

On Fennoscandian polypores 10. *Boletopsis leucomelaena* and *B. grisea* described and illustrated

TUOMO NIEMELÄ and REIMA SAARENOKSA

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Two European species are accepted in the polypore genus *Boletopsis*: *B. leucomelaena* (Pers.) Fayod and *B. grisea* (Peck) Bond. & Sing. Both are described and a comparison is made of the best determinative characters. The nomenclature is discussed and some common misapplications reviewed. *B. leucomelaena* has dark-capped, fragile fruit bodies and grows predominantly in rich spruce forests. *B. grisea* is silvery grey to dirty grey-brown, fairly hard, but when fresh easily torn in a radial direction; it grows almost solely in poor dry pine heath forests. The distributions of both species in Norway, Sweden and Finland are summarized with abbreviated locality lists and distribution maps, and the total distributions are estimated on the basis of published photographs. *B. leucomelaena*, being the more southern of the two, is rare in Fennoscandia and may need some protection. The abundance of *B. grisea* varies greatly, depending on the weather in the growing season, but in suitable years it is locally common, especially in the north. Both species are illustrated with *in situ* colour photographs and microscopical drawings.

Tuomo Niemelä & Reima Saarenoksa, Department of Botany, University of Helsinki, Unioninkatu 44, SF-00170 Helsinki, Finland

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Hydnellum) hymenophore, for which Donk (1961) and Maas Geesteranus (1974) outlined the family Thelephoraceae. The paramount feature of this entity is the tubercular shape of the spores, accompanied by the pale buff spore colour and certain fruit body pigments (Besl et al. 1975). Keller (1976) demonstrated with TEM photographs that *Boletopsis* has a close affinity to this group, and that some other hydneaceous fungi (e.g. *Bankera*, *Phellodon*) make up another, different and distinct family (Bankeraceae, Donk 1961).

In accordance with the proposal of Corner (1970), Oberwinkler (1976) raised the Thelephoraceae to the rank of an order, the Thelephorales. *Boletopsis* is the only poroid genus in this group of fungi.

While the generic concept of *Boletopsis* is clear and has been understood consistently, the species that it comprises have remained weakly defined and collective. Donk's (1974) acknowledgement of two European species has been neglected by almost all authors of manuals, local floras or lists dealing with

Introduction

The polypore genus *Boletopsis* Fay. (Fayod 1889) has its closest relatives amongst the genera with a smooth (e.g. *Thelephora*) or spiny (e.g. *Sarcodon*,

the polypores in the area. To our knowledge, only Harrison (1973, indirectly), Kotlaba (1984) and Cetto (1987) have recently accepted the two species of *Boletopsis* that we shall discuss here, and only a few others (e.g. Jülich 1984, Dunger 1987, Michael et al. 1988) have tentatively mentioned the possibility that two species are involved. The highly characteristic microscopy at the generic level (especially the tubercular spores), distinguishing the taxon clearly from any other group of polypores has drawn attention from the use of the morphological and ecological variation as an aid in separation of the species.

It must be admitted that difficulties are encountered in the use of macroscopic characters for defining the *Boletopsis* species. The colour, shape, surface structure and pore sizes of the fruit bodies change with their age. Variable drying conditions cause further secondary variation in herbarium specimens. The hyphal structure is greatly dependent on the mounting medium used in the microscopy. Our concept of the two species is based on notes made in the field and on fresh material in North Europe only, and the following descriptions must be understood accordingly.

It is quite possible that a gradual change in the characters may be seen if a certain species is studied along a wider geographical gradient. Also, the possibility of other southern and extra-European species should be kept in mind.

Unfortunately, no striking single character was found to separate the two species described here. Nevertheless, almost all the specimens could be identified by using our criteria. The only unsolved cases arose in identifying material that had been collected in a deteriorating state, or left to decay after collection, or handled roughly enough to spoil the hyphal structure of the stipe and cap tomentum. The difficulties in identifying *Boletopsis* are those familiar to the agaricologists, rather than to workers dealing with the polypores.

Materials and methods

The distribution maps, descriptions, and notes on the ecology and phenology are mostly based on material deposited in the Nordic herbaria: BG, GB, H, HFR, KUO, LD, O, OULU, S, TRH, TROM, TUR, UPS. The material of the reference collections of Mr Heikki Kotiranta (H.K.) and Tuomo Niemelä (T.N.) is included. Further records were obtained through fairly extensive private correspondence, and in some areas such a source changed the picture completely (e.g. northern Sweden, notes of Mr Mats Karström).

Some of these records (indicated as "pers. comm." or "in litt.") derive from the observer's notes or photograph, without a herbarium specimen, if we considered them reliable and adequate for identification. Further, type material and other important old collections, or information on these, were obtained from the following museums: L, NY and NYS.

In the lists of the localities, the numbers of specimens are given for each parish, and the herbaria are indicated. It was often difficult to estimate whether certain specimens in different herbaria are duplicates, and therefore such convolutes were consistently counted separately. Sometimes we had to guess parish names, if for instance only some mountain was given in the label, and errors are possible.

We have studied both the species repeatedly *in situ*, and some colleagues and students were kind enough to bring us fresh fruit bodies, which were essential in deciding the differences between the two species and in writing the descriptions.

The standard media used in microscopy were IKI (Melzer's reagent), CB (Cotton Blue, as defined by Niemelä 1985) and KOH (5% potassium hydroxide). Cresyl Blue (CRB) was used to only a limited extent. Cotton Blue proved to be the best mountant for studying these species: our measurements and drawings were made on material mounted in it and we recommend the use of CB in studying the spores or tomentum hyphae for identification.

The structure of the cap or stipe tomentum can best be studied from thin sections, cut along the surface in parts which have most probably avoided rubbing and fingerprints. It is advisable to take sections from several different places. The cover glass may be pressed only slightly; hard squashing or tapping with a dissecting needle will spoil the structure. The cortical layer under the tomentum should be studied from a vertical section, as should be also the structure of the mycelium deeper inside. The originally parallel hyphal orientation in some parts of the fruit bodies can be studied in this genus only from fresh specimens, because the collapse of the structure changes the image in dry specimens.

The hyphae are swollen in many parts of the fruit bodies, but in such areas also some portions of the hyphae still exhibit their narrow, regular shape with parallel walls. The expression "hyphae basically 4–7 µm" refers to such uninflated hyphae. The two descriptions have been written in the same manner, and the differences and similarities of the two species can be found by comparing the descriptions step by step.

The tubercles are included in the spore measurements. In genera with spiny spores, the spines have

