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ADDENDA TO THE *HEBELOMA FUNGA* OF ITALY
HEBELOMA PUSILLUM AND *H. SUBCONCOLOR*

Abstract

The present paper is a follow-up to the study of *Hebeloma* based on Italian collections (GRILLI *et al.* 2020), which was part of an ongoing project on occurrence and distribution of *Hebeloma* species in Italy. Its main focus is on Italian collections of *Hebeloma pusillum* and *H. subconcolor*, two of the taxa not treated there because at the time they had not yet been collected by, or come to the attention of, the first author. The two collections, which are fully described and illustrated, are perfectly congruent with the current morphological and molecular delimitation of the related species. Secondly it provides also a nomenclatural and taxonomic updating following the recent publication of papers on North American *Hebeloma* species published by C.H. Peck and W.A. Murrill that had a nomenclatural impact on some European species names, as well as an update on the number of current *Hebeloma* species worldwide.

Riassunto

Il presente lavoro fa seguito allo studio sul genere *Hebeloma* basato su raccolte italiane (GRILLI *et al.* 2020), che era parte di uno progetto tuttora in corso sulla presenza e distribuzione delle specie appartenenti a questo genere in Italia. L'attenzione principale del lavoro è concentrata su raccolte italiane di *Hebeloma pusillum* e *H. subconcolor*, due dei taxa non presentati in quella occasione perché al tempo non erano stati raccolti dal primo autore, né erano ancora stati sottoposti alla sua attenzione. Le due raccolte, esaurientemente descritte ed illustrate, sono perfettamente corrispondenti alla corrente delimitazione morfologica e molecolare delle due specie. Secondariamente, si provvede ad aggiornamenti di nomenclatura e tassonomici conseguenti alla recente pubblicazione di studi sulle specie nordamericane di *Hebeloma* pubblicate da C.H. Peck and W.A. Murrill che antedatano i nomi di alcune specie europee. Si propone altresì un aggiornamento del numero delle specie correnti presenti in Europa ed a livello mondiale.

Key words: *Hymenogastraceae*, *Hebeloma*, *H. pusillum*, *H. subconcolor*, Italy, Europe.

Introduction

Hebeloma (Fr.) P. Kumm. Supplement based on collections from Italy (GRILLI *et al.* 2020), below referred to as the Supplement, was meant to be a “southern” companion to the monograph on this genus appeared in 2016 (BEKER *et al.* 2016), below referred to as the Monograph. It covered most European countries, but the bulk of the material underpinning it came from western and northern Europe; therefore, the Supplement, which addressed occurrence and distribution of *Hebeloma* species in Italy, somehow went some way towards reducing the geographical bias of the Monograph.

Based on 510 Italian collections, 240 of which specifically studied and sequenced for the occasion, the Supplement presented 60 of the 84 species of *Hebeloma* at the time treated in the Monograph, plus one, *Hebeloma alpinicola* not included in the Monograph, a species that is a typical member of *Hebeloma* sect. *Hebeloma* subsect. *Hebeloma*, originally described from Idaho, in the United States (SMITH *et al.* 1983). Its type material, in fact, had been analysed,

both morphologically and molecularly, after the publication of the Monograph, and the name regarded as current (i.e. to be accepted and used), because even if it is morphologically closely related to *H. mesophaeum* and *H. excedens*, molecularly it is closer to *H. velatum* (CRIPPS *et al.* 2019; EBERHARDT *et al.* 2023b). Such a revision was conducted within a research project managed by H.J. Beker's *Hebeloma* team, aiming at shedding light into North American *Hebeloma* names, and was part of a larger-scale *Hebeloma* project, started in 2004, focusing first on European species and then on all species the world over.

Subdivided according to habitat preferences, the species present in Europe, but not confirmed from Italy at the time of the publication of the Supplement, amounted to 24. (Table 1)

Table 1. List of *Hebeloma* not confirmed for Italy

Arctic/Alpine	Subartic/Subalpine	Apparently predominantly Northern European
<i>H. aurantioumbrinum</i>	<i>H. hygrophilum</i>	<i>H. echinospermum</i>
<i>H. grandisporum</i>	<i>H. monticola</i>	<i>H. erebium</i>
<i>H. islandicum</i>	<i>H. melleum</i>	<i>H. fragilipes</i>
<i>H. louisae</i>	<i>H. naviculosporum</i>	<i>H. fuisporum</i>
<i>H. nigellum</i>		<i>H. helodes</i>
<i>H. oreophilum</i>		<i>H. ingratum</i>
<i>H. pallidolabiatum</i>		<i>H. psammophilum</i>
<i>H. perexiguum</i>		<i>H. pusillum</i>
<i>H. pubescens</i>		
<i>H. spetsbergense</i>		
<i>H. subconcolor</i>		

After the release of the Supplement, further contributions were published within the above-mentioned North American project, among which two focusing on the taxa published by C.H. Peck and W.A. Murrill (EBERHARDT *et al.* 2022a and EBERHARDT *et al.* 2023a). As a result, (see the list below) three of the above names, as well as two more among those treated in both the Monograph and the Supplement, had to be changed because they had turned out to be synonyms of Peck's and Murrill's species, the names of which, having priority, were adopted as current.

