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Inocybe (Basidiomycota, Agaricales) from Kamchatka (Siberia, Russia): taxonomy and ecology

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Little is known about the occurrence and distribution of *Inocybe* spp. (Cortinariaceae, Agaricales) in the Kamchatka peninsula (Russia, Siberia) situated at the far-eastern border of Eurasia, North to Japan and close to the American continent. On the occasion of a 'Trans-Siberian Mycological Expedition' in August 1997, about 45 collections of *Inocybe* spp. representing 24 species (including 4 varieties) have been gathered. The following 24 taxa of *Inocybe* are described and/or illustrated with their specific macroscopical and/or microscopical characters: *Inocybe acutella*, *I. alnea*, *I. assimilata*, *I. brunneorufa*, *I. calospora*, *I. cookei* var. *kuthanii*, *I. egenula*, *I. fastigiella*, *I. flocculosa* var. *crocifolia*, *I. fuscidula*, *I. geophylla*, *I. glabrescens*, *I. grammata*, *I. lacera* var. *helobia*, *I. lacera* var. *rhacodes*, *I. malenconii*, *I. mixtilis*, *I. nitidiuscula*, *I. ochroalba*, *I. petiginosa*, *I. phaeocomis* var. *major*, *I. rimosa*, *I. rufoalba*, and *I. xanthocephala*.

Geographical and ecological information on all recorded species is provided. The present results indicate that the majority of the *Inocybe* species observed in Kamchatka actually have a circumpolar distribution in the northern hemisphere and also occur in the alpine, boreal and/or temperate belt both in Europe and North America.

Keywords: Cortinariaceae, distribution, ectomycorrhiza.

On the occasion of the "Russian-Scandinavian Trans-Siberian Mycological Expedition 1997" various groups of Basidiomycetes were collected in the Kamchatka peninsula (Russian Far-East) (e.g. Kotiranta & Mukhin, 1998). Among other Agaricales, many collections of *Inocybe* (Fr.) Fr. (Cortinariaceae) were gathered during this collecting trip.

The mycobiota of Kamchatka is of special interest because of its particular geographical position and its interesting vegetation composed of locally dominant endemic trees and shrubs, e.g. *Betula ermanii* Cham., *B. kamtschatica* var. *kenaica* (W.H. Evans) C. A. Jansson, *Picea jezoensis* (Sieber & Zucc.) Carrière, *Larix gmelinii* subsp. *gmelinii* (Rupr.) Rupr., *Alnus viridis* subsp. *fruticosa* (Rupr.) Nyman, *Alnus kamtschatica* (Kom.) Jarm. ex Czerep., *Populus sua-*

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veolens Fisch., *Chosenia arbutifolia* (Pall.) A. Skvorts., *Pinus pumila* (Paalas) Regel, *Salix sachalinensis* Fr. and *Dryas octopetala* var. *kamtschatica* (Juz.) Hultén. The timberline is formed by *Betula ermanii* and is situated approximately at an altitude of 300 m a.s.l. on the eastern Kamchatka range and at about 700 m a.s.l. in the central Kamchatka depression. Subalpine brushwoods are formed by *Pinus pumila* and *Alnus kamtschatica*. The tundra belt is dominated by the dwarf birch *Betula exilis* Sukacz. (Kalamees & Vaasma, 1993).

By comparison, the present knowledge concerning agarics and in particular Cortinariaceae from Arctic regions of Siberia is scarce: Nezdoiminogo (1993) and Nezdoiminogo & Petrov (1999) cited 27 species (30 taxa) of *Inocybe* for this huge territory. Previous to our survey only five *Inocybe* spp. have been reported from the Kamchatka peninsula (Kalamees & Vaasma, 1981, 1993).

The aim of the present study on *Inocybe* is to add new and comprehensive data to this group of ectomycorrhizal Basidiomycetes in Kamchatka and Siberia in general, and to provide geographical and ecological information on selected taxa.

Materials and methods

During a one-month long collecting trip to Kamchatka many different habitats, from coastal dunes to alpine slopes, have been visited. The 18 collecting sites (S1–S18) are listed in Tab. 1, together with the respective geographical information and the dominating trees.

Colors of fresh basidiomes relate to the color codes Cailleux (1983) (Caill.) and Kornerup & Wanscher (1981) (M). Microscopic examination was carried out using standard techniques with a Nikon Optiphot 2 microscope in 10% NH_4OH and/or 4% NaOH. Microscopic data have been gathered from videoprints (Sony Multiscan Videoprinter UP-930). Spore measurements are given as (minimum-) mean value $\pm$ standard deviation (-maximum). Sample size is indicated by (n). The quotient (Q) is the ratio of spore length to spore width. Basidiospores were measured from spore prints or removed from either the stipe or the pileipellis to make sure that only mature basidiospores are taken into consideration. In the case of gibbous basidiospores, bulges (in median position) are included in the measurements. The length of mature basidia excludes the sterigmata. Cystidia are measured without apical incrustation. Following Kuyper (1986), the thin-walled, clavate to pyriform cells at the lamellar edges are called paracystidia. Collections used for the description and drawings are marked with an asterisk (*) in the list of material. The specimens described in this paper are deposited both in the Mycological Herbarium of Innsbruck (IB, Austria) and

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Tab. 1. – Enumeration of the collecting sites in Kamchatka (S1–S18) visited during the "Russian–Scandinavian Trans-Siberian Mycological Expedition 1997", with geographical coordinates, altitude, date of visit and dominating trees.

No.	Locality	Coordinates	Altitude	Date of visit	Dominating trees
S1	NE of Razdolny, Avacha river valley	53°18′N – 158°20′E	100 m	31 Jul. 1997	*Betula ermanii, Alnus fruticosa, Sorbus kamtschatica, Populus suaveolens*
S2	Razdolny, Bridge over Avacha river	53°13′N – 158°20′E	100 m	01 and 23 Aug. 1997	wet riverine area: *Salix sachalinensis, Chosenia arbutifolia, Abies kamtschatica*
S3	W of Ust–Bolsheretsk, Bystraya river valley	52°47′N – 156°12′E	0–20 m	13 Aug. 1997	sand dunes with *Sphagnum* sp., *Salix* sp., *Betula nana, Arctostaphylos* sp.
S4	Bystraya river valley, 18 km from the main road	55°59′N – 159°17′E	150 m	12 Aug. 1997	dense stand of young *Larix gmelinii* with *Betula ermanii*
S5	6 km NW of Esso, Uksichan river valley	55°56′N – 158°36′E	600 m	03 and 11 Aug. 1997	*Betula ermanii, Larix gmelinii, Abies kamtschatica, Pinus pumila, Populus suaveolens, Populus tremula, Chosenia arbutifolia, Salix sachalinensis*
S6	N of Esso, burned mountain slope	55°56′N – 158°41′E	800 m	05 Aug. 1997	*Larix gmelinii, Betula ermanii*
S7	5 km NE of Esso, Kozyrevsky Range, Tupikin Klyuch	55°58′N – 158°47′E	700–1000 m	04 Aug. 1997	*Salix tschuktschorum, Betula nana, Pinus pumila*
S8	3 km NE of Kozyrevsk, Kamchatka river valley	56°05′N – 159°57′E	150 m	08 Aug. 1997	*Picea* forest with very old trees of *Larix*
S9	13 km NE of Kozyrevsk	56°08′N – 160°02′E	250 m	08 and 10 Aug. 1997	*Picea* forest with *Larix gmelinii, Betula ermanii, Sorbus kamtschatica, Salix hultenii*
S10	Paratunka	52°57′N – 158°16′E	100 m	16. Aug. 1997	natural stand and planted trees: *Betula ermanii, Salix sachalinensis, Abies kamtschatica*

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Tab. 1 (cont.). – Enumeration of the collecting sites in Kamchatka (S1–S18) visited during the "Russian–Scandinavian Trans-Siberian Mycological Expedition 1997", with geographical coordinates, altitude, date of visit and dominating trees.

No.	Locality	Coordinates	Altitude	Date of visit	Dominating trees
S11	Petropavlovsk	53°02′N – 158°41E	40–100 m	30. Jul., 15 and 18 Aug. 1997	natural stand and planted trees: *Betula ermanii, Salix sachalinensis, Abies kamtschatica*
S12	Yurta Mountain, Plotnikova River Valley	53°10′N – 157°26′E	250 m	14 Aug. 1997	*Betula ermanii* intermixed with *Salix hultenii*
S13	2 km W of Paratunka, Termalny	52°56′N – 158°12′E	300–900 m	16 and 17 Aug. 1997	*Betula ermanii, Salix sachalinensis, Abies kamtschatica*
S14	Tolbachinsky Volcano	55°41′N – 161°11′E	950 m	06 and 07 Aug. 1997	volcanic ash with *Dryas* sp.
S15	Vodopadny Creek, Seismic Station	55°45′N – 160°13′E	1000 m	07 Aug. 1997	volcanic ash with *Alnus fruticosa*
S16	Vilyuchinsky Volcano	52°40′N – 158°13′E	500–800 m	24 Aug. 1997	tundra with *Alnus fruticos*
S17	Zhupanovo	54°06′N – 159°58′E	10–80 m	10 and 21 Aug. 1997	forest dominated by *Betula ermanii*
S18	8 km N of Zhupanovo	54°08′N – 159°57′E	30 m	21 Aug. 1997	forest dominated by *Abies nephrolepis*

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parts of the collections are also kept in the Herbarium Zurich (ZT, Switzerland).

For the identification of the Kamchatkan *Inocybe* material the following publications have been routinely employed:

Alessio (1980), Bon (1997a, 1997b, 1997c, 1998), Heim (1931), Horak (1987), Kauffman (1924), Y. Kobayashi (1952), Kühner & Boursier (1932), Kuyper (1986), Stangl (1989), and Stangl & Eberle (1983). Further leading literature is also found in these references.

Key to Kamchatkan species of *Inocybe*

1. Basidiospores smooth 2
1*. Basidiospores spinose, bumpy or nodulose 15

2. Basidiospores (in lateral view) allantoid, phaseoliform, parameciiform, or subfusiform. Cystidia metuloid or not 3
2*. Basidiospores (in lateral view) ovoid, amygdaliform or sublimoniform. Cheilo- and pleurocystidia metuloid 9

3. Cheilocystidia and paracystidia thin-walled. Pleurocystidia absent. Crystals absent. Basidiospores mostly <11 µm long . . . 4
3*. Cheilocystidia (at least at apex) metuloid. Pleurocystidia present. Crystals absent or present. Basidiospores mostly >11 µm long 8

4. Only vesiculose, articulate paracystidia present. Basidiospores <4 µm diam. Pileus convex, squamulose . . 1. *I. malenconii*
4*. Articulate paracystidia absent. Cheilocystidia vesiculose, clavate, broadly fusoid or uteriform. Basidiospores >4 µ diam. Pileus conical to papillate, fibrillose-rimose, radially splitting towards margin 5

5. Stipe at base equal. Pileus pale yellow 6
5*. Stipe at base bulbous or marginate-bulbous. Pileus reddish brown 7

6. Pileus pale yellow. Basidiospores >6 µm wide . . . . 4. *I. rimosa*
6*. Pileus bright yellow. Basidiosopores <6 µm wide . . . . . 5. *I. xanthocephala*

7. Base of stipe distinctly marginate-bulbous . . . . . 2. *I. cookei* var. *kuthanii*
7*. Base of stipe bulbous . . . . . 3. *I. fastigiella*

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8. Pileus dark brown, squamulose, not radially splitting. Base of stipe equal or slightly swollen. Metuloid caulocystidia absent. Basidiospores (in lateral view) phaseoliform to parameciiform. In arctic-subarctic tundra with dwarf *Salix* . . . . . 9. *I. lacera* var. *helobia*

8*. Same as above in all repects, but basidiospores (in lateral view) subfusoid, often bluntly angled. Catenulate cystidia present . . . . . 10. *I. lacera* var. *rhacodes*

9.(2*) Basidiospores distinctly sublimoniform. Stipe fibrillose (distinctive caulocystidia absent) . . . 12. *I. phaeocomis* var. *major*

9*. Basidiospores ovoid to amygdaliform. Stipe pruinose at least at apex (distinctive caulocystidia present) 10

10. Basidiomes white. Odor spermatic . . . . . 8. *I. geophylla*

10*. Basidiomes of different color 11

11. Basidiomes with distinctive yellow-ochre to orange colors. Odor not distinctive 12

11*. Basidiomes with different colors. Pileus fuscous. Odor spermatic 14

12. Cheilo- and pleurocystidia <45 µm long. Basidiospores 8–9.5 µm long . . . . . 17. *I. ochroalba*

12*. Cheilo- and pleurocystidia 50–90 µm long 13

13. Basidiospores 7.5–9 µm long . . . . . 16. *I. glabrescens*

13*. Basidiospores 9.5–11 µm long . . . . 6. *I. flocculosa var. crocifolia*

14. Stipe with reddish tinge . . . . . 11. *I. nitidiuscula*

14*. Stipe white to pale ochre becoming pale brown . . . . . 7. *I. fuscidula*

15.(1*) Basidiospores spinose. Pileus conical to papillate . . . . . 20. *I. calospora*

15*. Basidiospores angular, bumpy or distinctly nodulose 16

16. Basidiospores angular (cf. also 10. *I. lacera* var. *rhacodes* and 24. *I. rufoalba*) 17

16*. Basidiospores with low bumps or well defined nodules 18

17. Pileus dark brown, conical to papillate. Base of stipe equal or subclavate. Odor not distinctive . . . . . 13. *I. acutella*

17*. Pileus ochre with reddish brown tinge, umbonate. Base of stipe distinctly marginate-bulbous. Odor spermatic . . . . . 21. *I. grammata*

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18. Pileus <8 mm diam. Base of stipe equal or subclavate. Metuloid caulocystidia present. Odor not distinctive 19
18*. Pileus larger. Base of stipe bulbous or marginate-bulbous. Odor distinctive or not 20

19. In alpine tundra with *Dryas* sp. ..... 15. *I. egenula*
19*. In lowland forest under *Betula* and *Salix* ... 23. *I. petiginosa*

20. Basidiospores large, >9 µm long. Base of stipe marginate-bulbous 21
20*. Basidiospores small, <8.5 µm long. Base of stipe bulbous or marginate-bulbous 22

21. Cheilo- and pleurocystidia <60 µm long ... 19. *I. brunneorufa*
21*. Cheilo- and pleurocystidia 60–80 µm long ..... 18. *I. alnea*

22. Cheilo- and pleurocystidia 60–80 µm long. Basidiospores often with poorly defined bumps ..... 24. *I. rufoalba*
22* Cheilo- and pleurocystidia <50 (–60) µm long. Basidiospores with well defined bumps or nodules 23

23. Stipe fibrillose, base bulbous. Metuloid caulocystidia absent. Basidiospores with well defined bulges ..... 14. *I. assimilata*
23*. Stipe distinctly pruinose, base marginate-bulbous. Metuloid caulocystidia present. Basidiospores nodulose ... 22. *I. mixtilis*

Results

During July-August 1997, about 45 collections of *Inocybe* spp. representing 24 taxa (including 4 varieties) were gathered in Kamchatka. The list of these taxa is presented in Tab. 2.

Enumeration and descriptions of Kamchatkan species of *Inocybe*

Inocybe Subgen. *Mallocybe*

1. *Inocybe malenconii* R. Heim, Encycl. Mycol. 1: 163. 1931. – Fig. 1: 1–2.

Selected illustrations: Heim (1931: Pl. 5, Fig. 1), Rebaudengo (1980: 3).

