatinous annulus, which when young is white or partly yellow, and with age faded. The colour of stipe is similar to that of the pileus, with dense reddish-brown variegation or dots, yellowish-white at the base, above the annulus yellow, often with reddish-brown variegation or dots. *Tubes* yellow, subdecurrent to decurrent, 6–12 mm long. Pores small and dense, when cut or bruised becoming light greyish brown, darkening to rust-brown. *Context* light yellow to reddish-yellow, in the stipe reddish yellow to flushed brown, especially at the base; essentially soft and loose. Both the taste and scent are mild. *Spore-print* ochre to sienna. *Spores* smooth, very pale fulvous, pale straw-colour or nearly hyaline, ellipsoid, 7–10 x 3–4  $\mu\text{m}$ ; colour of a few spores stronger fulvous, some with small reddish-brown granules inside. Length/width ratio of the spores 2.3–3.0, volume

34–74  $\mu\text{m}^3$ , average 52  $\mu\text{m}^3$ . *Caulobasidia* are present far down on the stipe; see drawings by Šutara (1987). *Cheilocystidia* are numerous, mainly in bundles, cylindric to narrowly clavate or fusiform, fulvous, partly encrusted. *Pileipellis* with gelatinized intermixed hyphae, they are mostly hyaline or nearly so, with some small dark colour particles in a gelatinised matrix, end cells 3–8 x 30–80  $\mu\text{m}$ .

### Nomenclature

The correct name of *Suillus grevillei* has been discussed by several authors during the past ten years. For instance, Alessio (1985) called it *S. elegans* and Šutara (1987) *S. flavus*. Likewise Breitenbach and Kränzlin (1991) wondered whether *S. elegans* should be adopted. However, as indicated by Palm and Stewart (1986), *S. grevillei* must be interpreted as a name sanctioned by E. Fries — though is lacking in the list of sanctioned names by Gams (1984) — and it thus definitely overrides the other two, earlier names. In addition, *Boletus elegans* Schumacher 1803, always regarded as the basionym of *S. elegans*, is an illegitimate later homonym and cannot act as a basionym at all; apparently only in 1878 was the epithet *elegans* used in another combination, *Cricunopus elegans* P. Karsten, which is the legitimate basionym to be cited according to Art. 72, Note in the present code. *S. flavus* probably really refers to this species, as typified by Dörfelt (1984), though the identity of the type (illustration) is doubted by Palm and Stewart (1984); in any event, *Boletus flavus* has been much misused earlier.

### Distribution and ecology

*Suillus grevillei* has a very wide distribution in Europe and more generally within the range of *Larix* in the whole Northern Hemisphere, reaching the polar timberline in the north (e.g. Vasil'kov 1955: 21, Smith & Thiers 1964, 1971, Singer 1965, Kallio & Heikkilä 1992). It closely follows various *Larix* species, both native and cultivated, and can be found even under single planted trees in parks far outside the natural range. For example, in Iceland, where *Larix* has been planted extensively, *S. grevillei* has become one of the major wild edible mushrooms (Thors 1991).

Traditionally *S. grevillei* has been recognized as an obligate mycorrhizal partner of *Larix*, though it has sometimes been reported forming mycorrhiza with other trees. For example, in southern Finland (Lapinjärvi) it is associated with planted *Pseudotsuga menziesii* (Mirb.) Franco (Korhonen 1991).

*Suillus grevillei* fruits early in southern Finland, of starting in July and continuing until the first part of October. It produces basidiomes fairly regularly annually, and in large quantities. Accordingly it is a favourite of mushroom pickers.

## 2. *Suillus clintonianus* — Figs. 3, 4, 5e–h, 6

*Suillus clintonianus* (Peck) Kuntze, Rev. Gen. Pl. 3:535. 1898. — *Boletus clintonianus* Peck, Ann. Rep. Reg. State New York 23 (app. C): 128, pl. 5. 1872 ('1873'). — *Suillus grevillei* var. *clintonianus* (Peck) Singer, Lilloa 22:657. 1951 ('1949'). — *Boletinus grevillei* var. *clintonianus* (Peck) Pomerleau, Fl. Champ. Québec 429. 1980, nom. inval. — Type: U.S.A. New York. Genesee Co.: North Elba, Peck (NYS! holotype).

