

## NOTES ON HYGROPHORUS—III

### The group of *Hygrophorus olivaceoalbus* (*Hygrophorus* subsect. *Olivaceoumrini* Bat.) in north-western Europe

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A taxonomical and nomenclatural revision is given of *Hygrophorus* subsect. *Olivaceoumrini* Bat., as found in western and central Europe, and represented by four species. Extensive descriptions and a key to these species are presented. For nomenclatural reasons one new species is described, viz. *Hygrophorus persoonii*, identical with *H. dichrous* Kühn. & Romagn. (invalidly published) and *H. limacinus* in the concept of some authors. Neotypes are designated for *H. latitabundus* Britz. and *H. olivaceoalbus* (Fr. ex Fr.) Fr. Special attention is paid to the ecology and geographical distribution of the concerning species in the Netherlands and Belgium.

Subsection *Olivaceoumrini* Bat. seems to be a relatively natural and rather well distinguishable unit within the genus *Hygrophorus*. It comprises species with olivaceous or brownish caps, having a strongly viscid stem due to the presence of a glutinous veil (Singer, 1975: 200).

While preparing the section on *Hygrophorus* for the Checklist of Agaricales in the Netherlands, I came across the fungus at present generally known as *H. dichrous* Kühn. & Romagn. This name has not been validly published, as noted previously by several authors (see p. 371). To solve the risen nomenclatural and taxonomical questions it has been useful to investigate exsiccata from other countries with emphasis on Belgium.

The very confused situation in this species-complex can be demonstrated by the fact that, from the 14 collections labelled as *H. olivaceoalbus* in Belgian herbaria, five appeared to belong to *H. persoonii* (syn. *H. dichrous* sensu Kühn. & Romagn.) and two to *H. latitabundus* (syn. *H. fuscoalbus* sensu Ricken). Most exsiccata labelled as *H. fuscoalbus* have been identified by me as *H. persoonii*. Yet the species in this group can be distinguished fairly well, mostly even in exsiccata without annotations. Misidentifications are due to the neglect of some microscopic characters, particularly pigmentation of the pileipellis, and especially to the emphasis in keys on

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some macroscopic properties of the stem, namely the absence or presence of brownish belts and spots. In general the clarity of these belts decreases according to the series *H. olivaceoalbus*, *H. persoonii*, *H. latitabundus*, *H. mesotephrus*. However this character depends also largely on the age of the carpophores and weather conditions. Within one group of carpophores of *H. persoonii* I found young specimens with evenly pale ochre stems and mature ones with more or less pronounced olive-brown belts and spots alternating with yellowish parts. The belts become far more distinct on drying out, but usually become almost indistinguishable again in exsiccata. In the same way the stem in moist carpophores of *H. latitabundus* is predominantly white, mostly showing rather few small brownish fibrillose spots. When dry the stem shows distinct grey-brown belts, and sometimes it is almost completely coloured. This phenomenon can be explained by the strong shrinkage of the glutinous layer during the process of drying, which causes the loosely arranged pigmented hyphae to aggregate into a predominantly longitudinal direction.

Bresinsky & Huber (1967) have published a key to the exsiccata of *Hygrophorus sensu stricto*. Within *Hygrophorus* sect. *Colorati*, *H. olivaceoalbus* and *H. dichrous* (syn. *H. persoonii*) are distinguished from the other species (among others *H. fuscoalbus*, syn. *H. latitabundus*) on account of their thick pileipellis (180–300  $\mu\text{m}$  thick, in the remaining species less than 180  $\mu\text{m}$ ) and the presence of brown spots and belts on the stem. As noted above the pattern on the stem gradually disappears in exsiccata and is often completely invisible after a few years. Moreover *H. latitabundus* can show darker spots in dried specimens. In my opinion neither the thickness of the pileipellis is a good character. The degree to which this ixotrichodermal tissue can be revived, is completely dependent on the methods used for drying. I found the following variation: *H. olivaceoalbus* 150–530  $\mu\text{m}$ ; *H. persoonii* 200–800(–1300)  $\mu\text{m}$ , and *H. latitabundus* 300–850(–1000)  $\mu\text{m}$ . Nevertheless, I think that exsiccata of these species can in most cases be clearly distinguished, employing some of the same characters as used to distinguish fresh fruitbodies. However, I did not find a reliable means of distinguishing small specimens of *H. persoonii* from *H. mesotephrus*, a species not being included in the key of Bresinsky & Huber (l.c.).

It appears that *H. mesotephrus* is the only species of this group of which original material has been preserved (see p. 376). To achieve a clear and reproducible concept of the other species under consideration I have designated neotypes for *H. latitabundus* and *H. olivaceoalbus*, which are responding to the original descriptions and collected in the regions, in which the species were originally recorded. These neotypes can be especially useful for comparison with species from other continents, e.g. the North American taxa described by Hesler & Smith (1963). In addition new characters may be tested in the future. It responds to the plea made recently among others by Smith (1977: 150).

Next to the morphological characters, special attention has been paid to ecological data and the geographical distribution of the species in the Netherlands and Belgium. On account of the frequent misidentifications in this group I have only indicated those observations on the maps, which are supported by revised collections in an official Herbarium. Hence, the maps do not give a complete picture but, before a sufficient number of collections have been studied, the patterns are probably representative. For the Netherlands I have accepted the 5  $\times$  5 km grid used for the mapping of phanerogams (Mennema & al., 1979). For Belgium I followed the 'Atlas de la Flore Belge et Luxembourgeoise' (van Rompaey & Delvosalle, 1972), where squares of 4  $\times$  4 km have been used as basal units.

## PRESENTATION OF DATA

The macroscopic characters in the descriptions are based on the rather few collections studied in fresh condition by the author or on exsiccata provided with extensive original annotations. The microscopic characters come from all exsiccata listed after the descriptions. Characters observed in exsiccata are designated with the abbreviation 'exs.'

The colour codes mentioned are according to Kornerup & Wanscher (1967). For the use of some other terms and abbreviations the reader is referred to 'Notes on *Hygrophorus*—I' (Arnolds, 1975).

## ACKNOWLEDGMENTS

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KEY TO THE SPECIES OF HYGROPHORUS SUBSECT.  
OLIVACEOUMBRINI IN NORTH-WESTERN EUROPE

- 1a. Spores (9-)10-16(-18) × (6-)6.5-9 μm, on the average 11.5-14.1 × 7.4-8.6 μm. Basidia 61-81 × (9.5-) 10-14(-14.5) μm, on the average 64-78 × 10.5-13.6 μm. Hyphae of pileipellis almost exclusively with intracellular pigment, smooth or occasionally very slightly roughened, without extracellular granules, not becoming blue in alkaline solutions. Stem 4-10 mm thick (exs.: 2.5-9 mm), slenderly cylindrical, with distinct dark belts, apex smooth or pubescent. Associated with conifers on acid soil  
*H. olivaceoalbus*, p. 376
- b. Spores (7.5-)8-12(-13.5) × (4.5-)5-7.5(-8.5) μm, on the average 9.0-10.6 × 5.5-6.8 μm. Basidia (40-)45-71(-80) × 7-11.5(-13) μm, on the average 51-64(-70) × 8-10.5 μm. Hyphae of pileipellis with intracellular pigment, but at least in part rough by encrusting pigment and often with extracellular granules, sometimes becoming blue in alkaline solutions. If stem slenderly cylindrical, then associated with deciduous trees; if associated with conifers then growing on calcareous soil, and stem 10-38 mm thick (exs.: (7-)8-22 mm), fusiform or ventricose. Apex of stem with small whitish pustules, usually turning orange-brown in exsiccata. . . . . 2
- 2a. Cap 20-40 mm broad, pale brownish to beige with dark brown centre. Stem slender, 45-65 × 3.5-6.5 mm, in all conditions white or pale brownish without darker belts. Pileipellis with rather faintly encrusting pigment; extracellular granules absent or scarce, never becoming blue in alkaline solutions. Associated with deciduous trees . . . . . *H. mesotephrus*, p. 374
- b. Cap (27-)30-100 mm broad, rather dark olivaceous to greyish brown with very dark centre. Stem cylindrical to ventricose, (4.5-)6-38 mm thick, mostly with olive to grey-brown belts, at least on drying; if no distinct belts present, then with a very stout stem (10-38 mm thick) and associated with conifers. Encrusting and extracellular pigment in pileipellis often blue in alkaline solutions. . . . . 3
- 3a. Cap 50-100 mm broad (exs.: (27-)35-80 mm), brown to grey brown, with at most weak olivaceous tinge. Stem 10-38 mm thick (exs.: (7-)8-22 mm), ventricose or fusiform, when moist almost completely white or with more or less pronounced greyish brown spots, turning more distinct and darker on drying. Flesh compact and firm, in centre of cap c. 10-25 mm thick, white. Gills white to pale pinkish cream. Extracellular pigment in pileipellis not blue in alkaline solutions. Associated with conifers  
*H. latitabundus*, p. 360

- 3b. Cap (27–)30–70(–85) mm broad (exs.: 20–60(–70) mm), brown with more or less distinct olivaceous, ochraceous or pinkish tinge, especially towards the margin. Stem (4.5–)6–15(–17) mm thick (exs.: 3.5–9(–12) mm), cylindrical or slightly fusiform, when moist ochraceous or yellowish, usually with darker olivaceous or brown belts and spots, at least in mature carpophores, turning more distinct and darker on drying. Flesh first firm and white, at centre of cap up to 14 mm thick, becoming softer and greenish yellow with age. Gills first white, often becoming greenish yellow with age. Extracellular pigment in pileipellis well developed, often (but not invariably) turning in part dark green-blue in alkaline solutions, usually only at the most superficial hyphae. Associated with deciduous trees . *H. persoonii*, p. 365

HYGROPHORUS LATITABUNDUS BRITZ.—Figs. 1–8

*Hygrophorus latitabundus* Britz. in Bot. Zentbl. 80: 118, pl. 437 f. 14. 1899. — Neotype (design. mihi): R. Gröninger, 4 Oct. 1962, Augsburg (M).

*Hygrophorus olivaceoalbus* f. *obesus* Bres., Fungi trid. 92. 1887.

MISAPPLIED NAMES.—*Limacium fuscoalbum* sensu Ricken, Blätterp.: 13, pl. 5, f. 1. 1915. — *Hygrophorus fuscoalbus* sensu Dennis & al. in Trans. Br. mycol. Soc. 43: 74. 1960; sensu Bresinsky & Stangl in Z. Pilzk. 32: 21. 1966; sensu Bresinsky & Huber in Nova Hedwigia 14: 156, 162. 1967; sensu Arnolds in Coolia 17 (suppl.): 33. 1974; sensu Moser, Kl. KryptogFl. 2 (b/2): 80. 1978; sensu auct. eur. plur.

