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Spongipellis sibirica, comb. nova (Basidiomycetes), and its affinities to the polypore genera *Tyromyces*, *Aurantioporus* and *Climacocystis*

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The species was recently described as *Tyromyces sibiricus* Penzina & Ryvarden. The new combination *Spongipellis sibirica* (Penzina & Ryvarden) Penzina & Kotir. is proposed, based on microscopic characteristics, e.g., thick-walled, cyanophilous spores and the structure of the contextual hyphae. The microscopical details are described and illustrated, and comparisons made with the similar-looking species *Aurantioporus fissilis* (Berk. & M. A. Curtis) H. Jahn, *Climacocystis borealis* (Fr.) Kotl. & Pouzar and *Spongipellis spumea* (Sowerby: Fr.) Pat. The affinities to the genus *Tyromyces* P. Karsten are briefly discussed; *S. sibirica* lacks the special, spiny encrustations, characteristic of the species of *Tyromyces*. The species was earlier known from the type locality only. In this paper it is reported from Siberia, Buryat Rep., Lake Baykal, Russian Far East, Kamchatka and China.

Key words: *Aurantioporus*, China, *Climacocystis*, Siberia, *Spongipellis*, taxonomy, *Tyromyces*

Introduction

During a mycological expedition to the Kamchatka peninsula (Russian Far East) in 1997 an unknown sappy polypore was collected. In the field it looked like a hybrid of *Spongipellis spumea* (Sowerby: Fr.) Pat., *Climacocystis borealis* (Fr.) Kotl. & Pouzar and *Aurantioporus fissilis* (Berk. & M. A. Curtis) H. Jahn. However, the hairs on the upper surface were longer than in the above mentioned species and, moreover, they were clearly pink, especially close to the margin of the basidiocarp. In fresh conditions the radially fibrose structure of context very much resembled that of *C. borealis*, whereas in a dry state the fungus shared characteristics of both *S. spumea* and *A. fissilis* in having an oily brown, somewhat constricted tube layer. The specimen remained unidentified until autumn 2000 when the authors were collecting around Lake Baykal. There, Mrs. Penzina found and identified one further specimen.

The type specimen was collected in Siberia in the north-eastern part of Lake Baykal, in a nature reserve in the middle course of the river Levaya Frolikha (Penzina & Ryvarden 1998). Another specimen grew on the shore of Lake Baykal, only about 200 km south-west of the type locality. Further collections are here reported from north-eastern China, collected by Y. C. Dai and T. Niemelä. The most far-eastern record was made on the Kamchatka peninsula along a small river close to the village Esso. The Russian collecting sites are all close to water because the hosts *Chosenia arbutifolia* (Pall.) A. Skvorts. and *Populus suaveolens* Fisch. (or hybrids of *P. suaveolens* and *P. tremula* L.) grow by lake sides or along watercourses. The first Chinese specimen was collected in a deciduous forest (reported as *Tyromyces* cf. *sibiricus*, Dai 2000) and the second in a coniferous forest in a river valley.

Material and methods

The material studied is preserved in the herbaria O, H, and/or in the reference herbarium of Heikki Kotiranta (H.K.) or Tuomo Niemelä (T.N.), and is listed below.

Table 1. Spore dimensions of specimens studied.