Pileus 10–24 mm, plano-convex to plane, with straight to slightly involute margin, ochraceous brown with distinctive, darker brown, squarrulose, lanose squamules, these are more prominent at the center of the pileus, margin fibrillose. Cortina fugaceous. – Lamellae broadly adnate to slightly decurrent, moderately crowded, chocolate brown to olivaceous-brown, edges floccose, white. –

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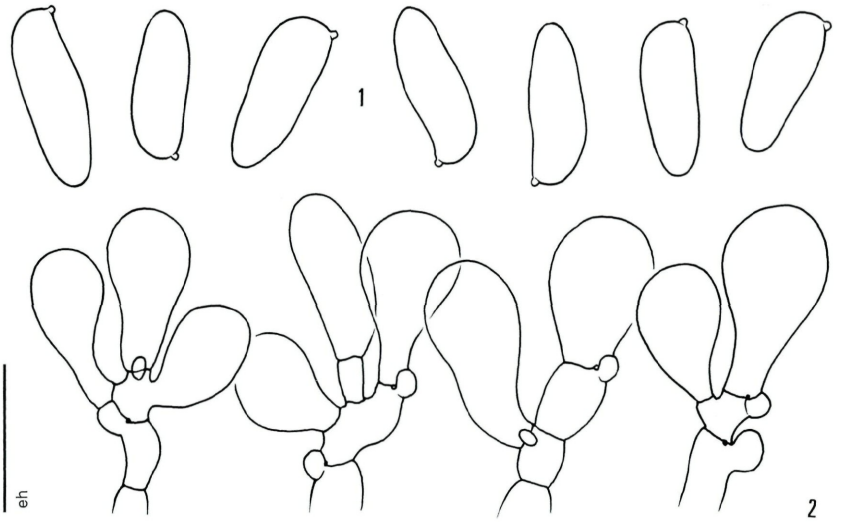


Fig. 1. *Inocybe malenconii* (IB 19970907). – 1. Basidiospores. – 2. Cheilocystidia. Scale bar: 1 = 5 µm; 2 = 10 µm.

Stipe 15–25 × 3–5 mm, cylindrical, solid, subconcolorous brown, fibrillose, base whitish. – Context whitish to ochraceous in stipe. – Odor and taste not distinctive.

Basidiospores (9–)10 ± 0.5(–11) × (4–)4.5 ± 0.5(–5.5) µm, Q = (1.8–)2.3 ± 0.2(–2.6), V = (71)109 ± 20(–154) μm^3, n = 31, elongate cylindrical to slender fusoid, shape reminescent of *I. lacera* basidiospores, smooth. – Basidia 27–37 × 7–9 µm, 4(2)-spored, partly with yellow plasmatic pigment. – Cheilocystidia (13–)20 ± 4(–30) × (11–)12 ± 1(–14) µm, n = 21, clavate, thin-walled, hyaline. – Pleurocystidia absent. – Clamp connections present.

Habitat and distribution. – *Inocybe malenconii* typically occurs in mesic forests, but has also been reported from alpine sites in the French Alps (Kühner, 1988; Bon 1997a, 1997c).

Material examined. – RUSSIA: Siberia, Kamchatka, Kamchatka River Valley, 15 km NE of Kozyrevsk, 56°09′N – 160°05′E, 250 m, in *Picea* forest with *Larix gmelinii*, *Betula ermanii*, *Sorbus kamtschatica*, 10 Aug. 1997, leg. Peintner, IB 19970907* (ZT 8605).

Inocybe malenconii can be separated from other taxa in the *I. dulcamara* complex by the narrow (Q = 2–3), slightly angular basidiospores of the '*lacera* type'. However, the delimitation among closely related taxa can be critical: *I. malenconii* var. *megalospora* Stangl & Bresinsky (1983) has broader basidiospores reaching up to 12.5 × 6.5 µm. *I. stenospora* Stangl & Bresinsky (1983) is characterised by larger basidiospores 15–18(–20) × 5–6(–7) µm. *I. arthro-*

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Tab. 2. – List of *Inocybe* species collected in Kamchatka during July–August 1997, with reference to potential ectomycorrhizal host trees and collecting sites.

Taxa	Putative ectotrophic host trees	Site number
Subgen. *Mallocybe*		
1. *I. malenconii*	*P. jezoensis, L. gmelinii, B. ermanii, S. kamtschatica*	S9
Subgen. *Inosperma*		
2. *I. cookei* var. *kuthanii*	*B. ermanii*	S17
3. *I. fastigiella*	*B. ermanii, S. hultenii*	S10, S12
4. *I. rimosa*	*B. ermanii, S. hultenii*	S12
5. *I. xanthocephala*	*B. ermanii*	S17
Subgen. *Inocybe* Sect. Cortinatae: smooth-spored taxa		
6. *I. flocculosa* var. *crocifolia*	*B. ermanii, S. sachalinensis, A. fruticosa, A. kamtschatica*	S13, S14
7. *I. fuscidula*	*B. ermanii, A. fruticosa, S. hultenii, P. suaveolens*	S15, S17
8. *I. geophylla*	*B. ermanii, L. gmelinii*	S6, S17
9. *I. lacera* var. *helobia*	*S. tschuktschorum, B. nana, P. pumila, B. ermanii, S. hultenii*	S7, S17
10. *I. lacera* var. *rhacodes*	dwarf *Salix, Rhododendron*	S16
11. *I. nitidiuscula*	*L. gmelinii, B. ermanii*	S4
12. *I. phaeocomis* var. *major*	*B. ermanii*	S10, S11
Sect. Cortinatae: nodulose-spored taxa		
13. *I. acutella*	*Sphagnum* sp., dwarf *Salix, B. nana, Arctostaphylos* sp.	S3
14. *I. assimilata*	*B. ermanii*	S17
15. *I. egenula*	*Dryas* sp.	S14

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Tab. 2 (cont.). – List of *Inocybe* species collected in Kamchatka during July–August 1997, with reference to potential ectomycorrhizal host trees and collecting sites.

Taxa	Putative ectotrophic host trees	Site number
Sect. Marginatae: smooth-spored taxa		
16. *I. glabrescens*	*B. ermanii, S. hultenii*	S12
17. *I. ochroalba*	*Picea* sp., *L. gmelinii, B. ermanii, S. kamtschatica*	S9
Sect. Marginatae nodulose-spored taxa		
18. *I. alnea*	*B. ermanii, L. gmelinii, A. kamtschatica, P. pumila, P. tremula, P. suaveolens, Ch. arbutifolia, S. sachalinensis.*	S5
19. *I. brunneorufa*	*B. ermanii*	S17
20. *I. calospora*	*B. ermanii, S. sachalinensis, S. kamtschatica*	S17
21. *I. grammata*	*B. ermanii*	S17
22. *I. mixtilis*	*L. gmelinii, B. ermanii, P. jezoensis, S. kamtschatica*	S6, S8
23. *I. petiginosa*	*P. jezoensis, L. gmelinii, B. ermanii, S. kamtschatica, S. hultenii*	S9, S12
24. *I. rufoalba*	*B. ermanii, S. sachalinensis, A. kamtschatica*	S13

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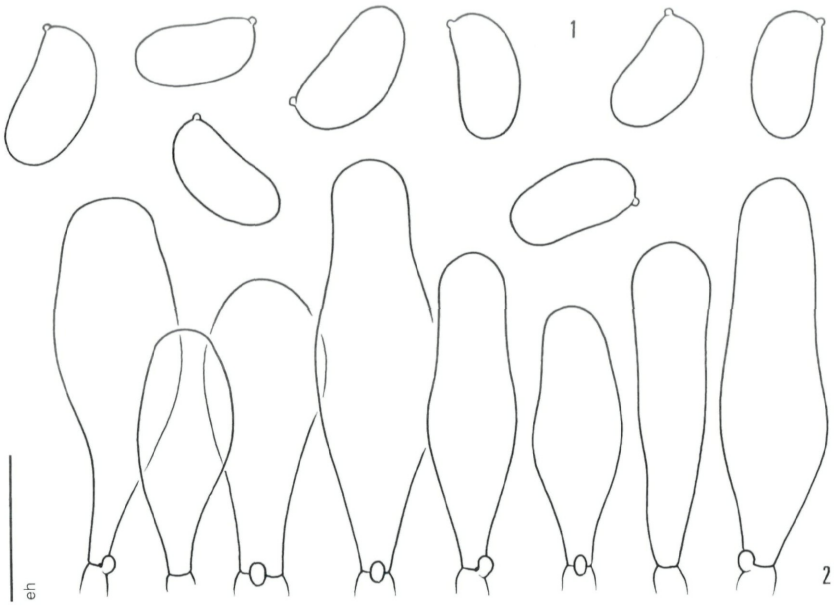


Fig. 2. *Inocybe cookei* var. *kuthanii* (IB 19970906). – 1. Basidiospores. – 2. Cheilocystidia. Scale bar: 1 = 5 µm; 2 = 10 µm.

cystis Kühner (1988) has a granular surface of the pileus reminescent of *Cystoderma* with subisodiametric, articulate cheilocystidia and has been found exclusively in alpine habitats with dwarf willows. *I. perbrevis* (Weinm.) Gillet can be delimited by a fibrillose pileus and the cylindrical to ovoid basidiospores of 7.5–12 × 5–6 µm.

Inocybe Subgen. *Inosperma* Kühner

2. *Inocybe cookei* var. *kuthanii* (Stangl & Veselsky) Kuyper, Persoonia, Suppl. 3: 51. 1986. – Fig. 2: 1–2.

≡ *Inocybe kuthanii* Stangl & Veselsky, Česká Mykologie 33: 134. 1979.

Selected illustrations: Stangl (1989: Pl. 7, Fig. 1), Bizio & Ferrari (1999: 21).

Pileus 20–35 mm, campanulate, with distinctive subpapillate umbo, pale brown, reddish-brown (Caill. R35, R47), smooth around the disc, radially fibrillose towards margin, veil absent. – Lamellae narrowly adnate, moderately crowded, 3–4 mm broad, olivaceous (Caill. M77), floccose edges white. – Stipe 30–70 × 2–5 mm, equal, base marginate-bulbous, bulb up to 12 mm diam., solid, first whitish (Caill. K75), becoming brown with age, bulb remaining white, only slightly pruinose at apex. – Context whitish. – Odor and taste not distinctive.

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Basidiospores (8–)9 ± 0.5(–10.5) × (4–)5 ± 0.5(–6) µm, Q = (1.5–)1.8 ± 0.2(–2.3), V = (83)122 ± 22(–178) µm^3, n = 31, phaseoliform, smooth. – Basidia (24–)28 ± 3(–33) × (7)9 ± 0.6(–9.8) µm, 4-spored. – Cheilocystidia (39–)53 ± 9(–74) × (10.6–)13 ± 3(–19) µm, n = 20, clavate to broadly fusoid (to subuteriform), thin-walled, hyaline. – Pleurocystidia absent. – Caulocystidia present only at apex, similar to cheilocystidia. – Pileipellis a cutis composed of slightly incrusted hyphae with connections, diam. of hyphae 8–12 µm. – Clamp connections present.

Habitat and distribution. – Usually associated with *Quercus*, *Fagus*, *Betula* and *Carpinus*. Reported from the Czech Republic, Germany and Russia.

Material examined. – RUSSIA: Siberia, Kamchatka, Zhupanovo, forest of *B. ermanii* W of Old Zhupanovo; 54°06′N – 159°58′E, 10–80 m, 20 Aug. 1997, leg. Læssøe, IB 19970906 (ZT 8601).

Inocybe cookei var. *kuthanii* differs from *I. cookei* var. *cookei* Bres. (1892) by the colour of the pileus and the slightly farinaceous odor. The closely related *I. quietiodor* Bon (1976) differs by the odor reminiscent of *Lactarius quietus* and the brighter color of the pileus, as well as broader and more regular basidiospores. Furthermore, *I. cookei* can be confused with *I. maculata* Boud. (1885). The basidiome of this species with non-bulbous stipe has slightly narrower basidiospores (4.5–6 µm) and narrower cheilocystidia (9–26 µm). In alpine sites, *I. microfastigiata* Kühner (1988) can readily be mistaken, but is delimited by larger, elliptic to phaseoliform basidiospores (8.5–12 × 5.5–7 µm).

3. *Inocybe fastigiella* G.F. Atk., Amer. J. Bot. 5: 211. 1918. – Fig. 3: 1–2.

Selected illustrations: Stangl (1989: Pl. 5, Fig. 4), Lange (1935: 116E), Rebaudengo (1980: Pl. 16, 17), Bizio & Ferrari (1999: 22).

Pileus 20–30 mm, conical with incurved margin, umbonate, reddish brown (Caill. N57, NP59), smooth around disc, radially rimose towards margin, covered with white velar patches. – Lamellae adnate to almost free, moderately crowded, 3–5 mm broad, young pale grey, later olivaceous-grey, subfloccose edges white. – Stipe 30–70 × 2–6 mm, equal, subbulbous, solid, whitish (Caill. K71), becoming brown with age, bulb remaining white, only slightly pruinose in uppermost part, longitudinally white-fibrillose towards base. – Context whitish. – Odor difficult to define, somewhat spermatic, sweetish or fungoid. – Taste similar to odor.

Basidiospores (8–)10–11 × (4.5)5.5–6 µm, Q = (1.5–)1.8 ± 0.2(–2.1), V = (105–)157 ± 29(–230) µm^3, n = 31, phaseoliform,

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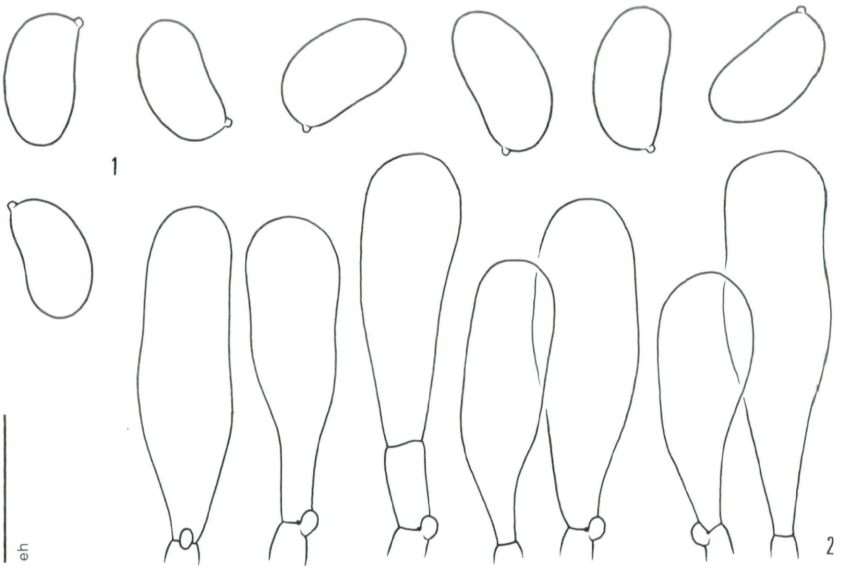


Fig. 3. *Inocybe fastigiella* (IB 19970904). 1. – Basidiospores. – 2. Cheilocystidia. Scale bar: 1 = 5 µm; 2 = 10 µm.

smooth. – Basidia (27–)31 ± 4(–38) × (8.5)10 ± 1(–11) µm, n = 10, 4-spored. – Cheilocystidia (36–)46 ± 5(–53) × (10–)14 ± 3(–21) µm, n = 24, clavate to subuteriform, thin-walled, hyaline. – Pleurocystidia absent. – Caulocystidia only at apex, similar to cheilocystidia. – Pileipellis a cutis composed of slightly incrusted hyphae, 8–12 µm diam. – Clamp connections present.

Habitat and distribution. – In Kamchatka under deciduous trees. Widespread in Europe and North America.