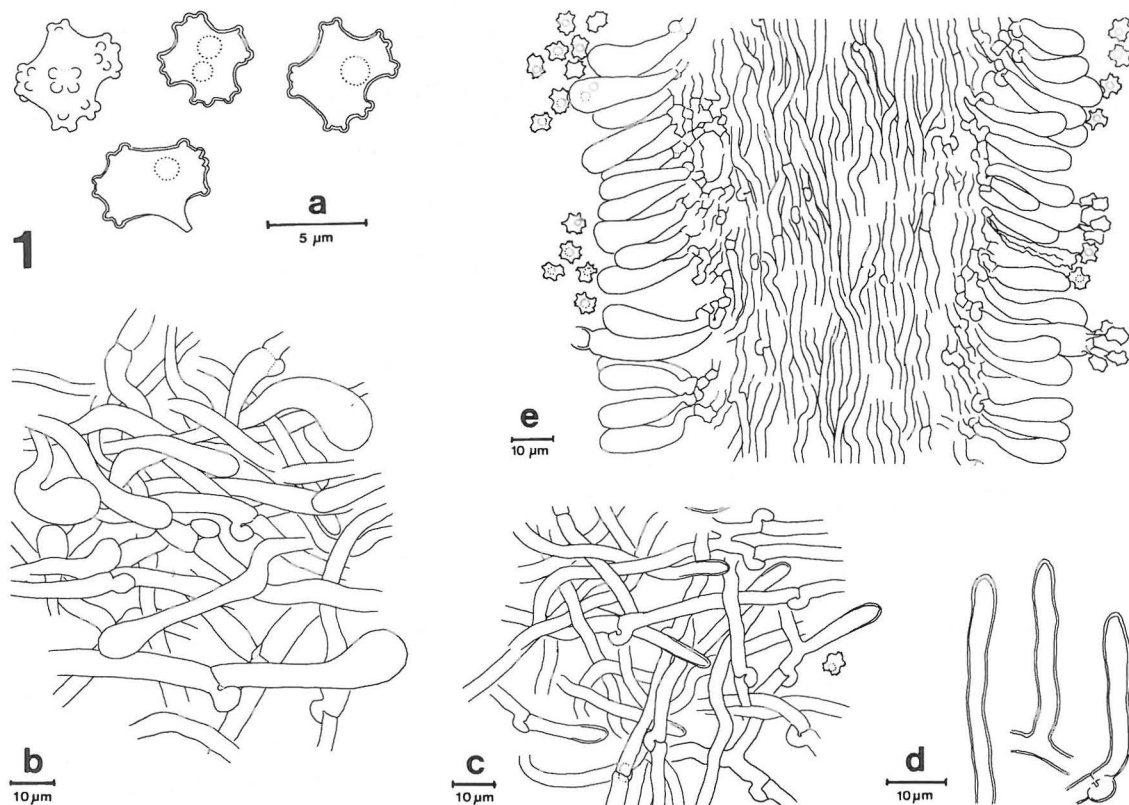


Fig. 1a–e. Anatomical details of *Boletopsis leucomelaena*. — a: Spores in surface view and optical section. — b: Hyphae of the cap tomentum in a section along the surface. — c: Stipe tomentum in a section along the surface. — d: Finger-like hyphal apices in the stipe tomentum. — e: Dissepiment in vertical section. Drawn in CB (Finland, Varsinais-Suomi: Lohja, 15.VIII.1977 Harmaja, H).

often been disregarded when the spore sizes are given. The practice is variable, however, and many authors fail to mention their measuring routine. In *Boletopsis* it is difficult to exclude the tubercles, as they arise very gradually from the spore surface and the estimation of its basic size is quite subjective.

Boletopsis leucomelaena

?*Fungus porcinus* Paulet, *Traité des champignons* 2:361, 1793. Type: not designated. See section Nomenclature of *B. leucomelaena*, and Donk (1974: 32).

Boletus leucomelas Persoon, *Synopsis methodica fungorum* 1:515, 1801. Lectotype: "*Boletus leucomelas*, Syn. fung. p. 515, hab. in Hercynia". Herb. Persoon 911.81-22 (L, labelled as 'type' by M.A. Donk 1932; selected here as a lectotype). — *Polyporus subsquamosus* L.: Fr. (var.) γ *leucomelas* (Pers.) Fries, *Systema mycologicum* 1:346, 1821. — *Polyporus leucomelas* (Pers.) Pers., *Mycologia europaea* 2:40,

1825. — *Boletopsis leucomelaena* (Pers.) Fayod, *Malpighia* 3:72, 1889 ('melaleuca').

For further synonyms, see Donk (1974) and Bresinsky & Stangl (1968). No type or other original collections were found for *Polyporus scoparius* Persoon 1825.

Not *Polyporus subsquamosus* L.: Fr., *Systema mycologicum* 1:346, 1821. See section Nomenclature of *B. leucomelaena*.

Shape and general characters. Fruit body annual, pileate, terrestrial, with a central or slightly eccentric stipe, growing in dense clusters of three to ten, or less often solitarily. Cap roundish, (4)–5–8(–10) cm in diam, flat–convex, often with a few wide lobes or irregular, and with a slightly umbonate centre. Caps expand to their final size in a late phase, standing free above the soil debris and moss. Fresh cap and in particular the stipe easily cracking without fibrous orientation. Margin entire, acute, spread or slightly down-curved. Stipe cylindrical or tapering towards the base, 3–5(–10) cm long, (1)–1.5–2.5 cm in diam;

fresh fruit bodies 4–8(–12) cm tall, depending on depth of moss layer. Specimens dry rapidly and easily, all parts becoming soft–brittle, the tubes remaining open even in poor drying conditions. Spot of KOH permanently sepia black in all parts. Odour indistinct, sourish; taste mild but slowly developing a slightly soapy or bitter after-taste; dried fruit bodies odourless and slightly bitter.

Surface. Upper surface smooth, glabrous, matted and non-viscid, water-absorbing, azonate, greyish sepia or black–brown and often with a tinge of magenta; young fruit bodies paler towards the margin, without radial streaks or fissures. Old upper surface rough, and sometimes with minute scales at the centre. Snail-eaten pits pink–grey at surface in both cap and stipe. Dried cap dark brownish grey to greenish black, wrinkled. Pore surface at first cream, but soon attaining a pale lilac–grey or smoky grey–brown tint inside the tubes, changing to pinkish where bruised; after drying grey–brown or olivaceous grey. Pores angular or finally somewhat sinuous, in young fruit bodies 2–3 per mm, in old ones 1–2 per mm, walls thin, finally lacerate especially near the stipe; tubes somewhat decurrent and the demarcation from the stipe well defined. Stipe dark grey–brown, black–brown, or faintly pinkish grey, with a slight sheen, bleaching downwards and having small, bright orange patches at the base in between the attached soil particles; surface of old stipe sometimes breaking into narrow and thin, upward-projecting scales. Dry stipe dark olivaceous grey to black–brown, shrunken with longitudinal grooves.

Section. Cap context homogeneous, soft fleshy, hygrophanous, 1–2 cm thick at attachment to stipe, in young caps cream-coloured and changing to lilac–grey (especially at margin near surface) when cut or broken, in adult fruit bodies light grey with a lilac tint and no further changes, slightly darker towards the tubes. Tube layer 1–2 mm thick, smoke-coloured. Stipe context homogeneous but becoming firmer towards the surface, solid (old stipes eaten hollow by insect larvae), cream when young, hygrophanous and pale greyish–brown when old. Dry context homogeneous, soft fragile, grey–brown and with a green tint (especially close to cap margins and on dry broken surfaces), pigmented pellicle visible in section as a black, 0.2–0.4 mm thick line.

Microscopy. Hyphal system monomitic, hyphae hyaline (except tomentum), thin-walled (except stipe tomentum), with clamp connections, IKI–, CRB–, weakly CB+, wall thickness unchanged in KOH. Hyphae of cap tomentum greenish grey, in KOH bright moss green, winding, basically 4–7(–10) μm in diam, but hyphal tips and less often cell ends next

to the clamp connections swollen, (8–)11–15 (–18) μm in diam. Cortical layer indistinct, hyphae basically 5–10 μm in diam, often gradually swollen to (9–)13–17(–25) μm in diam, loosely intermixed, in KOH releasing yellow–brown dye. Gloeoplerous hyphae uncommon, yellow in IKI and KOH, blue in CB, 4–6 μm in diam. Context hyphae inflated into a homogeneous network, orientation indistinct. Stipe tomentum with tortuous hyphae, basically (3–)3.5–4.5(–6.5) μm in diam, having greenish and slightly thickened (0.4–0.8 μm) walls and frequent branches; finger-like terminal cells only slightly inflated to (5.5–)6–7(–9.5) μm in diam. Stipe context hyphae inflated, subparallel, in KOH yellow–brown. Tube tramal hyphae of even thickness, 2–3(–3.5) μm in diam, tightly packed, subparallel in an undulating manner, unstained in KOH. Hyphal tips at dissepiment edges 3 μm in diam, undifferentiated, ciliate. Subhymenium indistinct. Basidia clavate, (17–)22–27 \times 5.5–8.5 μm , with four sterigmata 3–4 μm long or (less often) two sterigmata 6–8 μm long; basidiosoles similar but smaller, both with basal clamp connections. No cystidia. Spores (4.6–)5–6.3(–8) \times (3.6–)4–5(–6.2) μm , tubercular, slightly flattened dorsiventrally, thin-walled (0.3 μm), hyaline (in mass yellow–brownish), with single, several or no guttules (best seen in CB), IKI–, CB+. Apiculus prominent, oblique, arising from the flattened side, in microscope not easily found among the tubercles.