	L	*L**	*W*	*W**	*Q*	*Q**
Aur. fissilis						
Kotiranta 2091	**4.0–4.5**	4.2	**2.5–2.9**(–3.1)	2.7	1.4–1.7	1.5
Kotiranta 6077	**3.8–4.2**(–4.6)	4.1	**2.8–3.3**(–3.5)	3.0	1.2–1.5	1.4
Kotiranta 4221	**4.0–4.5**(–4.7)	4.2	(2.6–)**2.8–3.5**	3.1	1.2–1.5	1.3
Cli. borealis						
Kotiranta 6010	(5.2–)**5.5–6.2**(–6.6)	5.9	**3.9–4.2**(–4.6)	4.1	1.3–1.7	1.5
Kotiranta 1072	**5.5–7.2**(–7.4)	6.3	**3.8–4.5**(–4.8)	4.2	1.3–1.8	1.5
Kotiranta 1378	**5.0–5.9**(–6.2)	5.5	**3.4–4.0**	3.7	1.3–1.7	1.5
Spo. sibirica						
Dai 1723	**4.7–5.5**(–6.3)	5.1	**3.8–4.6**(–4.8)	4.3	1.1–1.4	1.2
Niemelä 6407	(4.7–)**4.9–5.7**(–6.3)	5.3	**3.8–4.6**(–4.8)	4.2	1.1–1.3	1.2
Penzina 176	**4.5–5.5**(–6.0)	4.9	(3.7–)**3.9–4.7**(–4.9)	4.2	1.1–1.3	1.2
Kotiranta 17668	**4.6–5.9**(–6.2)	5.3	**3.6–4.3**(–4.5)	4.0	1.2–1.5	1.3
Kotiranta 12880	**4.4–4.9**(–5.1)	4.7	**3.5–4.0**	3.8	1.1–1.4	1.2
Spo. spumea						
Kotiranta 9992	**6.0–6.8**(–7.0)	6.4	(4.7–)**4.9–6.0**	5.2	1.1–1.4	1.2
Kotiranta 5965	**5.7–6.3**(–6.5)	6.1	(4.5–)**4.7–5.3**(–5.5)	5.0	1.1–1.3	1.2
Kotiranta 7182	(6.0–)**6.2–7.6**(–7.8)	6.8	(4.5–)**4.7–5.7**(–5.9)	5.2	1.1–1.5	1.3
Kotiranta 17669	(5.3–)**5.5–6.6**(–7.2)	6.2	(4.5–)**4.7–5.6**	5.0	1.1–1.4	1.2

Thirty spores per specimen were measured from sections mounted in Cotton Blue (CB) or Melzer's reagent (IKI). The third mounting media used was 5% potassium hydroxide (KOH). In the text the following abbreviations are used: L = mean spore length, W = mean spore width, Q = range of the variation in L/W ratio, Q^* = quotient of the mean spore length and mean spore width (L/W). The measurements for each specimen are given in Table 1, and in the text only the mean Q^*-value and the mean spore length and width of *all the* specimens are given. The values L and W (in Table 1) given in bold include at least 90% of the spores. None of the measurements derive from spore print.

The co-ordinates given of the Finnish localities are according to the Uniform Grid 27°E system.

Specimens examined

Aurantioporus fissilis. — **Finland**: Varsinais-Suomi: Tammisaari, cavity of living *Ulmus glabra*, 6674:308, 10.VIII.1980 *Kotiranta 2091* & *Koski* (H, H.K.). Uusimaa: Helsinki, hollow *Betula pendula*, 6679:387, 5.VIII.1986 *Kotiranta 6077* & *Saarenoksa* (H, H.K.). Etelä-Häme: Lammi, dying *Populus tremula* ashore, 6773:394, 13.IX.1982 *Kotiranta 4221*, *Niemelä et al*. (H, H.K.).

Climacocystis borealis. — **Finland**: Uusimaa: Sipoo, Rörstrand Nat. Res.,dead, erect *Picea abies*, 6706:402, 13.X.1985 *Kotiranta 6010* (H.K.). Perä-Pohjanmaa: Rovaniemi comm., Pisavaara Strict Nat. Res., fallen *Picea abies*, 7359:417, 28.VII.1979 *Kotiranta 1072* & *Niemelä* (H.K.). Koillismaa: Kuusamo, Oulanka Nat. Park, *Picea abies* snag, 7367:601, 2.VIII.1979 *Kotiranta 1378* & *Niemelä* (H.K.).