*Ixocomus grevillei* f. *badius* Singer, Rev. Mycol. 3:40. 1938. — *Suillus grevillei* f. *badius* (Singer) Singer, Pilze Mitteleur. 5(1): 66. 1965. — *Suillus grevillei* var. *badius* (Singer) Watling, Brit. Fungus Fl. 1:68. 1970, nom. inval.; (Singer) Kallio in Ulvinen, Suursieniopas 46. 1976, nom. inval.; (Singer) Kallio & Heikkilä in Hansen & Knudsen, Nordic macromyc. 2:70. 1992, nom. inval. — Type: Russia. Gorno-Altai Republic, Chuyskie Alps, 1937 Singer & Vasil'eva 511 (LE 4698!, apparent syntype).

Illustrations: Peck (1873: plate 5, as *Boletus clintonianus*), Miller (1978: photo 285, as *S. grevillei*), Korhonen (1992, as *S. grevillei* var. *badius*).

*Pileus* 5–16 cm, reddish-brown, dark reddish-brown, dark chestnut-brown, exceptionally some yellow colour on the disc centre. Colour dark when young, the intensity remaining essentially unchanged with age. Young pileus hemispheric, adhering at the margins to the annulus, which initially covers the tubes. Mature pileus with thick context in the centre, high convex, thin at the sharp margins, becoming essentially plane with age. Pileipellis with thick layer of slime in rain, viscid when wet, shiny when dry. *Stipe* 5–15 cm long, 1.5–2.5 cm thick, essentially equal, viscid; with floccose, soft and slightly gelatinous annulus, which is light yellow below, with reddish-brown gelatinous ring by the upper margin, inner surface light yellow, yellowish-white. With age the annulus becomes

thin, fading to become viscid on the surface of the stipe. Stipe is yellow with dense reddish-brown variegation or dots, yellowish-white at the base, yellow above the annulus, often with reddish-brown variegation. *Tubes* light yellowish-orange with rusty tinge, colour more intense when young, decurrent to long decurrent, 6–10 mm long. Pores small and dense, when cut or bruised becoming light greyish-brown, darkening to rust-brown. *Context* light orange-yellow, in the stipe light brown to flushed rust-brown, at the base occasionally becoming bluish; especially in mature caps soft. Taste and scent are mild. *Spore-print* ochre to sienna. *Spores* ellipsoid, smooth, pale straw-colour, pale fulvous or nearly hyaline, but fairly often also pale reddish-brown, with small red-brown granules inside, 8.5–12 × 3.5–4.5 µm, length/width ratio 2.2–3.0, volume 47–125 µm<sup>3</sup>, average 83 µm<sup>3</sup>. *Caulobasidia* are present down on the stipe, as in *S. grevillei*. *Cheilocystidia* are cylindric to clavate or fusiform, fulvous, separate or in fascicles, and are incrustated. *Caulocystidia* in fascicles, fulvous brown, incrustated. In tube trama among hyaline hyphae there are a few brown-yellowish lactiferous-like hyphae. *Pileipellis* with both gelatinous hyaline hyphae and abundant gelatinous hyphae with incrustating dark-brown-material, and with numerous dark red-brown colour particles in a gelatinised matrix; end cells 5–10 × 35–110 µm.

## Nomenclature

*Suillus clintonianus* was earlier much used in North America for *S. grevillei* coll., but for a long time now it has not been recognized, except sometimes as a variety of *S. grevillei*. In Europe, especially Finland, the name *S. grevillei* "var. *badius*" has been used for the same taxon (e.g. Kallio 1976), though the combination has probably never been published validly.

## Distribution and ecology

In Finland, *Suillus clintonianus* has been recorded in many provinces, from the south to the north. It is more common in northern Finland, in some regions even more so than *S. grevillei*. In southern Finland it has been reported from only a few localities. Everywhere it is associated with





Figs. 1–2. *Suillus grevillei*. — 1: yellow ("normal") variant. Finland, Uusimaa, Lapinjärvi, 1989 *Korhonen* 9626 (H). — 2: ochraceous variant. Finland, Perä-Pohjanmaa, Tornio, Kalkkimaa, 1988 *Korhonen* 8482 (H). — Photos: Mauri Korhonen.





Figs. 3–4. *Suillus clintonianus*. — 3: Finland, Perä-Pohjanmaa, Rovaniemi parish, Vanttauskoski 1990 *Korhonen* 9634 (H). — 4: Finland, *Korhonen* 8570. — Photos: Mauri Korhonen.