H. velatum (Peck) Peck 1910 is an earlier name for *H. dunense* L. Corb. & R. Heim 1929; *H. album* Peck 1902, for *H. fragilipes* Romagn. 1965; *H. paludicola* Murrill 1917, for *H. hygrophilum* Poummarat & Corriol 2016 and *H. discomorbidum* (Peck) Peck 1910, for both *H. oreophilum* Beker & U. Eberh. 2015 and *H. clavulipes* Romagn. 1965.

Furthermore, it is to be considered that since the publication of the Monograph there has been a slight increase in the number (87) of the *Hebeloma* species present in Europe, due to the publications of two taxonomic novelties and the report of an additional North American species from Europe.

H. adherens Monedero & P. Alvarado, a species to date known only from Cantabria, Spain (type), in association with *Fagus sylvatica* L. (MONEDERO & ALVARADO 2020), and Switzerland, in association with *Picea abies* (L.) H. Karst. Phylogenetically, it is recovered in a separate clade, close to but distinct from *Naviculospora*. This taxonomic addition is accommodated in a section of its own, *Hebeloma* sect. *Adherentia*.

H. arcticum Beker & U. Eberh., a species originally described from Greenland, which has also been reported from Siberia and, in Europe, from Iceland. It belongs in *Hebeloma* sect. *Denudata* subsect. *Crustuliniformia*, within which it can easily be recognized by the combination of almost smooth and rather strongly dextrinoid spores, which is unique in this subsection (EBERHARDT *et al.* 2021).

H. excedens (Peck) Sacc. 1887, a species originally described from Saratoga county, New York (USA), growing with *Pinus* sp. and belonging in *Hebeloma* sect. *Hebeloma* subsect. *Hebeloma*, which, morphologically and molecularly, is very close to *H. mesophaeum*. Macroscopically, Peck emphasized the exceeding pileus margin (*inde nomen*) as a separating character, which is certainly useful when present, but its occurrence is unfortunately inconsistent. To date, in Europe, the species has been recorded only from France (PECK 1872; EBERHARDT *et al.* 2021; EBERHARDT *et al.* 2022a).

At present, following the morphological and, where permitted, molecular study of all available types from around the world carried on by H.J. Beker's *Hebeloma* team, the number of names in *Hebeloma* worldwide considered current amounts to 135 (<https://hebeloma.org>). Eighty-seven are present in Europe (of which eight originally described from Northern America); 75 occur in Northern America (Greenland, USA and Mexico) (including 36 originally described from Europe), and 17, in Temperate and Tropical Asia, Southwestern Pacific and Australasia.

The two Italian collections presented here are the first confirmed records of *Hebeloma pusillum* and *H. subconcolor* for the Italian territory. As already pointed out in the Supplement, with "confirmed" it is just meant that the identifications are both morphologically and molecularly in line with the delimitations adopted in the Monograph for the two species. It is worth reminding, in fact, that before the publication of the Monograph and, in general, before the widespread adoption of molecular tools for species delimitation, there was wide disagreement as to interpretations and circumscriptions of *Hebeloma* species. Accordingly, including records for which it was not possible to conduct complete morphological and molecular analyses (requiring the availability of voucher material), and accepting them only based on descriptions or even mere inclusions in lists of species would only lead to misinformation.

For example, regarding past Italian records of *H. pusillum*, in ONOFRI (2005) are cited CERUTI *et al.* (1987-88), TOMEI *et al.* (1997) and GAGGIANESE *et al.* (1999). As it is obvious, they all date back to a period in which the genus was still in a state of uncertainty over species circumscriptions and, further, they consist only of checklists with information only about habitat and no indications of collection numbers or fungaria where they might be deposited. In addition, while in GAGGIANESE *et al.* (1999) at least the habitat of *H. pusillum* (under *Salix* on wet ground) is the one most common, in CERUTI *et al.* (1987-88), it is recorded as growing with *Fagus*, which is unlikely according to present knowledge. Therefore, not taking these reports in due consideration is not playing down these researchers' work, it just stresses the fact that it is impossible to judge such records only based on their inclusions in a checklist.

Materials and methods

The collections related to the two species object of the present work were first identified morphologically soon after collection and then dried samples were sent to U. Eberhardt and H.J. Beker, who after obtaining sequences from them, assessed the molecular congruence of the identifications.