Spongipellis sibirica. — **China:** Jilin Prov.: Huadian county, Dongxing, broadleaf forest, living *Acer*, 19.X.1993 *Y.C. Dai 1723* (H). Jilin Prov.: Antu, between Changbai Prot. Sta. and Sky Lake, coniferous forest in river valley, alt 1300 m. a.s.l., living *Populus koreana*, 18.IX.1998 *Niemelä 6407 & Dai* (H, T.N.). **Russia**: Buryat Rep., Lake Baykal, district Severobaikal'sk, Frolikhinskii Nat. Res., in the mid-course of the river Levaya Frolikha, living *Populus suaveolens*, 4.VIII.1996 *Penzina 176* (holotype of *Tyromyces sibiricus*, O). Buryat Rep., Lake Baykal, Severnyy Kedrovyy, fallen *Populus suaveolens* ashore, also *S. spumea* (*Kotiranta 17669*), 54°27´N 108°33´E, 9.IX.2000 *Kotiranta 17668*, *Penzina et al.* (H, H.K.). Kamchatka, Esso 6 km NW, dead *Chosenia arbutifolia* on riverside, 55°57´N, 158°38´E, 3.VIII.1997 *Kotiranta 12880, Laessøe 4669 et al.* (C, H.K.).

Spongipellis spumea. — **Finland**: Varsinais-Suomi: Lohja, small living *U. laevis*, 6683:326–7, 25.IX.1991 *Kotiranta 9992* & *Pykälä* (H, H.K.). Uusimaa: Helsinki, living *Acer platanoides*, 66761:3858, 23.VIII.1984 *Kotiranta 5965* & *Niemelä 2955* (H, H.K.). Helsinki, living *A. platanoides*, 6677:382, 1.I.1989 *Kotiranta 7182* (H, H.K.). **Russia**: Buryat Rep., Lake Baykal, Severnyy Kedrovyy, fallen *Populus suaveolens*, also *Spongipellis sibirica* (*Kotiranta 17668*), 54°27´N 108°33´E, 9.IX.2000 *Kotiranta 17669, Penzina et al*. (H, H.K.).

Spongipellis sp. — **Russia**: Khabarovsk Kray: Khrebet Khrekhtsir, living *Quercus*, 48°18´N 135°03´E, 11.VIII.1998 *Kotiranta 14149 & Corfixen* (H.K.).

Tyromyces chioneus. — **Finland:** Pohjois-Savo: Heinävesi, 692:58, 8.IX.1951 *Ruotsalo A4439* (H.K.). Kittilän Lappi: Kittilä, Pallas–Ounastunturi Nat. Park, hanging *Betula pubescens*, 754:37, 6.IX.1982 *Kotiranta 4116* (H). Inarin Lappi: Inari, Lemmenjoki Nat. Park, corticated *Betula pubescens* on the ground, 762:45, 9.VIII.1982 *Kotiranta 3873* (H.K.).

Tyromyces kmetii. — **Finland**: Inarin Lappi: Inari, Inarijärvi E, corticated *Betula pubescens* on the ground, 766:56, 3.VIII.1982 *Kotiranta 3922* (H.K.). **Russia**: Buryat Rep., Lake Baykal, fallen *Betula*, 15.IX.1987 *Penzina* (H.K.).

Tyromyces subgiganteus. — **Costa Rica**: Road to Volcan Poas, 30.XII.1972 *Welden 3175* (O). Punta Arenas: Carrara Biol. Res., 14.VI.1991 *Ryvarden 29739* (O). **Puerto Rico**: Maricao: Maricao forest, deciduous wood, 25.VI.1996 *Ryvarden 39050* (O). Rio Grande, Luquillo Mts., *Cyrella raciniflora*, 1VII.1998 *Cantrell* (O). **USA**: Tennessee: Great Smokey Mts. Nat. Park, Glinsmans dome, *Picea*, 6.IX.1977 *Ryvarden 14132* (O).

Results and discussion

As mentioned above, in the field *Spongipellis sibirica* resembles *Aurantioporus fissilis*, *Climacocystis borealis* and *Spongipellis spumea* (Fig. 1). The colour of the hairy upper surface is reminiscent of *Tyromyces kmetii* (Bres.) Bondartsev & Singer, but as a rule not so orange, but pink or almost white when very young.