Material examined. – RUSSIA: Siberia, Kamchatka, Plotnikova River Valley by Yurta Mountain, 53°10′N – 157°26′E, 250 m, in forest of *B. ermanii* with *S. hultenii*, 14 Aug. 1997, leg. Peintner, IB 19970904 (ZT 8616); leg. Læssøe, IB 19970905. – Paratunka; 52°57′N – 158°16′E, 100 m, under natural and planted *B. ermanii*, 16 Aug. 1997, leg. Peintner, IB 19970903*.

The drawings of *Inocybe fastigiella* published in Rebaudengo (1980: Pl. 17) as well as one basidiome in the figures of *I. maculata* (Pl. 16, left, bottom) correspond very well with the present collection. Kuyper (1986) assumes that this American taxon "falls within the range of variation of *I. maculata*." However, Bon (1997a) considers this taxon on species rank. *Inocybe fastigiella* can be confused with *I. cookei* Bres. (1892). The latter has a paler pileus color, a distinctly bulbous-marginate stipe, a sweetish odor, as well as slightly narrower basidiospores [4–5 (–5.5)] µm) and cheilocystidia [11–18 (–22) µm].

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4. *Inocybe rimosa* (Bull.: Fr.) P. Kumm., Führ. Pilzk., 78. 1871.

≡ *Agaricus rimosus* Bull.: Fr., Syst. mycol. 1: 258. 1821 (*Agaricus rimosus* Bull., Herb. France: 388. 1789).

Selected illustrations: Lange (1935: 114B). – Stangl (1989: Pl. 6).

Pileus 12–50 mm, campanulate or conical, pale buff to pale ochraceous (Caill. K70, K51), smooth around disc, radially fibrillose and finally splitting towards margin. – Lamellae adnate to almost free, moderately crowded, 1–3 mm broad, young pale grey (Caill. L71), later olivaceous (Caill. M75), fimbriate edges white. – Stipe 20–70 × 2–5 mm, equal, solid, whitish to pale buff over whole length, velutinous in upper half, downwards longitudinally white-fibrillose. Cortina not observed. – Context whitish. – Odor and taste not distinctive.

Basidiospores (9–)10 ± 0.5(–11) × (5.5–)6.5 ± 0.5(–7.5) µm, Q = (1.4–)1.55 ± 0.1(–1.8), V = (140–)205 ± 37(–320) µm^3, n = 31, slender subphaseoliform to elliptical, smooth. – Basidia 30–35 × 9–12 µm, 4-spored. – Cheilocystidia (43–)48 ± 6(–59) × (9–)14.2(–16) µm, n = 14, polymorphic, slender fusoid-subcapitate to subuteriform, thin-walled. – Pleurocystidia absent. – Caulocystidia (48–)55 ± 8(–71) × (13–)18 ± 5(–27) µm, n = 8, in clusters at apex of stipe, shape resembling cheilocystidia but often more clavate. – Pileipellis a cutis composed of slightly incrusted cylindrical hyphae, 8–10 µm diam. – Clamp connections present.

Habitat and distribution. – Under deciduous trees and conifers, also in alpine habitats (Kuyper, 1986). Widespread in Europe and North America.

Material examined. – RUSSIA: Siberia, Kamchatka: Plotnikova River Valley by Yurta Mountain, 53°10′N – 157°26′E, 250 m, in *B. ermanii* forest with *S. hultenii*, 14 Aug. 1997, leg. Læssøe, IB 19970899* (= TL 4795), IB 19970942; leg. Peintner, IB 19970902 (ZT 8613). – Zhupanovo, 3 km S of the village, *B. ermanii* forest, 54°03′N – 159°58′E, 10–80 m, 21 Aug. 1997, leg. Peintner, IB 19970900.

Regarding its macroscopic features, the basidiomes of *Inocybe rimosa* are very variable. Also in Kamchatka this taxon was observed having many different sizes, shapes and shades of color. The basidiospores observed on the Russian collections reach a maximum length of only 11.5 µm.

5. *Inocybe xanthocephala* P.D. Orton, Trans. Brit. mycol. Soc. 43: 277. 1960.

Pileus 25–70 mm, conical, indistinctly umbonate, pale ochraceous (Caill. KL77) to almost whitish around the disc, more yellowish at the margin of the pileus, smooth to silky around disc, slightly

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greasy, indistinctly fibrillose towards margin. Velipellis present on disc. – Lamellae adnate to almost free, crowded, narrow only 3–4 mm broad, not ventricose, pale greyish yellow, subfloccose edges white. – Stipe 60–110 × 9–12 mm, equal, solid, whitish (Caill. K71), becoming yellowish with age, only slightly pruinose at apex, downwards longitudinally fibrillose. – Context whitish. – Odor not distinctive.

Basidiospores (10.5–)11.5 ± 1(–14) × (5–)5.5 ± 0.5(–6.5) µm, Q = (1.8–)2 ± 0.1(–2.2), V = (136–)195 ± 42(–320) µm^3, n = 27, phaseoliform, smooth. – Basidia 4-spored. – Cheilocystidia (43–)68 ± 13(–92) × (11–)14 ± 2(–20) µm, n = 16, conspicuous, articulate, terminal cells cylindrical to clavate, thin-walled or thick-walled near apex (–2 µm diam.), hyaline, occasionally with yellow content in 10% NH_4OH. – Pleurocystidia absent. – Caulocystidia only at apex, shape and size similar to cheilocystidia. – Pileipellis a cutis composed of incrusted hyphae. – Clamp connections present.

Habitat and distribution. – In Europe reported from wet habitats, also in association with *Salix* spp.

Material examined. – RUSSIA: Siberia, Kamchatka: Zhupanovo, S of Old Zhupanovo, 54°06′N – 159°58′E, in *B. ermanii* forest, 10–50 m, 19 Aug. 1997, leg. Peintner, IB 19970932 (ZT 8616). – Zhupanovo, forest 3 km S of the village, 54°03′N – 159°58′E, 10–80 m, in forest of *B. ermanii*, 21 Aug. 1997, leg. Peintner, IB 19970901*.

Inocybe xanthocephala P. D. Orton (= *I. flavella* auct. pp.) is characterised by rather large basidiomes with pilei up to 90 mm diam., basidiospores 10–14.5(–16.5) × 5–6.5(–7.5) µm and clavate cheilocystidia with 10–20(–25) µm diam. The closely related *I. flavella* P. Karst. can be distinguished by its smaller basidiomes with a pileus diam. up to only 30 mm, shorter basidiospores (9–)10–11(–12) × 6–7(–8) µm, and cylindrical cheilocystidia with a diam. up to 15 µm. The present collection agrees in all morphologically relevant features with the type description. In contrast to Bon (1997a), Kuyper (1986) regards *I. xanthocephala* as a synonym of *I. flavella*.

Inocybe Subgen. *Inocybe* (Fr.) Fr., Sect. Cortinatae (with smooth basidiospores)

6. *Inocybe flocculosa* var. *crocifolia* (Herink) Kuyper, Persoonia, Suppl. 3: 163. 1986. – Fig. 4: 1–4.

≡ *Inocybe crocifolia* Herink, Česká Mykologie 8: 123. 1954.

Selected illustrations: Stangl & Veselsky (1977: 123), Stangl (1989: Pl. 18, Fig. 2).

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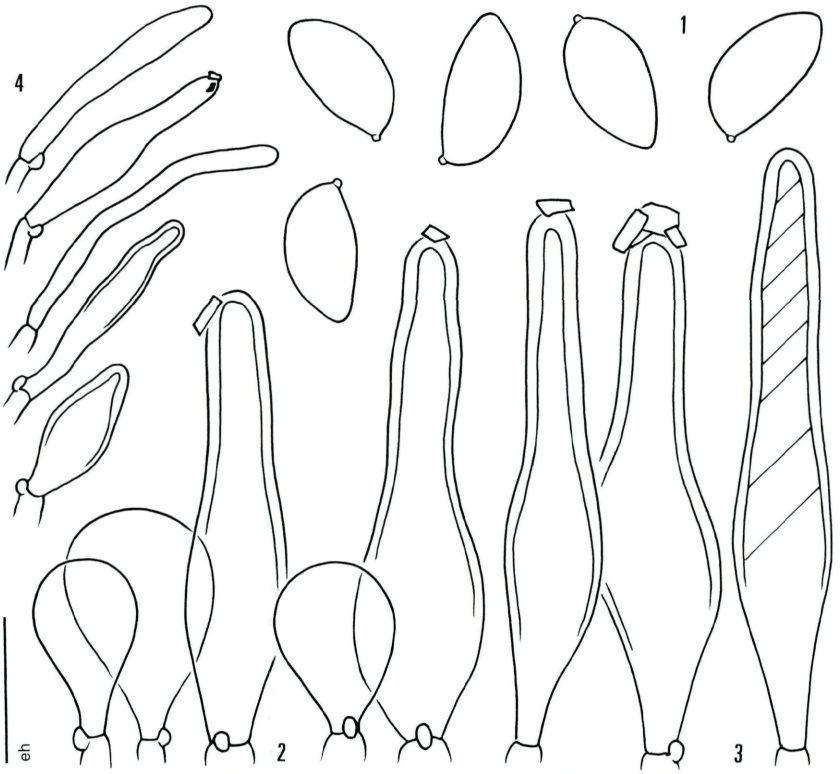


Fig. 4. *Inocybe flocculosa* var. *crocifolia* (IB 19970909). – 1. Basidiospores. – 2. Paracystidia. – 3. Cheilo- and pleurocystidia. – 4. Caulocystidia. Scale bar: 1 = 5 µm; 2, 3 = 10 µm; 4 = 20 µm.

Pileus 10–25 mm, conical-convex to plano-convex, pale brown (Caill. PR49, R47) to brown, with distinctive orange-yellow tinge, subtomentose to scaly around centre, radially fibrillose at the margin. Velipellis not distinctive. – Lamellae narrowly adnate, moderately crowded to distant, at first cream-yellowish then yellowish, occasionally olivaceous (Caill. L70), fimbriate edges white. – Stipe 25–45 × 2–4 mm, equal, solid, concolorous to pileus or paler, pruinose at apex. Cortina not observed. – Context whitish in pileus. – Odor none or unpleasant. – Taste not distinctive.

Basidiospores (8.5–)9.5 ± 0.5(–10.5) × (5–)5.5 ± 0.5(–6.5) µm, Q = (1.5–)1.7 ± 0.1(–1.9), V = (117)154 ± 22(–206) µm^3, n = 33, amygdaliform, apex often mucronate, smooth. – Basidia 26–33 × 8–10 µm, 4-spored. – Cheilocystidia (47–)53–62 ± 8(–81) × (11–)14 ± 3(–19) µm, n = 13, shape similar to pleurocystidia. – Pleurocystidia (45–)53–66 ± 6(–7.5) × (14–)17 ± 2(–21) µm, n = 13, cylindrical, fusiform to lageniform, metuloid, wall up to 1.5(–2) µm

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diam., content (and walls) pale yellowish in 10% NH_4OH, crystals at apex. – Caulocystidia present in upper third of stipe only, resembling thin-walled cheilocystidia, intermixed with caulo-paracystidia. – Pileipellis a cutis composed of incrusted, short-celled hyphae. – Clamp connections present.

Habitat and distribution. – Associated with deciduous trees and conifers. Rare in Europe, recorded from Austria, Czech Republic, France, Germany and the Netherlands.

Material examined. – RUSSIA: Siberia, Kamchatka: Tolbachinsky Volcano, Vodopadny Creek, Seismic Station, in volcanic ash with *A. fruticosa*, 55°41′N – 161°11′E, 1000 m, 06 Aug. 1997, leg. Peintner, IB 19970912* (ZT 8619). – Paratunka, 52°57′N – 158°16′E, 100 m, in *B. ermanii* forest with *S. sachalinensis* and *A. kamtschatica*, 17 Aug. 1997, leg. Peintner, IB 19970909 (ZT 8620).

The present material corresponds in all details to Herink's original description.

7. *Inocybe fuscidula* Vel., Ceské Houby: 378. 1920.

non *Inocybe fuscidula* Bres. (1930).

Selected illustrations: Kuyper (1986: 153), Bizio & Ferrari (1999: 27).

Pileus 15–30 mm, conical-convex to plano-convex, sometimes with indistinctive umbo, pale-brown to brown (Caill. M49, N20, M70, L75), outwards paler, smooth to subtomentose around centre, radially fibrillose towards margin. Velipellis white. – Lamellae narrowly adnate, moderately crowded, 3–6 mm broad, young whitish, later pale olivaceous, fimbriate edges white. – Stipe 30–65 × 2–5 mm, equal, solid, whitish to pale ochraceous, pruinose in uppermost part only, when young covered by velar patches. – Context whitish. – Odor spermatic.

Basidiospores (8.5–)10 ± 0.5(–12) × (5–)5.5 ± 0.5(–6.5) µm, Q = (1.6–)1.9 ± 0.2(–2.2), V = (114–)154 ± 24(–213) µm^3, n = 31, subamygdaliform, smooth. – Basidia 4-spored. – Cheilocystidia (45–)62 ± 10(–75) × (14–)19 ± 3(–27) µm, n = 12, shape and size similar to pleurocystidia, fusoid, clavate and pyriform, paracystidia clavate. – Pleurocystidia (67–)78 ± 10(–102) × (16–)22 ± 3(–28) µm, n = 12, cylindrical, fusiform to lageniform, metuloid (walls up to 2 µm thick), hyaline in 10% NH_4OH, with incrustations at the apex, frequent. – Caulocystidia at apex of stipe only, similar to cheilocystidia in shape and size, but with thinner walls, intermixed with cauloparacystidia. – Pileipellis a cutis composed of incrusted hyphae, 8–12 µm diam. – Clamp connections present.

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Habitat and distribution. – Associated with deciduous trees and conifers. Widespread in Europe and North America.

Material examined. – RUSSIA: Siberia, Kamchatka: Zhupanovo, 3 km S of the village, 54°03′N – 159°58′E, 10–80 m, forest of *B. ermanii*, 21 Aug. 1997, leg. Peintner, IB 19970908*. – Avacha River Valley, NE of Razdolny, 53°18′N – 158°20′E, 100 m, slope with *B. ermanii, A. fruticosa, S. hultenii, P. suaveolens*, 31 Aug. 1997, leg. Peintner, IB 19970911 (ZT 8611).

Inocybe fuscidula is characterised by a distinctive velipellis over the smooth centre of the pileus and pleurocystidia with hyaline walls. The Siberian collection resembles the basidiome type found in Western Europe which is characterised by a slender habit, brown pilei and the relatively long stipe. *I. xantholeuca* Kuyper (1986) differs by lemon yellow lamellae in young basidiomes. Another similar species is *I. nitidiuscula* (Britzelm.) Sacc. with a reddish apex of the stipe, more thick-walled cystidia and larger basidiospores.

8. *Inocybe geophylla* (Fr.: Fr.) P. Kumm., Führ. Pilzk., 78. 1871.

≡ *Agaricus geophyllus* Fr.: Fr., Syst. mycol. 1: 258. 1821.

Selected illustrations: Rebaudengo (1980: 29). – Kuyper (1986: 85). – Stangl (1989: Pl. 11, Fig. 1).

Pileus 10–25 mm, campanulate, with umbo, white to pale buff, ochraceous, smooth to silky, dry to slightly greasy. – Lamellae adnate to almost free, moderately crowded, ventricose, young whitish, later greyish-yellow, floccose edges pallid or concolorous. – Stipe 20–30 × 2–4 mm, equal, solid, whitish, pruinose at apex, downwards smooth. – Context whitish. – Odor spermatic.