The Monograph and, to a lesser extent, the Supplement provide all the necessary information on the genus *Hebeloma* and a detailed analysis of all the characters currently utilized in species delimitation. The format of species description follows that adopted in the Supplement. Habitat data, however, now also include specifications from the IUCN Habitats Classification Scheme and Terrestrial Ecoregions of Italy (BLASI *et al.* 2018). The observational protocol,

descriptive terminology and coding conventions follow that specified and used in the previous two works and the contributions published by H.J. Beker's *Hebeloma* team. It is worth remembering, however, that the average spore values were determined by measuring at least 50 spores from each collection. Since spore prints were not available, measures were taken from a lamellar squash of exsiccate material, but an assessment of the diagnostic spore features in naturally shed (mature) spores was preliminarily made observing a mount from the stipe apex. In an attempt to reduce subjectivity in the degree of spore dextrinoidity, coded according to VESTERHOLT'S (2005) scale (D0; D1; D2; D3; D4), the codes in the descriptions are correlated to colours from KORNERUP & WANSCHER (1978). Given its diagnostic value, the average width of the apex (A) of cheilocystidia was assessed based on at least 100 cheilocystidia from unsquashed mounts of lamellar sections, unselectively measuring all apices properly in focus within a field. The average measures of the other cheilocystidium features (L, M and B) were obtained by measuring in excess of 30 entire cheilocystidia from squashed mounts. They were chosen to provide an acceptably accurate picture of the relative percentages of cheilocystidium types observed, L, A, M and B being the initial letters of *length*, *apex width*, *median width* (approximately the narrowest median point, but see below) and *basal width* (width of base or, if present, basal swelling), respectively. Three of these measures (A, M and B) are also used to calculate the A/M, A/B and B/M ratios, which are considered useful to make the most of cheilocystidium shape. Since where to measure the median width (M) might be controversial, here is reported what further specified in the Supplement (p. 8):

"Where [M] should be measured does, in practice, rather depend on the cystidial shape. Where there is a constriction below the apex, as often happens with species from H. sect. Denudata, for example, M should be measured at this constriction, thus giving a measure of the constriction. Where the top half of the cystidium is more or less cylindrical (as often happens in H. sect. Hebeloma) or where the cystidium was more or less cylindrical in its entire length (as often happens in H. sect. Scabrispora) or where the cystidium was more or less gently clavate from the base towards the apex (as often happens in H. sect. Velutipes), M should be measured about a third of the way down from the apex (not necessarily at the narrowest point, which might often be in the lower part of the cystidium). This description is not as precise as one might wish, but unfortunately the cystidia in Hebeloma are not as regular as one would hope".

The drawings in **Figure 1**, however, show better than words can describe where the measures should be taken.

The standardized terms used in the description of lamellar density (L = number of full-length lamellae) follow GRILLI *et al.* (2016): distant (L < 32), subdistant (L < 40), close (L 40-59), subcrowded (L 60-80), and crowded (L > 80).

The Database referred to in the present paper and elsewhere is the one that has been built by H.J. Beker's *Hebeloma* team over the last 20 years. In the Database, hosted on version 12 BioloMICS from Bioaware SA NV, are stored all the data (morphological and molecular alike, as well as images) on some 10,000 collections (including all types worldwide that could be located and loaned) related to the 135 *Hebeloma* species at present regarded as current. This huge mass of data can be accessed on the website, <https://hebeloma.org>. The website offers exhaustive up-to-date species descriptions, accurate information about every *Hebeloma* name published to date, and tools for the comparisons of species, species parameters, species geography and habitats, as well as a species Identifier based on AI machine learning. (BARTLETT *et al.* 2021; BARTLETT *et al.* 2022a; BARTLETT *et al.* 2022b).

In the macroscopic descriptions, colour shades are correlated to colours in MUNSELL (1975) and/or KORNERUP & WANSCHER (1978).

The voucher material of the collections presented are stored in the first author's and H.J. Beker's fungaria.