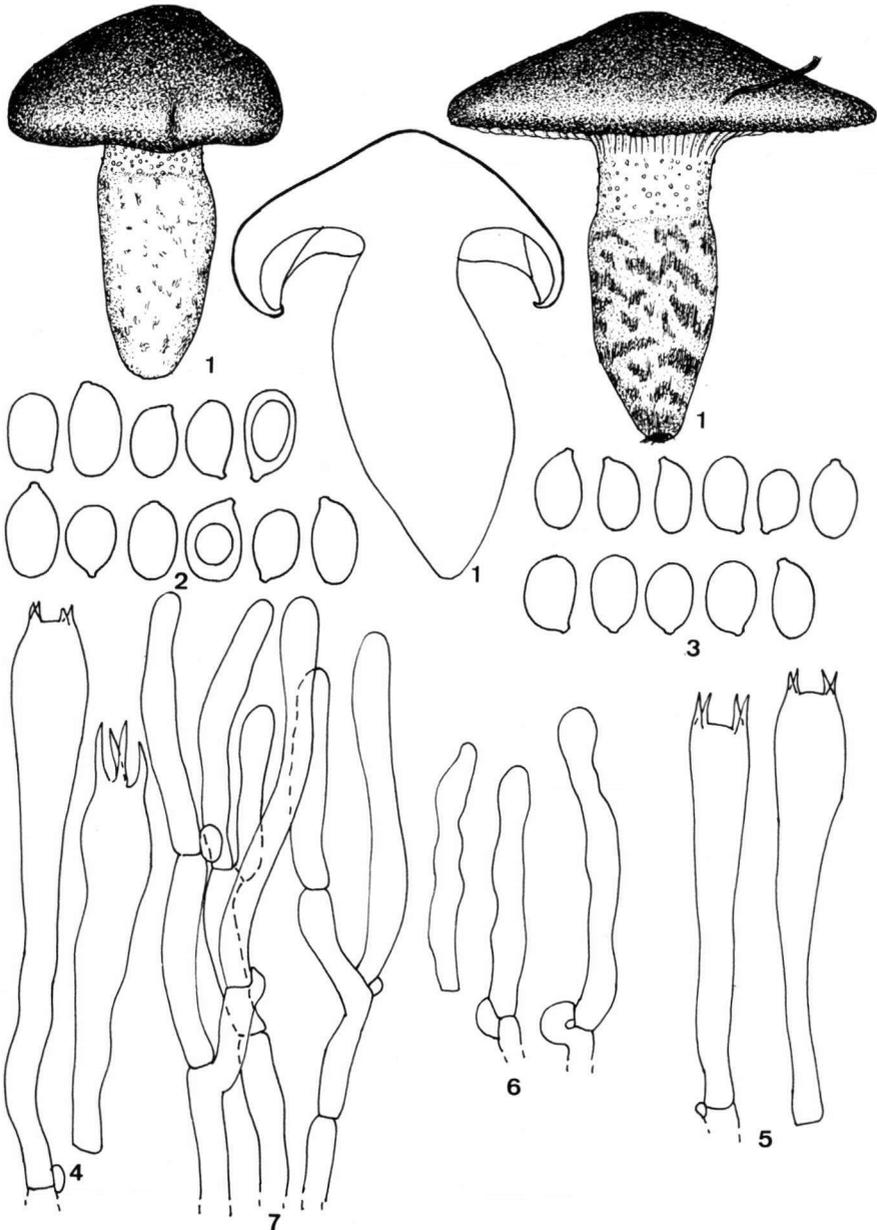
*Hygrophorus limacinus* sensu Kühn. & Romagn., Flore anal.: 60. 1953; sensu Romagn., Nouv. Atl Champ. 4: 259. 1967; sensu Bon, in Docums mycol. 7 (27–28): 39. 1977; sensu Moser, Kl. KryptogFl. 2 (b/2): 80. 1978.

COLOURED ILLUSTRATIONS.—Bresadola, l.c.; Ricken, l.c.; Romagnesi, l.c.; Bull. Soc. mycol. France 85, Atlas 180. 1969; Cetto, I Funghi dal vero 2: 650. 1976.

SELECTED DESCRIPTIONS.—Bresinsky & Stangl, l.c.; Romagnesi, l.c.; Bon, l.c.; Bull. trimest. Soc. mycol. France, l.c.

Cap [14/4] (50–)65–90(–120) mm broad, first semiglobate or obtusely conical with strongly involute margin, then expanded to almost flat with prominent obtuse umbo, not hygrophanous, first rather dark greyish brown (M 5E6, 6E6) or with faint olivaceous tinge (slightly towards 4E6), with dark fuscous centre (M 5F6, 6F6), then slightly paler, near margin to rather light greyish brown (M 5D4), at extreme margin first whitish tomentose, very strongly glutinous, glabrous or very faintly fibrillose below slime layer. Gills [L = 50–70, l = 1–3] broadly adnate to subdecurrent, thick, distant, not ventricose, up to 9 mm broad, white to pale pinkish cream. Stem 50–115 × (11–)14–38 mm, very stout, fusiform or ventricose, often attenuate downwards, first connected with margin of cap by a glutinous hyaline veil, above veil at apex (15–20 mm) dry, white with small white floccose warts, sometimes with hyaline droplets, downwards strongly glutinous with small grey-brown fibrillose spots scattered to rather dense on whitish background, drying with larger and darker spots and transversal bands to almost evenly grey-brown (M 4D4, E5). Flesh in cap up to 25 mm thick, firm, white; in stem also white or slightly yellowish at base. Smell on cutting agreeable, sweetish; taste none. Macrochemical reactions: KOH on apex of stem light yellow with yellow warts; on base of stem and cap orange; in flesh negative or yellow in base of stem.

Spores [100/10/9] (7.8–)8.1–11.5(–13.4) × 4.7–7.7(–8.1) μm, on the average 9.0–10.6 × 5.7–6.7 μm, Q = (1.25–)1.3–1.9(–2.2), ellipsoid to ellipsoid-oblong, not constricted, with large obtuse apiculus (Figs. 2, 3). Basidia [45/9/8] (45–)47–71(–81) × (7.2–)8.0–11.5(–13.0) μm, on the average 53–63(–70) × 8.2–10.5 μm, Q = (4.6–)5.0–7.3(–8.2), slenderly clavate, 4-spored, sometimes a few 2- or 3-spored (Figs. 4, 5); in some carpophores intermixed with scattered cylindrical basidiolae, c. 29–41 × 4–5.5 μm (Fig. 6). Hymenophoral cystidia none. Trama of gills divergent, composed of long chains consisting of short to moderately long, cylindrical or somewhat inflated elements, measuring [35/6/5] 20–125(–192) × 3.8–14.0 μm. Pileipellis a well developed ixotrichodermium,



Figs. 1-7. *Hygrophorus latitabundus*. — 1. Carpophores,  $\times 0.5$ . — 2, 3. Spores,  $\times 1000$ . — 4, 5. Basidia,  $\times 1000$ . — 6. Basidiola,  $\times 1000$ . — 7. Section of warts on apex of stem,  $\times 1000$ . (Figs. 1, 2, 4, 6, 7 from *Arnolds 3878*; Figs. 3, 5 from *Gröniger*, 4 Oct. 1962, neotype.)

up to 1100  $\mu\text{m}$  thick, (in exsiccata reviving variably, mostly to 300–850  $\mu\text{m}$  thick), consisting of irregularly branched erect hyphae, loosely interwoven in the upper part, more compactly downwards, with cylindrical elements 1.5–4.8(–6.0)  $\mu\text{m}$  broad; hyaline or with intracellular dispersed light brown pigment and a variable part of the hyphae with encrusting pigment, also commonly with more or less intercellular granules not changing colour in alkaline solutions (Fig. 8). Stipitepellis an ixotrichodermium like pileipellis but thinner, up to 400  $\mu\text{m}$  thick. Warts at apex of stem consisting of compact fascicles of branched hyphae with cylindrical or slenderly clavate terminal cells, *c.* 38–65  $\times$  4.3–5.8  $\mu\text{m}$ , smooth with greenish intracellular pigment and some intercellular granules (Fig. 7). Stipitetrama regular with rather long cylindrical elements, *c.* 4.5–10.5  $\mu\text{m}$  broad. Clamps numerous in most tissues of the carpophores.

EXSICCATA.—Cap (27–)35–70(–80) mm broad, often with thick involute margin, fleshy, greyish ochre brown to rather dark greyish brown with fuscous to almost black centre, dull or moderately shining, often slightly radially fibrillose. Gills cream to orange- or brownish ochre. Stem (43–)50–90  $\times$  (7–)8–22 mm, fusiform, apical part distinct, cream to ochraceous with many small orange brown to dark brown pustules, downwards mostly ochre brown to light orange brown, darker at base, sometimes with grey brown tinge, mostly almost evenly coloured but in some carpophores with pronounced darker spots and belts.

NOTES ON THE NEOTYPE (*R. Gröniger s.No.*, 4 Oct. 1962, M).—Exsiccata or three halves of rather young carpophores in good condition. Spores [10/1] 8.6–10.5  $\times$  6.2–7.2(–7.5)  $\mu\text{m}$ , ellipsoid (Fig. 3). Basidia [5/1] *c.* 53–69  $\times$  8.6–9.6  $\mu\text{m}$ , slenderly clavate, 4-spored (Fig. 5). Gill trama bilateral with narrow cylindrical elements, *c.* 23–105  $\times$  4.3–6.2  $\mu\text{m}$ . Pileipellis an ixotrichodermium reviving in KOH 5% to up to 850–1100  $\mu\text{m}$  thick; hyphae 1.8–4.8  $\mu\text{m}$  broad, hyaline or with pale olivaceous intracellular pigment, moreover with encrusting pigment and rather numerous extracellular granules, not becoming green blue in alkaline solutions.

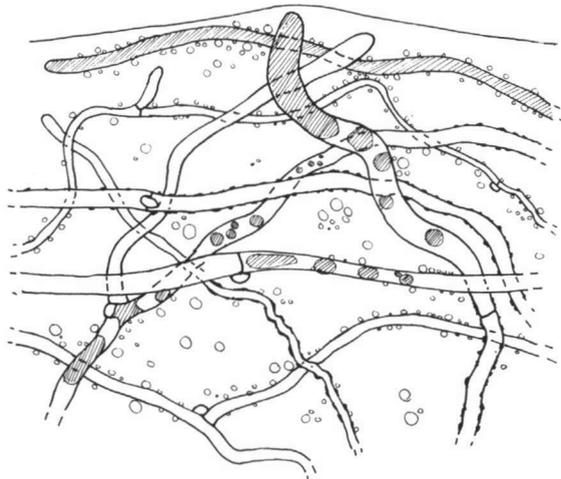


Fig. 8. *Hygrophorus latitabundus*, radial section of pileipellis,  $\times 1000$  (from Arnolds 3878).

ECOLOGY.—*Hygrophorus latitabundus* has been reported by all authors from natural or planted forests of *Pinus* (e.g. Ricken, 1915: 13; Romagnesi, 1967: 259; Bresinsky & Stangl, 1966: 21). From the eleven collections studied, eight were reported from the neighbourhood of *Pinus sylvestris*, but two collections from Belgium are reported to have been found near *Picea*. From one collection (Damblon, 21 Oct. 1952) no details about the habitat are known.

Near Augsburg the species grows in *Pinus* woods with a herb layer dominated by *Molinia* on calcareous soil (Bresinsky & Stangl, 1966: 22). A preference for limestone has also been reported by almost all other authors (e.g. Ricken, l.c.; Romagnesi, l.c.; Bon, 1977: 39). The distribution pattern in Belgium confirms these observations (see below). Probably *H. latitabundus* occurs optimally in open grassy woodland and at wood edges. Near Ave-et-Auffe it has been observed for several years growing in the direct surroundings of one isolated pine at the margin of a dry limestone grassland (*Mesobrometum*) on stony soil with low humus content. This clearly indicates a mycorrhizal relationship with trees (in this case with conifers), as is supposed for all members of *Hygrophorus* sensu stricto (e.g. Singer, 1975: 198), although no direct proof has yet been given. Fructification occurs in western Europe in October and November. In more southern regions carpophores have been observed until December.

DISTRIBUTION.—*Hygrophorus latitabundus* seems to be widespread in the temperate and warm regions of central Europe, especially in hilly and mountainous districts. It has not been reported in Scandinavia and seems to be also absent from the Netherlands. A probable record of *H. fuscoalbus* sensu Ricken from the Netherlands by Arnolds (1974: 33) relates most likely to *H. persoonii* (syn. *H. dichrous* sensu Kühn. & Romagn.).

In Belgium the species has only been observed in the calcareous hills in the southern part of the phytogeographical 'Meuse-district', characterized by the occurrence of numerous calciphytic and thermophytic phanerogams (de Langhe & al., 1973).

COLLECTIONS EXAMINED.—Belgium: prov. Namur: Ave-et-Auffe, Le Roptai, Tiène del Côte, 6 Oct. 1977, E. Arnolds & J. Frencken, Arnolds 3878 (WAG-W); s.loc., 2 Nov. 1975, J. Frencken s.No. (L); Biron S. of Barvaux, 21 Sept. 1952, J. Damblon s.No. (LG); Barvaux, 19 Nov. 1970, P. Heinemann 4962 (BR, GEMBL); between Vierves and Treignes, 9 Nov. 1970, A. Marchal 70.219 (GEMBL).

FRANCE: Provence, Carqueiranne near Toulon, Dec. 1959, A. W. Koopman & A. C. Veth s.No. (L).