Basidiospores (8–)8.5 ± 0.5(–10) × (4.5–)5 ± 0.5(–6) µm, Q = (1.4–)1.7 ± 0.1(–1.8), V = (97–)117 ± 18(–181) µm^3, n = 21, ovoid to subamygdaliform, smooth. – Basidia 20–25 × 7–9 µm, 4(2)–spored. – Cheilocystidia (40–)51 ± 8(–66) × (13–)16 ± 3(–25) µm, n = 11, shape similar to pleurocystidia, paracystida present. – Pleurocystidia (54–)57 ± 3(–61) × (13–)15 ± 1(–18) µm, n = 10, subuteriform to fusiform, metuloid, apical parts of the wall up to 2 µm diam., hyaline in 10% NH_4OH, crystals at apex. – Caulocystidia present in the uppermost part of the stipe only, similar to cheilocystidia, intermixed with vesiculose paracystidia, lower part of the stipe with caulocystidioid hairs. – Pileipellis a cutis composed of incrusted hyphae, up to 12 µm diam. – Clamp connections present.

Habitat and distribution. – Associated with both conifers and deciduous trees, widespread in Europe and North America.

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Material examined. – RUSSIA: Siberia, Kamchatka: Esso, mountain slope N of Esso; 55°56′N – 158°41′E, 800 m, under *L. gmelinii*, *B. ermanii*, 05 Aug. 1997, leg. Hansen, IB 19970919*. – Zhupanovo, W of Old Zhupanovo, 54°06′N – 159°58′E, forest of *B. ermanii*, 10–80 m, 20 Aug. 1997, leg. Peintner, IB 19970918 (ZT 8607).

The Siberian collections agree in all relevant features with the current interpretation of this species. *Inocybe phaeodisca* var. *geophylloides* Kühner (1955a) has more radially rimose pilei, and basidiospores with a conical apex and no caulocystidia. *I. whitei* (Berk. & Broome) Sacc. f. *armeniaca* (Huijsman) Kuyper (1986) can be readily separated by the prominent and subacute papilla and by basidiomes reddening on bruising and drying (Kuyper, 1986).

9. *Inocybe lacera* var. *helobia* Kuyper, Persoonia, Suppl. 3: 103. 1986. – Fig. 5: 1–3.

Selected illustrations: Stangl (1989: Pl. 12, Fig. 2).

Pileus 5–15 mm, convex, plano-convex to expanded, young with incurved, appendiculate margin, brown (Caill. R45, R47, R49, S67, S69), margin more ochraceous brown, fibrillose to subsquamulose. – Lamellae broadly adnate, moderately crowded, 3–6 mm broad, ventricose, beige to ochraceous brown (Caill. M49), fimbriate edges white. – Stipe 20–30 × 1–3 mm, equal, solid, not pruinose, concolorous with pileus (Caill. NP55), base slightly darker. Cortina present. – Context whitish. – Odor and taste not distinctive.

Basidiospores (11.5–)13.5 ± 1.5(–17) × (5–)6 ± 0.5(–7) µm, Q = (1.9–)2.3 ± 0.3(–3), V = (130–)151 ± 39(–351) µm^3, n = 48, polymorphic, shape ranging from slender elliptical, subfusoid or subamygdaliform, rarely indistinctly angular (near apiculus), smooth. – Basidia 29–32 × 9–11 µm, 4-spored. – Cheilocystidia (29–)50 ± 8(–64) × (14–)17 ± 2(–20) µm, n = 21, polymorphic, shape ranging from clavate to broadly fusoid or uteriform, thin-walled or walls slightly thicker near apex (–1.5 µm diam.), crystals usually absent or rare, vesiculose paracystidia present. – Pleurocystidia (50–)63 ± 6(–75) × (14–)15 ± 1(–17) µm, n = 10, similar to cheilocystidia but more thick-walled, wall pale to slightly yellowish, up to 2 µm diam. – Caulocystidia absent. – Pileipellis a cutis composed of incrusted hyphae. – Clamp connections present.

Habitat and distribution. – *Inocybe lacera* var. *helobia* typically occurs on marshy soil under frondose trees (*Alnus*, *Betula*, *Salix*).

Material examined. – RUSSIA: Siberia, Kamchatka: Vilyuchinsky Volcano, near the water fall, 52°39′N – 158°10′E, 700 m, arctic tundra with dwarf willow (*Salix* sp.), *Rhododendron*, 24 Aug. 1997, leg. Peintner, IB 19970915* (ZT 8612).

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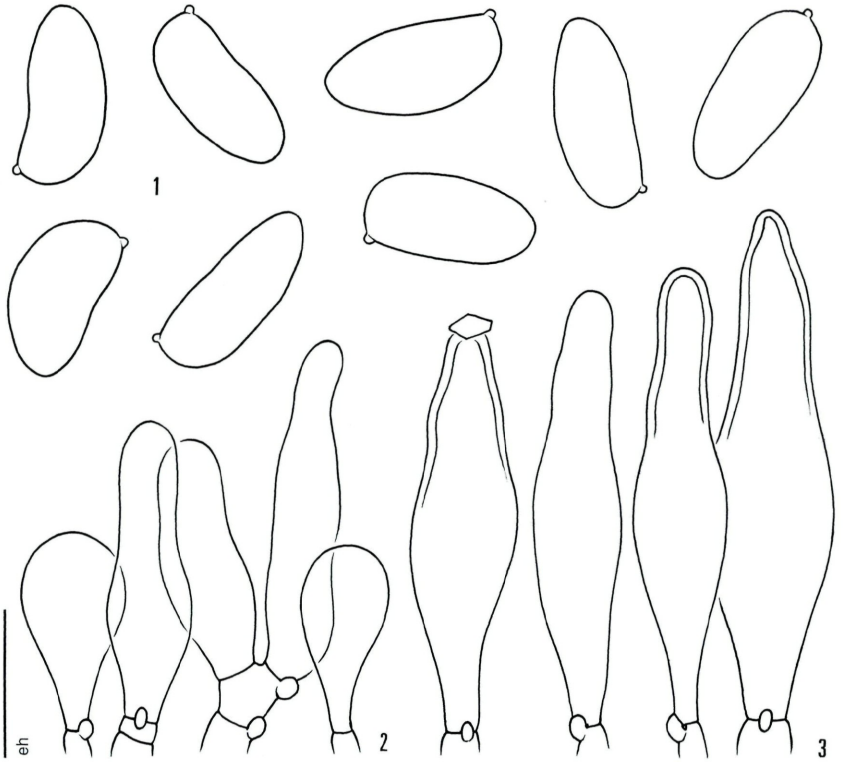


Fig. 5. *Inocybe lacera* var. *helobia* (IB 19970915). – 1. Basidiospores. – 2. Cheilocystidia. – 3. Pleurocystidia. Scale bar: 1 = 5 µm; 2, 3 = 10 µm.

Inocybe lacera var. *helobia* differs from *I. lacera* var. *lacera* (Fr.: Fr.) P. Kumm. by the narrower, angular basidiospores (Q = 1.9–2.3) and the more thick-walled pleurocystidia with pale to bright yellow walls. The collections from Kamchatka agree in all morphological and ecological characters with typical European material.

10. *Inocybe lacera* var. *rhacodes* (J. Favre) Kuyper, Persoonia, Suppl. 3: 102. 1986. – Fig. 6: 1–2.

≡ *Inocybe rhacodes* J. Favre, Ergebn. wiss. Unters. Schweiz. Nat. Parks 5: 201. 1955.

Selected illustrations: Favre (1955: Pl. 7, Fig. 5).

Pileus 8–35 mm, convex, plano-convex, to applanate, when young with incurved appendiculate margin, (dark) brown (Caill. N/P 67/69, R70, P53, P75), fibrillose to subsquamulose. – Lamellae broadly adnate, moderately crowded, 3–6 mm broad, ventricose, beige to ochraceous brown (M49), fimbriate edges white. – Stipe 20–

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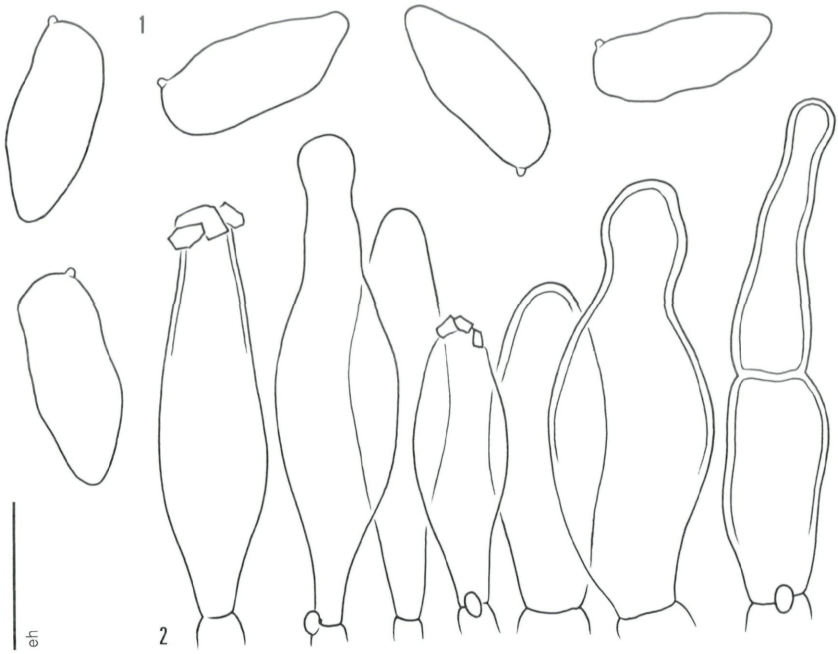


Fig. 6. *Inocybe lacera* var. *rhacodes* (IB 19970917). – 1. Basidiospores. – 2. Cheilo- and pleurocystidia. Scale bar: 1 = 5 µm; 2 = 10 µm.

35 × 2–5 mm, equal, solid, not pruinose, concolorous with pileus, base slightly darker. Cortina present. – Context whitish in pileus, brown to dark brown in the base of stipe. – Odor acidulous. – Taste not distinctive.

Basidiospores (11.5–)13 ± 1(–14.5) × (5.5–)6 ± 0.5(–6.5) µm, Q = (1.9–)2.2 ± 0.1(–2.4), V = (198–)250 ± 32(–339) µm^3, n = 21, polymorphic, shape ranging from slender elliptical, subfusoid or subamygdaliform, often distinctly angular, smooth. – Basidia 29–32 × 9–11 µm, 4-spored. – Cheilocystidia (56–)60 ± 4(–66) × (17–)18 ± 1(–21) µm, n = 10, shape similar to pleurocystidia, intermixed with thin-walled, catenate cylindrical elements, sometimes with slightly thickened brownish walls. – Pleurocystidia (64–)67 ± 4(–74) × (15–)16 ± 1.5(–19) µm, n = 10, polymorphic, shape ranging from cylindrical to slender fusoid or broadly fusoid-uteriform, crystals at apex or incrusted, hyaline wall up to 2 µm diam. – Caulocystidia absent. – Pileipellis a cutis composed of incrusted cylindrical hyphae. – Clamp connections present.

Habitat and distribution. – Associated with dwarf willows (*Salix* spp.) in subalpine and alpine habitats. In Europe reported only from the Alps and Scotland (Kuyper, 1986).

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Material examined. – RUSSIA: Siberia, Kamchatka: Esso, Kozyrevsky Range, Tupikin Klyuch, 5 km NE of Esso, 55°58′N – 158°47′E, 700–1000 m, under *S. tschuktschorum*, *B. nana*, *P. pumila*, 04 Aug. 1997, leg. Peintner, IB 19970916 (ZT 8247). – Plotnikova River Valley by Yurta Mountain, 53°10′N – 157°26′E, 250 m, in forest of *B. ermanii* with *S. hultenii*, 14 Aug. 1997, leg. Peintner, IB 19970925 (ZT 8614). – Zhupanovo, 3 km S of the village, 54°03′N – 159°58′E, 10–80 m, in *B. ermanii* forest, 21 Aug. 1997, leg. Peintner, IB 19970917* (ZT 8248). – SWITZERLAND: Ct. Grisons, Swiss National Park, S-charl, Val Sesvenna, 2550 m, 20 Aug. 1943, Favre 111 (GC, holotype).

Inocybe lacera var. *rhacodes* differs from *I. lacera* var. *lacera* (Fr. : Fr.) P. Kumm. and *I. lacera* var. *helobia* Kuyper (1986) by the typical catenulate cheilocystidia, the angular basidiospores, the robust habit of the basidiomes, the veil remnants at the margin of the pileus, and its occurrence in alpine habitat with dwarf willows. Bon (1997b) regards this taxon as a distinctive species.

11. *Inocybe nitidiuscula* (Britzelm.) Sacc., Syll. Fung. 11: 53. 1895.

≡ *Agaricus nitidiusculus* Britzelm. Hymenomyc. Südbayern: 7. 1891.

= *Inocybe friesii* R. Heim (1931). – *Inocybe tarda* Kühner (1955a). – *I. nemorosa* (R. Heim) Grund & D.E. Stuntz (1968).

Selected illustrations: Bresadola (1930: Pl. 721, Fig. 1, as *I. scabella*), Rebaudengo (1980: Pl. 46, Fig. 1, as *I. friesii*), Stangl (1989: Pl. 14, Fig. 2), Bizio & Ferrari (1999: 35).

Pileus 10–40 mm, convex to plano-convex, mostly umbonate, brown (Caill. NPR49), nearly smooth around disc, fibrillose towards margin. Velipellis not distinctive. – Lamellae narrowly adnate, crowded, young whitish, then yellowish brown, fimbriate edges white. – Stipe 20–60 × 2–8 mm, equal, solid, apex reddish brown (Caill. P59), whitish at base, pruinose in upper half. Cortina present in young specimen. – Context whitish in pileus, reddish in cortex of the apical part of the stipe. – Odor spermatic to acidulous. – Taste not distinctive.

Basidiospores (9–)10 ± 0.5(–11.5) × (5–)6 ± 0.5(–6.5) µm, Q = (1.5–)1.7 ± 0.1(–1.9), V = (115–)181 ± 30(–242) µm^3, n = 21, ovoid to subamygdaliform, occasionally subamygdaliform, smooth. – Basidia (26–)32 ± 3(–38) × (8–)9 ± 0.5(–10) µm, n = 10, 4-spored. – Cheilocystidia shape similar to pleurocystidia, intermixed with paracystidia. – Pleurocystidia (61–)81 ± 9(–93) × (17–)20 ± 2(–23) µm, n = 20, fusiform to lageniform, wall distinctly metuloid, up to 2.5 µm diam. thick, hyaline or pale yellowish, crystals at apex. – Caulocystidia shape similar to pleurocystidia, intermixed with cauloparacystidia. – Pileipellis a cutis composed of incrusted, short-celled hyphae. – Clamp connections present.

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Habitat and distribution. – Associated with *Picea*, *Pinus*, *Larix*, *Quercus*, *Corylus*, *Carpinus*, on calcareous soil (Kuyper 1986). Widespread in Europe and North America.

Material examined. – RUSSIA: Siberia, Kamchatka, Bystraya River Valley, 18 km from the main road, 55°59'N – 159°17'E, 150 m, in young and dense forest of *L. gmelinii*, *B. ermanii*, 12 Aug. 1997, leg. Peintner, IB 19970921* (ZT 8609).

Inocybe nitidiuscula differs from the closely related *I. leiocephala* D. E. Stuntz (in Smith & Stuntz, 1950) by the presence of a cortina, lack of caulocystidia for whole length of stipe and by basidiospores with subconical apex (Kuyper, 1986). *I. nitidiuscula* can also be readily confused with *I. fuscidula*, but typical basidiomes of *I. nitidiuscula* have a distinctive reddish tinge in the stipe, larger basidiospores and pleurocystidia with thicker walls.