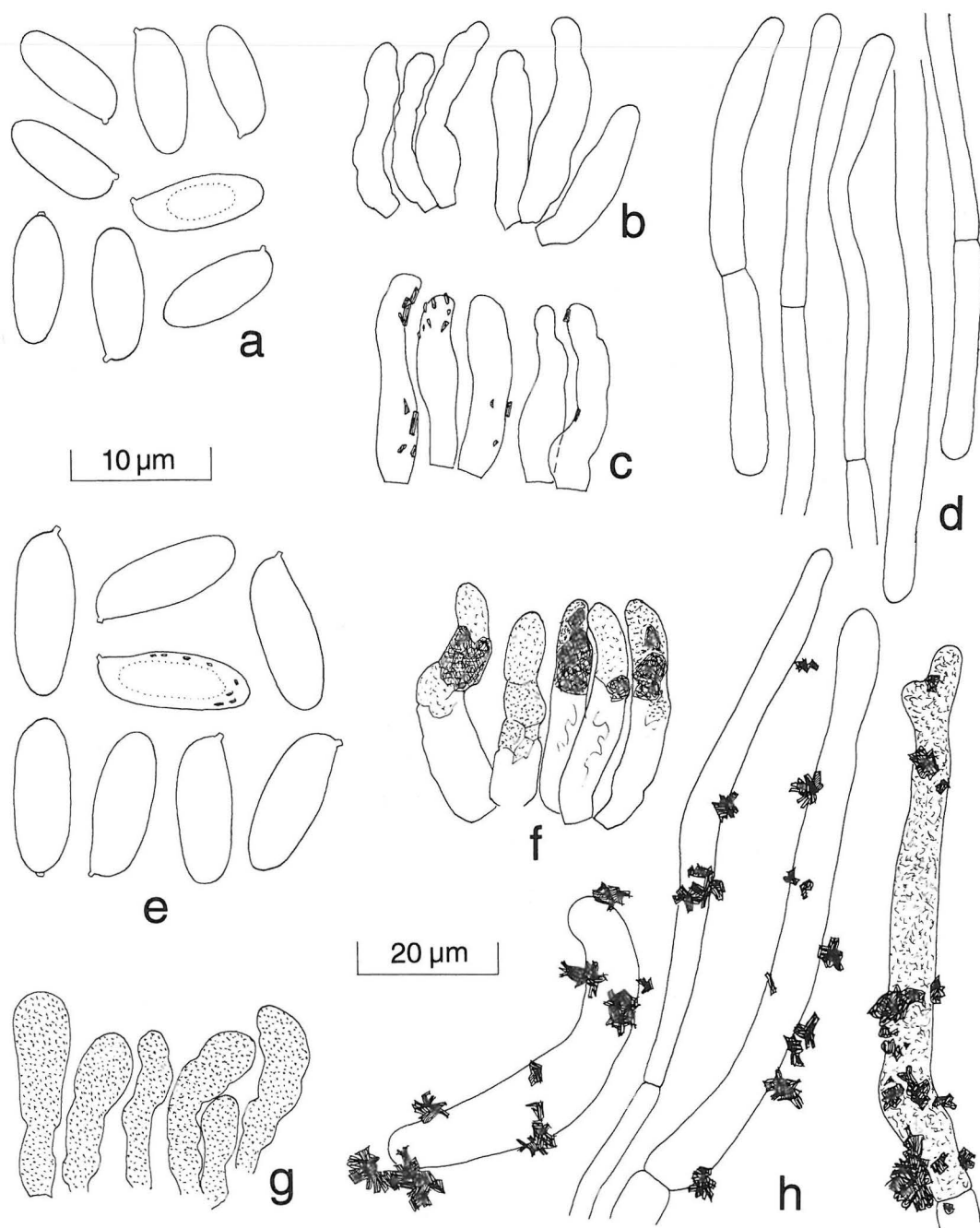


Fig. 5a–h. — a–d. *Suillus grevillei* (Finland, Rovaniemi parish, Vanttauskoski, 1990 Korhonen 9653, H). a: spores, b: cheilocystidia, c: caulocystidia and d: hyphae of pileipellis. — e–h. *S. clintonianus* (1956 Tuomikoski). e: spores, f: cheilocystidia, g: caulocystidia and h: hyphae of pileipellis. — Scale of spores  $\times 2\,000$ ; other elements  $\times 1\,000$ .