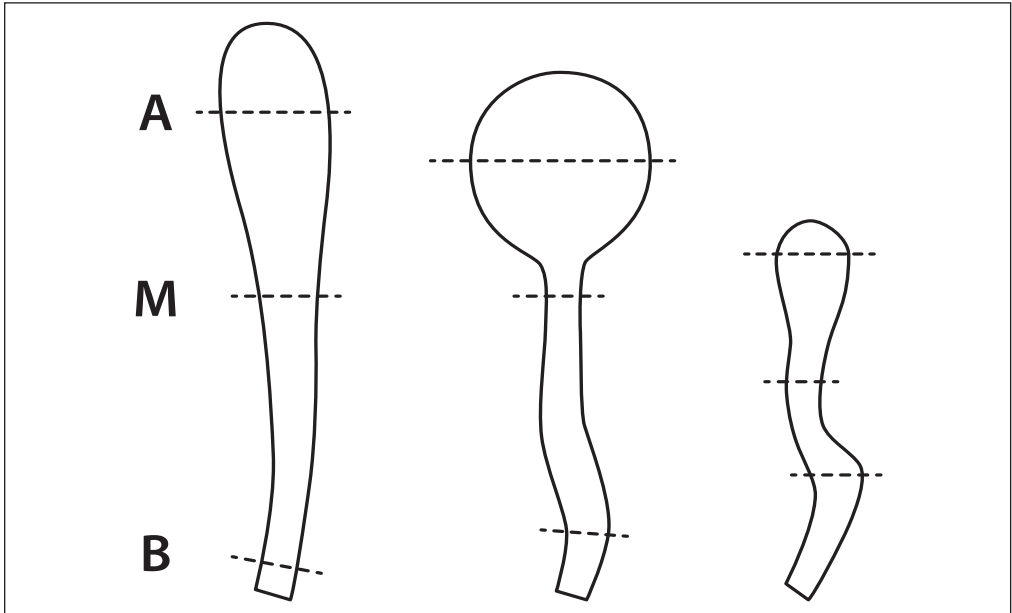


Fig. 1. Measuring cystidia width of apex (A), width at narrowest point in central region (M), and maximum width in lower half (B) illustrated on left to right gently clavate, clavate-stipitate and clavate-ventricose cystidia. Reproduced from EBERHARDT *et al.* (2022a).

Taxonomy

Hebeloma sect. *Denudata* subsect. *Crustuliniformia* Quadr.

Doc. Mycol. 14: 30 (1985)

Hebeloma pusillum J.E. Lange

Flora Agaricina Danica V. Society for the Advancement of Mycology in Denmark and Danish Botanical Society, Copenhagen: page 4 (105 p.) (1940)

Types: Lange, Danmarks Agaricaceer. Held at Herbarium, Natural History Museum of Denmark, University of Copenhagen: 4 (1893-1910) pl. 460, lectotype (icon) designated by Beker *et al.*, *Hebeloma* (Fr.) P. Kumm.: (2016) page 257 (MBT202550) **DENMARK:** F, Langeskovene s of Morud UTM NG7444 TBU 29 (approx. N55.434, E10.199, alt. approx. 30 m a.s.l.) on boggy soil in willow thicket under *Salix* sp., 16 Oct. 1991, J. Vesterholt (91-685) (Epitype. herbarium acc. no. C JV-91-685, HJB1000128). Epitype designated by Vesterholt, *Fungi N. Eur.* 3: 82 (2005).

Homotypic synonyms: *Hebeloma pusillum* J.E. Lange, *Dansk Botanisk Arkiv* 9 (6): 6 (1938); *Hebelomatis pusillum* (J.E. Lange) Locq.; *Flore Mycologique* Vol III - Text. *Cortinariales* A: 146 (1979) ["1977"]

Heterotypic synonyms: *Hebeloma pusillum* var. *longisporum* Bruchet, *Bull. Mens. Soc. Linn. Lyon* 39, supplement 6: 126 (1970); *Hebeloma vaccinum* var. *cephalotum* Enderle & Vesterh., *Die Pilzflora des Ulmer Raumes*: 379 (2004)

Original diagnosis

Pileo 0.8–2 cm, e conico-convexo expanso, alutaceo; umbone minuto, prominente, spadiceo-rufo; velo nullo. *Lamellis* latis, margine guttulatis, e pallido incarnato-argillaceis. *Stipite* 2-4 cm × 1-2.5 mm, albo,

pulverulento. Odor leviter raphanoideus. Sporis ellipsoideo-limoniformibus, 12-13 × 6 µm. Cystidiis clavatis, 45-60 × 6-11 µm. In Salicetis paludosis. 1907.

Macroscopic description (EG221031.01; HJB20668) (Figure 2.0)

Pileus 15-24 mm in diameter, subapplanate to applanate, shallowly umbonate, orbicular to slightly lobate, margin straight to revolute, smooth, bearing no velar remnants. Surface smooth, tacky when moist, almost unicoloured and rather dark, blackish-violet (16E3/4) to purplish-grey (13D/E3) for most of the radius, excepting a lighter-coloured narrow marginal belt where the colour is partly masked by a frosted overlay, to bicoloured, with shades of dark brown (6E8; 7E5) on the disc, shades of brownish-orange on the peridiscal area and whitish on the margin.

Lamellae adnate to emarginate, subventricose, 2-3 mm broad, density in the subdistant range (L 34-35); edge whitish, fimbriate, indistinctly beaded, and spotted brown.

Stipe 25-43 × 2.0-3.5 mm, cylindraceous with slightly clavate base, white, tending to discolour brownish downwards on handling, pruinose at the apex, at times slightly twisted; stuffed. No cortinate velar remnants. Stipe Q (7.1) 11.6-21.5.

Context hardly fleshy, whitish, tending to brownish in lower stipe. Smell raphanoid, taste not recorded. Slenderness measure: (8.1) 19-54.4.