12. *Inocybe phaeocomis* var. *major* (S. Petersen) Kuyper, Persoonia, Suppl. 3: 140. 1986.

≡ *Inocybe obscura* var. *major* S. Petersen, Danske Agaricaceer: 329. 1911.

Selected illustrations: Rebaudengo (1980: Pl. 30, as *I. obscura*).

Pileus 8–20 mm, conico-convex to plano-convex, sometimes appendiculate, ochraceous to ochraceous brown (Caill. NP49), squamulose around disc, towards margin fibrillose-squamulose. – Lamellae broadly to narrowly adnate, moderately crowded, 2–4 mm broad, greyish-brown (Caill. M50), young with violaceous tinges, slightly fimbriate edges brown. – Stipe 20–55 × 2–6 mm, equal, base not bulbous, solid, in upper part violaceous, with irregular brown fibrillose squamules (Caill. M53). Cortina present on young basidiomes. – Context violaceous in apical part of the stipe, otherwise whitish. – Odor spermatic. – Taste not distinctive.

Basidiospores (8.5–)9 ± 0.5(–11) × (5–)5.5 ± 0.5(–6) µm, Q = (1.3–)1.6 ± 0.1(–1.8), V = (109–)151 ± 31(–230) μm^3, n = 31, amygdaliform to sublimoniform, with distinctive conical mucronate apex, smooth. – Basidia 31–36 × 9–11 µm, n = 10, 4-spored. – Cheilocystidia broadly fusoid, clavate or shape similar to pleurocystidia. – Pleurocystidia (53–)71 ± 8(–85) × (13–)16 ± 2(–20) µm, n = 14, slender fusiform, hyaline wall up to 1.5 µm thick, crystals at apex. – Caulocystidia absent, but with caulocystidioid hairs, sometimes with brown incrusted wall. – Pileipellis a cutis composed of incrusted hyphae, 8–12 µm diam. – Clamp connections present.

Habitat and distribution. – Associated with deciduous trees and conifers on nutrient-rich soil. Widespread in Europe and North America.

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Material examined. – RUSSIA: Siberia, Kamchatka: Petropavlovsk, Nikolskaya Mountain by the harbour, 53°10′N – 157°21′E, 40–80 m, under *B. ermanii*, 15 Aug. 1997, leg. Peintner, IB 19970914 (ZT 8249). – Paratunka, 52°57′N – 158°16′E, 100 m, in stand of natural and planted *B. ermanii*, 16 Aug. 1997, leg. Peintner, IB 19970913* (ZT 8617).

Inocybe phaeocomis var. *major* differs from *I. phaeocomis* var. *phaeocomis* (Pers.) Kuyper (1986) by the more robust basidiomes (especially the stipes) and by almond-shaped to sub-limoniform basidiospores. Other *Inocybe* species with violaceous tinge in the apical part of the stipe are *I. griseolilacina* J. E. Lange (1917) and *I. huijsmanii* Kuyper (1986), both characterized by subcapitate pleurocystidia, *I. amethystina* Kuyper (1986) with lageniform pleurocystidia, *I. pusio* P. Karst. (1889) with fusiform hyaline pleurocystidia, and two rarely encountered taxa viz. *I. hygrophana* Glowinski & Stangl (in Stangl & Glowinsky, 1981) and *I. ionochlora* Romagn. (1979), both distinctive due to their hygrophanous pilei.

Subgen. *Inocybe* Sect. Cortinatae (with nodulose basidiospores)

13. *Inocybe acutella* Bon, Documents Mycologiques 24: 45. 1976. – Fig. 7: 1–3.

Selected illustrations: Heim (1931: Pl. 30, Fig. 5). – Lange (1935: 117D).

Pileus 10–30 mm, conical to conico-campanulate, with distinctive papilla, dark brown (Caill. S 67/69), smooth but strongly radially fibrillose, velipellis absent. – Lamellae adnate to almost free, ventricose, 3–4 mm broad, at first greyish-white, later greyish-brown, floccose edges white. – Stipe 60–100 × 2–4 mm, cylindrical, gradually wider towards the equal or subclavate base, solid, dark brown but paler as pileus (Caill. P55), browning with age, fibrillose, pruinose only at apex. – Context whitish in pileus, concolorous in stipe. – Odor and taste not distinctive.

Basidiospores (8.5–)10 ± 0.5(–11.5) × (5–)5.5 ± 0.5(–6.5) µm, Q = (1.5–)1.8 ± 0.1(–2), V = (125–)175 ± 36(–271) µm^3, n = 42, irregular-angular in outline, with few but distinctive nodules. – Basidia (31–)33 ± 1.5(–35) × (8.5–)9.4 ± 0.9(–10.6) µm, n = 8, 4-spored, sometimes with yellow-brown, oil-like contents. – Cheilocystidia similar to pleurocystidia. – Pleurocystidia (53–)63 ± 6(–74) × (13–)15 ± 2(–17) µm, n = 17, fusiform to lageniform, apex often capitate or hammer-shaped, metuloid, wall at apex up to 1.5(–2) µm thick, sometimes with yellow, oil-like contents, usually without crystals at apex. – Caulocystidia restricted to apex of the stipe. – Clamp connections present.

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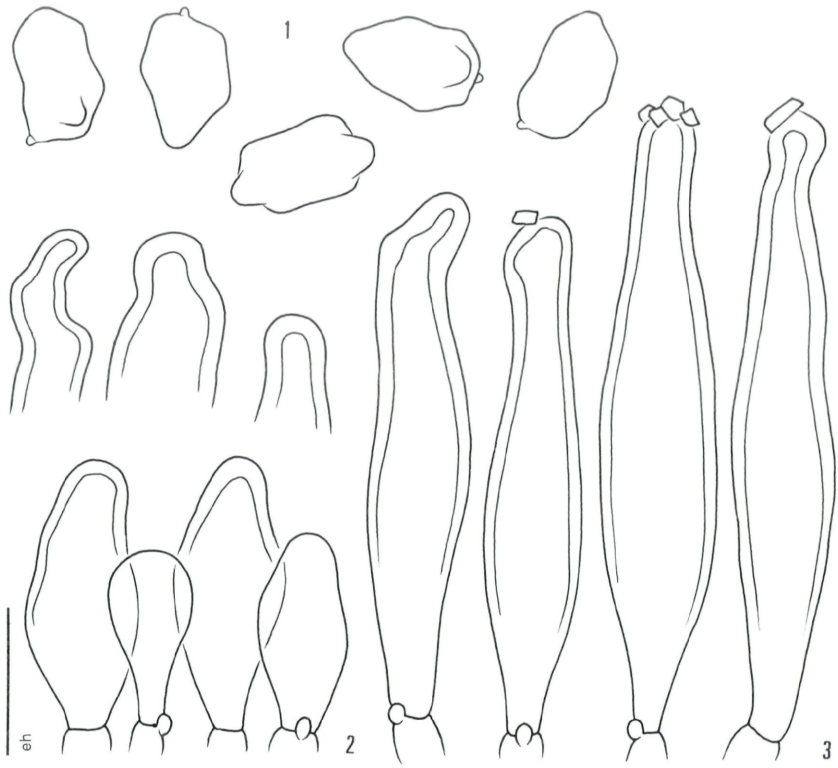


Fig. 7. *Inocybe acutella* (IB 19970940). – 1. Basidiospores. – 2. Cheilocystidia. – 3. Pleurocystidia. Scale bar: 1 = 5 µm; 2, 3 = 10 µm.

Habitat and distribution. – *Inocybe acutella* is typically found in riverine forests or swampy localities among *Sphagnum*.

Material examined. – RUSSIA: Siberia, Kamchatka, Bystraya River Valley, coast W of Ust–Bolsheretsk, 52°47′N – 156°12′E, 0–20 m, among *Sphagnum* sp., *Salix* sp., *B. nana*, *Arctostaphylos* sp., 13 Aug. 1997, leg. Peintner, IB 19970940* (ZT 7496). – BELGIUM: Ardennes, Lac des Vieilles Forges, in Bidention with *Salix* and *Alnus*, Oct. 1969, leg. Bon 91055B (holotype, LIP).

Inocybe acutella is the valid name for *I. umboninota* Peck ss. R. Heim (1931) and *I. acuta* ss. auct. pp. (Bon 1976, 1998; Romagnesi 1989). The present species can be confused with the two following species: *Inocybe umboninota* Peck which is separated by the different shape of the basidiospores and a darkening stipe, and *I. acuta* Boud., characterised by larger basidiomes and the more slender habit.

Macroscopically, the Kamchatkan collection is very close to small basidiomes of *I. napipes* J. E. Lange (1917). Microscopically, however, the basidiospores of *I. napipes* are more nodulose, the

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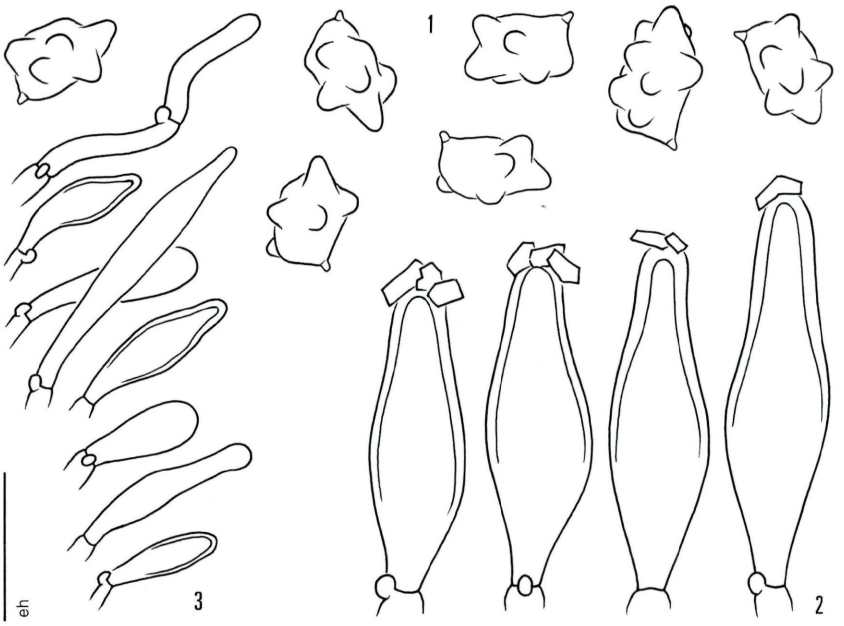


Fig. 8. *Inocybe assimilata* (IB 19970926). – 1. Basidiospores. – 2. Cheilo- and pleurocystidia. – 3. Caulocystidia. Scale bar: 1 = 5 µm; 2 = 10 µm; 3 = 20 µm.

cystidia broader clavate and the base of the stipe is marginate. *I. napipes* has often been confused with *I. transitoria* (Britzelm.) Sacc., which microscopically can be distinguished by the more thick-walled cystidia, less nodulose basidiospores and different habitat (nutrient-rich soils in association with deciduous trees). Finally, the similar *I. striata* Bres. (1930) is associated with conifers and has a clavate, but not bulbous stipe. Microscopically, this species also differs by the broader cystidia and the larger, gibbose basidiospores.

14. *Inocybe assimilata* (Britzelm.) Sacc., Syll. Fung. 5: 789. 1887. – Fig. 8: 1–2.

≡ *Agaricus assimilatus* Britzelm., Ber. naturhist. Ver. Augsburg 26: 137, Pl. 166, Fig. 12. 1881.

= *Inocybe umbrina* Bres., Fungi Tridentini 1: 50. 1884.

Selected illustrations: Rebaudengo (1980: Pl. 87, Fig. 1), Lange (1938: 118G), Stangl (1989: Pl. 27, Fig. 2).

Pileus 15–25 mm, conical to plano-convex, slightly umbonate, reddish brown to dark brown (Caill. S67, S69), underlying context yellowish, disc smooth (distinctive velipellis absent), margin radially fibrillose, rimose. – Lamellae adnate to almost free, crowded, 2–4 mm broad, ventricose, at first whitish, later olivaceous (Caill.

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M91), subfloccose edges concolorous. – Stipe up to 35 × 2–4 mm, base bulbous (up to 8 mm diam.), solid, at first whitish, then yellowish (Caill. L79) at apex, brownish (Caill. M77, N67) near base, later brown over whole length with exception of the whitish bulb, fibrillose, not distinctly pruinose. Cortina present in young basidiomes. – Context whitish. – Odor spermatic.

Basidiospores (7–)8 ± 0.5(–9) × (4–)5.5 ± 0.5(–6.5) µm, Q = (1.3–)1.5 ± 0.2(–2), V = (76–)116 ± 20(–170) µm^3, n = 31, distinctly nodulose. – Basidia 24–28 × 8–9 µm, 4-spored. – Cheilocystidia (45–)53 ± 7(–69) × (13–)14 ± 1(–16) µm, n = 12, rather rare, fusiform, walls up to 1.5 µm diam., hyaline, crystals at apex. – Pleurocystidia shape and size similar to cheilocystidia. – Caulocystidia rare, intermixed with clavate and catenulate paracystidia. – Pileipellis a cutis composed of incrusted hyphae. – Clamp connections present.

Habitat and distribution. – Associated with conifers. Widespread in Europe.

Material examined. – RUSSIA: Siberia, Kamchatka, Zhupanovo, 3 km S of the village, 54°03′N – 159°58′E, 10–80 m, *B. ermanii* forest, 12 Aug. 1997, leg. Peintner, IB 19970926* (ZT 8604).

Inocybe assimilata is characterised by rather small basidiomes and a pale brown colored stipe with white bulb. The present Siberian collection differs from typical *I. assimilata* by the initially very pale, but later browning stipe. Similar species are *Inocybe napipes* J. E. Lange and *I. transitoria* (Britzelm.) Sacc. A distinctive feature of the comparatively large *I. napipes* is the bulbous, the at first whitish but later brown stipe, the strongly nodulose basidiospores and the fusiform to claviform cystidia with rather thin, usually hyaline walls.

Inocybe transitoria has basidiospores with less prominent bulges, a concolorous (dark brown) stipe and fusiform to claviform cystidia (cf. also observations regarding *I. acutella*).

15. *Inocybe egenula* J. Favre, Ergebn. wiss. Unters. Schweiz. Nationalpark 5: 114. 1955. – Fig. 9: 1–3.

Selected illustrations: Favre (1955: Pl. 8, Fig. 10).

Pileus 3–7 mm, convex to conico-campanulate, centre becoming depressed, brown (Caill. P 60), disc smooth, squamulose to flocculose-squarrulose towards the margin, striate. Velipellis greyish in young basidiomes, fugaceous. – Lamellae at first whitish, later becoming greyish-brown, even edges concolorous. – Stipe 5–10 × 1–1.5 mm, equal, cylindrical, at first whitish then brown, pruinose at apex.