GERMANY: Bavaria, Augsburg, Siebentischwald, 4 Oct. 1962, R. Gröninger s.No. (neotype, M); s.loc., s.dat., C. Bas 2791 (L); Augsburg, Hainstetterwald, 3 Oct. 1969, R. Gröninger s.No. (M); s.loc., Oct. 1958, A. Bresinsky s.No. (M).

*Hygrophorus latitabundus* is the most robust representative of *Hygrophorus* subsect. *Oliva-ceoumbri* and can even be distinguished in the field on account of its thick and heavy flesh and its stout stem. Like *H. olivaceoalbus*, it is associated with coniferous trees, but the latter species grows on poor acid soils, whereas *H. latitabundus* seems to be restricted to calcareous soils. As a consequence, these two species occur in different phytogeographical districts in Belgium (Fig. 9). Moreover numerous macroscopic and microscopic characters exist: in *H. olivaceoalbus* the cap is smaller and the stem much more slender without a floccose apex and with distinct darker belts also when moist, the flesh under the pileipellis is usually yellow; spores and basidia are significantly larger (Figs. 33, 34) and encrusting pigment in the pileipellis is lacking.

For the differences between *H. latitabundus* and *H. persoonii* the reader is referred to the key on page 359. These species, too, appear to be well separated in morphological and ecological respects. However completely reliable microscopic differences have not been found, although *H. persoonii* generally possesses more pronounced encrusting pigment and intercellular granules

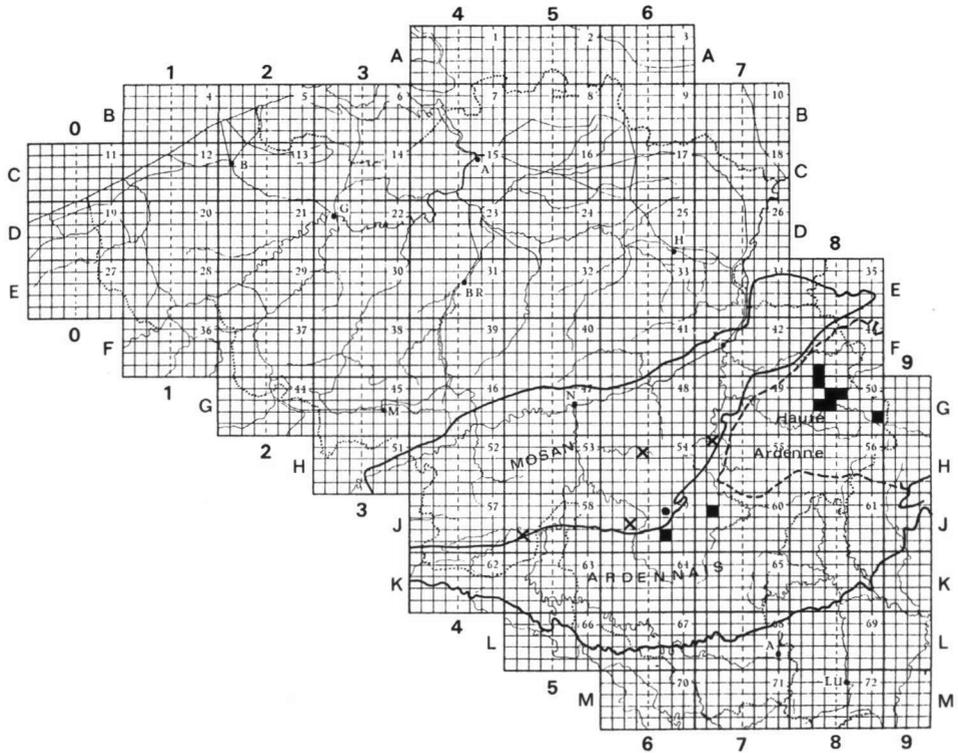


Fig. 9. Geographical distribution of *Hygrophorus latitabundus* (x), *H. mesotephrus* (●) and *H. olivaceoalbus* (■) in Belgium. The relevant phytogeographical districts have been indicated according to de Langhe & al. (1973).

often turning blue in alkaline solutions. Exsiccata without annotations cannot always be distinguished with certainty.

*Hygrophorus latitabundus* is best known in Europe under the name of *Hygrophorus fuscoalbus*, especially since the interpretation of that name given by Ricken (1915). However the original description of *Agaricus fuscoalbus* by Lasch (1829: 520) shows large discrepancies with the species above: it should be a fungus with a stature near *Agaricus olivaceoalbus* with the cap 39–65 mm broad and the stem 52–78 × 6.3–12.6 mm, hence considerably smaller than *H. latitabundus*. Moreover the stem should be not viscid, without spots or belts, but on the contrary white and floccose-squamulose ('*Stipes floccoso-squamulosus, neque maculatus nec viscosus*'). This description suggests a species near *H. agathosmus* (Fr. ex Fr.) Fr. and *H. pustulatus* (Pers. ex Fr.) Fr. in *Hygrophorus* subsect. *Tephroleuci* Bat. A fungus which meets this description is not known to me.

In the 'Flore analytique' Kühner & Romagnesi (1953: 60) have described this species as '*H. limacinus* Fr. ex Scop.' Scopoli (1772: 422) described *Agaricus limacinus* as a slender fungus with

a stature completely different from that of *H. latitabundus*. According to Orton (1960: 258) it might represent *H. mesotephrus* Berk. & Br. Also Fries used the name always for a much more slender species. In my opinion the epithet 'limacinus' has to be rejected as a 'nomen ambiguum et confusum', which will be argued in the discussion on *H. personii* (p. 373).

Kühner & Romagnesi (l.c.) were followed mainly by French authors. Moser (1978: 80) distinguishes *H. limacinus* sensu Romagnesi from *H. fuscoalbus* sensu Ricken mainly on account of the grey brown belts and spots on the stem of the first compared to the white stem in the latter species. Bresinsky & Stangl (1966: 22) have established that in the surroundings of Augsburg the clothing of the stem varied from indistinct to very pronounced belts. I observed in the collection Arnolds 3878, that fresh and moist carpophores had almost completely white stems, but that striking grey brown girdles developed during the process of desiccation. Consequently in my opinion both taxa are synonymous, which coincides with the idea of Bon (1977: 39).

In a publication of Bresinsky & Stangl (1966) dealing with a revision of Britzelmayr's 'Hymenomyceten aus Südbayern' I came across the name *Hygrophorus latitabundus* Britz., which is identical with *H. fuscoalbus* according to these authors. Indeed Britzelmayr's plate (1899: 437, f. 14) shows the characteristic stature of our fungus and his description fits also well. Moreover Bresinsky & Stangl were able to study a collection of this mushroom from the type locality in the Siebentischwald near Augsburg. It seems self-evident to choose this collection, which is in perfect condition, as the neotype of *H. latitabundus*. To my knowledge this is the oldest acceptable name for the fungus described above, although it is not impossible that an older name will be discovered in future.

#### *Hygrophorus personii* Arnolds, *spec. nov.*—Figs. 10–16

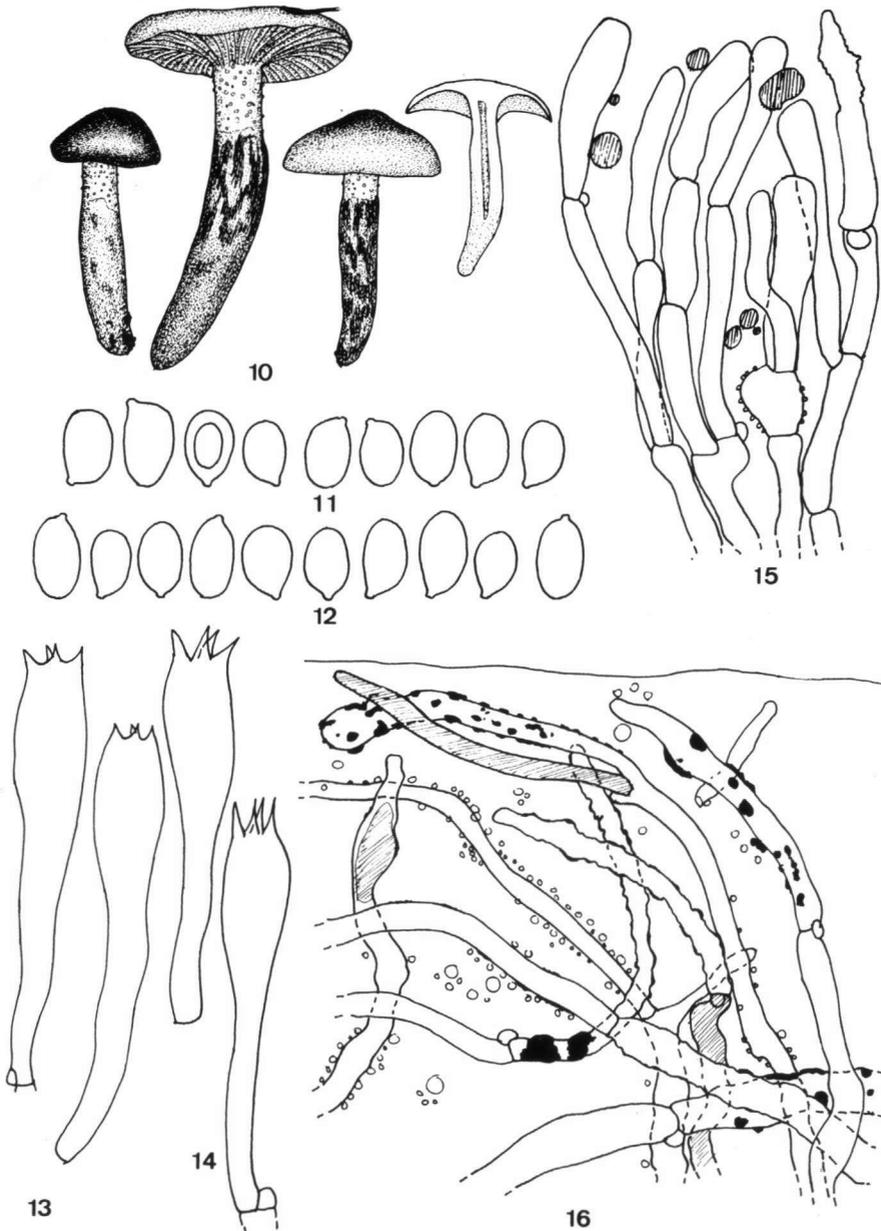
*Agaricus limacinus* Schaeff., *Fung. Bav.* 4 (Index primus): 74. 1774 (pl. 312, 1771); ex Pers., *Mycol. europ.* 2: 94. 1828 [non *Hygrophorus limacinus* (Scop. 1772) ex Fr. 1838 =? *H. mesotephrus*].

*Hygrophorus dichrous* Kühn. & Romagn., *Flore anal.*: 60. 1953 (not validly published); Orton in *Trans. Br. mycol. Soc.* 43: 258. 1960 (n.v.p.); Bresinsky & Huber in *Nova Hedwigia* 14: 156, 162. 1967 (n.v.p.); Malençon & Bertault, *Champ. sup. Maroc* 2: 496. 1975 (n.v.p.); Moser in *Gams, Kl. KryptogFl.* 4. Aufl. 2 (b/2): 80. 1978 (n.v.p.); non *Hygrophorus dichrous* Hongo in *J. Jap. Bot.* 33: 101. 1958 (= species of subgenus *Hygrocybe*).

COLOURED ILLUSTRATIONS.—Cooke, *Ill. Brit. Fungi* 6: 881 (897). 1888; Lange, *Fl. agar. dan.* 5: 162A. 1940; Marchand, *Champ. Nord Midi* 2: 112. 1973.

SELECTED DESCRIPTIONS.—Kühner & Romagnesi, l.c.; *Trans. Br. mycol. Soc.* 43: 258. 1960; Westfäl. Pilzbr. 9: 36. 1972; *Coolia* 17 (suppl.): 31. 1974; Malençon & Bertault, l.c.; *Docums mycol.* 7 (27–28): 39. 1977.