Microscopic description (Figures 2.1, 2.2, 2.3 and 2.4)

Spores (11) 11.4 12.6 14 (14.4) × 5.5 6.1 6.6 (7.4) µm, Q (1.87) 1.90 2.07 2.32 (2.36), amygdaloid to fusoid. Ornamentation subdistinct to distinct. Myxosporium undulating to rugulose, occasionally scantily vesiculate. Dextrinoidity weak (4B3; 4C4). Spore Code: **O2 O3; P0 P1, D2.**

Basidia 24-38 × 7.2-9.6 µm, avg. Q 3.5, clavate to clavate-constricted, four-spored.

Cheilocystidia (22) 24 46 71 (96) × (4.8) 5.6 9.5 13.6 (16) × 3.2 4.0 5.2 (6.0) × 3.0 4.8 7.0 (7.2) µm, lamellar edge sterile. Main shape clavate-stipitate to capitate-stipitate, not infrequently with slightly widened base, often also capitate-lageniform or clavate-lageniform. Occurrence of special features: apex at times spatulate; high refringent wall thickening occasionally apical, wall up to 0.8 µm thick. Cheilocystidium ratios: **A/M = 2.37; A/B = 2.19; B/M = 1.20.**

Pleurocystidia none noted.

Habit and habitat: scattered on grassy ground with *Phragmites australis* (Cav.) Trin. ex Steud. and *Carex* sp., in hygrophilous broadleaf woodland with *Populus tremula* L., *P. alba* L. and *Alnus glutinosa* (L.) Gaertn. Former peat bog near water with floating plants (*Laminetum*). **IUCN habitat:** 5. Wetlands (inland); 5.4 Bogs, marshes, swamps, fens, peatlands. **Italian Ecoregion:** 1 Temperate Division; 1 A Alpine Province; 1A2 Central and Eastern Alps Section; 1A2b Dolomiti and Carnia Subsection.

ITALY: Trentino-Alto Adige, Valsugana, Lago Pudro, Pergine Valsugana (TN), (N46.0775, E11.223888, alt. 525 m a.s.l.), *Populus tremula*, *P. alba* and *Alnus glutinosa*, Oct. 31 2022, A. Fellin (AF-055-2022; EG221031.01; HJB20668).

Additional collections cited: **France,** Ain, Saint-Etienne-du-Bois, Bourg, (approx. N46.26, E5.28, alt. approx. 30 m a.s.l.), *Salix aurita* L. and *Alnus glutinosa*, Oct. 19 1964, G. Bruchet (LY BR64-36; HJB1000067; EG641019.01). This is the holotype of *Hebeloma pusillum* var. *longisporum*.

Notes and comments

Hebeloma pusillum, placed by LANGE (1940) (Lectotypus **Figure 3**) in an unranked group “*a Ingrata*” (because of the “smell of radish”) of *Hebeloma* sect. *Denudata*, according to the systematics proposed in the Monograph, is a typical member of *Denudata* subsect. *Crustuliniformia* as clearly evidenced by the clavate-stipitate main shape of cheilocystidia. Within the



Fig. 2.0. *Hebeloma pusillum* (EG221031.01), scale bar 1 cm.

Photo credit: Alessandro Fellin

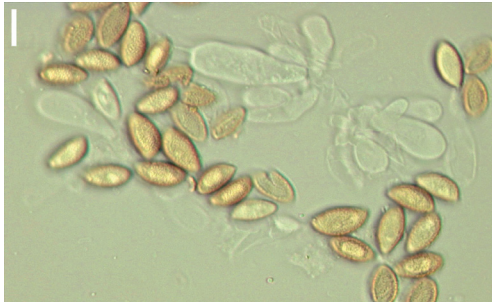


Fig. 2.1. *H. pusillum* (EG221031.01). Spore ornamentation. Scale bar 10 μ m.

Photo credit: Alessandro Fellin



Fig. 2.2. *H. pusillum* (EG221031.01). Spore in Melzer's. Scale bar 10 μ m.

Photo credit: Alessandro Fellin



Fig. 2.3. *H. pusillum* (EG221031.01). Cheilocystidia. Scale bar 10 μ m.

Photo credit: Alessandro Fellin

subsection, it can easily be recognized macroscopically by the diminutive size, tall and slender stature, two-toned pileus and low lamellar density (L 20-48), while the weakly dextrinoid, mostly fusoid spores, on average exceeding 11 μ m in length, and the high percentage of capitate-stipitate cheilocystidia do resolve any possible identification doubts.

The above collection offers evidence of a perfect macro-, microscopic (see the Comparison table below) and molecular congruence with *H. pusillum* as delimited in EBERHARDT *et al.* (2015) and the Monograph.