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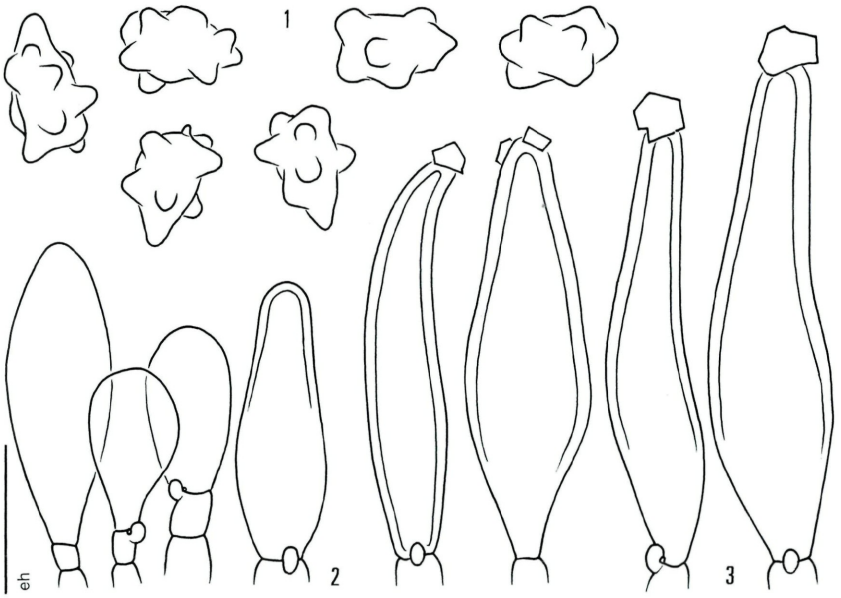


Fig. 9. *Inocybe egenula* (IB 19970939). – 1. Basidiospores. – 2. Cheilocystidia. – 3. Pleurocystidia. Scale bar: 1 = 5 µm; 2, 3 = 10 µm.

Basidiospores (7–)8.5 ± 1(–10.5) × (4–)5.5 ± 0.5(–6.5) µm, Q = (1.3–)1.6 ± 0.2(–2.1), V = (76–)127 ± 32(–242) µm^3, n = 31, distinctly nodulose. – Basidia 27–35 × 8.5–9 µm, 4-spored. – Cheilocystidia (42–)54 ± 8(–63) × (13–)15 ± 1(–17) µm, n = 20, shape similar to pleurocystidia, intermixed with polymorphic paracystidia. – Pleurocystidia (53–)57 ± 3(–61) × (12–)13 ± 1(–15) µm, n = 7, fusiform, metuloid, wall at apex up to 1.5 µm diam., crystals at apex. – Caulocystidia and caulocystidioid cells inconspicuous. – Clamp connections present.

Habitat and distribution. – So far only reported from alpine habitats in the Swiss Alps. Restricted to snow beds with *Salix* spp. or among *Dryas* sp.

Material examined. – RUSSIA: Siberia, Kamchatka, Tolbachinsky Volcano, volcanic ash, 55°41′N – 161°11′E, 950 m, among *Dryas* sp., 07 Aug. 1997, leg. Læssøe, IB 19970939* (ZT 7498). – SWITZERLAND: Ct. Grisons, Swiss National Park, God il Fuorn, 1850 m, 10 Aug. 1941, Favre 581a (GC, holotype).

The Kamtchatkan collection differs by basidiomes with longer and narrower stipes as compared to typical material from the Alps. However, this character is considered a mere ecotype due to the edaphic conditions on volcanic ash. Horak (1987) notes that the microscopic characters of *Inocybe egenula* very closely resemble

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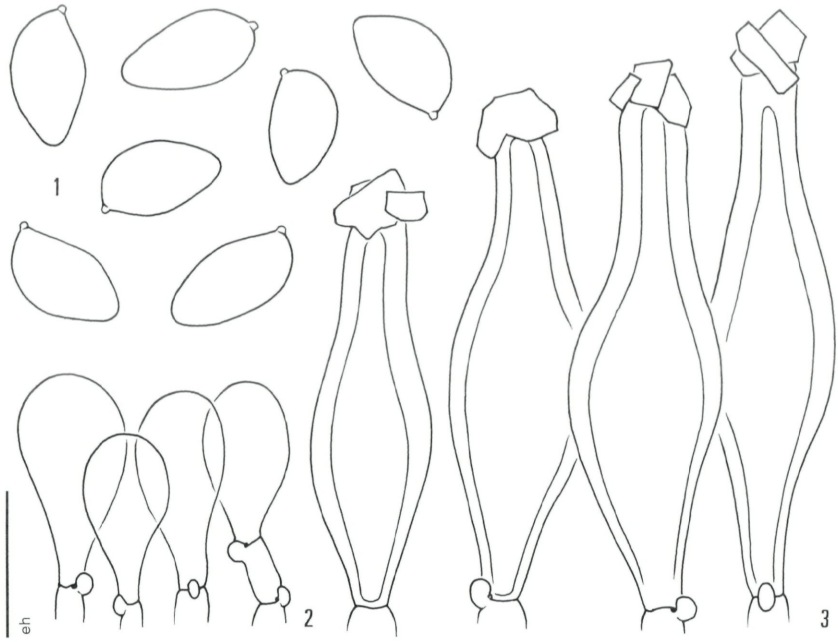


Fig. 10. *Inocybe glabrescens* (IB 19970922). – 1. Basidiospores. – 2. Paracystidia. 3. Cheilo- and pleurocystidia. Scale bar: 1 = 5 µm; 2, 3 = 10 µm.

those of *I. nematoloma* Joss. (1974). However, this latter species [macroscopically resembling *Hypholoma polytrichi* (Fr. : Fr.) Singer] grows in moist localities under conifers. Other species belonging to the *I. egenula*-complex are *Inocybe naucoriiformis* Vel., which according to Kuyper (1990) is probably a synonym of *I. jacobi* Kühner and *I. subexilis* (Peck) Sacc., another suspected synonym of *I. nematoloma* Joss. (Kuyper, 1990)].

Subgen. *Inocybe* Sect. Marginatae (with smooth basidiospores)

16. *Inocybe glabrescens* Vel., České Houby: 373. 1920. – Fig. 10: 1–3.

= *Inocybe metrodii* Stangl & Veselsky (1979: 220). – *I. abietis* Kühner (1955a: 3).

Selected illustrations: Stangl (1989: Pl. 24, Fig. 2), Stangl & Veselsky (1979: 221).

Pileus 8–15 mm, convex to plano-convex, with indistinct, broad umbo, brown (Caill. NP49), disc nearly smooth, otherwise radially fibrillose to rimulose at the margin. Velipellis not observed. – Lamellae adnate, moderately crowded, 2–4 mm broad, ventricose, yellow brown, fimbriate edges white. – Stipe 15–25 × 1.5–2.5 mm, equal, solid, ochraceous brown but apex whitish, pruinose

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over whole length. Cortina not observed. – Context whitish. – Odor not distinctive. – Taste not recorded.

Basidiospores (8–)8.5 ± 0.5(–9.5) × (4.5–)5.5 ± 0.5(–6.5) µm, Q = (1.4–)1.6 ± 0.1(–1.8), V = (78–)124 ± 22(–181) µm^3, n = 34, amygdaliform, smooth. – Basidia 25–30 × 9–10 µm, 4-spored. – Cheilocystidia shape similar to pleurocystidia, intermixed with vesiculose paracystidia. – Pleurocystidia (42–)62 ± 9(–75) × (14–)16 ± 2(–19) µm, n = 14, fusiform to broadly lageniform, metuloid, wall up to 1.5(–3.5) µm diam., hyaline, crystals at apex. – Caulocystidia present over whole length of stipe, shape resembling pleurocystidia but often less thick-walled, intermixed with cauloparacystidia. – Clamp connections present.

Habitat and distribution. – Associated with *Picea* spp. Europe.

Material examined. – RUSSIA: Siberia, Kamchatka, Plotnikova River Valley by Yurta Mountain. 53°10′N – 157°26′E, 250 m, *B. ermanii* forest with *S. hultenii*, 14 Aug. 1997, leg. Peintner, IB 19970922* (ZT 7499).

The present collection differs from typical *Inocybe glabrescens* Vel. by the smaller basidiomes and the habitat in association with *Betula* spp. and *Salix* spp. Bon (1997b) regards *Inocybe abietis* Kühner (1955a) as a distinctive taxon differing from *I. glabrescens* by the more ochre colors of the pileus and the lack of distinctive caulocystidia towards the base of the stipe. Another similar species is *I. vaccina* Kühner (1955a) with bright orange-brown coloured basidiomes.

17. *Inocybe ochroalba* Bruyl., Bull. Soc. mycol. Fr. 85: 345. (1969) 1970. – Fig. 11: 1–3.

Selected illustrations: Stangl (1989: Pl. 25, Fig. 4, specimen on the right side). – Bizio & Ferrari (1999: 60).

Pileus 15–25 mm, conical to campanulate, umbonate, ochraceous-yellow to ochraceous brown (Caill. P60, N57), at first paler (Caill. M70, M71) due to conspicuous velipellis, smooth to finely fibrillose, neither squamulose nor radially rimulose. Cortina absent. – Lamellae adnate, crowded, narrow (up to 2 mm wide), at first whitish, later olivaceous brown, non–floccose edges concolorous. – Stipe 20–35 × 2–5 mm, equal to slightly bulbous, solid, upper half distinctly pruinose, whitish, becoming slightly ochraceous at the apex. – Context whitish, in young basidiomes pale reddish in apex of stipe. – Odor acidulous to spermatic.

Basidiospores (8–)8.5 ± 0.5(–9.5) × (5–)5.5 ± 0.5(–6) µm, Q = (1.4–)1.6 ± 0.1(–1.8), V = (104–)133 ± 15(–163) µm^3, n = 43, ovoid to

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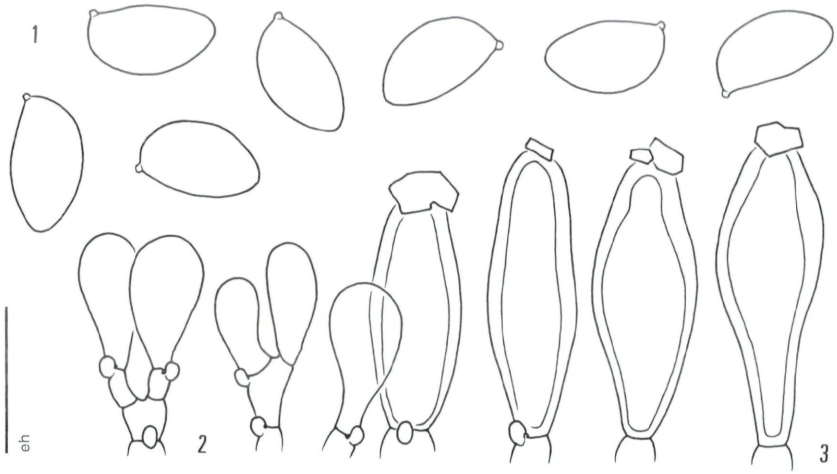


Fig. 11. *Inocybe ochroalba* (IB 19970920). – 1. Basidiospores. – 2. Paracystidia. – 3. Cheilo- and pleurocystidia. Scale bar: 1 = 5 µm; 2, 3 = 10 µm.

subamygdaliform, smooth. – Basidia 28–33 × 7.5 –9.5 µm, 4(2)-spored. – Cheilocystidia (43–)48 ± 7(–69) × (11–)15 ± 2(–20) µm, n = 17, rather short, shape similar to pleurocystidia, intermixed with vesiculose paracystidia. – Pleurocystidia (40–)46 ± 4(–56) × (14–)17 ± 2(–20) µm, n = 21, rather short, broadly clavate to subfusiform, metuloid, wall at apex up to 2.5 µm diam., hyaline to pale yellow in 10% NH_4OH, crystals at apex. – Caulocystidia (37–)61 ± 8(–74) × (8–)14 ± 3(–19) µm, n = 22, shape like pleurocystidia, intermixed with vesiculose paracystidia. – Pileipellis a cutis composed of incrusted cylindrical hyphae. – Clamp connections present.

Habitat and distribution. – Associated with deciduous trees and conifers. Widespread in Central Europe.

Material examined. – RUSSIA: Siberia, Kamchatka, Kamchatka River Valley, 15 km NE of Kozyrevsk, 56°09′N – 160°05′E, 250 m, in *Picea* forest with *L. gmelinii*, *B. ermanii*, *S. kamtschatica*, 10 Aug. 1997, leg. Læssøe, IB 19970920* (ZT 8610).

Macroscopically, *Inocybe ochroalba* ss. Kuyper (1986) is a very variable taxon. However, within this complex of polymorphic taxa, Bon (1997b) distinguishes various distinctive species. Following Bon's concept, the macroscopic characters closely resemble those of *I. subalbidodisca* Stangl & Veselsky (1975). According to Kuyper (1986), similar species are *Inocybe langei* R. Heim (1931), which has smaller basidiospores with a more obtuse apex, and *I. pelargonium* Kühner (1955a) with more slender fusiform cystidia and a submarginate to bulbous base of stipe.

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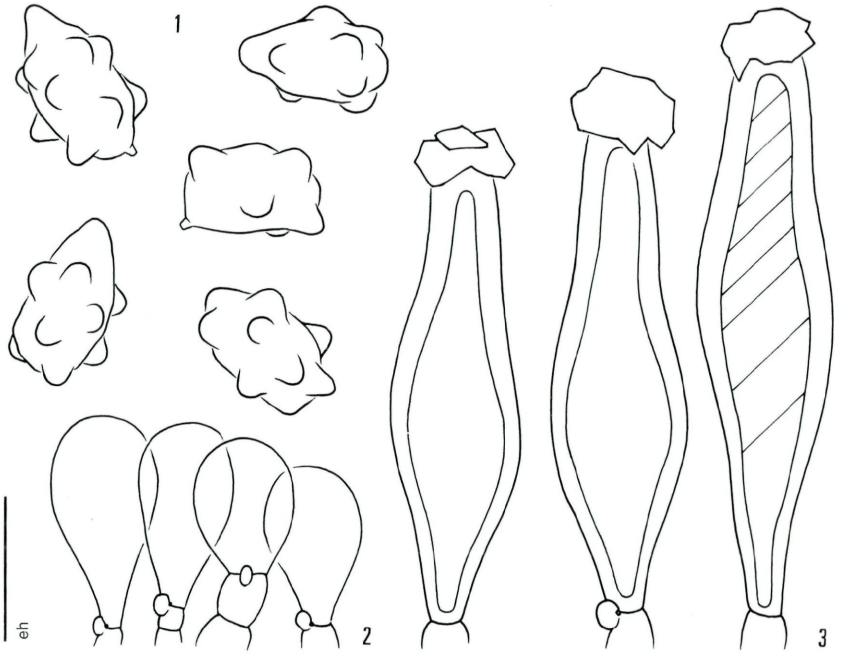


Fig. 12. *Inocybe alnea* (IB 19970934). – 1. Basidiospores. – 2. Paracystidia. – 3. Pleurocystidia. Scale bar: 1 = 5 µm; 2, 3 = 10 µm.

Subgen. *Inocybe* Sect. Marginatae (with nodulose basidiospores)

18. *Inocybe alnea* Stangl, Zeitschrift Mykologie 45: 151. 1979. – Fig. 12: 1–3.

Selected illustrations: Stangl (1989: Pl. 33, Fig. 1).

Pileus 12–25 mm, conical with incurved margin, umbonate, olivaceous brown (Caill. P60), nearly smooth around disc, radially fibrillose to rimulose towards margin, cortina present only on young basidiomes. – Lamellae adnate to almost free, moderately crowded, 3–5 mm broad, at first whitish, later becoming olivaceous-grey, subfloccose edges white. – Stipe 20–40 × 2–4 mm, cylindrical, base bulbous to submarginate-bulbous, solid, at first whitish, becoming brownish in age, pruinose over whole length. – Context whitish. – Odor earth-like.

Basidiospores (9.5–)11 ± 1(–12.5) × (6–)7 ± 0.5(–8.5) µm, Q = (1.3–)1.6 ± 0.2(–1.9), V = (170–)286 ± 63(–424) µm^3, n = 31, distinctly nodulose. – Basidia 4-spored. – Cheilocystidia shape similar to pleurocystidia, intermixed with vesiculose paracystidia. – Pleurocystidia (64–)75 ± 6(–85) × (16–)18 ± 1(–20) µm, n = 10, fusiform to lageniform, strongly metuloid, walls up to 3.5 µm diam., contents

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yellow in 10% NH_4OH, large crystals at apex. – Caulocystidia frequent, similar to pleurocystidia but less thick-walled, intermixed with vesiculose paracystidia. – Pileipellis a cutis composed of slightly incrusted hyphae, 7–11 µm diam. – Clamp connections present.