Ecology and phenology

Boletopsis leucomelaena favours fairly rich habitats. In Finland it is found characteristically in spruce-dominated forests, referred in the Finnish forest classification to the *Oxalis–Maianthemum* type (OMaT) and the *Oxalis–Vaccinium myrtillus* type (OMT). The floristic elements of these forest site types have been listed by, for example, Kalliola (1973) and Kujala (1979).

The first forest site type (OMaT) is spruce-dominated grass–herb forest, intermixed with *Betula* species, *Populus tremula*, *Corylus avellana* and other deciduous trees and shrubs. Dwarf shrubs are few and mostly restricted to hummocks; demanding grasses and herbs predominate in the field layer. Hygromorphic mosses are common in the ground layer, but do not form a continuous mat, being interspersed with areas of decaying leaf litter and bare mull soil. Most collections of *B. leucomelaena* were made in this site type.

The second forest type (OMT) is moist heath forest, with almost pure stands of well-growing *Picea*

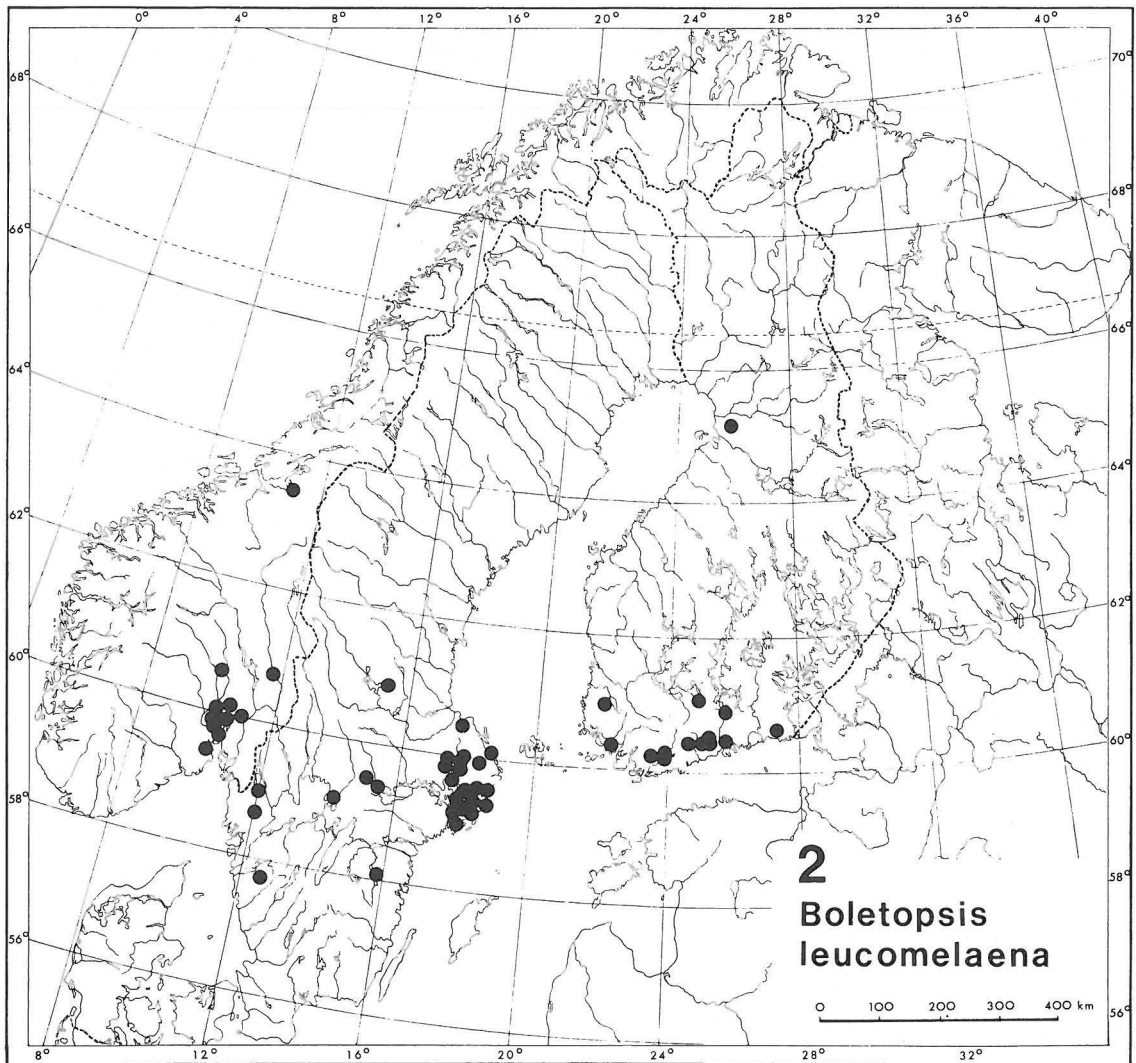


Fig. 2. The distribution of *Boletopsis leucomelaena* in Fennoscandia based on the specimens examined and on selected personal reports.

abies. The field layer contains a number of grasses and herbs, but dwarf shrubs are dominant, especially *Vaccinium myrtillus* and sterile *V. vitis-idaea*. Less demanding mosses (species of *Hylocomium*, *Pleurozium*, *Dicranum*, etc.) are abundant, and a deep mat of moss was mentioned in some collections of *B. leucomelaena* from this site type. The soils are podsolized with a raw humus layer.

Both these forest types are shady and have a moist microclimate. Further, the lower vegetation under

which the fruit bodies hide stabilizes the moisture even during periods of drought.

Most Finnish collections were made from at least slightly calcareous areas, which indicates that *B. leucomelaena* tolerates soils on limy bedrock. Whether the species is truly calciphilous, we do not know. It is mostly collected by mycologists studying terrestrial agarics and Ascomycetes; in Finland such mycologists are almost overwhelmingly attracted to the few calcareous areas with their special mycoflora and

local rarities. This brings about an imbalance in the amounts of collections from different soil types: the most extensive and characteristic taiga forests, having acid podsol soils with a raw humus layer, remain under-represented.

The first Nordic collections of the species were made in the last days of July, the main fruiting starting at the end of August, and ending in October. According to our (rather restricted) experience, the species appears fairly regularly in its sites in successive years.

Inclusion of *B. leucomelaena* in the revised Finnish list of endangered species is being considered. This is partly due to the rarity of the species, but more particularly because its restricted, scattered sites are threatened by intensive forestry, suburban building, and other environmental pressures. The species of *Boletopsis* are becoming threatened in many parts of Central Europe (e.g., Benkert 1982, Dunger 1987, Hirsch et al. 1988).

Distribution

Distribution in Fennoscandia:

Norway. Akershus og Oslo: Asker (2 specimens: herb. OSLO). Lørenskog (1: OSLO). Oslo (4: OSLO). Oppland: Lunner (1: OSLO). Nordre Land (1: OSLO). Østre Toten (3: H, OSLO, OULU). Vestre Toten (1: OSLO). Buskerud: Drammen (1: OSLO). Hole (1: OSLO). Lier (1: OSLO). Nedre Eiker (1: OSLO). Norderhov (3: OSLO). Røyken (1: OSLO). Vikar (1: OSLO). Vestfold: Hof (1: OSLO). Nord-Trøndelag: Frosta (2: OSLO, TRH).

Sweden. Göteborg: Björketorp (1: GB). Dalsland: Dals-Ed (1: S). Rännelanda (1: GB). Östergötland: Tjärstad (1: S). Värmland: Södra Råda (1: S). Närke: Rinkaby (1: S). Södermanland: Älvsjö (1: S). Botkyrka (1: S). Grödinge (1: S). Hudinge (1: S). Torö (1: S). Uppland: Älvkarleby (1: UPS). Börje (2: S, UPS, F. Exs. Succ. 1309). Börstil (3: S, UPS, pers. comm.). Danderyd (1: S). Danmark (1: UPS). Dävensö (1: S). Djurö (2: S). Fasterna (1: S). Knivsta (1: UPS). Läby (1: UPS). Lena (2: S, UPS). Ljusterö (1: S). Lovö (1: S). Östra Ryd (1: S). Rö (1: S). Sånga (1: S). Sollentuna (1: S). Uppsala (7: UPS). Värmdö (1: S). Västmanland: Vikar (6: GB, S). Dalarna: Rättvik (2: UPS).