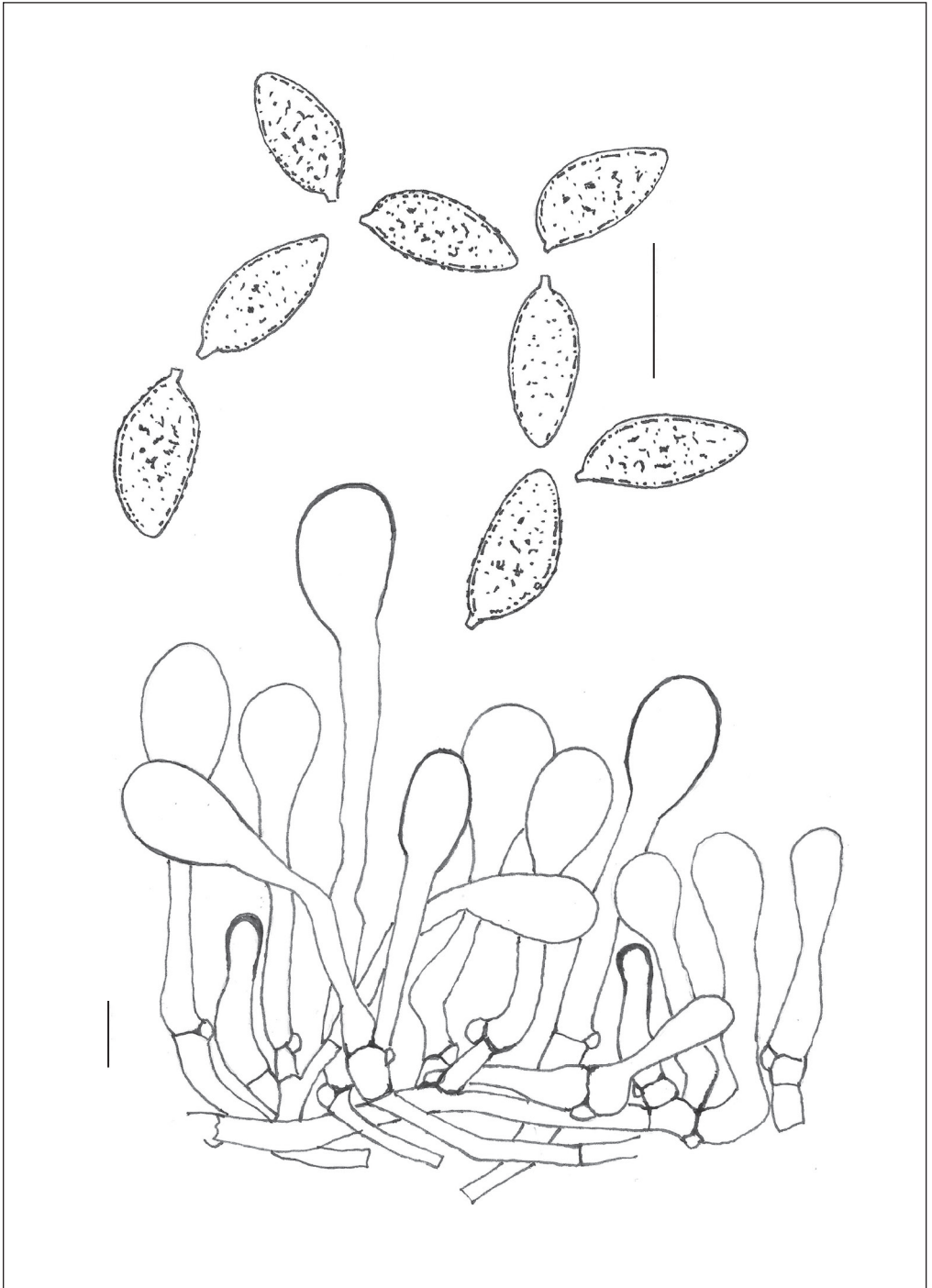


Fig. 2.4. *Hebeloma pusillum* (EG221031.01). Spores and cheilocystidia. Scale bars 10 μ m.