Habitat and distribution. – Associated with *Alnus* spp. in sandy riverine forests, rare but locally common. Europe.

Material examined. – RUSSIA: Siberia, Kamchatka, Esso, Uksichan River Valley, 6 km NW of Esso, 55°57′N – 158°34′E, 600 m, sandy soil along the river, in mixed forest with *B. ermanii, L. gmelinii, A. kamtschatica, P. pumila, P. tremula, P. suaveolens, Ch. arbutifolia, S. sachalinensis*, 03 Aug. 1997, leg. Peintner, IB 19970934* (ZT 8061).

Microscopically, *Inocybe alnea* is characterised by the obtusely angular basidiospores and the fusiform to lageniform cystidia with a long neck. Macroscopically, *Inocybe alnea* can be distinguished from the closely related *I. dunensis* P. D. Orton (1960) by the inconspicuous or absent veil and the fibrillose pileus. *I. dunensis* grows in sand dunes with *Salix* spp. and has rather thick-walled lageniform pleurocystidia lacking a long neck. Another closely related taxon is *I. dunensis* var. *paucicystidiosa* Bon (1998), which is characterized by darker colored basidiomes, broader basidiospores and its association with *Crataegus*. In contrast to the above-described species, *Inocybe pallida* Vel. (1920) and *I. ochracea* Stangl (1979) are recognized by the presence of a strongly developed and persisting veil.

19. *Inocybe brunneorufa* Stangl & J. Veselsky, Česká Mykologie 25: 5. 1971. – Fig. 13: 1–3.

Selected illustrations: Stangl & Veselsky (1971: Pl. 79, Fig. 39), Stangl (1989: Pl. 36, Fig. 4).

Pileus 15–30 mm, conical, slightly umbonate, brown (Caill. R47, R49) to reddish brown, disc almost smooth to subtomentose, fibrillose to fibrillose-rimulose towards margin, veil remnants absent. – Lamellae adnate to almost free, medium crowded, 2–3 mm broad, at first whitish, later grey, floccose edges white. – Stipe up to 45 mm × 2–3 mm, cylindrical, with a small, white marginate bulb up to 6 mm diam., solid, brown in upper half, towards base reddish-brown (Caill. N55), pruinose over whole length. – Context whitish. – Odor not distinctive or weakly acidulous.

Basidiospores (8–)9 ± 0.5(–10.5) × (5.5–)7 ± 1(–8.5) µm, Q = (1.1–)1.3 ± 0.1(–1.6), V = (138–)244 ± 64(–373) μm^3, n = 31, distinctly nodulose. – Basidia 24–32 × 8–10 µm, 4-spored. – Cheilocystidia shape similar to pleurocystidia, intermixed with vesiculose paracystidia. – Pleurocystidia (54–)63 ± 7(–75) × (17–)18 ± 1(–21) µm,

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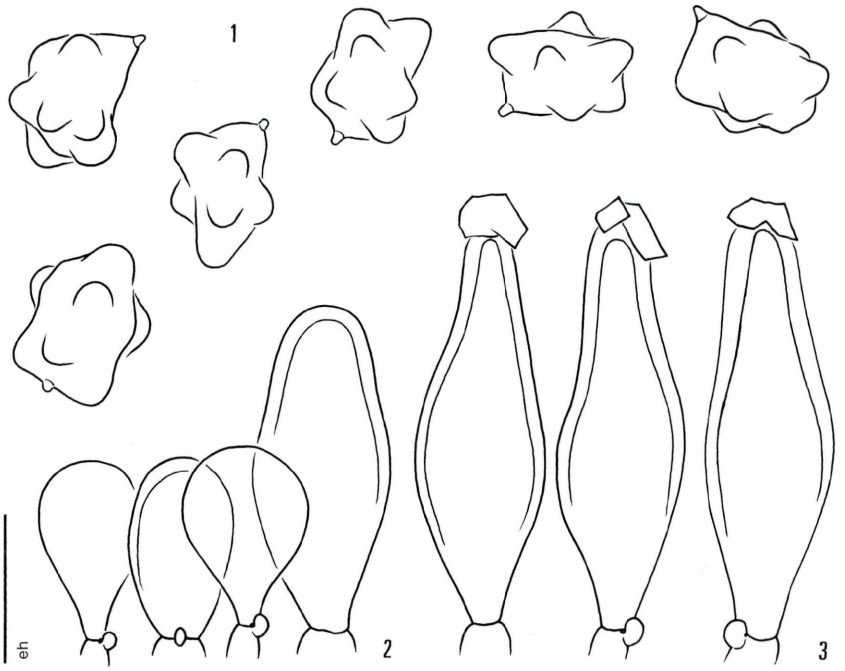


Fig. 13. *Inocybe brunneorufa* (IB 19970938). – 1. Basidiospores. – 2. Paracystidia. – 3. Cheilo- and pleurocystidia. Scale bar: 1 = 5 µm; 2, 3 = 10 µm.

n = 10, broadly fusiform, metuloid, walls up to 2 µm diam. at apex, crystals at apex. – Caulocystidia shape similar to pleurocystidia, intermixed with vesiculose paracystidia. – Clamp connections present.

Habitat and distribution. – Associated with both deciduous trees and conifers. Europe and Caucasus.

Material examined. – RUSSIA: Siberia, Kamchatka, Zhupanovo, 3 km S of the village, 54°03′N – 159°58′E, 10–80 m, in *B. ermanii* forest, 21 Aug. 1997, leg. Peintner, IB 19970938* (ZT 8606).

The characters of the present collection correspond in all details with the original description of *Inocybe brunneorufa*. Kuyper (1986) emphasizes, although with some hesitation, that *Inocybe calida* Vel. (1920) is conspecific with *I. brunneorufa*. However, *I. calida* has been described with a white stipe without bulb at the base (Velenovsky, 1920; Pilát, 1948; Bon, 1998). Habitually similar species are also *I. fuligineo-atra* Huijsman (1955) with grey veil and cystidia with walls only up to 1 µm diam. In addition, *Inocybe glabrodisca* P. D. Orton (1960) differs by more clavate cystidia, and *I. humilis* J. Favre 1960 (= *Astrosporina humilis* J. Favre & E. Horak in Horak (1987),

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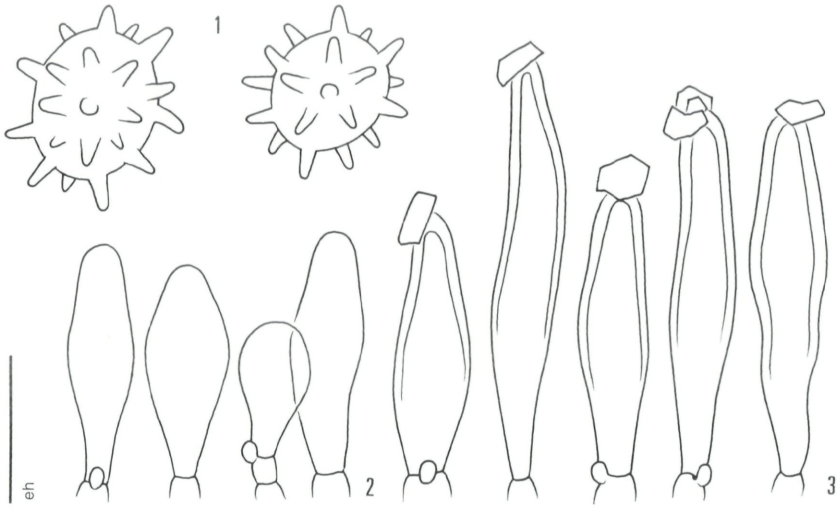


Fig. 14. *Inocybe calospora* (IB 19970931). – 1. Basidiospores. – 2. Para- and cheilocystidia. – 4. Pleurocystidia. Scale bar: 1 = 5 µm; 2, 3 = 10 µm.

which is distinctly characterised by pale yellow lamellae, different spore shape and alpine habitat.

20. *Inocybe calospora* Quél. in Bresadola, Fungi Tridentini 1: 19. 1882. – Fig. 14: 1–3.

Selected illustrations: Bresadola (1882: Pl. 21), Vauras (1989: Figs. 1–5), Stangl (1989: Pl. 31, Fig. 3), Bizio & Ferrari (1999: 64).

Pileus 10–25 mm, conical to acutely papillate, brown (Caill. P55, R50), in old specimens paler, scaly to fibrillose. Velipellis absent. – Lamellae adnate to almost free, distant, 2–3 mm broad, at first white or greyish white, then olivaceous, fimbriate edges white. – Stipe 20–50 × 2–3 mm, slender, cylindrical, equal, hollow, reddish brown (Caill. N55, P55), slightly striate, pruinose over whole length. Cortina not observed in young specimen. – Context whitish. – Odor absent to slightly earthy. – Taste not distinctive.

Basidiospores (without spines) (9–)10.5 ± 1(–12) × (7–)9.5 ± 1(–11) µm, Q = (1–)1.15 ± 0.1(–1.3), V = (240–)490 ± 148(–743) µm^3, n = 26, subglobose to ovoid, with numerous prominent, up to 3 µm long conical spines. – Basidia 37–40 × 10–12 µm, 4-spored. – Cheilocystidia (21–)35 ± 8(–48)x (9–)13 ± 3(–21) µm, n = 21, shape similar to pleurocystidia, intermixed with vesiculose paracystidia. – Pleurocystidia (42–)49 ± 5(–55) × (11–)13 ± 1(–15) µm, n = 10, rather short, slender fusiform to lageniform, metuloid, walls at apex up to 2 µm diam., crystals at apex. – Caulocystidia (27–)42 ± 11(–64) × (8–)12 ± 2(–14) µm, n = 10, over whole length of

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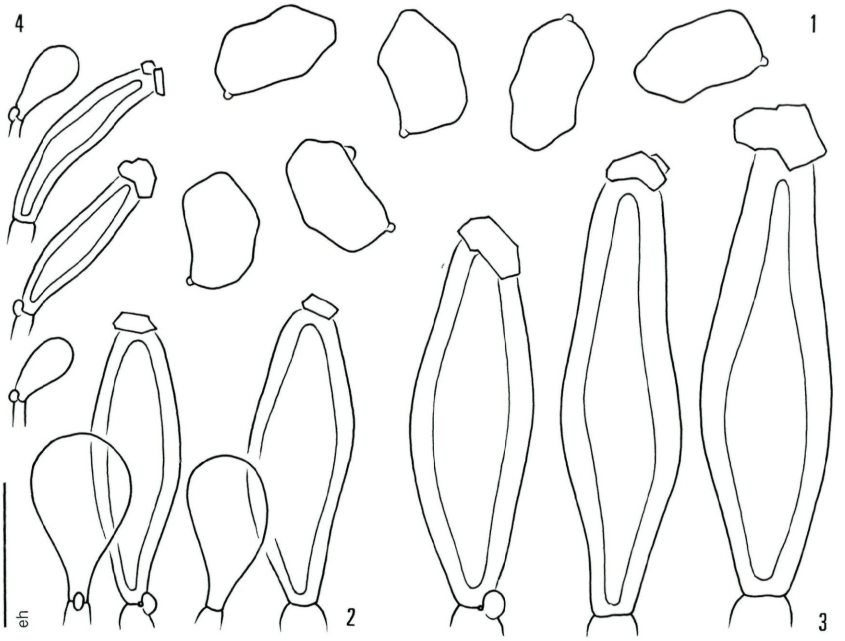


Fig. 15. *Inocybe grammata* (IB 19970929). – 1. Basidiospores. – 2. Cheilocystidia. – 3. Pleurocystidia. – 4. Caulocystidia. Scale bar: 1 = 5 µm; 2, 3 = 10 µm; 4 = 20 µm.

stipe, shape similar to cheilocystidia, intermixed with vesiculose cauloparacystidia. – Pileipellis a cutis composed of incrusted, relatively short-celled, hyphae. – Clamp connections present.

Habitat and distribution. – Common in Europe, mostly associated with deciduous trees, e.g. *Alnus, Betula.*

Material examined. – RUSSIA: Siberia, Kamchatka: Zhupanovo, forest S of Old Zhupanovo, 54°03′N – 159°58′E, 10–80 m, 19 Aug. 1997, leg. Læssøe IB 19970931 (ZT 8246). – Zhupanovo, forest 3 km S of the village, 54°03′N – 159°58′E, 10–80 m, *B. ermanii, S. sachalinensis, S. kamtschatica*, 21 Aug. 1997, leg. Læssøe, IB 19970930* (ZT 8608), IB 19970933 (ZT 8250).

The present species is related to *Inocybe multicoronata* A. H. Smith (1939), a rare taxon so far reported only from Northern America and Finland. It differs from *I. calospora* by its characteristic basidiospores ornamented with warts crowned with small obtuse projections, and by pleurocystidia longer than 60 µm.

21. *Inocybe grammata* Quél., Bull. Soc. Amis. Nat. Rouen, Sér. 2, 15: 12. 1879. – Fig. 15: 1–4.

Selected illustrations: Stangl (1989: Pl. 35, Fig. 2), Bresadola (1930: Pl. 762, as *Inocybe hiulca*), Rebaudengo (1980: Pl. 82), Moser &

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Jülich (1985: Pl. 26, Fig. 1), Lange (1938: 116D), Bizio & Ferrari (1999: 70).

Pileus 20–40 mm, conical with incurved margin, umbonate, reddish brown (Caill. MN50), with distinctive velipellis in young basidiomes, radially rimulose, but soon nearly smooth or even glabrous and shiny, veil remnants absent. – Lamellae adnate to almost free, moderately crowded, 3–5 mm broad, when at first whitish, later becoming olivaceous-grey, dentate edges concolorous. – Stipe 40–60 × 3–6 mm, bulbous at base, solid, cream-colored with distinctive reddish tinges especially in the apical region, bulb whitish and up to 12 mm diam., pruinose over whole length. – Context whitish in pileus, cream (Caill. L70) in stipe. – Odor acidulous to spermatic.

Basidiospores (7–)8 ± 0.5(–9) × (4.5–)5 ± 0.5(–7.5) µm, Q = (1.3–)1.6 ± 0.1(–1.9), V = (88–)112 ± 9(–155) µm^3, n = 31, angular (or with low bumps), distinctive knobs absent. – Basidia 4-spored. – Cheilocystidia (47–)53 ± 5(–58) × (13–)15 ± 1(–17) µm, n = 7, similar to pleurocystidia, intermixed with vesiculose paracystidia. – Pleurocystidia (53–)60 ± 4(–64) × (15–)17 ± 1(–20) µm, n = 7, broadly fusiform, metuloid, wall up to 3.5 µm diam., hyaline, crystals at apex. – Caulocystidia similar to pleurocystidia, intermixed with vesiculose cauloparacystidia. – Pileipellis a cutis composed of slightly incrusted hyphae, 10–16 µm diam. – Clamp connections present.

Habitat and distribution. – A widespread species occurring in association with both deciduous and coniferous trees.

Material examined. – RUSSIA: Siberia, Kamchatka: Zhupanovo, forest 3 km S of the village, 54°03′N – 159°58′E, 10–80 m, *B. ermanii*, 21 Aug. 1997, leg. Peintner, IB 19970929* (ZT 8615). – Zhupanovo, forest S of Old Zhupanovo, 54°06′N – 159°58′E, 10–50 m, 19 Aug. 1997, leg. Læssøe, IB 19970928.

The Siberian collections agree in all essential characters with the current circumscription and interpretation of *Inocybe grammata* (Vauras, 1997; Stangl, 1989).