Finland. Varsinais-Suomi: Karjaa (2: H). Lohja rural comm. (3: H). Parainen (1: TUR). Pohja (1: H). Uusimaa: Espoo (1: H). Orimattila (1: H). Porvoo (1: H). Sipoo (9: H, KUO, OULU, TUR, H.K., T.N.). Tuusula (1: HFR). Etelä-Karjala: Vehkalahti (1: H). Satakunta: Honkilahti (2: TUR). Etelä-Häme: Lammi (1: H). Pohjois-Pohjanmaa: Kiiminki (2: OULU).

Boletopsis leucomelaena is rare and its distribution is fairly restricted in all the Nordic countries. A great majority of the collected fruit bodies derives from the Hemiboreal zone (map in Koski-Kotiranta & Niemelä 1988). The northernmost Norwegian find (N. Trøndelag: Frosta), on the coast of the Trondheim fjord,

was made in an isolated outlier of the Hemiboreal zone. The northernmost Swedish collection (Dalarna: Rättvik), made by Lake Siljan, is from the transitional area between the Southern and Middle Boreal zones. In Finland there are many collections from the southern part of the Southern Boreal zone.

The isolated northern locality in Finland (Pohjois-Pohjanmaa: Kiiminki) is interesting. Lying deep in the northern part of the Middle Boreal zone, it disagrees with the otherwise southerly picture. The region is a botanically rich limestone area, and characterized by many exacting vascular plants. These often show a special distributional pattern, having an extensive coherent southern area, but occurring as isolated patches in rich calcareous northern biotopes. The vegetation of the northern outliers deviates sharply from that of the surrounding barren areas. Finnish examples of this pattern are provided by *Thelypteris palustris* Schott., *Listera ovata* (L.) R.Br., *Humulus lupulus* L., *Galium odoratum* (L.) Scop. and *Lonicera xylosteum* L. (I. Kytövuori, pers. comm.).

The western coasts of Norway and Sweden have strikingly few collections, as compared with the numerous eastern localities. This may merely be the result of the strong collecting activity around the metropolitan areas; besides, fertile soils and the most luxuriant forest types are commonest around Oslo in Norway and the great lakes axis of southern Sweden.

The general distribution of *B. leucomelaena* in Fennoscandia seems to be the combined result of a southern preference and the requirement of rich forest biotopes on calcareous soils.

B. leucomelaena seems to be rare or very rare in most parts of Europe. The descriptions (indication of an almost black pileipellis) and other data (grassy spruce forests and other rich habitats) give the impression that the species has a wide distribution, and is found mainly in lowlands, up to the submontane (oroboreal) mixed spruce and fir forests. Reliable records, however, are extremely few. Kotlaba (1984) deals with both *B. leucomelaena* and *B. grisea*, the very short description and ecological notes show that his concept is the same as ours. In his Atlas of the Czechoslovakian polypores, *B. leucomelaena* is recorded from four localities in Slovakia; his maps of the two species are the only published ones that we know.

The illustration in Breitenbach and Kränzlin (1986) represents *B. leucomelaena*, and the ecological notes support the determination; their record is from Switzerland. Cetto (1987) presented a very good, characteristic colour print (as *B. leucomelaena*), evidently photographed in Italy, although this

was not indicated. Marchand (1976) published a picture of two deteriorating fruit bodies which had been transferred from their original site to more convenient and 'beautiful' surroundings, and were ecologically out of place; they originated from France. Schmid-Heckel's (1985) records from the West German Alps can be traced to this species. We are reluctant to classify old hand-painted illustrations in general, but Fries (1877–1894: 179), Bresadola (1931: 949) and Cortin & Hahnwald (1956) were most probably in possession of this species.

Lincoff (1981) published a picture of two old fruit bodies from the U.S.A. Many other records, too, indicate that both species are present in that continent, in particular the notes of Harrison (1973, from the Pacific Northwest) and Donk (1974, Idaho). *B. leucomelaena* seems to be the rarer of the two in North America, however, since most descriptions fit *B. grisea* better (Gilbertson & Ryvarden 1986) or can only refer to that species (Overholts 1967).

The coloured illustration of Imazeki and Hongo (1971) from Japan agrees fairly well with *B. leucomelaena*, although the stipe is paler than what we have been used to, and a central depression is seldom seen in the cap of the Nordic material. The description in that book seems to include elements of both *B. leucomelaena* and *B. grisea*. The common Japanese names fit better with the former species: *kurotake* (black mushroom), *kurokawa* (black skin); the name *rouji* (old man) may also be more appropriate for *B. leucomelaena*, though this is perhaps a matter of opinion. In the U.S.A. *kurotake* has been applied to both *B. leucomelaena* (Lincoff 1981, McKenny & Stuntz 1987) and *B. grisea* (Tylutki 1987).

Nomenclature of *B. leucomelaena*

Besides the confusion in distinguishing *B. leucomelaena* from *B. grisea*, the name of the former has changed many times and the present practice is still unsettled.

In our opinion the species has no name sanctioned at the specific level by Fries (1821). This means that according to the present Code (Greuter et al. 1988) names validly published before 1821 must also be considered.

It appears (Donk 1974) that *Fungus porcinius* Paulet is the oldest available name. However, we wish to refrain from making a new combination until a good type specimen has been selected for it, and to leave the field open to other mycologists.

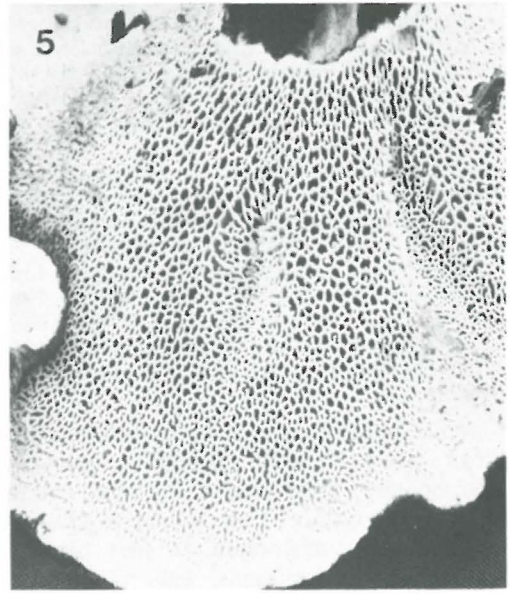
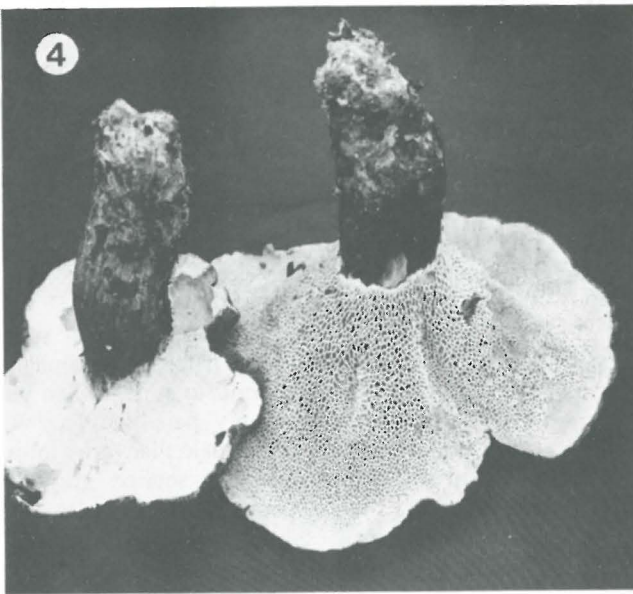
The old specific name *leucomelas* (fem.: *leucomelaena*) of Persoon (1801) was sanctioned by Fries

(1821) at the varietal level only. The epithet itself and the protologue support the present concept, and the type specimen, albeit in poor condition, is identifiable accordingly. After lengthy discussions with Dr. R.A. Maas Geesteranus (Leiden) and Dr. Pekka Isoviita (Helsinki), we decided to select the specimen as a lectotype. In the description Persoon indicated the type locality as 'Hercynia', i.e. the Harz Mts. in Germany. He is known to have lived in Göttingen (now in the Federal Republic of Germany) in 1787–1802, though he spent the rest of his life in Paris. Therefore it is highly probable that he had this specimen by him when writing the description, and there is no reason to suspect that it was later discarded and replaced with a newer 'Hercynian' specimen. As pointed out by Dr. Maas Geesteranus (in litt.), the specimens of Persoon are sometimes too readily assumed to be holotypes or lectotypes. It was common practice to substitute new better specimens for the old ones, without any written indication on the sheet.