Macroscopically the fibrous context is reminiscent of *Climatocystis borealis*. Microscopically, however, the two differ clearly. The context of *C. borealis* consists of two types of hyphae: fairly thick-walled, sparsely clamped, strictly parallel, 6–7 µm wide hyphae, and thin-walled, richly branched 4 µm wide hyphae. Trama of *C. borealis* consists predominantly of thin-walled parallel hyphae which are inter-

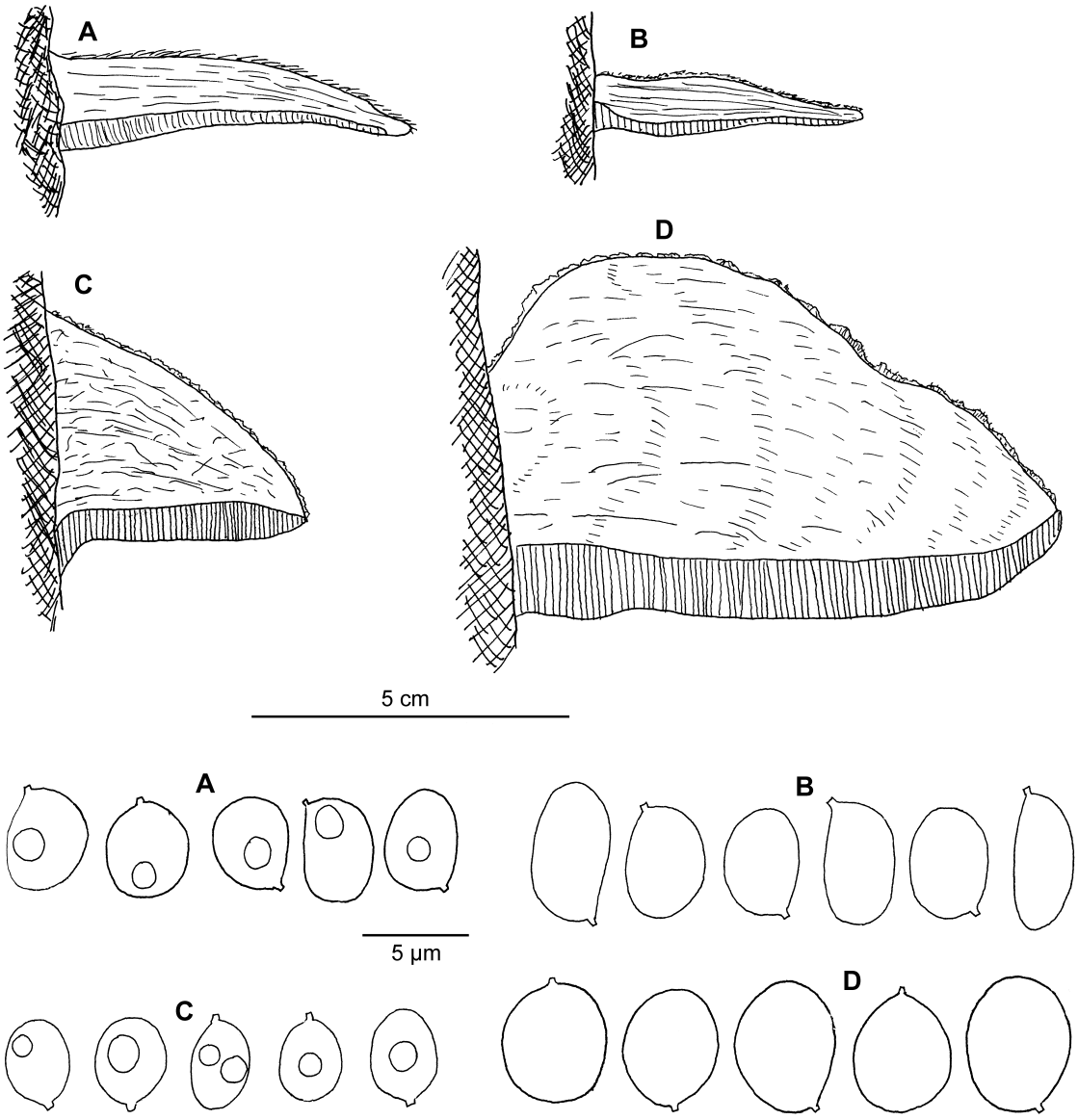

Fig. 1. Split basidiocarps and basidiospores, specimens *Kotiranta 17668, Penzina et al.* (**A**), *Kotiranta 1378 & Niemelä* (**B**), *Kotiranta 4221 & Niemelä* (**C**), *Kotiranta 5965 & Niemelä* (**D**). — **A**: *Spongipellis sibirica* (Penzina & Ryvarden) Penzina & Kotir. — **B**: *Climacocystis borealis* (Fr.) Kotl. & Pouzar. — **C**: *Aurantioporus fissilis* (Berk. & M. A. Curtis) H. Jahn. — **D**: *Spongipellis spumea* (Sowerby: Fr.) Pat.