22. *Inocybe mixtilis* (Britzelm.) Sacc. Syll. Fung. 5: 780. 1887.

≡ *Agaricus (Clypeus) mixtilis* Britzelm., Ber. naturhist. Ver. Augsburg 28: 152. 1885.

Selected illustrations: Rebaudengo (1980: Pl. 79, Fig. 1), Lange (1938: 115A), Stangl (1989: Pl. 34, Fig. 3).

Pileus 15–25 mm, conical, subumbonate, ochraceous (Caill. MN60/65), disc nearly smooth, finely fibrillose towards margin. – Lamellae adnate to almost free, crowded, 2–5 mm broad, ventricose, at first whitish, later becoming greyish-olivaceous, with

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shades of violaceous, subfloccose edges concolorous. – Stipe up to 45 mm × 2–5 mm, cylindrical, base with whitish distinctly marginate bulb, solid, at first whitish, becoming yellowish, pruinose over whole length. – Context whitish. – Odor spermatic.

Basidiospores (6–)8 ± 1(–9) × (4–)5.5 ± 1(–7) µm, Q = (1.2–)1.5 ± 0.2(–2.1), V = (64–)124 ± 42(–219) µm^3, n = 22, distinctly nodulose. – Basidia 24–30 × 8–10 µm, 4-spored. – Cheilocystidia (37–)42 ± 6(–55) × (12–)15 ± 2(–18) µm, n = 13, shape similar to pleurocystidia, intermixed with vesiculose paracystidia. – Pleurocystidia (45–)49 ± 2(–53) × (16–)19 ± 2(–22) µm, n = 12, rather short, broadly fusiform, metuloid, wall at apex up to 3 µm diam., hyaline, crystals at apex. – Caulocystidia (33–)39 ± 4(–43) × (11–)13 ± 2(–16) µm, n = 5, shape similar to pleurocystidia, crystals at apex, intermixed with vesiculose cauloparacystidia. – Pileipellis a cutis composed of incrusted hyphae, up to 12 µm diam. – Clamp connections present.

Habitat and distribution. – Associated with conifers, rarely with deciduous trees. Widespread in Europe.

Material examined. – RUSSIA: Siberia, Kamchatka: N of Esso, 55°56′N – 158°41′E, 800 m, *L. gmelinii, B. ermanii*, 05 Aug. 1997, leg. Peintner, IB 19970943*. – Bystraya River Valley, 18 km from the main road, 55°59′N – 159°17′E, 150 m, in dense forest of young *L. gmelinii* and *B. ermanii*, 12 Aug. 1997, leg. Peintner, IB 19970927 (ZT 8603). – Kamchatka River Valley, 3 km NE of Kozyrevsk, 56°05′N – 159°57′E, 150 m, in forest of *P. jezoensis* with very old trees of *L. gmelinii*, scattered *B. ermanii, S. kamtschatica*, 08 Aug. 1997, leg. Peintner, IB 19970924.

Collection IB 19970924 is characterized by basidiomes with viscid cap and darker colors. This feature may have been caused by the age of the basidiomes and/or the influence of weather. *Inocybe viscosissima* (Fr.) Sacc. ss. Bon is distinguished by other colors on pileus and lamellae, and larger basidiospores and cystidia. *Inocybe mixtilis* is similar to *I. pallida* Vel. (1920) and *I. praetervisa* Quél. (in Bresadola 1883), but both have larger basidiospores. Also *Inocybe xanthomelas* Boursier & Kühner (in Kühner 1933) has larger basidiospores and lacks yellowish tinges on the stipe. Finally, *Inocybe margaritispora* (Berk.) Sacc. is distinguished by its fibrillose to squamulose pileipellis and larger cystidia.

23. *Inocybe petiginosa* (Fr.: Fr.) Gillet, Champ. France, 521. 1878.

≡ *Agaricus petiginosus* Fr. : Fr. Syst. mycol. 1: 243. 1821.

Selected illustrations: Rebaudengo (1980: Pl. 91), Lange (1938: 118A), Stangl (1989: Pl. 31, Fig. 3).

Pileus 3–7 mm, conical to convex, umbonate, centre dark brown (Caill. S69), margin paler brown (Caill. P60, P47, P49),

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strongly fibrillose-squamulose. Veil remnants absent. – Lamellae adnate to almost free, subdistant, 1–2.5 mm broad, ventricose, at first greyish-white, later becoming ochraceous brown, floccose edges white. – Stipe up to 15–20 × 1–2 mm, cylindrical, equal or tapering towards base, solid, concolorous to paler brown, sometimes with reddish hue at apex, pruinose over whole length. – Context whitish in the pileus, pale brown in stipe. – Odor spermatic or not distinctive.

Basidiospores (7–)8.5 ± 0.5(–9.5) × (4–)5.5 ± 0.5(–6.5) µm, Q = (1.3–)1.6 ± 0.1(–1.9), V = (68–)122 ± 29(–196) µm^3, n = 36, distinctly nodulose. – Basidia 22–30 × 7–8 µm, 4-spored. – Cheilocystidia shape similar to pleurocystidia, intermixed with scattered vesiculose paracystidia. – Pleurocystidia (80–)93 ± 7(–106) × (16–)19 ± 2 (–22) µm, n = 10, slender fusiform, metuloid, wall at apex up to 2 µm diam., hyaline, crystals at apex. – Caulocystidia shape and size similar to pleurocystidia, paracystidia present. – Pileipellis a cutis composed of incrusted cylindrical hyphae. – Clamp connections present.

Habitat and distribution. – Associated with deciduous trees. Europe.

Material examined: RUSSIA: Siberia, Kamchatka: Kamchatka River Valley, 15 km NE of Kozyrevsk, 56°09′N – 160°05′E, 250 m, *Picea* forest with *L. gmelinii, B. ermanii, S. kamtschatica*, 10 Aug. 1997, leg. Peintner, IB 19970936* (ZT 8602). – Plotnikova River Valley by Yurta Mountain, 53°10′N – 157°26′E, 250 m, in forest of *B. ermanii* with *S. hultenii*, 14 Aug. 1997, leg. Peintner, IB 19970935. – Zhupanovo, *B. ermanii* forest S of village, 54°04′N – 159°58′E, 10–80 m, 19 Aug. 1998, leg. Peintner, IB 19970937.

Species of *Inocybe* with similar features, also reported to be in association with conifers, are: *Inocybe jacobi* Kühner (1955b) with more nodulose, slightly broader basidiospores [7.5–10(–10.5) × 5.5–7 µm], *Inocybe sapinea* Vel. (Stangl,1989) with more reddish-brown colored basidiomes, absent veil remnants, slightly larger and more thin-walled cystidia, and mostly angular basidiospores with indistinct knobs, and *Inocybe rufoalba* Doass. & Pat. (in Pat. & Doass. 1886).

24. *Inocybe rufoalba* Doass. & Pat. in Pat. & Doass., Rev. Mycol. (Toulouse) 8: 26. 1886. – Fig. 16: 1–3.

Selected illustrations: Heim (1931: Pl. 31, Fig. 49). – Rebaudengo (1980: Pl. 92, Fig. 2).

Pileus 15–30 mm, convex to conico-campanulate, umbonate, brown (Caill. N/P 69, R47, R33), paler towards margin (R47), radially

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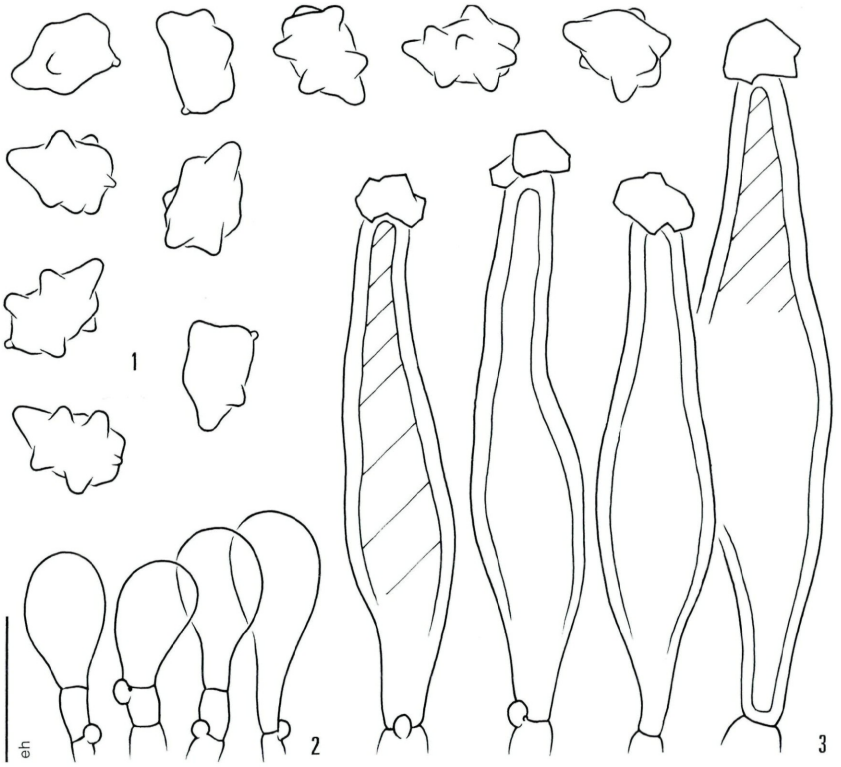


Fig. 16. *Inocybe rufoalba* (IB 19970941). – 1. Basidiospores. – 2. Paracystidia. – 3. Pleurocystidia. Scale bar: 1 = 5 µm; 2, 3 = 10 µm.

fibrillose, surface covered by white velar patches. – Lamellae adnexed, narrow, up to 4 mm broad, brownish-olivaceous (Caill. N67, N69), even edges white. – Stipe 30–50 × 2–3 mm, equal, cylindrical, base occasionally with submarginate bulb, concolorous, pruinose over whole length. – Context whitish. – Odor acidulous to spermatic, unpleasant.

Basidiospores (6.5–)7.5 ± 0.5(–8.5) × (4–)4.5 ± 0.5(–5.5) µm, Q = (1.3–)1.6 ± 0.1(–1.9), V = (55–)80 ± 12(–110) µm^3, n = 42, irregular-angular or with few bulges. – Basidia 24–30 × 7.5–9.5 µm, 4-spored. – Cheilocystidia size and shape asimilar to pleurocystidia, intermixed with vesiculose paracystidia. – Pleurocystidia (59–)74 ± 7(–80) × (17–)19 ± 1(–20) µm, n = 21, fusiform to lageniform, with elongate pedicels, metuloid, wall at apex up to 2.5 µm diam., content often yellow-brown in 10% NH_4OH, crystals at apex. – Caulocystidia size and shape similar to pleurocystidia, intermixed with scattered cauloparacystidia. – Clamp connections present.

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Habitat and distribution. – In Kamchatka found among moss in wet locality with *B. ermanii*, *Salix* and *Alnus*.

Material examined. – RUSSIA: Siberia, Kamchatka, Termalny, mountains 2 km W of town, 52°56'N – 158°12'E, 300–400 m, *B. ermanii* forest with *S. sachalinensis* and *A. kamtschatica*, 17 Aug. 1997, leg. Peintner, IB 19970941* (ZT 7497).

Inocybe rufoalba belongs to sect. Petiginosae (R. Heim) Bon, and is characterised by relatively small, angular basidiospores and fusiform cystidia. The closely related *I. petiginosa* (Fr.) Gillet differs by its darker pileus color, squamulose-squarrulose surface, larger pleurocystidia and less nodulose basidiospores. *Inocybe jacobi* Kühner (1955b) is distinguished by larger basidiospores, more orange-brown colored basidiomes and its association with conifers. *Inocybe polycystidiata* Y. Kobayasi (1952), originally described from Japan, has smaller polyhedral basidiospores (5–6.5 × 4.5–5.5 µm) and orange-brown colored pilei. *Inocybe ambigua* Romagn. (1979) is clearly separated from *I. rufoalba* by its small, rectangular basidiospores without distinctive nodules in combination with fusiform and remarkably thin-walled cystidia.

Discussion

During the stay in Kamchatka (August 1997), 45 collections of *Inocybe* were gathered which partly relate to the 24 species (including 4 varieties) described in this paper (Tab. 1, 2). Several collections (probably representing new taxa) remain unidentified because the inadequate quality of the specimens did not allow allocation of names or sufficient data to describe a new taxon.

During the period of field work (July-August) in Kamchatka, five species (*Inocybe calospora, I. fastigiella, I. mixtilis, I. petiginosa* and *I. rimosa*) were found in several localities and thus are considered to be common and of wide distribution. These taxa were collected three or more times, while the remaining enumerated species were encountered less often.

Several species appear to be adapted to special habitats: *Inocybe egenula* and *I. lacera* var. *rhacodes* were collected in alpine localities, *Inocybe acutella* in coastal dunes, and *I. flocculosa* var. *crocifolia* grew in volcanic ash. Furthermore, *I. mixtilis* was collected twice in close association with conifers. All other *Inocybe* spp. were found in mixed deciduous forests mostly dominated by *Betula ermanii*. The fact that five species of *Inocybe* were found in the environs of Zhupanovo (S17) is reflected by the comparatively intensive collecting activity in this locality during several days.

This contribution adds novel information about the Kamchatkan mycota, in particular the Agaricales, the occurrence and biodi-

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versity of which in this geographic region is still scarcely documented. In earlier publications on macromycetes from Kamchatka, Kalamees & Vaasma (1981, 1993) reported *I. geophylla* var. *geophylla*, *I. geophylla* var. *violacea* Pat. [= *I. geophylla* var. *lilacina* (Peck) Gillet], *I. geophylla* var. *lateritia* (Weinm.) Moser [= *I. whitei* (Berk. & Broome) Sacc.] from deciduous or mixed forests, and *I. giacomi* J. Favre and *I. lacera* (Fr.) P. Kumm. from subalpine or alpine habitats. Taking these species into account, at present about 30 taxa of *Inocybe* are now recorded from Kamchatka.

For Siberia, the Arctic and Subarctic representatives of *Inocybe* are summarized by Nezdoiminogo (1993) who published a key encompassing 17 species. Recently, Nezdoiminogo & Petrov (1999) reported 10 more taxa, representing first records for Russia. Taking into account all earlier published references to Siberian *Inocybe*, 16 taxa described in the present study (*Inocybe acutella*, *I. alnea*, *I. rufoalba*, *I. assimilata*, *I. calospora*, *I. cookei* var. *kuthanii*, *I. egenula*, *I. fastigiella*, *I. flocculosa* var. *crocifolia*, *I. fuscidula*, *I. glabrescens*, *I. lacera* var. *rhacodes*, *I. ochroalba*, *I. petiginosa*, *I. phaeocomis* var. *major* and *I. xanthocephala*) are considered to be new records for this geographical region.

The majority of the Kamchatkan *Inocybe* species are actually boreal to temperate species with a circumpolar Eurasian distribution. Thus, it is not surprising that numerous European taxa were recorded in the Kamchatkan peninsula. Also several species native to North American biota have been detected. One of those is *Inocybe fastigiella*, which by some authors is considered a mere color variant of *I. maculata*. In addition, in continental North America three species (*I. flavella, I. flocculosa and I. phaeocomis* var. *major*) have been described by Cripps (1997) as ectomycorrhizal partners in pure stands of aspen (*Populus tremuloides*). Y. Kobayashi (1952) and T. Kobayashi (1993, 1995) reported about 40 species of *Inocybe* from Japan, but only the cosmopolitan species *Inocybe geophylla* var. *geophylla, I. geophylla* var. *lilacina, I. lacera, I. rimosa* and *I. maculata* occur in both Japan and the Kamchatka Peninsula.

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