Polyporus subsquamosus L.: Fr. is the name which has brought about most of the present nomenclatural confusion. As *Boletopsis subsquamosa* (L.: Fr.) Kotl. & Pouz. it has been widely used to cover the present species complex, and even appears in some of the newest floras (Gilbertson & Ryvarden 1986). Donk (1969) strongly urged that name be abandoned in this context, demonstrating, step by step, that the sanctioning description (Fries 1821) and its retrogressive references can only mean some species in the *Scutigera ovinus* (Schaeff.: Fr.) Murr. complex. After carefully checking his arguments, we are of the same opinion.

The colours given by Fries (1821: *Polyporus subsquamosus*) rule out *Boletopsis*, but fit well with *Scutigera ovinus* or some species closely related to it: *pileo ... lento albido, poris ... niveis*. *S. ovinus* and its relatives lack grey tones in their caps, tubes and flesh, but the stipe surface (at least in *S. subrubescens* Murr.) often exhibits faintly grey or pinkish grey flecks, which can be extensive. This explains Fries's wording: *stipes ... albidus l. cinerascens* (white or becoming grey), which emphasizes that a grey tone can be present in the stipe only. This combination of colour terms could not have been selected for any *Boletopsis*, young or old.

Of the references made by Fries (1821) to the older literature, the mention of Linnaeus (1755, species number 1250) deserves special attention, because Fries's description closely follows that of Linnaeus, by whom the name *subsquamosus* was given. Linnaeus's protologue describes the pileus as *albido-flavescens* (white — becoming yellow), which even more clearly rules out *Boletopsis*. No greyish tones



Figs. 3–5. *Boletopsis leucomelaena*. — 3: Fruit bodies, photographed in situ, $\times 0.9$. — 4: Young and adult fruit body, $\times 1.3$. — 5: Detail of the latter, $\times 1.7$ (Finland, Uusimaa: Sipoo, 31.VIII.1986 Niemelä 3551 & Saarenoksa, H).

are mentioned. Donk (1969, 1974) has checked and discussed the other references in the treatment of Fries (1821), showing that they, too, support the connection with *Scutigera*. For instance, *Boletus carinthiacus* Pers. (Persoon 1801: 514), indicated to be conspecific with *P. subsquamosus* by Fries (1821), has *substantia nivea, corticis flavissima!*

Besides *Scutigera ovinus*, there are other pale-coloured species in that genus. Their morphological characteristics and nomenclature have not yet been well defined, and many *Scutigera*s are 'subsquamose' when old and if they have grown up during dry weather. In *Boletopsis*, a 'subsquamose' pileus is clearly found in old *B. grisea* (which is then distinctly grey-brown), and less clearly in *B. leucomelaena* (almost black in the squamulose stage). The widely used misconception of *P. subsquamosus* can be traced to certain later papers and illustrations (especially Fries 1860–1866). These, of course, may not be used to alter the original typification, which must rely solely on the protologue and sanctioning treatment.

Could *Polyporus subsquamosus* be the old name for *Scutigera subrubescens*?

Boletopsis grisea

Polyporus griseus Peck, New York State Mus. Nat. Hist. Ann. Rep. 26:68, 1874. Holotype: "*Polyporus griseus* Pk. Copake, Columbia Co., C.H. Peck" (NYS, marked as 'type' in the box). The specimen was accepted as a holotype according to the proposal of Petersen (1980: 6). Usually this kind of undated collection would deserve the status of a lectotype or a neotype only. — *Boletopsis grisea* (Peck) Bond. & Singer, Ann. Mycologici 39:47, 1941.

Polyporus subsquamosus L.: Fr. (var.) β *repandus* Fries, Systema mycologicum 1:346, 1821. Type: not designated, no original collections found. — *Polyporus repandus* (Fr.) Karst., Medd. Soc. Fauna Fl. Fennica 5:37, 1879 ('1880').

Polyporus earlei Underwood, Bull. Torrey Bot. Club 24:84, 1897. Type: "Pine woods, Auburn, Alabama, Nov. 1896. Prof. F.S. Earle", not located in NY. Overholts (1967) refers to original collections. The description of Underwood (1897) is good and favours synonymy with *B. grisea* rather than with *B. leucomelaena*.

Shape and general characters. Fruit body annual, pileate, terrestrial, with a central or rarely eccentric stipe, solitary, gregarious or less often in tight clusters of two or three. Cap circular if growing free, (4–)7–13(–17) cm in diam, at first hemispherical with down-rolled margins, later plano-convex or with depressed centre. Initial development occurring under and within the soil debris, and lateral expansion being more rapid than the upward growth, so that emerging caps push litter and lichens aside when

evolving to their final size. Fresh cap and stipe radially soft-fibrous, and the fruit body can be split into two halves by tearing from the cap margin. Stipe cylindrical, bulbous or rarely tapering, 2–4(–6) cm long, 1.2–2(–3.5) cm in diam; fresh fruit bodies 4–7 cm tall. Specimens dry slowly, and discolour, disintegrate and harden if not properly dried, and in such cases the tubes become filled with secondary mycelium. Spot of KOH in fresh specimen faint greenish, in dry specimen black-brown in all parts. No distinct odour; taste mild but not palatable; dried fruit bodies odourless, gradually developing a bitter taste.

Surface. Upper surface initially smooth, glabrous, viscid especially at the margins, azonate, evenly grey-white to silvery grey, or more grey-brown at the exposed centre. Adult cap surface pellicular, extensively grey-brown but paler outwards, margins with brown radial streaks caused by scraping of litter particles during cap expansion; knife-cut-resembling, deep, radial slits common, such fissures white with a grey tint. Central areas of old fruit bodies with mosaic-like cracking or small squamules. Properly dried cap pale grey or light grey-brown, with silky or straw-like sheen, wrinkled with low, almond-shaped warts. Pore surface first white to cream, attaining a silver-grey tone inside the tubes, changing to pinkish grey-brown where bruised (visible also in dry specimens); after drying sordid white to grey and sometimes with a greenish tint. Pores in young fruit bodies round to angular, 3–4 per mm; in old ones angular to radially split, 2–3 per mm, walls fairly thin, mouths even and ciliate (under lens, $\times 50$); tubes somewhat decurrent, demarcation from the stipe indistinct. Stipe pale silvery grey or brownish or pinkish grey, with a slight sheen, having grey-white or rarely pale ochre mycelium at the base in between the attached sand particles; surface of old stipe splitting into upward-projecting scales and deep cracks. Dry stipe pale brownish grey, with a silky sheen, shrunken with longitudinal grooves.