planted *Larix* spp., normally with *Larix sibirica* Ledeb. (syn. *L. russica* (Endl.) Sabine ex Trautv.), which is a very frequent cultivated (never native) tree in Finland (Hämet-Ahti et al. 1992). Perhaps the majority of the *Larix sibirica* stands derive from provenances introduced from an old plantation at Roshchino (Raivola), NW of St. Petersburg. For instance, 10 000 young *Larix* trees were transplanted to Liimatta, near Vyborg (Viipuri) in 1887 (Thesleff 1920), and transplants of those trees later made their way to places all over Finland. Accompanying those 10 000 trees, undoubtedly, were the mycorrhizal fungi of *Larix*, among them *S. clintonianus*, since this species had been collected by Thesleff at Roshchino. In Scandinavia, *S. clintonianus* has been recorded only in Finland and Sweden. There are no records from Norway or Denmark (Kallio & Heikkilä 1992). However, in Denmark, Norway and Sweden *Larix sibirica* is not commonly planted, but instead the Central European *L. decidua*.

*Suillus clintonianus* has occasionally been found in the British Isles (Watling 1970), but with the hybrid larch *L. x marschlinii* Coaz (*L. x eurolepis* A. Henry) (R. Watling, in litt.). One locality has been reported from the Faroe Islands and two from the Alps, Switzerland (M.E.

Noordeloos, pers. comm.). The taxon *S. clintonianus* actually appears to have a circumpolar distribution. It is found even at the northern timberline, always associated with *Larix*, being common in the extensive native *Larix* forests of northern Russia and Siberia, and especially in the eastern parts (K. Kalamees, pers. comm.). The range extends southward along the mountains, and it has been found in the Ural and Altai Mts. and in China. There it is associated with several species of *Larix*, though primarily with *L. sibirica* and *L. gmelinii*. It is common in North America — in the eastern parts of the continent less common than *S. grevillei*, while in western parts it may be even more common (Slipp & Snell 1944, Miller 1978).

The fruiting period is like that of *S. grevillei*, from July to September, and on the south coast of Finland extending into early October.

## Discussion

Macroscopically, *Suillus clintonianus* is most easily distinguished from *S. grevillei* by its dark reddish-brown pileus. The colour of *S. grevillei* varies widely but darkest hues are attained only by old pilei, when they are greyish ochre-brown.