Pileus (27–)30–70(–85) mm latus, primo obtuso-conicus vel semiglobatus margine involutus, dein convexus vel expansus, umbonatus, non hygrophanus, olivaceo- vel griseo-brunneus, margine pallidior ochraceo-brunneus vel isabellinus, glutinosissimus. Lamellae [L=28–52, l=1–7] late adnatae vel subdecurrentes, subdistantes, latae, frequenter intervenosae, primo albae dein pallide virido-luteae. Stipes 43–85(–105) × (4.5–)6–15(–17) mm, aequalis vel subfusiformis, deorsum attenuatus, apice siccus, albus, albo-flocculosus, deorsum velo universali glutinoso, primo ochraceus vel pallide brunneus, mox olivaceo-brunneo-maculatus. Caro in pileo usque ad 12 mm lata, primo compacta, alba, dein mollis, frequenter pallide viridis, odore saporeque indistinctis vel leviter fructio-odoris. Sporae (7.7–)8.0–11.5(–12.0) × (4.3–)4.8–6.7(–7.2) μm, ellipsoideae, ovoideae vel oblongae. Basidia 45–68 × (7.2–)8.0–12.0 μm, vulgo 4-sporigera, raro pro parte minore 2-sporigera. Cystidia nulla. Lamellarum trama divergens, cellulis (29–)33–



Figs. 10–16. *Hygrophorus persoonii*. — 10. Carpophores,  $\times 0.5$ . — 11, 12. Spores,  $\times 1000$ . — 13, 14. Basidia,  $\times 1000$ . — 15. Section of warts on apex of stem,  $\times 1000$ . — 16. Radial section of pileipellis,  $\times 1000$ . (Figs. 10, 11, 13 from *Arnolds 3892*, holotype; Figs. 12, 14, 15 from *Bas 955*; Fig. 16 from *Bas & Swanenburgh de Veije*, 21 Oct. 1954.)

148 × (3.8–)5.4–25 μm. Pileipellis ixotrichodermiformis, 500–1200 μm latus, exsiccata (200–)250–800(–1300) μm, hyphis tenuibus ramosis, (1.5–)2.0–5.8(–8.5) μm latis, cylindricis, pigmento intracelluloso olivaceo cum pigmento incrustante et granulis extracellularibus frequenter pro parte obscure caeruleoviride in NH<sub>4</sub>OH et KOH. Verrucae ad apicem stiptis hyphis compactis, cellulis terminalibus clavatis vel cylindricis, (17–)25–62 × 4.3–7.2 μm. Stiptipellis ixotrichodermiformis ut pileipellis sed tenuior. Fibulae frequentes. Ad terram in silvis deciduis, sub *Quercus*.

HOLOTYPE.—Belgium, Prov. of Namur, Tiène aux Pauquis near Nismes, 10 km S. of Philippeville, 3 Oct 1977, *Arnolds 3892* (L; isotypus WAG-W, BR).

ETYMOLOGY.—Named in honour of C. H. Persoon (1761–1836).

Cap [26/8] (27–)30–70(–85) mm broad, first obtusely conical or semiglobate with involute margin, then convex to expanded with weak to large obtuse umbo, not hygrophanous, first rather dark greyish or olivaceous brown (M 4E7/8, 6E7 or more olivaceous towards 4E7) with dark greyish to blackish brown centre (M 5F7, 6E7/F7, 6F7), then paler especially in marginal zone towards light greyish or olivaceous brown, ochre brown to pale orange ochre, incarnate or isabella (M 6C4, 6D5, 5C4, 5C4/4C4, 5B3, 5B3/4), mostly with olivaceous tinge, centre always much darker, sometimes slightly fibrillose near centre, very strongly glutinous. Gills [L = 28–52, l = 1–7] broadly adnate to shortly decurrent, rather thick, subdistant to distant, often interveined, up to 9 mm broad, first white, discolouring gradually light greenish yellow (M 1A3, 3B3, 3B4, 3B4/C4). Stem 43–85(–105) × (4.5–)6–15(–17) mm, Q = 3.8–8.5, rather firm to rather slender, cylindrical to slightly fusiform, gradually attenuate towards base, at apex (c. 8–15 mm) dry, first white then pale greyish or greenish, with many small white floccose warts, downwards glutinous, first evenly ochraceous to light brown (M 4B4, 4B4/C5, 5C6), gradually more or less breaking up into irregular olivaceous to greyish brown fibrillose bands and spots (M 5D6, 5C5, 5D5 or more olivaceous towards 4D5, C5) on whitish background; this pattern becoming more prominent in dry condition. Flesh in cap up to 12 mm thick, first firm and white, then softer and often with pale greenish tinge, especially below pileipellis; in stem becoming fibrillose, white; smell and taste variable: almost neutral to fruity or disagreeable sweetish, always weak. Spore-print white.

Macrochemical reactions: NH<sub>4</sub>OH on cap negative or exceptionally blue-green (not observed by me, mentioned by Kühner & Romagnesi 1953: 59); KOH 10% on cap yellow brown to orange, on base of stem orange-red.

Spores [115/12/12] (7.7–)8.0–11.5(–12.0) × (4.3–)4.8–6.7(–7.2) μm, on the average per mount 9.1–10.3 × 5.4–6.4 μm, Q = 1.4–1.8(–1.9), ellipsoid or ellipsoid-oblong to ovoid with rather large obtuse apiculus (Figs. 11, 12). Basidia [45/9/9] 45–68 × (7.2–)8.0–12.0 μm, on the average per mount 52–64 × 8.0–10.6 μm, Q = (4.6–)4.8–7.6(–8.5), slenderly clavate, 4-spored or sometimes a few 2-spored (Figs. 13, 14). Cylindrical basidiolae sometimes present. Hymenial cystidia absent. Trama of gills with rather short cylindrical to strongly inflated elements, [40/7/7] (29–)33–148 × (3.8–)5.4–25 μm.

Pileipellis a well developed ixotrichodermium, in fresh carpophores c. 500–1200 μm thick, in exsiccata variably re-inflating to (200–)250–800(–1300) μm thick, consisting of slender erect branched hyphae, above the trama rather compact but towards the surface very loosely interwoven, (1.5–)2.0–5.8(–8.5) μm broad, hyaline or with olive green intracellular pigment, but also a variable part of the hyphae with irregularly encrusting pigment, moreover with numerous hyaline or pale green granules on and in between the hyphae; often (but not constantly) some extracellular pigment turning dark blue green in alkaline solutions, especially on the most superficial layers (Fig. 16). Warts on apex of stem consisting of closely packed erect hyphae, frequently forked and with slenderly clavate or cylindrical terminal elements, c. (17–)25–62 × 4.3–7.2 μm, colourless or with olive yellow or green contents, in between with greenish granules and clods, up to 25 μm broad, not discolouring in alkaline solutions (Fig. 15). Stiptipellis downwards an ixotrichodermium like the pileipellis but slightly thinner, hyphae with vacuolar and encrusting pigments, also extracellular granules, which turn sometimes in part

blue green in alkaline solutions. Stipitetrema with rather long elements, *c.* 4.0–12.5  $\mu\text{m}$  broad. Clamps numerous in all parts of the carpophore.

EXSICCATA.—Cap 20–60(–75) mm broad, with thin flesh, strongly wrinkled near margin, dull to very much shining, strongly variable in colour: greyish, orange, olivaceous, ochraceous to rather dark reddish brown, darker at centre. Gills cream, greenish to orange ochre. Stem 40–85 (–90)  $\times$  3.5–8(–12) mm, cylindrical; apical part distinct, whitish, cream to ochraceous or light orange brown with small orange or brown pustules; downwards greyish, ochraceous or orangy brown, frequently slightly darker towards base, evenly coloured or with mostly inconspicuous darker spots and belts.

NOTES ON THE HOLOTYPE (*E. Arnolds* 3892, L).—Exsiccata of nine carpophores in good condition with extensive notes on fresh specimens and water-colour drawing (originals preserved at the Biological Station, Wijster).

Spores [10/1] 8.1–10.8(–11.3)  $\times$  (5.3–)5.5–6.5(–6.7)  $\mu\text{m}$  (Fig. 11). Basidia [6/1] *c.* 50–64  $\times$  8.6–10.5  $\mu\text{m}$ , 4-spored (Fig. 13). Pileipellis an ixotrichodermium up to 800  $\mu\text{m}$  thick; hyphae 2–5 (–6.5)  $\mu\text{m}$  broad with greenish intracellular pigment, moreover with numerous irregular en-crustations and extracellular granules, in most carpophores in part turning dark greenish blue in  $\text{NH}_4\text{OH}$ . Collected under one oak (*Quercus robur*) at the transition from deciduous wood towards poor grassland (*Mesobrometum*) on dry calcareous soil.

ECOLOGY.—In the Netherlands *Hygrophorus persoonii* has only been found in the neighbourhood of oaks (*Quercus robur*) in deciduous forests on mesotrophic and subneutral sandy or loamy soils, often with a high lime content, varying from rather moist to dry. All these vegetations belong to the suballiance *Ulmion carpinifoliae* (see e.g. Westhoff & den Held, 1969: 266). In Belgium most collections have been made in deciduous forests on dry loamy calcareous soils, belonging to the alliance *Carpinion betuli*. In north-western Europe *H. persoonii* can be regarded a character species of the order *Fagetalia sylvaticae*.

The species has also been observed at margins of woods or near isolated oaks in grasslands on limestone. Some Belgian collections are reported from pine woods, but we have some doubts as to whether no deciduous trees were present. All detailed accounts on the habitat of *H. persoonii* (e.g. Michael-Hennig, 1964: 222; Jahn, 1972: 36) mention the presence of *Quercus* as a mycorrhiza partner. It is not certain whether it can also grow amongst other (deciduous) trees.

DISTRIBUTION.—It is difficult to establish the precise area in Europe as a result of the high degree of confusion around this species. On the basis of the present data it is very probable that its distribution coincides with the area of the oak, viz. from the Mediterranean area (e.g. in Maroc; Malencon & Bertault, 1975: 496) to southern Scandinavia.

In the Netherlands *H. persoonii* is a rare fungus; it has a characteristic distribution along the big rivers (the 'Fluviatiel' phytogeographical district, see van Soest in Heukels-van Ooststroom, 1973) and on the inner side of coastal dunes rich in lime (the 'Duin' district; Fig. 17). In Belgium the species seems to be restricted to the calcareous hills of the Meuse-district (de Langhe & al., 1973), where it is rather common (Fig. 18). It has never been observed in the western part of that country, as confirmed in a letter by Imler (Antwerpen). On the basis of its habitat *H. persoonii* would also be expected to occur in the southern-most part of the Netherlands, which forms part of the Meuse-district. However it seems to be absent there and also in the adjacent part of northern Belgium.