Section. Cap context homogeneous but splitting radially, firm fleshy, at most patchily hygrophanous, 1–3 cm thick at attachment to stipe, when young white and changing to evenly pale lilac-grey when cut or broken, in adult caps pale lilac-grey throughout. Tubes 1–3 mm deep, in section grey-white. Stipe context homogeneous and firm, distinctly fibrous (when fresh splitting easily longitudinally), solid, pale lilac-grey. Dry context in properly dried, cut specimens homogeneous, light brownish grey, in best specimens with an ochraceous orange tint in the stipe; context light grey if broken when dry, in slowly dried and old fruit bodies blackened and with

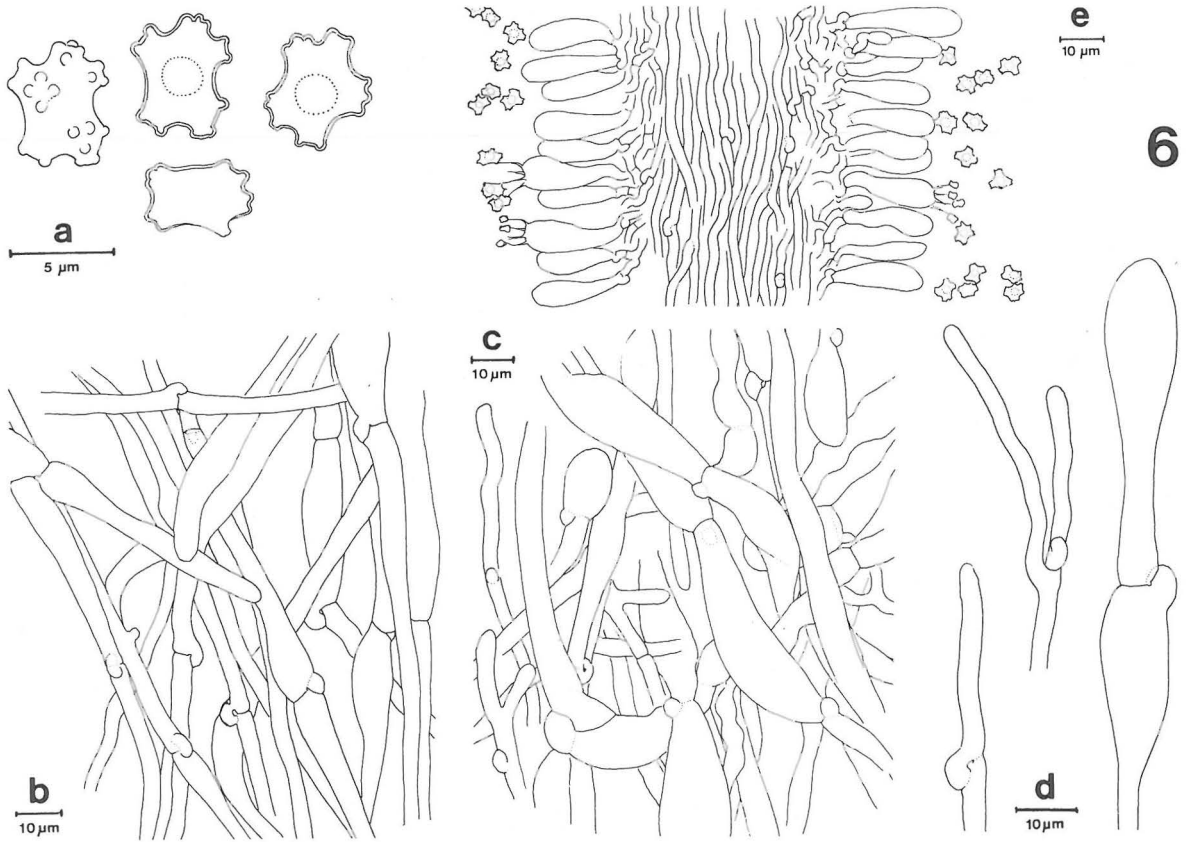


Fig. 6a–e. Anatomical details of *Boletopsis grisea*. — a: Spores in surface view and optical section. — b: Hyphae of the cap tomentum in a section along the surface. — c: Stipe tomentum in a section along the surface. — d: Hyphal apices in the stipe tomentum. — e: Dissepiment in vertical section. Drawn in CB (Sweden, Lule Lappmark: Jokkmokk, 26.VIII.1988 Kuoljok 4 & Karström, H).

hard, glassy, black layers especially next to the surface.

Microscopy. Hyphal system monomitic, hyphae hyaline or nearly so, thin-walled, with clamp connections, IKI–, CRB–, weakly CB+, wall thickness unchanged in KOH. Hyphae of the cap tomentum hyaline or with a faint olivaceous tint (especially in KOH), straight and often in bundles, loosely intermixed in a polygonal pattern, basically 4–7(–9) µm in diam, sometimes swollen next to the clamp connections to 8–11(–16) µm in diam, but hyphal tips only slightly swollen and not easily found. Cortical layer distinct, hyphae basically (2.5–)4–7(–9) µm in diam, commonly gradually swollen to 8–12(–15) µm

in diam, forming a tight texture with a predominantly radial orientation and hyphal bundles; in KOH faintly yellow. Gloeoplerous hyphae common especially in and under the cortex, yellow in IKI and KOH, blue in CB, 4–10(–17) µm in diam. Context hyphae inflated into a homogeneous network, radially oriented but often collapsed and difficult to study. Stipe tomentum with straight or flexuous hyphae, basically (2–)4–5(–7) µm in diam, with hyaline (KOH faint olivaceous) and thin walls and few branches, swollen terminally and less often next to the clamp connections to (8–)11–13(–15) µm in diam, swellings club-shaped, ellipsoid or vesicular, sometimes repetitive. Stipe context hyphae inflated, parallel, fairly tightly

packed and often in bundles; in KOH yellowish. Tube tramal hyphae of even thickness, 2–3.1 µm in diam, tightly packed, subparallel in an undulating manner, unstained in KOH. Hyphal tips at dissepiment edges 3 µm in diam, undifferentiated, ciliate. Subhymenium indistinct. Basidia clavate, 16–20(–25) × 6–7 µm, mostly with four sterigmata 2–3.5 µm long; basidioles similar but smaller, both with basal clamp connections. No cystidia. Spores (4.2–)5–6(–6.5) × (3.2–)3.9–4.5(–5.1) µm, tubercular, slightly flattened dorsiventrally, thin-walled (0.2–0.3 µm), hyaline (in mass yellow-brownish), mostly with a single, distinct (especially in CB) guttule, IKI–, CB+. Apiculus prominent, oblique, arising from the flattened side, but in microscope not easily found among the tubercles.

Ecology and phenology

Boletopsis grisea is a fungus of poor habitats. It is found almost exclusively in dry pine forests, in South and Central Finland in the *Calluna* (CT) and *Vaccinium vitis-idaea* type (VT), and in the north in their equivalents (Kalliola 1973).

The *Calluna* type (CT) consists of pure pine forests on sandy soils. Dwarf shrubs (*Calluna vulgaris*, *Vaccinium vitis-idaea*, *V. myrtillus*, in the north also *Empetrum nigrum* and *E. hermaphroditum*) occur in patches. Grasses (e.g., *Calamagrostis epigejos*) and herbs (e.g., *Melampyrum pratense*) are very few and scanty. Drought-tolerant mosses (*Pleurozium schreberi*, *Dicranum polysetum*) are intermixed with abundant lichens (especially species of *Cladina* and *Cladonia*).

The *Vaccinium vitis-idaea* type (VT) is characterized by pine, though weakly growing spruce and birch also occur. *Vaccinium vitis-idaea* is the dominant dwarf shrub, but many other species are also found to a lesser extent. Xeromorphic grasses are slightly commoner than in the *Calluna* type. Most of the ground is covered by *Pleurozium schreberi* and *Dicranum polysetum*; lichens occur mainly around the trees and on the hummocks and old stumps.

Tarja and Pertti Renvall (Helsinki) could give us a more detailed description of the occurrence of *B. grisea* in the pine forests of the Värriö National Park, northeastern Finland. In 1988 the species was abundant in the moderately dry forests of the northern *Vaccinium uliginosum*–*V. vitis-idaea* site type (UVT), but no specimens were seen in the *Cladina* site type (CIT), which consists of the pine forests of the driest and poorest soils. Also, no records were obtained from the *Empetrum*–*Vaccinium myrtillus* site type (EMT), which is a moister, richer kind of

pine forest than the above two, being a northern counterpart of the VT type in southern Finland.