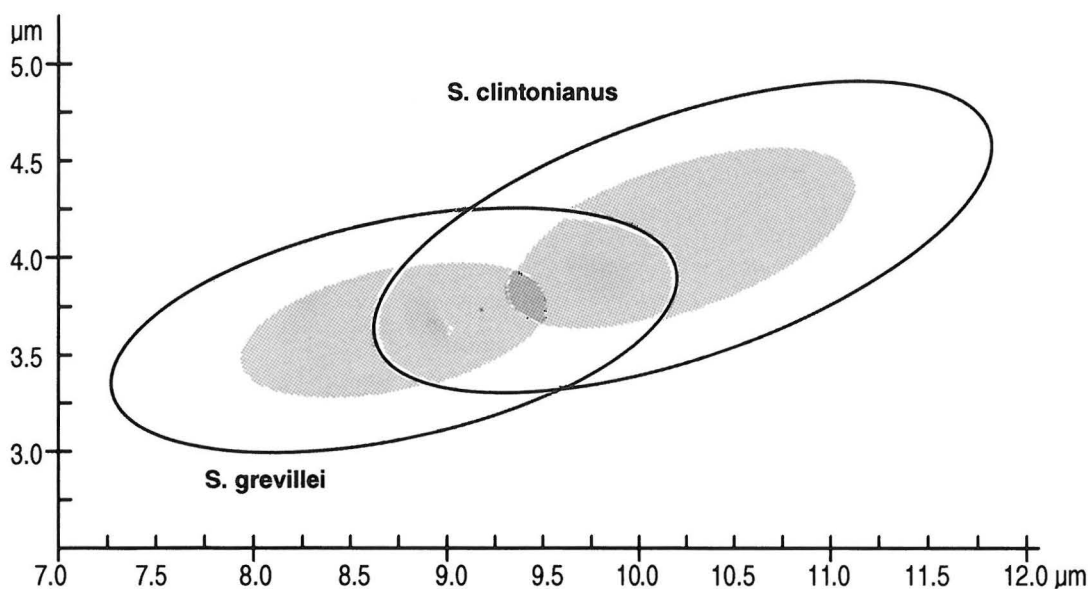


Fig. 6. Diagram showing the spore size difference of *Suillus grevillei* and *S. clintonianus*. The lines are drawn on the basis of scatter diagrams and embrace ca. 95% of the spores measured of each species. 80% of all the measured spores of each species lie in the darkened areas (*S. grevillei*, 770 spores, 21 specimens; *S. clintonianus*, 885 spores, 24 specimens); x-axis, length of spores; y-axis, width of spores.



By contrast, *S. clintonianus* may become lighter with age. There is also a some difference in the colour of the pores, those of *S. clintonianus* being yellowish-orange with rust-coloured hue, while *S. grevillei* has yellow pores and tubes. The clearest differences are seen only in a close study of the microscopical features, however. The hyphae of the pileipellis are hyaline in *S. grevillei* and mainly encrusted in *S. clintonianus* (Fig. 5). The spores are smaller (average volume  $52 \mu\text{m}^3$ ) in *S. grevillei* than in *S. clintonianus* (average volume  $83 \mu\text{m}^3$ ).

*Representative specimens examined:*

**Canada.** Ontario: Ottawa, Highfield Crescent, 1966 *Groves* (H ex DAOM 115344). Québec: La Verendrye, Lac des Loups, 1963 *Pantidou & Elliott* (H ex DAOM 93205); Tourville, 1966 *Groves* 66-72 (H ex DAOM 115327). **U.S.A.** Idaho: Payette National Forest, near road to Brundge Mt., 1975 *Miller 15052* (VPI). **Sweden.** Västmanland: Skinnkatteberg, Riddarhyttan, 1983 *Kytövuori 83557* (H). Västerbotten: Umeå, Södra Bäcksjön, 1987 Olofsson (UME). **Finland.** Varsinais-Suomi: Paimio, Preitilä, 1985 *Mäkinen & Laine 85-977* (TUR); Tammisaari, Bromarv, Solböle, 1990 *Korhonen 10002* (H). Uusimaa: Porvoo parish, Vessö, 1930 *Nyberg* (H). Etelä-Häme: Lammi, Evo, 1956 *Tuomikoski* (H). 1975 *Korhonen 1434* (H). Etelä-Savo: Punkaharju, 1990 *Korhonen 9602* (H). Pohjois-Häme: Ähtäri, 1970 A. & K. *Pohjola* (TUR). Pohjois-Karjala: Kitee, Puhos, 1978 *Korhonen & Tuomikoski 2228* (H). Oulun Pohjanmaa: Pudasjärvi, Kurenala, 1965 *Ahti 20015* (H). Perä-Pohjanmaa: Rovaniemi parish, Muurola, 1991 *Vauras 5799* (TURA); Vanttauskoski, 1988 *Korhonen 8570*, 1990 *Korhonen 9626* (H). Koillismaa: Kuusamo, 1989 *Ahti 48504* (H). Inarri Lappi: Inari, Toivoniemi, 1968 *Kallio* (TUR). **Faroe Islands.** Streymoy: Tórshavn, Gundadalur Plantation, 1988 *Petersen et al.* (C). **Russia.** Amur Region: Nikolaevsknana-Amure, 1906 *Shestukhov* (LE 158903). Bashkortostan: Bashkirian State Reserve, Alakbar Mtn, 780 m, 1953 *Selivanova-Gorodkova 491* (LE 4715). Gorno-Altai Rep.: Chuyskie Alps, 1937 *Singer & Vasil'eva 593* (LE 17804), Akturu, 1937 *Singer & Vasil'eva 511a* (LE 4700). Irkutsk Region: Listvenichnoe, 1947 *Vasil'kov* (LE 4701, 4704, 4705, 4707, 17806); Slyuden District, Vydrino Sta., 1981 *Petrov* (LE 4706). Krasnoyarsk Territory: Sayan-Shushenskiy Reserve, Sarla R., 1984 *Kovalenko 84-8-8* (LE 4693). Leningrad Region: Roshchino (Raivola), 1892 *Thesleff* (H). Tyumen' Region: Labytnangi, 1962 *Vasil'kov* (LE 4691).

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