COLLECTIONS EXAMINED.—NETHERLANDS: prov. Gelderland, Wilp, estate 'de Poll', 29 Oct. 1978, *G. & H. Piepenbroek* 68 (WAG-W); prov. Utrecht, Breukelen, estate 'Gunterstein', 22 Oct. 1955, *H. v. d. Laan* s.No. (L); Driebergen, Sept. 1862, Anon. s.No. (L); Utrecht, Sept. 1862, *Hartig* s.No. (L); prov. Noord-Holland, Castricum, 'Geversduin', 21 Oct. 1954, *C. Bas* s.No. (L); s.loc. 31 Oct. 1964, *E. Kits van Waveren* s.No. (L); Castricum, 1 Nov. 1964, *J. van Brummelen* 1879 (L); Santpoort, 'Neethof', Nov. 1911, *C. Cool* s.No. (L); Velzen, 'Duin en Kruidberg', 13 Nov. 1962, *E. Kits van Waveren* s.No. (L); s. loc., s. dat., *C. Bas* 2904 (L); IJmuiden, 'Heerenduinen', 6 Nov. 1976, *C. Bas* s.No. (WAG-W); prov. Zuid-Holland, Wassenaar,

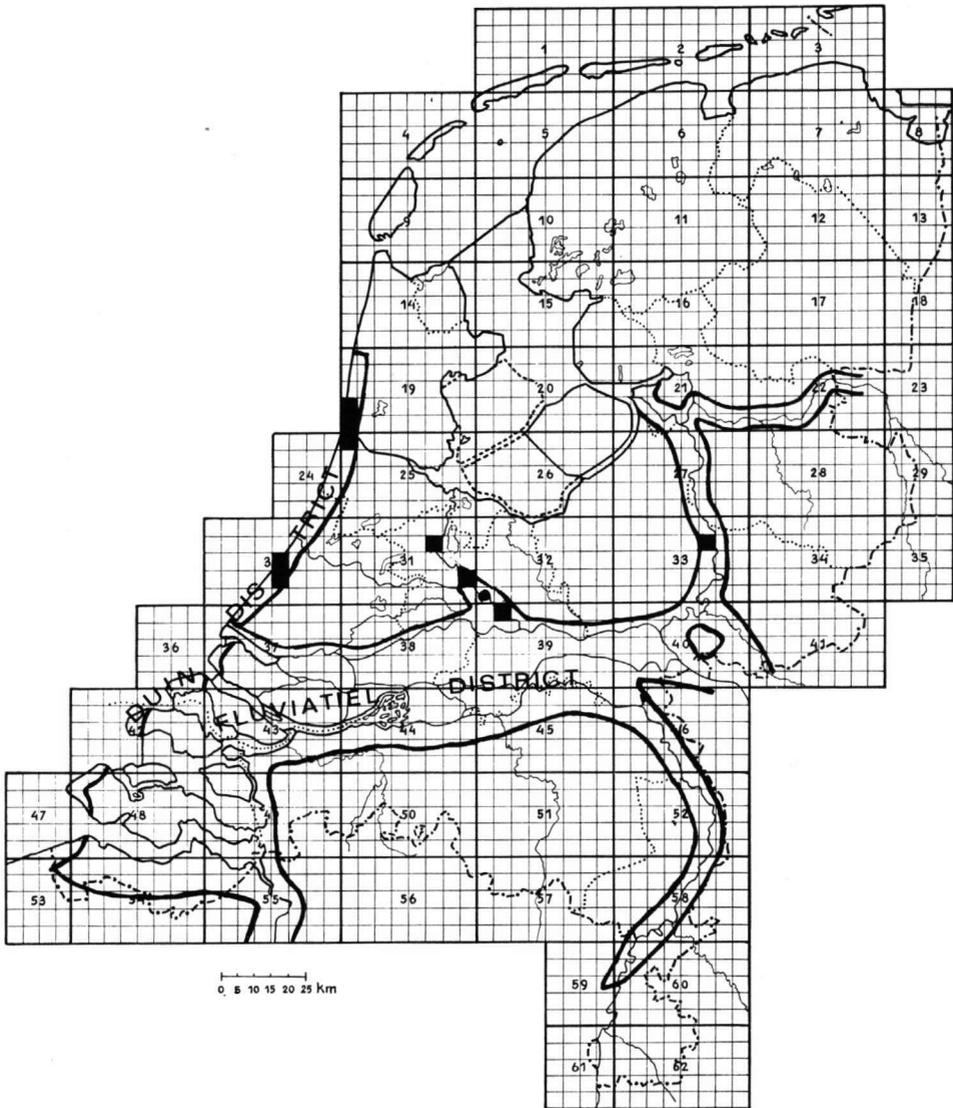


Fig. 17. Geographical distribution of *Hygrophorus persoonii* (■) and *H. mesotephrus* (●) in the Netherlands. The relevant phytogeographical districts have been indicated according to van Soest in Heukels & van Oostroom (1973).

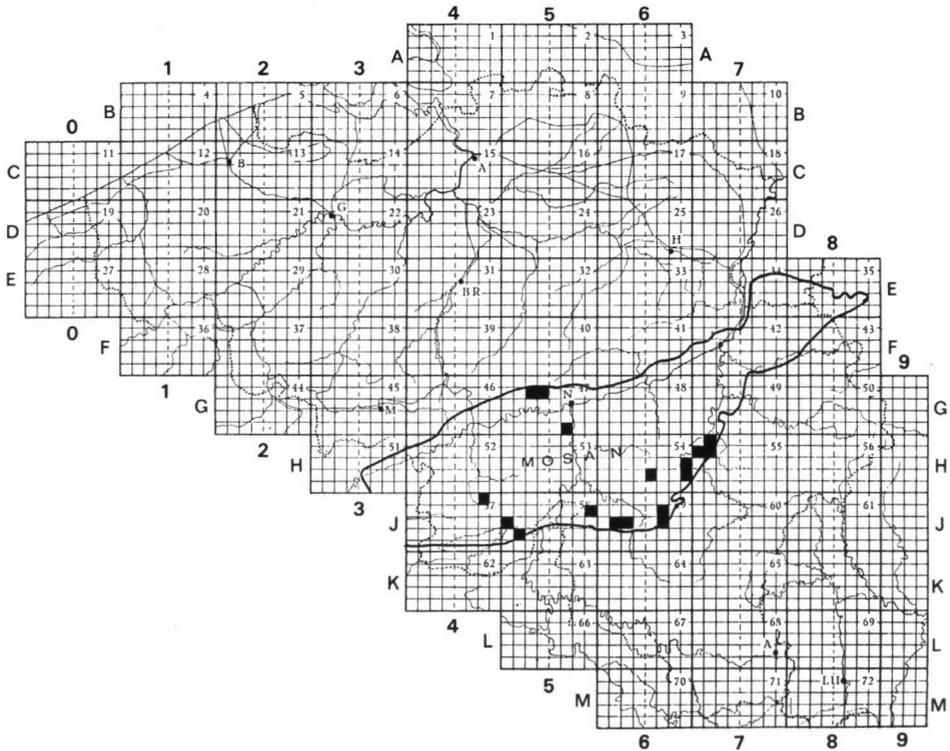


Fig. 18. Geographical distribution of *Hygrophorus persoonii* in Belgium. The Mosan phytogeographical district has been indicated according to de Langhe & al. (1973).

'Meyendel', 30 Oct. 1955, *C. Bas* 955 (L); Wassenaar, 'Raaphorst', Sept. 1923, Anon. s.No. (L); s.loc., 6 Oct. 1974, *C. Bas* 6423 (L).

**BELGIUM**: prov. Namur, Wavreille, 'Champs Spaloux', 24 Sept. 1950, *F. Darimont* s.No. (LG); Beaumont (Etneux), 7 Nov. 1944, *F. Darimont* s.No. (LG); Hogne, 20 Oct. 1974, *V. Damblon* s.No. (LG); Onoz-Spy, 28 Oct. 1943, *P. Heinemann* s.No. (GEMBL); Profondeville, 15 Oct. 1952, *P. Heinemann* 1918 (BR, GEMBL); Senzeille, 1951, *P. Heinemann* s.No. (GEMBL); Olloy, 17 Sept. 1967, *P. Heinemann* 4170 (GEMBL); s.loc., 22 Oct. 1948, *P. Heinemann* 1522 (BR); Ave-et-Auffe, 22 Oct. 1967, Anon. s.No. (GEMBL); Grupont, 26 Sept. 1969, *Thoen* 4166 (BR); Balâtre, 1942, *P. Heinemann* 1220<sup>bis</sup> (BR); Nismes, 'Tiène aux Pauquis', 3 Oct. 1977, *E. Arnolds* 3892 (holotype: L; isotypes: WAG-W, BR); Lavaux-S<sup>se</sup> Anne, 5 Oct. 1977, *E. Arnolds* 3866 (WAG-W); prov. Luxembourg, Wéris, Bouchaimont, 4 Nov. 1973, *J. Lambinon* s.No. (LG); Warenne, near 'Château de Verdène', 5 Oct. 1969, *J. Lambinon* s.No. (LG); Wéris, E. of the road Barvaux-Erezée, 15 Oct. 1967, *J. Lambinon* s.No. (LG); Hotton, 'Tier de Tine', 5 Oct. 1969, *J. Lambinon* s.No. (LG); Grandhan, 'Bois de Grandhan', 17 Oct. 1969, *V. Demoulin* s.No. (LG).

**GERMANY**: Bavaria, Kaltenberg S. of Augsburg, 20 Oct. 1973, *A. Bresinsky & J. Stangl* 699/73 (M); Riederau, Nature-reserve 'Seeholz', 7 Oct. 1978, *A. Einhellinger* 51/78 (M).

Without locality and date: '*Agaricus limacinus* Schaeff.' in Herbarium Persoon (L).

*Hygrophorus persoonii* can be clearly distinguished from the related species, as demonstrated in the key (p. 360).

Kühner & Romagnesi (1953: 59) used as the most important key character of this fungus, described under the name *H. dichrous*, the discolouring of extracellular pigment in the pileipellis to dark greenish blue in KOH and NH<sub>4</sub>OH. In some collections this reaction would be visible even macroscopically. Also Bon (1977: 39) regards this as a constant feature. However, Orton (1960: 258) mentioned the occurrence of one collection that did not turn blue at all. In the collections studied by me, only about 70 per cent showed the characteristic reaction with alkaline solutions under the microscope. Often only part of the granular bodies on the most superficial hyphae turned blue, sometimes even very locally. Moreover two collections showed the bluing only in fresh condition. I never observed a bluish discolouring on the cap macroscopically. On account of the large variation in this reaction I do not regard it as a constant property of *H. persoonii*; if present, however, it remains a good differentiating character, because it has never been demonstrated in other species.

The blue reaction with alkalis mainly occurs on the dark irregular crustlike encrustations on the hyphae, which can perhaps be better regarded as excretions than as true pigments. Moreover a variable amount of hyaline or greenish granules are present, which do not discolour at all and often occur in between the hyphae. Also these granules or perhaps droplets of unknown composition are perhaps excretions of the hyphae. Such an origin might explain the great variation in this character.

In a few collections I observed the bluing of extracellular pigment also in granular encrustations on the hyphae of the stipitepellis. This is regarded by Bon (1977: 39) as a possible character of his var. *fuscovinosus* of *H. dichrous*, which would be characteristic of evergreen deciduous forests in southern Europe. Another difference should be the size of the fruitbodies: cap 2–5(–6) cm in the typical variety, (4–)5–8(–10) cm in var. *fuscovinosus*; stem 5–8(–10) mm and 10–15 mm thick respectively. From the description above it is clear that such large forms also occur in cool-temperate regions. There is no hiatus between small and large carpophores. A possibly persisting difference is the constant occurrence of pink or reddish tinge in old carpophores of var. *fuscovinosus*.

It is obvious that the nomenclature of this species is rather confused. I shall try to explain why in my opinion it is necessary to introduce a new name to replace the epithets used in the past.

The fungus is usually called *Hygrophorus dichrous* in European literature since the introduction and clear definition of that name by Kühner & Romagnesi (1953: 60). Before that it had often been confused, especially with *H. olivaceoalbus*. Probably this is also the case in North America as the description and photograph of *H. olivaceoalbus* by Hesler & Smith (1963: 291, fig. 88) show a strong resemblance to *H. persoonii*. The former differs, however, in the more blackish brown colour of cap and stem and its habitat in woods of redwood and spruce.

Unfortunately Kühner & Romagnesi (l.c.) published their description of *H. dichrous* without a Latin diagnosis or a direct reference to a validly published name, as noted earlier among others by Orton (1960: 258), Moser (1967: 60), and Arnolds (1974: 32). However the authors of the Index of Fungi (Commonwealth mycological Institute, 1959: 474) considered *H. dichrous*, 'Validly published by reference to the Latin diagnosis of *H. olivaceoalbus* forma *obesa*

Bresadola'. In my opinion this statement is not correct for nomenclatural (1) and taxonomical (2) reasons. (1) Kühner & Romagnesi (l.c.) only mentioned the plate of Bresadola incidentally, while article 33.2 of the 'Code' (Stafleu & al., 1978: 31) states, that a nomen novum is published validly after 1 Jan. 1953 only if '... its basionym or the replaced synonym is clearly indicated and a full and direct reference given to its author and original publication with page or plate reference and date.' (2) The quoted plate of Bresadola (1887: 92) shows important differences with the original description of *H. dichrous*, e.g. in the ventricose stem and the habitat in coniferous forests. Doubt about the correctness of the reference of Kühner & Romagnesi has already been expressed by Orton (1960: 258). I agree with Bon (1977: 39) and Cetto (1976: 650), who regard *H. olivaceoalbus* f. *obesus* Bres. identical with *H. limacinus* sensu Romagnesi, i.e. *H. latitabundus*. For the sake of nomenclatural stability it is regrettable, that it is no longer possible to validate the name *Hygrophorus dichrous* as Hongo (1958: 101) used it for quite a different species from Japan belonging to the (sub-)genus *Hygrocybe*.