All these forest types occur on poor, rapidly drying podsol soils with a thin raw humus layer, developed on sandy alluvial deposits. The sites are well-illuminated and exposed because of the sparsely branched tree layer and the scantiness of the shrubs and lower vegetation. The microclimate is consequently very variable, and periods of hard drought are common.

Herb. H contains one collection (Kytövuori 79903) from southern Finland, made in a *Pinus contorta* plantation. The lodgepole pine stand is in an arboretum, established on a dry heath, formerly wooded with *Pinus sylvestris*.

Being dependent on the weather, the emergence of the fruit bodies is very unpredictable, and the species may remain invisible for many years. In this respect it resembles many hydneaceous fungi, e.g., *Sarcodon imbricatus* (L.: Fr.) Karst., *Bankera fuliginosa* (Schmidt: Fr.) Pouz., *Hydnellum ferrugineum* (Fr.: Fr.) Karst., *H. ferrugipes* Coker and *H. aurantiacum* (Batsch: Fr.) Karst., which occur in similar sites. Indeed, their optimal fruiting years generally coincide.

In Scandinavia and Finland the main fruiting period begins during the third week of August and ends in early October. The season of this species is somewhat shorter and more concentrated than that of *B. leucomelaena*.

Distribution

Distribution in Fennoscandia:

Norway. *Østfold*: Idd (1 specimen: herb, OSLO). Rakkestad (1: OSLO). *Akershus og Oslo*: Bærum (1: OSLO). Oppegård (1: OSLO). *Oppland*: Vestre Gausdal (1: OSLO). *Buskerud*: Nore (1: OSLO). Rollag (1: OSLO). *Vestfold*: Sande (1: OSLO). *Hordaland*: Voss (1: BG). *Finmark*: Sør-Varangen (1: TUR).

Sweden. *Småland*: Femsjö (3: S, UPS). *Västergötland*: Hemsjö (1: GB). *Värmland*: Nyed (1: UPS). *Södermanland*: Nacka (1: S). Salem (1: S). Stockholm (1: S). *Uppland*: Fasterna (1: S). Kalmar (1: S). Östra Ryd (2: S, UPS). *Västmanland*: Viker (1: S). *Dalarna*: Grandgårde (1: UPS). *Hälsingland*: Bollnäs (1: UPS). Norrbo (1: S). *Jämtland*: Mörsil (1: S). *Västerbotten*: Jörn (2: S). *Norrbotten*: Övertorneå (3: UPS). *Lule Lappmark*: Jokkmokk (4 specim. + ca. 50 pers. comm.).

Finland. *Varsinais-Suomi*: Kiikala (1: H). Vihti (1: H). *Uusimaa*: Nurmijärvi (1: H). Tammisaari (2: H, OULU). Tuusula (7: H, HFR). *Etelä-Karjala*: Miehikkälä (1: H). *Satakunta*: Harjavalta (1: HFR). Kankaanpää (3: H, H-LA, TUR). Oripää (1: TUR). Siikainen (3: H, H-LA, TUR). *Etelä-Häme*: Hämeenlinna (2: H). Lammi (4: H, T.N.). Tammela (3: H, UPS). *Etelä-Savo*: Kerimäki (1: H). Luumäki (2: H). Kalajärvi (1:



Figs. 7–9. *Boletopsis grisea*. — 7: Fruit bodies, photographed in situ, $\times 0.8$. — 8: Young fruit bodies with silvery colour and fissures, $\times 0.7$. — 9: Old, exposed, darkened caps with mosaic-like cracks, $\times 0.6$ (7 & 9: Finland, Pohjois-Pohjanmaa: Pudasjärvi, 10.IX.1970 Niemelä; 8: Finland, Inarin Lappi: Inari, Lemmenjoki Nat. Park, 3.IX.1980 Niemelä 2250 & Kotiranta, H).

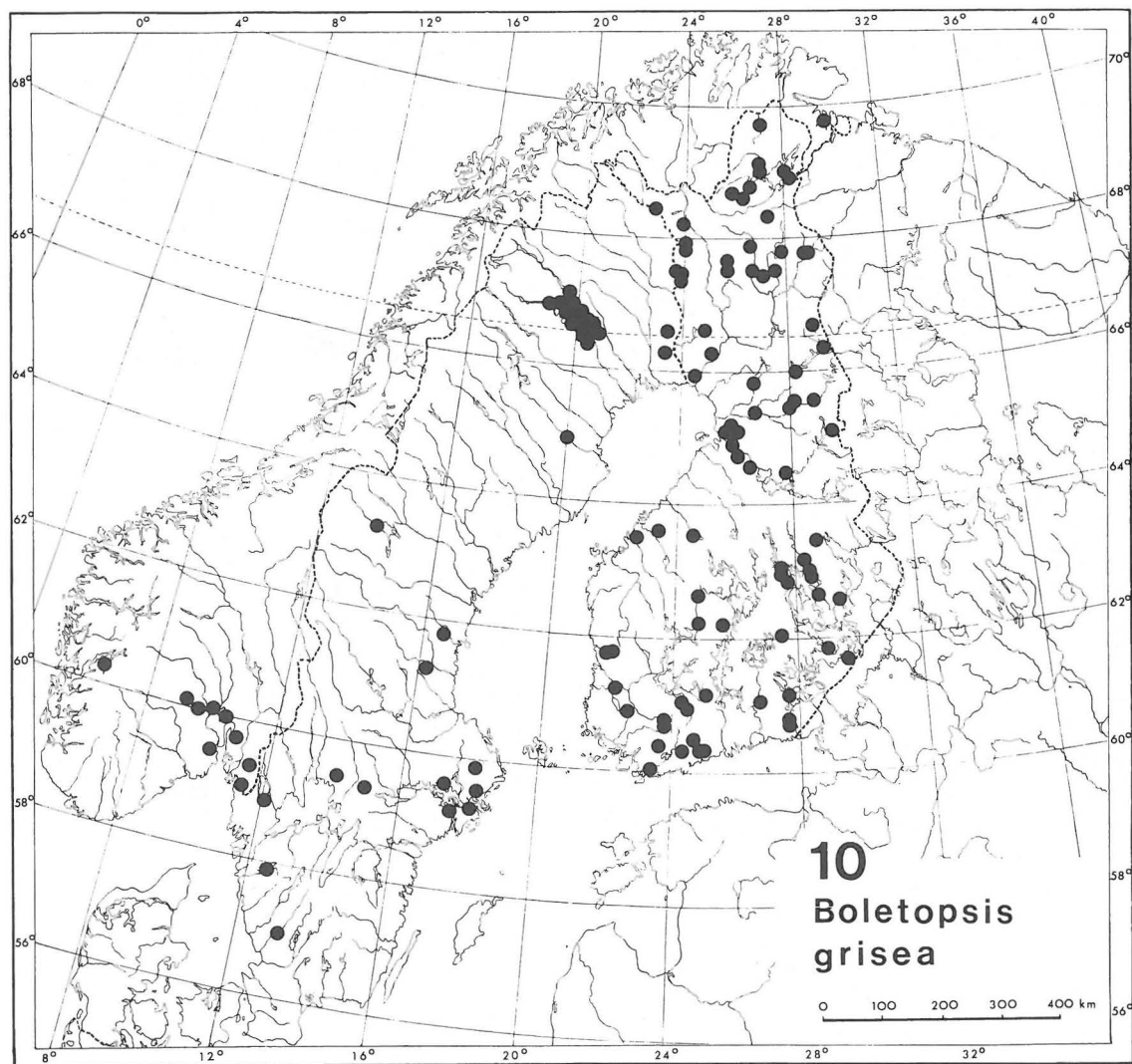


Fig. 10. The distribution of *Boletopsis grisea* in Fennoscandia, based on the specimens examined and on selected personal reports.