Plate credit: Edmondo Grilli

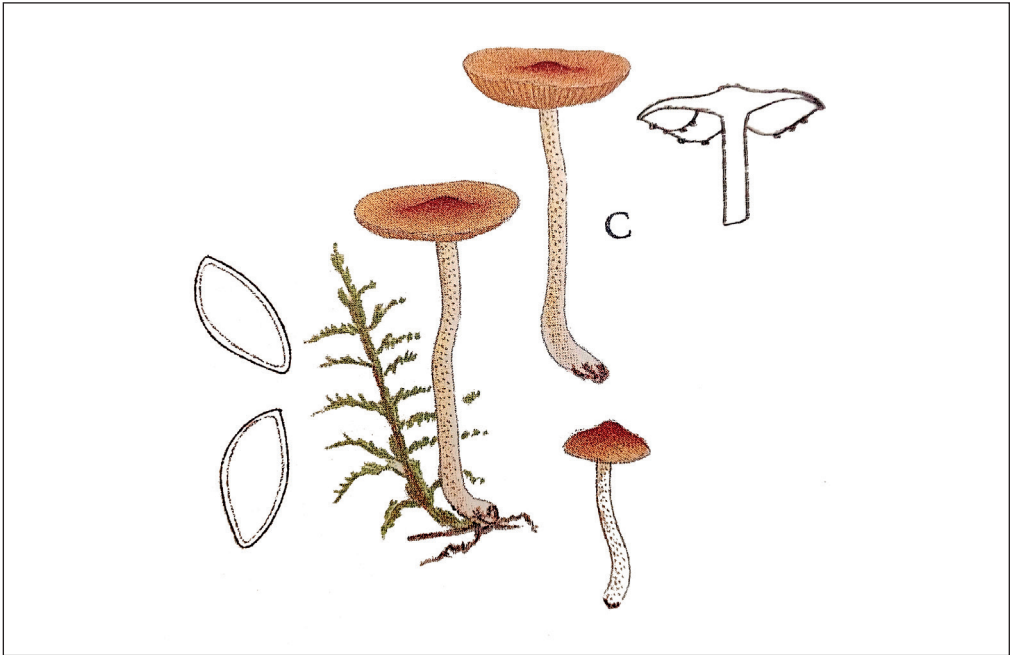


Fig. 3. Lectotypus (icon) of *Hebeloma pusillum* designated by BEKER *et al.* (2016).

Reproduced from plate 120c in *Flora Agaricina Danica V.* Society for the Advancement of Mycology in Denmark and Danish Botanical Society, Copenhagen: 4 (1940).

Regarding habitat and host preferences, *Hebeloma pusillum* generally grows in lowland or hilly areas, often in wetlands, and its preferred photobiont associate are *Salix* (95.7%) and occasionally *Alnus* (4.3%). When found in mixed woodland, other possible hosts are *Betula*, *Populus*, *Picea* and *Pinus*, but in this case it is impossible to establish which of the trees is the real partner. The putative mycorrhizal associate of the material presented is most likely *Alnus*, but *Populus* also present in the site cannot be ruled out.

The species with which it can possibly be confused are *Hebeloma luteocystidiatum* Beker, Vesterh. & U. Eberh. and *H. helodes* J. Favre, both belonging in the same subsection. The one more apt to ingenerate confusion is *H. luteocystidiatum* described only a few years ago (EBERHARDT *et al.* 2015) and already treated at length in both the Monograph and, for what concerns Italy, the Supplement. However, even if they share the same habitat, a rather similar stature, low lamellar density and have comparable spores and cheilocystidia, they are morphologically separable through pileus colours, generally duller in the latter species, and the cystidial apex that is consistently thick-walled (Figures 4.0 and 4.1) and yellowish under the microscope (*inde nomen*). Additionally, despite a wide overlap in measures, in the latter species the spores tend to be less long, less fusoid in shape and have a less distinct ornamentation (O2).

The confusion of *Hebeloma pusillum* with *H. helodes* J. Favre (FAVRE 1948) can now be considered dated, having had currency especially in the decades at the close of the past century. It followed the misinterpretation of *H. helodes* by BRUCHET (1970), who credited Lange's species with shorter spores and, consequently, had to propose *H. pusillum* var. *longisporum* (now a heterotypic synonym) (Figure 5) for a collection with roughly similar aspect, "mais de plus petite taille (...) plus largement coloré au disque (...) aux spores beaucoup plus grandes". At any rate,



Fig. 4.0. *Hebeloma luteicystidium* (EG800727.01). Republished from the Supplement.

Photo credit: Bruno De Ruvo

H. helodes is easily distinguished on its consistently shorter spores, on average not exceeding 11 μm in length, less slender basidiome build and the lighter, much less contrasted pileus colours. Finally, *H. helodes* associates with a wider range of hosts than *H. pusillum*, even if most frequently it also associates with *Salix* (53.6%).

For completeness sake, an additional species that might be a cause of confusion is *Hebeloma salicicola* Beker, Vesterh. & U. Eberh. (EBERHARDT *et al.* 2015). This is another medium to small species having a strong preference for *Salix* (95.5%) and with comparable spores and cheilocystidia for what concerns size. However, the stature is much less slender, with a facies calling to mind that of *H. vaccinum*, the spores tend to have a stronger reaction in Melzer's (D2 D3 vs D1 D2) and the percentage of clavate-ventricose cheilocystidia is higher than it generally is in the members of *Denudata* subsect. *Crustuliniformia*.

According to present data, *Hebeloma pusillum* occurs only in the European continent, where it has been recorded from Belgium, Denmark, France, Germany, Isle of Man, Italy, Netherlands, Norway, Spain and Wales. Interestingly, 32 out of 38 collections in the Database are from lowland to hilly areas (alt. between 0 and 320 m a.s.l.). Only rarely (three) are they from submontane areas of Germany, Italy and Spain (alt. 455, 525 and 670 m a.s.l. respectively), and three more from montane areas of the French Jura range (940, 940 and 1350 m a.s.l. respectively).