mixed with highly refractive, thick-walled (up to 1.3 µm), 3–4 µm wide hyphae. The latter look very much like skeletal hyphae, yet we failed to find clamps from them, even if they could be followed over 450 µm. The number of such hyphae varies and they are sometimes difficult to find. *C. borealis* is characterised by cystidia, measuring (35–)40–50 × (7–)9–11 µm and ellipsoid or broadly ellipsoid, thin-walled, acyanophilous spores, 5.9 × 4.0 µm, $Q^* = 1.5$ (Fig. 2).

The basidiocarps of *Aurantioporus fissilis* are usually thicker than those of *Spongipellis sibirica*. The context of the former is composed of radially arranged, thin- to fairly thick-walled clamped hyphae, which are (3–)4–6(–8) µm in diam. Tramal hyphae are subparallel, fairly thin-

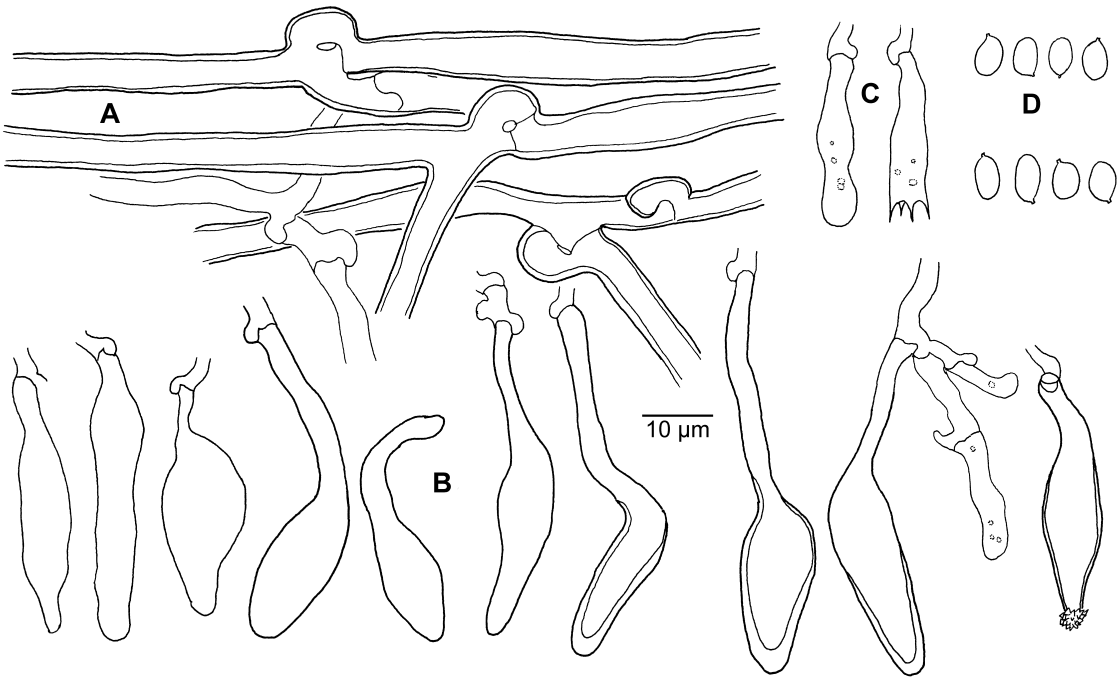

Fig. 2. *Climacocystis borealis* (Fr.) Kotl. & Pouzar, specimen *Kotiranta 1378 & Niemelä*. — **A**: Contextual hyphae. — **B**: Cystidia at different stages of development. — **C**: Basidia. — **D**: Basidiospores.

walled, 3–3.5 µm wide. Hyphae in the dissepiment edge are thin-walled, apically roundish and smooth. The spores are ellipsoid or broadly ellipsoid, 4.2 × 2.9 µm, Q^* = 1.4, thin-walled, acyanophilous, IKI– (Fig. 1). The chlamydospores of *A. fissilis* are strongly cyanophilous and often of the same size as the spores of *S. sibirica*.