H). Savitaipale (1: TUR). Valkeala (1: H). *Pohjois-Häme*: Ähtäri (2: H). Jyväskylä rural comm. (1: H). Keuruu (1: H). *Pohjois-Savo*: Juankoski (2: H, KUO). Kuopio (4: HFR, TUR). Siilinjärvi (2: KUO). Virtasalmi (1: H). *Pohjois-Karjala*: Lipperi (1: pers. comm.). Nurmes (1: H). Outokumpu (1: TUR). Säyneinen (1: H). *Keski-Pohjanmaa*: Alaveteli (1: OULU). Lestijärvi (1: H). Uusikaarlepyy (1: HFR). *Kainuu*: Paltamo (1: H). Suomussalmi (1: H). *Pohjois-Pohjanmaa*: Haukipudas (4: OULU, UPS). Keminmaa (1: H). Kiiminki (4: OULU, KUO). Muhos (4: H, OULU, TUR). Oulu (1: OULU). Pudasjärvi (4: OULU, TUR, H, T.N.). Ranua (1: H). Rovaniemi rural comm. (2: GB, TUR). Utajärvi (1: OULU). Ylikiiminki (1: OULU). Ylitornio (1: H). *Kuusamo*: Kuusamo (15: H, HFR, LD, OULU, TUR). Posio (1: OULU). Salla (1: H). Taivalkoski

(3: KUO, OULU). *Kemin Lappi*: Kittilä (1: H). Kolari (3: H, OULU). Muonio (2: H, H.K.). Savukoski (5: H). Sodankylä (4: H). *Enontekiön Lappi*: Enontekiö (3: H, OULU). *Inarin Lappi*: Inari (11: H, TUR, T.N.). Utsjoki (1: TUR).

The strikingly even distribution of *B. grisea* in Finland casts doubt on the picture in Norway and Sweden, as seen in the adjoining map.

The almost total lack of the species in western coastal Norway suggests a continental distribution pattern, but no differences are to be seen between the continental and oceanic parts of Finland. The Norwegian distribution may rather reflect the availability of

suitable sites. Only a few records were obtained from Sweden. The data of Mr. Mats Karström from Lule Lappmark reveal that the species may even prove to be frequent, at least in northern Sweden, if a look-out is kept for it over a long span of time.

The evenly distributed pattern of dots in Finland actually shows that the species is commoner in the north, because collecting is far less intensive there. Although it has been found all over continental Finland, we have not seen any specimen from Åland or the southwestern archipelago, and Laine (1967) failed to mention it from there. Since the species occurs exclusively in pine forests on sandy soils, its distribution depends greatly on edaphic factors. Suitable areas are found extensively in Finland, due to the sandy eskers and fluvial plains that developed during the last glaciation of the Quaternary period. Dry pine forests are widespread, especially in eastern and northern Finland, and the species has been observed repeatedly in some of the most favourable areas, such as the Lemmenjoki and Oulanka National Parks.

The difficult drying of the succulent fruit bodies may be a reason for the scantiness of the collections. Interviews with several mycologists showed us that the species has been observed much more often than it has been collected.

Most European descriptions of the collective '*B. leucomelaena*' or '*B. subsquamosa*' seem to contain elements of *B. grisea*, and the species may be commoner than *B. leucomelaena* sensu stricto. Kotlaba (1984) mapped almost 30 localities in western Czechoslovakia. In Central and South Europe, *B. grisea* occurs mainly on the mountains, but that may be due to the concentration of most pine forests there, rather than to any climatic preference. Cetto (1987, as *B. subsquamosa*) illustrated the species from Italy, although his photograph is too lilac-tinted, at least in our copy of the book. Govi (1970) published a beautiful picture of the species in Italy. The evident occurrence of *B. grisea* in the West African Canary Islands (Ryvarden 1976) shows the vast climatic flexibility of the species.

As stated before, *B. grisea* is widespread in North America, and the commoner of the two. Tylutki (1987) published a very good and characteristic colour print of this species, displaying young mature fruit bodies with the typical colours and even the grey-brown streaks on the cap margin, caused by the scraping of adjacent debris during growth. The account of Pomerleau (1980, eastern Canada) accords with the present species. Gilbertson and Ryvarden (1986) included a map of the collective species pair; it may well represent the general distribution of *B.*

BOLETOPSIS LEUCOMELAENA

11



B. GRISEA

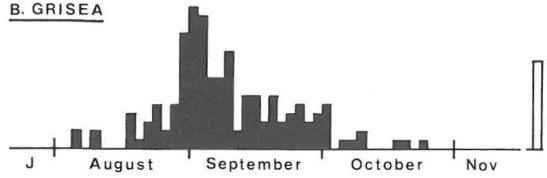
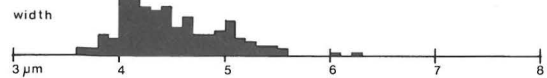


Fig. 11. The collecting periods of *Boletopsis leucomelaena* and *B. grisea*, according to the specimens in the Nordic herbaria. Each column represents a span of two days; the open column (lower right) is a scale representing 10 observations.

BOLETOPSIS LEUCOMELAENA

12



B. GRISEA



Fig. 12. *Boletopsis leucomelaena* and *B. grisea*. Variations in spore lengths and widths. Each graph is based on ca. 160 measurements made on material listed in the text, 5–10 measurements on a single specimen. The spore size differences between the species are marginal, but the size variation is smaller in the latter species, and the spore length in *B. leucomelaena* is much more commonly $\geq 6 \mu\text{m}$.

Table 1. A compilation of some characters differentiating *Boletopsis leucomelaena* and *B. grisea*. Most details have been generalized; for a complete account, see text.

	<i>B. leucomelaena</i>	<i>B. grisea</i>
Fresh characters		
Colours	blackish; contrast strong between upper and pore surface	pale greyish; upper vs. lower surface contrast small
Shape and height/width ratio	upward-growing; about as tall as wide	spreading; tends to be much wider than tall
Cap and stipe context	soft fleshy; easily breaking in all directions	tough fleshy; easily split if torn in radial direction
Dry characters		
Colour of well-dried fruit bodies	dark greenish grey or almost black	grey-white or pale brownish grey
Consistency	uniformly fragile; cap margins mostly broken in herbarium specimens	fairly tough; often with hard layer above the tubes; cap margins sturdy
Microscopy		
Cap tomentum	hyphal swellings pear-shaped, mostly terminal	swellings spindle-shaped, mostly intercalary
Cortical layer of cap under tomentum	indistinct; loose mesh of hyphae	compact layer of parallel hyphae
Stipe tomentum	finger-like, tortuous hyphal ends, 6–7 µm in diam.	thin-walled hyphae with swellings 11–13 µm in diam.
Mounts in IKI and especially in KOH	tomentum sections releasing olive–green pigment (variable)	only pale colour seen in tomentum sections
General		
Typical habitat	grassy spruce forest, on mull or raw humus soil	dry pine heath, on sandy soil
Distribution in Fennoscandia	southerly, mainly Hemiboreal to Southern Boreal	widespread, slight northern preference

grisea in North America. It shows a bipolar pattern, in which the East Coast and West Coast areas are separated by a wide empty belt formed by the inland states.

The coloured illustration by Kawamura (1965) from Japan (*kurokawa*, '*Polyporus leucomelas*') shows a group of young pale gray fruit bodies.

Discussion

Boletopsis leucomelaena and *B. grisea* resemble each other in very many respects. For instance, their spores are roughly similar, as seen in Fig. 11. The slight difference in the spore lengths is obscured by the tubercular surface and polygonal shape of the spores. Such irregularities lead to deviation in the measurements, if the spores are viewed from different angles. In *B. grisea* the saddles between the tubercles tend to be deeper than in *B. leucomelaena*, and so the spore profile has more the shape of an animal's hide (*toison* in French) in the former species, while being lumpier in the latter. This difference, too, is only a general trend.

The fruiting periods of the species roughly coincide (Fig. 12). That of *B. grisea* is somewhat shorter, evidently because the pine woodlands give less protection than the dense and shady groves of spruce.

Despite their similarities, there are also clear differences. The distribution patterns are quite unlike, and so are the ecological preferences. The adjoining

Table 1 should help in the identification of the two species of *Boletopsis*, and also in preparing keys for fungal floras.

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