Another name, earlier in use for *H. persoonii*, is *Hygrophorus limacinus*. Orton (1960: 258) has pointed out that in this case already before the nomenclatural starting point there existed two homonyms, viz. *Agaricus limacinus* of Scopoli (1772; later validated by Fries in 1838) and *A. limacinus* of Schaeffer (1774; later validated by Persoon in 1828). Scopoli (1772: 422) described a rather slender fungus with a white stem and a cap without olivaceous tinge, most probably different from the species described above. Orton (l.c.) thinks, that the original plate of Scopoli might represent *H. mesotephrus* Berk. & Br. I have not seen that plate myself, so I cannot judge this statement. According to the view of Donk and other European mycologists, including the present author, the description and plate by Scopoli should be regarded the nomenclatural type of *Agaricus limacinus* Scop. ex Fr. since Fries obviously wanted to redescribe Scopoli's species. In that case this name cannot be used for the present species.

Generally the validation of *A. limacinus* Scop. has been assigned to Fries (1821: 36). This author lists *A. limacinus* Scop. under the heading 'Species inquirendae', which means that these species have still to be investigated. From this it is clear, that Fries did not accept Scopoli's species at that point and consequently did not then validate Scopoli's name for it (article 34.1.a of the 'Code', Stafleu & al., 1978: 32). This is also the opinion of C. Bas (Leiden), R. A. Maas Geesteranus (Leiden), and V. Demoulin (Liège). It is true that Fries published *Hygrophorus limacinus* (Scop.) validly in the 'Epicrisis' (1838: 324), but this validation is antedated by others. To my knowledge Persoon (1828: 94) was the first author to validate the name *Agaricus limacinus*, based however on the description (1774: 74) and plate (1771: 312) by Schaeffer. The latter might be regarded the lectotype. It shows a fungus, which might be very well the species under consideration: the cap is about 40 mm broad, umbonate, brown with yellowish tinge near the margin; the stem has been depicted about 60 × 11 mm, yellowish, and would be spotted according to the description. Unfortunately no exact habitat has been indicated. Orton (1960: 258) also regards *Agaricus limacinus* Schaeff. ex Pers. identical with *H. dichrous* Kühn. & Romagn.

Persoon certainly used the name *H. limacinus* in this sense, as can be concluded from an investigation of material present in Persoon's Herbarium at Leiden. Singer (1961) published a study on types present in the Herbarium of Persoon, but he did not focus on *Agaricus limacinus*.

Therefore it seems useful to give a short description of this material (labelled: L 910.255–678). Persoon has written in the corner the names *Agaricus limacinus* Schaeff. and *A. olivaceoalbus* Fr.

The collection consists of one carpophore cut lengthwise, superficially affected by a mould, but revived relatively well in  $\text{NH}_4\text{OH}$  10%. Cap 38 mm broad, orange brown beneath mould. Stem  $47 \times 7.5$  mm, subfusiform, dirty orange ochre. Spores [10/1] (8.1–)8.7–9.8(–10.5)  $\times$  (5.2–)5.6–6.3(–6.7)  $\mu\text{m}$ , ellipsoid or oblong with obtuse apiculus, frequently collapsed. Basidia [5/1] c.  $48\text{--}56 \times 9.5\text{--}10.2$   $\mu\text{m}$ , almost all more or less collapsed, probably 4-spored. Pileipellis amazingly well reviving; an ixotrichodermium up to more than 1000  $\mu\text{m}$  thick, in the upper part very loosely interwoven; hyphae c. 2.1–5.6  $\mu\text{m}$  broad with olive green vacuolar pigment and moreover densely covered with irregular and granular encrustations, not discolouring blue in alkaline solutions. Stipitepellis of the same structure, but thinner. Clamps present.

From the above deliberations it is clear, that it would be appropriate to identify the species under consideration with *A. limacinus* Schaeff. ex Pers. Unfortunately that epithet is pre-occupied in the genus *Hygrophorus* by Fries, who made first the combination *Hygrophorus limacinus* in 1838 (: 324), based however upon Scopoli's name. Fries' description at that point of time is difficult to interpret. It is not impossible, that he had the same fungus in mind as Persoon, but he referred to Scopoli and did not mention Schaeffer's plate. Moreover he regarded only var.  $\beta$  of *A. limacinus* Schaeff. ex Pers. in *Mycologia europaea* identical. It is not clear, whether Fries had already seen the species himself.

A more detailed, new description has been published by Fries in 1852 (: 129). At that occasion he reports *H. limacinus* from frondose woods in the surroundings of Stockholm and for the first time he mentions dimensions of the carpophores, which together with other characters point in the direction of *H. persoonii*. However, he explicitly considers Scopoli as the only original source. Fries probably handled the same concept in 'Hymenomycetes' (1874: 409). In the latter book he cites a plate of Saunders & Smith (1872: 28 fig. 1) with the designation 'optime'. This plate shows a fungus with the typical habitus of *H. persoonii* with a dark brown cap and ochraceous stem, which would be 'fibroso-striated' according to the description. It is reported in 'leafy woods'.

According to M. Moser (Innsbruck; in letter) Fries' plate of *H. limacinus* in Stockholm shows a fungus with a coloured stem (contrary to the description by Scopoli) which could 'eventually suggest *H. dichrous*'. Because Fries knew *H. olivaceoalbus* very well from the surroundings of Femsjö (see p. 380) this seems quite probable.

In my opinion the final conclusion must be, that the name *Hygrophorus limacinus* has to be rejected as a 'nomen ambiguum et confusum' for the following reasons:—

(1) The existence of two early homonyms, viz. *Agaricus limacinus* Schaeff. and *A. limacinus* Scop. The first name belongs to the present species and has been validated (in the genus *Agaricus*) by Persoon (1828). The second name relating to another species has been validated somewhat later by Fries in 1838, but was the first to be transferred to *Hygrophorus* also by Fries in 1838.

(2) On behalf of this complex situation typification can be done in different conflicting ways.

(3) Fries' early concept of *A. limacinus* before 1852 remains unclear. Since 1852 it seems to cover the present species, although Fries never changed the original reference to Scopoli's description.

(4) Great confusion exists in the applications of the name *Hygrophorus limacinus* by later authors.

(5) A new but nomenclaturally invalid name has already been proposed for this species and has been generally accepted, viz. *Hygrophorus dichrous* Kühn. & Romagn. Unfortunately this name cannot be validly published on account of a validly published earlier homonym, viz. *H. dichrous* Hongo.

#### HYGROPHORUS MESOTEPHRUS Berk. & Br.—Figs. 19–25

*Hygrophorus mesotephrus* Berk. & Br. in Ann. Mag. nat. Hist. II 13: 402. 1854. — *Limacium mesotephrus* (Berk. & Br.) P. Henn. in Natürl. PflFam. 1 (1): 213. 1898.

MISAPPLICATIONS.—*Hygrophorus mesotephrus* sensu Cooke, Ill. Brit. Fungi: 293. 1889 (= *H. leucophaeus* (Scop. ex Fr.) Gill.); sensu Boudier, Icon. mycol. 1: 34. 1905–10 (= *H. leucophaeus*).

COLOURED ILLUSTRATIONS.—Lange, Fl. agar. dan. 5: 162 B. 1940 (but cap depicted too green).

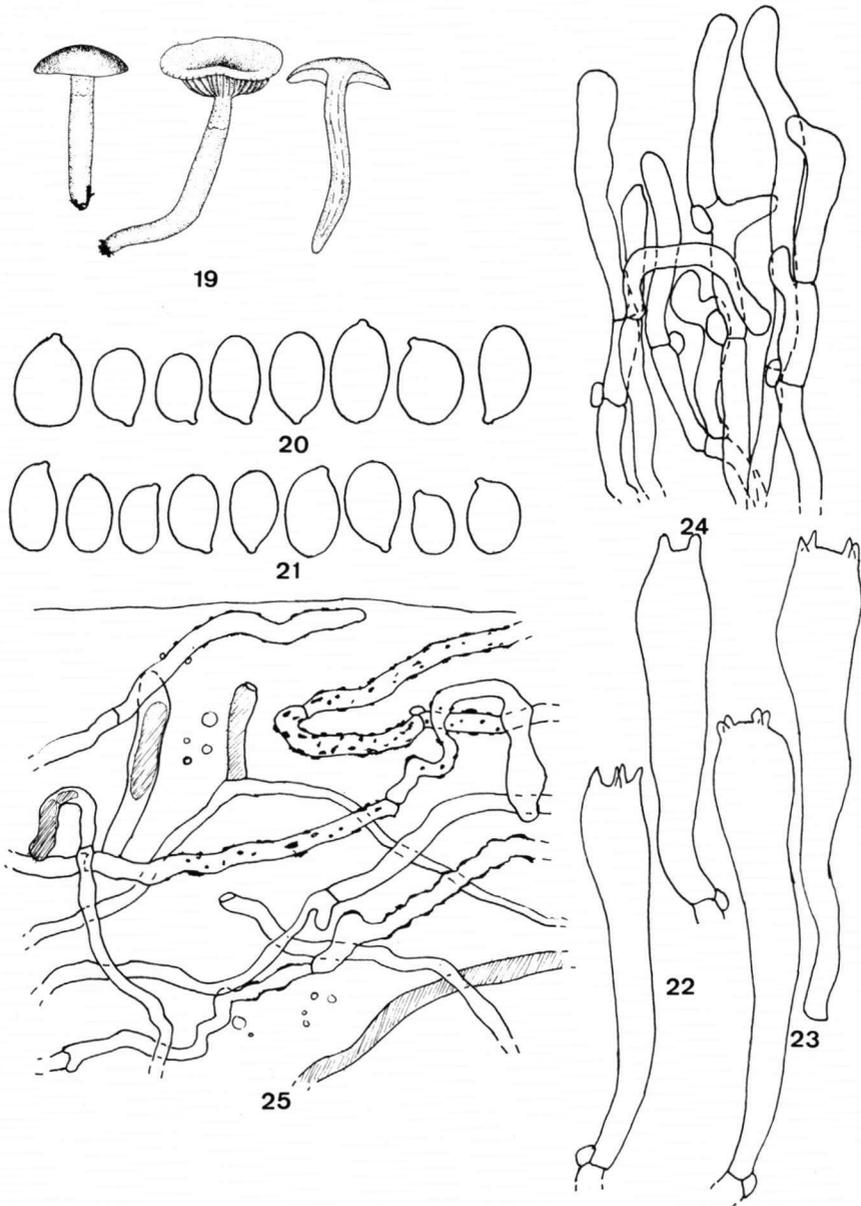
SELECTED DESCRIPTIONS.—Trans. Br. mycol. Soc. 43: 258. 1960; *Coolia* 17 (suppl.): 35. 1974; *Docums mycol.* 7 (27–28): 39. 1977.

Cap [5/1] 19–32 mm broad, first conico-convex, then expanded with weakly crenulate, sometimes ascending margin, not hygrophanous, pale greyish brown or beige, towards centre much darker greyish sepia with slight olivaceous tinge, strongly glutinous. Gills [L = c. 25–35, I = 1–3] shortly decurrent, rather distant, thick, becoming slightly ventricose with age, white to creamy. Stem 43–63 × 3.5–6.5 mm Q = 9–15, slightly fusiform, apex white, pruinose to minutely white floccose, dry, sometimes guttulate, sharply separated from remaining viscid part which is white or pale ochre-orange ('isabella'), becoming yellowish at base, without darker spots or belts, also on drying. Flesh white, in base of stem yellowish. Smell and taste absent.