The type species of the genus *Tyromyces* P. Karsten is *Polyporus chioneus* Fr. Its contextual hyphae have a very characteristic structure: they bear short side branches, which are often highly refractive (Fig. 3). Similar context is seen in, e.g. *T. fumidiceps* G. F. Atk. (Renvall & Kaaro 1998) and *T. kmetii* (Kotiranta 1986). The contextual hyphae of *T. fumidiceps* bear rose-thorn-shaped crystals (Renvall & Kaaro 1998) but such sharp-pointed encrustations are not uncommon in *T. chioneus* either (Figs. 3–4). The dissepimental hyphae of *T. kmetii* are smooth but in culture it produces similar crystals (Fig. 5). This kind of encrustation characterises the genera *Skeletocutis* Kotl. & Pouzar (David 1982, Niemelä 1998) and *Piloporia* Niemelä (Niemelä 1982). Moreover, all these genera comprise species, with acyanophilous, thin-walled spores and

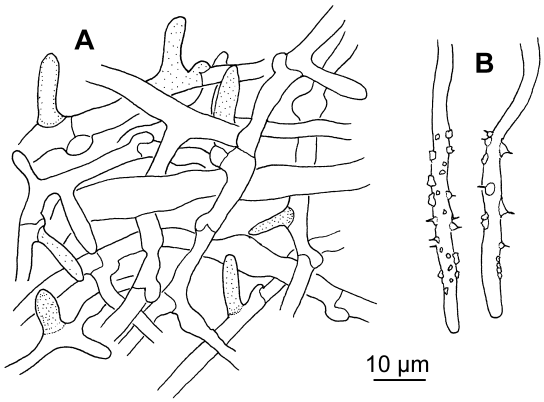

Fig. 3. *Tyromyces chioneus* (Fr.) P. Karsten, specimens *Kotiranta 4116* (a), *3873* (b). — **A**: Contextual hyphae. — **B**: Rose-thorn-shaped crystals on dissepimental hyphae.

small cystidioles. Weather they all really belong to different genera can only be solved by DNA-analyses. The context of *S. sibirica* differs clearly from that typical for the *Tyromyces-Skeletocutis-Piloporia* generic complex, its spores are thick-walled, faintly cyanophilous and its dissepimental hyphae are smooth. Moreover it lacks

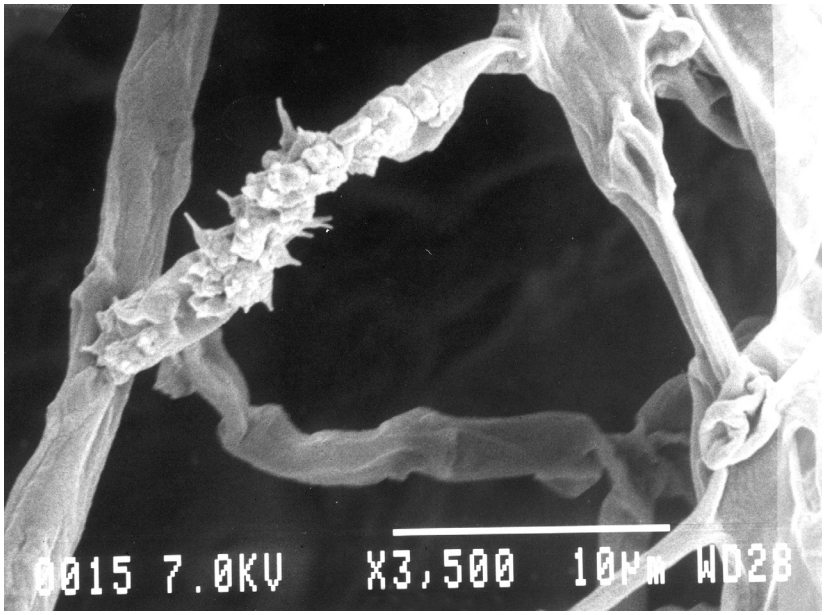

Fig. 4. *Tyromyces chioneus* (Fr.) P. Karsten, specimen *Ruotsalo 4439*. — SEM picture of rose-thorn-shaped crystals on dissepimental hyphae.