Spores [50/4/3] (8.4–)8.6–12.0(–12.2) × (5.3–)5.5–7.4(–8.6) μm, on the average 9.6–10.4 × 6.1–6.8 μm, Q = (1.3–)1.4–1.8, ellipsoid to ellipsoid- or ovoid-oblong with short obtuse apiculus (Figs. 20, 21). Basidia [25/4/3] (40–)44–60(–63) × (7.2–)7.7–10.0(–11.0) μm, on the average 51.6–54.2 × 8.0–9.4 μm, Q = (4.7–)5.1–7.7(–8.2), slenderly clavate, 4-spored or 4- and 2(–1)-spored intermingled (Figs. 22, 23). Hymenial cystidia absent. Hymenophoral trama bilateral, composed of short to moderately long cylindrical to strongly inflated elements, measuring [22/4/3] 28–131 × 3.8–21(–26) μm. Pileipellis a well developed ixotrichodermium, in exsiccata variably reinflatable to c. 120–870 μm thick, consisting of slender erect branched hyphae, 1.4–4.8 μm broad, hyaline or mostly with greenish intracellular pigment and intracellular granules, hyphae mostly smooth, but in some fruit-bodies a small percentage faintly rough by encrusting pigment; extracellular granules absent or few, pale greenish in alkaline solutions (Fig. 25). Warts on apex of stem consisting of fasciculate close hyphae c. 1.2–3.5 μm broad with cylindrical to slenderly clavate terminal elements, c. 2.5–6 μm broad, colourless (Fig. 24). Stipitepellis downwards an ixotrichodermium like the pileipellis but thinner. Stipitetrama with rather long elements, c. 3.8–14.5 μm broad. Clamps numerous in all parts of the carpophore.

EXSICCATA.—Cap 13–32 mm broad, with thin flesh, concentrically wrinkled, shining at centre, pale ochre yellow or brownish ochre to rather bright brown-orange with sharply delimited dark reddish brown centre. Gills creamy to orange ochre. Stem 36–85(–105) × 2–6 mm, cylindrical; apex whitish or pale ochre with obscure to striking small ochre to orange brown pustules; downwards shining, ochre orange to orange-brown, often red-brown at base, without darker spots.

ECOLOGY.—In the Netherlands *H. mesotephrus* is known from one locality in an old frondose wood with *Fagus* and *Quercus* on rather rich subneutral river clay. According to Bon (1977: 39) this species would occur in mixed frondose woods on silicate soils. The material from Belgium has been stated from a Fagetum with *Luzula*, so probably more in accordance with the data of Bon (l.c.). Fructification occurs in October.



Figs. 19–25. *Hygrophorus mesotephrus*. — 19. Carpophores,  $\times 0.5$ . — 20, 21. Spores,  $\times 1000$ . — 22, 23. Basidia,  $\times 1000$ . — 24. Section of warts on apex of stem,  $\times 1000$ . — 25. Radial section of pileipellis,  $\times 1000$ . (Figs. 19, 20, 23, 24 from Bas 1323; Figs. 21, 22, 25 from Heinemann 4277.)

**DISTRIBUTION.**—In the Netherlands and Belgium *H. mesotephrus* is very rare (Figs. 9, 17). This seems to be the case in other countries of western Europe too. Only Lange (1940: 12) mentions it as being 'not uncommon' in Denmark.

**COLLECTIONS EXAMINED.**—NETHERLANDS: prov. Utrecht, Zeist, near 'Wulperhorst', 20 Oct. 1957, *C. Bas 1323* (L).

BELGIUM: prov. Namur, Wavreille, 16 Oct. 1967, *P. Heinemann 4277* (GEMBL). Probably also belonging to this species (or perhaps *H. persoonii*): prov. Liège, Basse-Bodeux, 22 Oct. 1955, *J. Lambinon s.No.* (LG).

GERMANY: Bavaria, Landkreis Landsberg am Lech, Geltendorf, 20 Oct. 1973, *A. Bresinsky s.No.* (M, 2 wrappers).

*Hygrophorus mesotephrus* is the most slender species in the group of *H. persoonii* and can be recognized fairly easily by its pale cap and whitish stem without spots. Orton has studied the type of *H. mesotephrus* and published some details (1960: 258), so it seemed not necessary to repeat this investigation.

*Hygrophorus mesotephrus* sensu J. Lange has been regarded a misapplication by most authors. According to Orton (l.c.) Lange's plate is doubtfully distinct from *H. dichrous*, while Bon (1977: 38) regards it identical with *H. olivaceoalbus* f. *gracilis* Maire. Moser (1978: 80) also quotes this plate under *H. olivaceoalbus*, although between brackets. In my opinion and that of Bas (Leiden; priv. comm.) however Lange's plate depicts *H. mesotephrus* fairly well, although in the material from the Netherlands the cap centre is slightly more brownish and less olivaceous. Lange (1940: 11) describes the cap being 'olive-fuscous' at the centre. Certainly *H. mesotephrus* sensu Lange is totally unrelated to *H. olivaceoalbus* since colours of the stem, size of spores and habitat are quite different.

#### HYGROPHORUS OLIVACEOALBUS (Fr. ex Fr.) Fr.—Figs. 26–32

*Agaricus olivaceoalbus* Fr., Obs. mycol. 1: 5. 1815. — *Agaricus olivaceoalbus* Fr. ex Fr., Syst. mycol. 1: 35. 1821. — *Hygrophorus olivaceoalbus* (Fr. ex Fr.) Fr., Epicr.: 324. 1838. — *Limacium olivaceoalbum* (Fr. ex Fr.) Kummer, Führ. Pilzk.: 119. 1871. — Neotype (design. mihi): *M. Moser 72/190*, 6 Aug. 1972, Femsjö (IB).

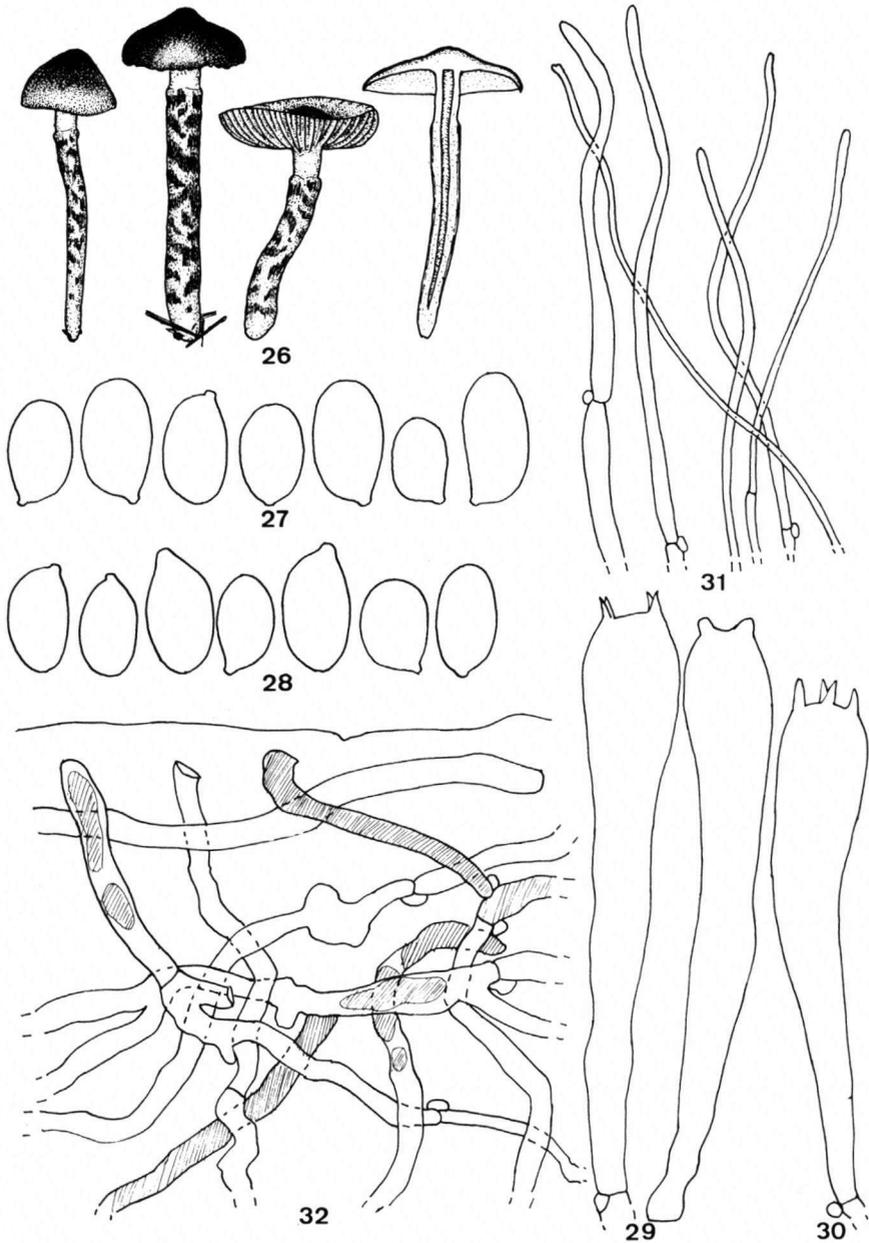
**MISAPPLICATIONS.**—*Limacium olivaceoalbum* sensu Ricken, Blätterp. 1: 13. 1915 (= *H. persoonii*); sensu J. Lange, Fl. agar. dan. 5: 162 A. 1940 (= *H. persoonii*). — *Hygrophorus olivaceoalbus* sensu Hesler & Smith, North American species of *Hygrophorus*: 291. 1963 (= *H. spec.*); sensu auct. eur. p.p. (= *H. persoonii*).

**COLOURED ILLUSTRATIONS.**—Bresadola, Icon. mycol. 7: 316. 1928; Michael-Hennig, Handb. Pilzfr. 3: No. 238. 1964; Marchand, Champ. Nord Midi 2: 154. 1973.

**SELECTED DESCRIPTIONS.**—Kühner & Romagnesi, Flore anal.: 60. 1953; Michael-Hennig, l.c.; Docums mycol. 7 (27–28): 38. 1977.

Cap [22/4] 19–55(–60) mm broad, first semiglobate to conical, then expanding with prominent subacute to obtuse umbo with convex sometimes crenulate margin, not hygrophanous, first grey- to olive-brown with dark brown to almost black centre, slightly paler when old. Gills [L = 22–35, l = 1–3(–5)] broadly adnate with tooth or decurrent, rather distant to distant, thick, up to 6 mm broad, white to creamy white. Stem 40–85(–100) × 4–10(–12) mm, Q = c. 8–14, rather slender, cylindrical or slightly fusiform, first with slimy-fibrillose veil between stem and margin of cap, apex dry, white, whitish pubescent to pruinose, below veil in young carpophores entirely olive-brown, but soon with olive or grey-brown transverse bands and spots on white background, most conspicuously so on drying, completely slimy when moist. Flesh in cap rather thin, up to 7 mm thick, rather firm, white but usually lemon yellow at centre below pileipellis; in stem fibrillose, white. Smell and taste not remarkable.

Spores [95/10/10] (9.1–)10.2–15.8(–18.2) × (6.2–)6.7–8.8(–9.1) μm, on the average 11.5–14.1 × 7.4–8.6 μm, Q = 1.4–1.9(–2.0), ellipsoid to ellipsoid-oblong with large obtuse apiculus (Figs.



Figs. 26–32. *Hygrophorus olivaceoalbus*. — 26. Carpophores,  $\times 0.5$ . — 27, 28. Spores,  $\times 1000$ . — 29, 30. Basidia,  $\times 1000$ . — 31. Hairs on apex of stem,  $\times 1000$ . — 32. Radial section of pileipellis,  $\times 1000$ . (Figs. 26, 27, 29, 31 from *Arnolds 804*; Figs. 28, 30 from *Moser 72/190*, neotype; Fig. 32 from *Roucart*, 5 Oct. 1951.)

27, 28). Basidia [42/9/9] 61–79(–83) × (9.6–)10.1–14.4 μm, on the average 64–77 × 10.5–13.6 μm, Q = (4.3–)4.8–7.5, rather slenderly to slenderly clavate, 4-spored, in some collections a few 2-spored (Figs. 29, 30). Hymenophoral trama bilateral, composed of rather short cylindrical to inflated elements, [27/5/5] 43–148 × 4.8–22 μm.