the small cystidioles.

We studied specimens of *Tyromyces subgiganteus* (Berk. & Curt.) Ryvarden, but unfortunately the material is more or less sterile, and infected by a Heterobasidiomycete. However, none of the specimens studied is conspecific with *S. sibirica*, in having thin-walled, acyanophilous spores. According to Gilbertson and Ryvarden (1987) and Penzina and Ryvarden (1998) the fruit body of *T. subgiganteus* shrinks strongly upon drying. This is not the case with *S. sibirica*. Also the figures of *Polyporus spumeus* var. *malicola* Lloyd (= *Tyromyces subgiganteus*, *see* Ryvarden 1984) in Overholts (1953) show a species not familiar to us. In our opinion, *T. subgiganteus* is not a species of *Tyromyces* in a strict sense.

We studied one *Spongipellis* specimen (*Kotiranta 14149*), which in outer appearance is like a dwarf *S. spumea*. However, the upper surface of the specimen is not at all hairy, and even less tomentose than in *S. spumea*. On the other hand, the spores are of the same size as in *S. sibirica*. For the time being, we leave it unnamed.

The closest relative of *Spongipellis sibirica* is *S. spumea*. The hyphal structures of the two are almost alike. *S. spumea*, however, has slightly more thick-walled hyphae in context (walls up to 1.8 µm thick), and the tramal hyphae are slightly wider, 4–4.5 µm in diam. The best distinguishing characteristic is the size of the spores, which are clearly larger in *S. spumea,* i.e. 6.4 × 5.1 µm, although the shape is the same (Fig. 1). We are convinced that the correct genus for *S. sibirica* is *Spongipellis*. Therefore, we propose the following combination:

Spongipellis sibirica (Penzina & Ryvarden) Penzina & Kotir., *comb. nova* (Figs. 1 and 6–9)

Tyromyces sibiricus Penzina & Ryvarden, Folia Cryptog. Estonica, Fasc. 33:109. 1998 (holotype *Penzina 176*, O).

Penzina and Ryvarden (1998) give a good description of the basidiocarp. However, it should be noted that the very young fruit bodies are almost pure white, very sappy, and that the old basidiocarps may be almost bold, having slightly wrinkled, mealy surface and long hairs only in margin.

Hyphal system monomitic. Context clearly monomitic; hyphae radially arranged, subparallel, sometimes wavy, fairly frequently clamped (large clamps) (4.5–)5–7(–8) µm wide, with up to 1.2 µm thick walls, faintly, but clearly CB+,

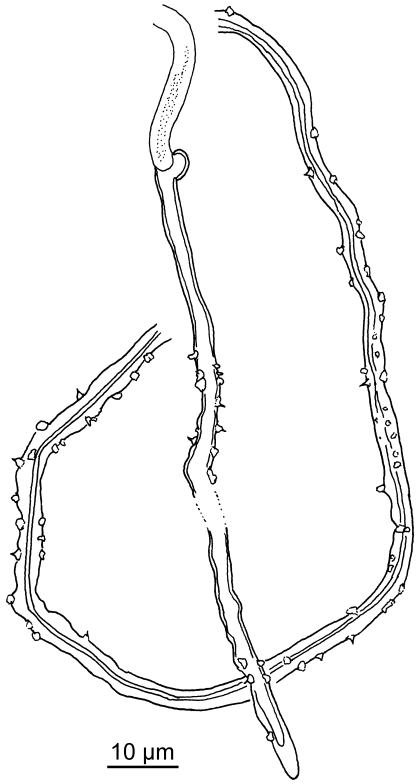

Fig. 5. *Tyromyces kmetii* (Bres.) Bondartsev & Singer, specimen *Kotiranta 3922*. — Rose-thorn-shaped crystals on thick-walled hyphae on culture.

IKI–. Trama monomitic, hyphae strictly parallel, 3–4(–5) µm wide, thin- or slightly thick-walled (walls up to 1 µm thick). Dissepimental hyphae smooth. Subhymenial hyphae richly branched, (2–)3–4 µm diam., thin-walled. Cystidia lacking, but thin-walled cystidioles occasional, (16–)22–30 × 4–6 µm. Basidia basally clamped, at first almost ovoid, later clavate or subclavate, often constricted in the middle part, (15–)18–25(–27) × 5–6(–7) µm with four thin, up to 3 µm long sterigmata. Spores ellipsoid, broadly ellipsoid or subglobose, 5.0 × 4.1 µm, Q^* = 1.2, often with a small apiculus, with somewhat thickened walls, faintly cyanophilous, IKI–, bearing a single, prominent guttule.

The cystidioles, which look very similar to those of *Spongipellis pachyodon* (Pers.) Kotl. & Pouzar (*see* Ryvarden & Gilbertson 1993: p. 644), are perhaps only as a result of secondary growth of basidioles.

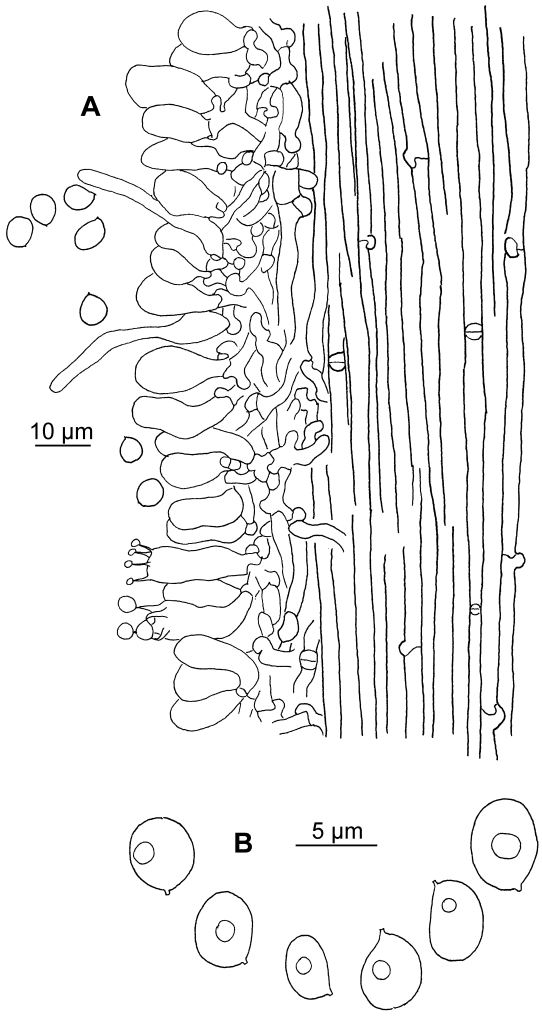

Fig. 6. *Spongipellis sibirica* (Penzina & Ryvarden) Penzina & Kotir., specimen *Kotiranta 17668, Penzina et al.* — **A**: Parallel tramal hyphae, hymenium with cystidioles, basidia and basidiospores. — **B**: Basidiospores.

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Fig. 7. *Spongipellis sibirica* (Penzina & Ryvarden) Penzina & Kotir., specimen *Niemelä 6423 & Dai*. Young specimen with hairy upper surface. Photo T. Niemelä.

Fig. 8. *Spongipellis sibirica* (Penzina & Ryvarden) Penzina & Kotir., specimen *Niemelä 6407 & Dai.* Profile. Photo T. Niemelä.

Fig. 9. *Spongipellis sibirica* (Penzina & Ryvarden) Penzina & Kotir., specimen *Niemelä 6407 & Dai*. Pore surface. Photo T. Niemelä.

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