Pileipellis a well developed ixotrichodermium, in exsiccata reinflating to c. 150–530 μm thick, in the upper layers loosely interwoven, consisting of branched slender cylindrical hyphae c. 2.2–6.7 μm broad, hyaline or with olivaceous vacuolar pigment, smooth or, exceptionally, a few can be slightly roughened, commonly completely without encrusting pigment and extracellular granules (Fig. 32). Stipitepellis at apex of stem a dry irregular cutis of thin hyaline hyphae with scattered long free ends, projecting up to c. 500 μm, cylindrical and hyaline, c. 2.8–5.8(–7.2) μm broad; fascicles of compact hyphae absent (Fig. 31). Stipitepellis below apex an ixotrichodermium like the pileipellis but thinner, up to 200 μm in exsiccata; hyphae 1.5–5 μm broad, sometimes on some hyphae with very fine encrustations. Stipitetrama regular with rather long cylindrical elements, c. 2.5–12.0 μm broad. Clamps numerous in all parts of the carpophore.

EXSICCATA.—Cap 16–48(–60) mm broad, with thin flesh, mostly strongly concentrically wrinkled, dull to weakly shining, rather dark brown, often with greyish, reddish or orange tinge, with very dark brown centre. Gills creamy ochre to orange ochre. Stem 30–95 × 2.5–9(–11) mm, cylindrical, apex whitish to ochraceous, pubescent or pruinose without pustules, often sharply delimited from the remaining part, which is ochre to rather dark brown, with or without conspicuous darker belts and spots.

NOTES ON THE NEOTYPE (*M. Moser 72/190*, 6 Aug. 1972, IB).—Exsiccata of 3 mature carpophores. Spores [10/1] (10.5–)12.0–14.5(–17.2) × (7.2–)7.4–8.8(–9.1) μm, ellipsoid or ellipsoid-oblong (Fig. 28). Basidia [5/1] c. 64–79 × 12.9–14.4 μm, slenderly clavate, 4-spored (Fig. 30). Pileipellis an ixotrichodermium reviving in KOH 5% to up to 200–390 μm thick; hyphae c. 2.2–5.8 μm broad, hyaline or with olivaceous vacuolar pigment, smooth, without granular elements.

ECOLOGY.—Mentioned by all authors from coniferous forests with preference for spruce (*Picea abies*). In Belgium *H. olivaceoalbus* occurs only in spruce plantations on acid peaty soil. Also other authors mention a preference for moss-rich forests on moist acid soils (e.g. Favre, 1960: 393; Michael-Hennig, 1964: 220; Bon, 1977: 38). Fructifying from August until November.

DISTRIBUTION.—In Europe *H. olivaceoalbus* seems to have a mainly boreo-montane distribution: it is widespread in Scandinavia as well as in the montane and subalpine belts of the central European mountains. It is far more rare in the western European lowland and has never been found in the extensive spruce plantations of the Netherlands. However, it has been found several times in the adjacent part of northern Germany.

In Belgium *H. olivaceoalbus* has a characteristic distribution pattern: it seems to be confined to the phytogeographical district of the Ardennes, which is the highest part of Belgium mainly consisting of Devonian, Silurian and Cambrian silicate rocks, giving rise to acid soils poor in lime (de Langhe & al., 1973). The species is especially common in the subdistrict of the high Ardennes ('Haute Ardennais'), which is situated for the greater part higher than 500 meter above sea level. This region was covered mainly with extensive peat moors ('Hauts Fagnes'), but large areas have now been planted with *Picea* (Fig. 9).

COLLECTIONS EXAMINED.—BELGIUM: prov. Liège, S. of Eupen, 'Herzogenwald' (alt. 500 m), 16 Sept. 1970, *E. Arnolds 804* (WAG-W); Robertville, 'Pessière de Drello', 2 Aug. 1950, *F. Darimont s.No.* (LG); *s. loc.*, 5 Oct. 1951, *R. Roucart s.No.* (LG); Robertville, Mont Rigi, 23 Aug. 1936, *P. Heinemann 468* (BR); Robertville, near Sourbrodt, 12 Sept. 1937, *P. Heinemann 595* (BR); Robertville, near Sourbrodt, 'Pont de la Roer', 23 Oct. 1955, *J. Lambinon s.No.* (LG); Malmédy, near Bevercé, 15 Aug. 1957, *C. Bas 1332* (L); Rockerath, 'Drei Herrn Wald', 14 Oct. 1956, *J. Lambinon s.No.* (LG); prov. Luxembourg, Champlon, 'La Converserie' (alt. 550 m), 17 Oct. 1961, *P. Heinemann 3167* (BR, GEMBL); Awenne, 17 Oct. 1958, *P. Heinemann 2614* (BR).

SWEDEN: Smoland, Femsjö, E. of Dullaberget, 6 Aug. 1972, *M. Moser 72/190* (neotype, IB).

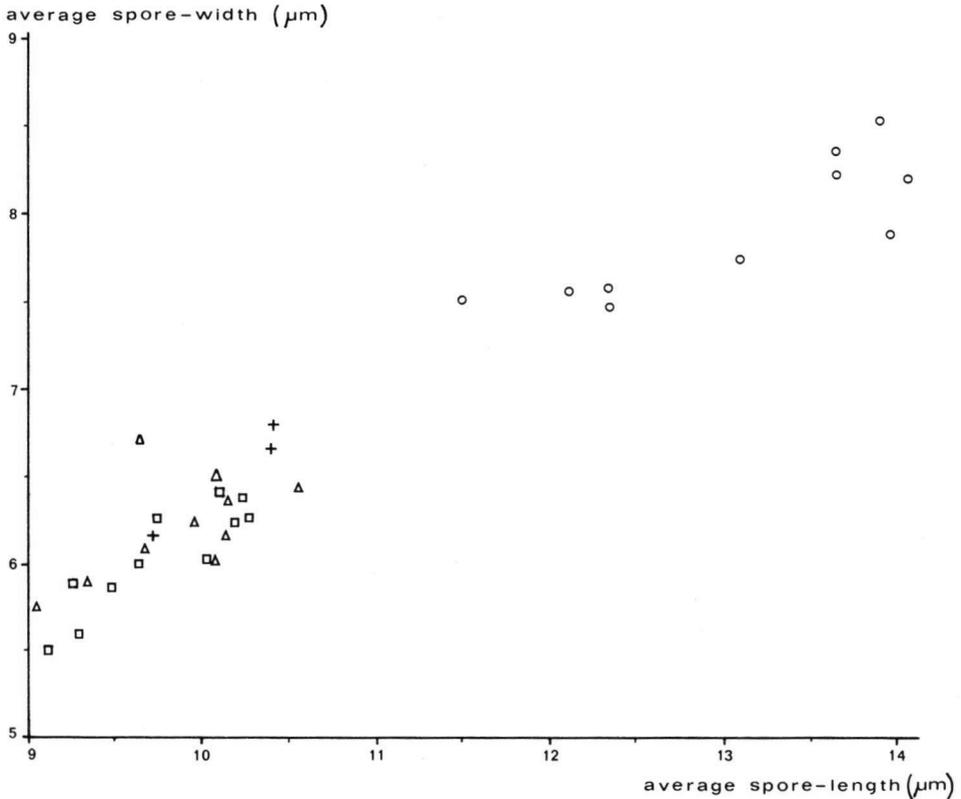


Fig. 33. Scatter diagram of average length and width of basidiospores of *Hygrophorus latitabundus* (Δ), *H. persoonii* (□), *H. mesotephrus* (+) and *H. olivaceoalbus* (○).

GERMANY: Westfalen, SW of Ibbenbüren, 18 Oct. 1961, *J. Barkman* 7148 (WAG-W); Niedersachsen, Oldenburg, 'Neuenburger Urwald' near Zetel, 24 Oct. 1961, *J. Barkman* 7207 (WAG-W).

The name *H. olivaceoalbus* has been frequently misapplied in the past, especially as a consequence of confusion with *H. persoonii*. As indicated in the key (p. 359) important macroscopic as well as microscopic and ecological differences exist between the two species. The significant difference in spore size is demonstrated in the scatter diagram of Fig. 33. However, in a single specimen the variation of spore measurements can be considerable and may show some overlap with those of other species in this group. Also basidia in *H. olivaceoalbus* are larger than in other species treated here (Fig. 34). However, the difference in length can be obscured by strong reinflation of the basidia in alkaline solutions, resulting in a relatively broadly clavate shape. Differences in reinflating of exsiccata are probably due to differences in the process of drying.

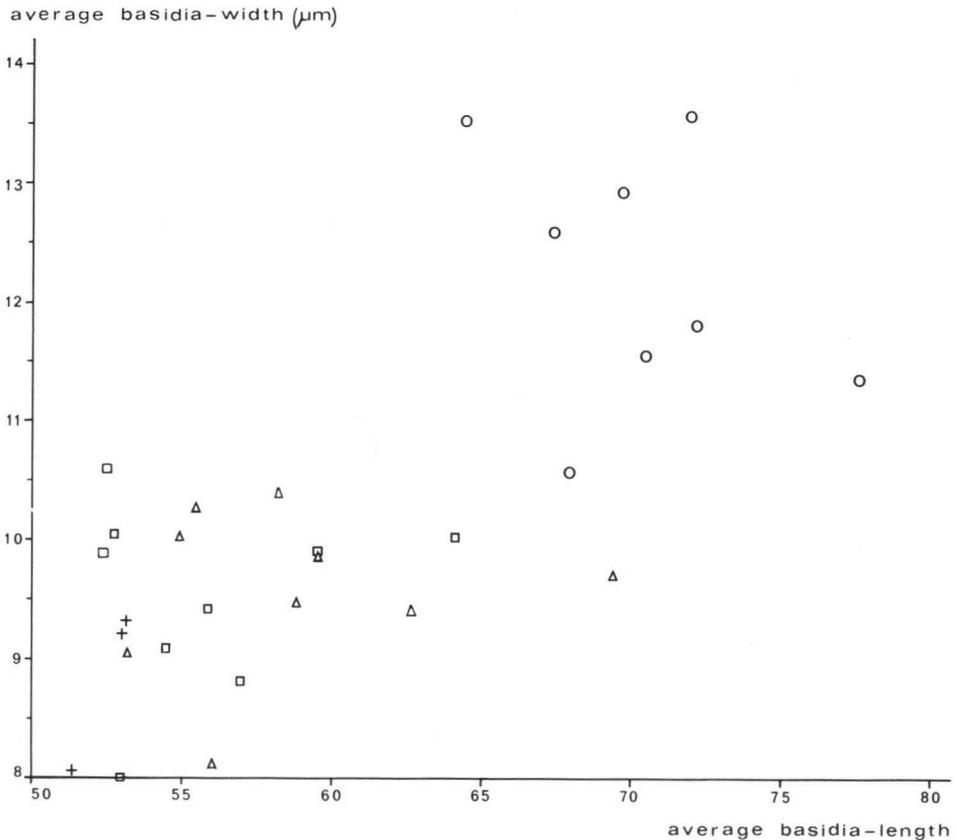


Fig. 34. Scatter diagram of average length and width of basidia of *Hygrophorus latitabundus* (Δ), *H. personii* (□), *H. mesotephrus* (+) and *H. olivaceoalbus* (○).

It is beyond any doubt, that Fries meant the fungus described above when introducing the name *Agaricus olivaceoalbus* in his *Observationes* (1815: 5). In *Systema* (1821: 35) he mentions, that this species should be frequent in coniferous forsts. According to Moser (in letter) this is still true for the surroundings of Femsjö, where Fries collected during that period of his life. Moser kindly sent me one collection from this region on loan, which is proposed here as neotype.

*Hygrophorus olivaceoalbus* forma *obesa*, described by Bresadola (1887: 92) is identical with the species described here under the name *H. latitabundus*. *Hygrophorus olivaceoalbus* var. *gracilis* Maire (1933: 53), described in contrast to var. *obesus* (Bres.) Maire, is in my opinion the same as typical *H. olivaceoalbus*, like described above.

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