Apart from the reports discussed above (Introduction), recently, *Hebeloma pusillum* has also been included in the Checklist of Sicilian Macrofungi (FERRARO *et al.* 2022), and collections of the species are reported for the provinces of Catania and Messina (with no indication of habitat though). Regrettably, our request to the herbarium SAF for the loan of the related exsiccata could not be granted because the specimens appear to be lost. Therefore, the above-mentioned collection from Trentino is the first confirmed record for Italy.

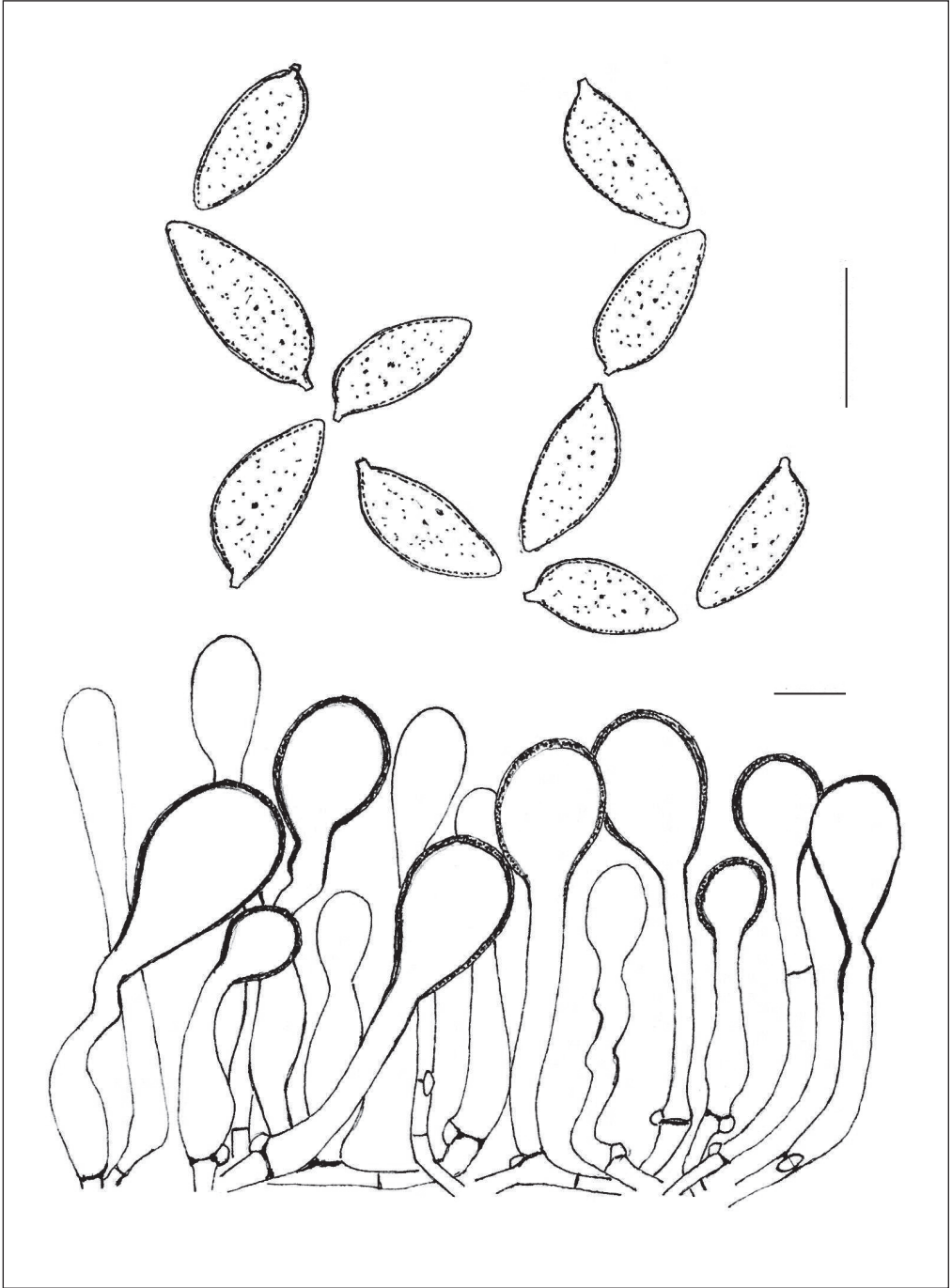


Fig. 4.1. *Hebeloma luteicystidium* (EG080727.01). Spores and cheilocystidia. Scale bars 10 μ m. Republished from the Supplement. Plate credit: Edmondo Grilli

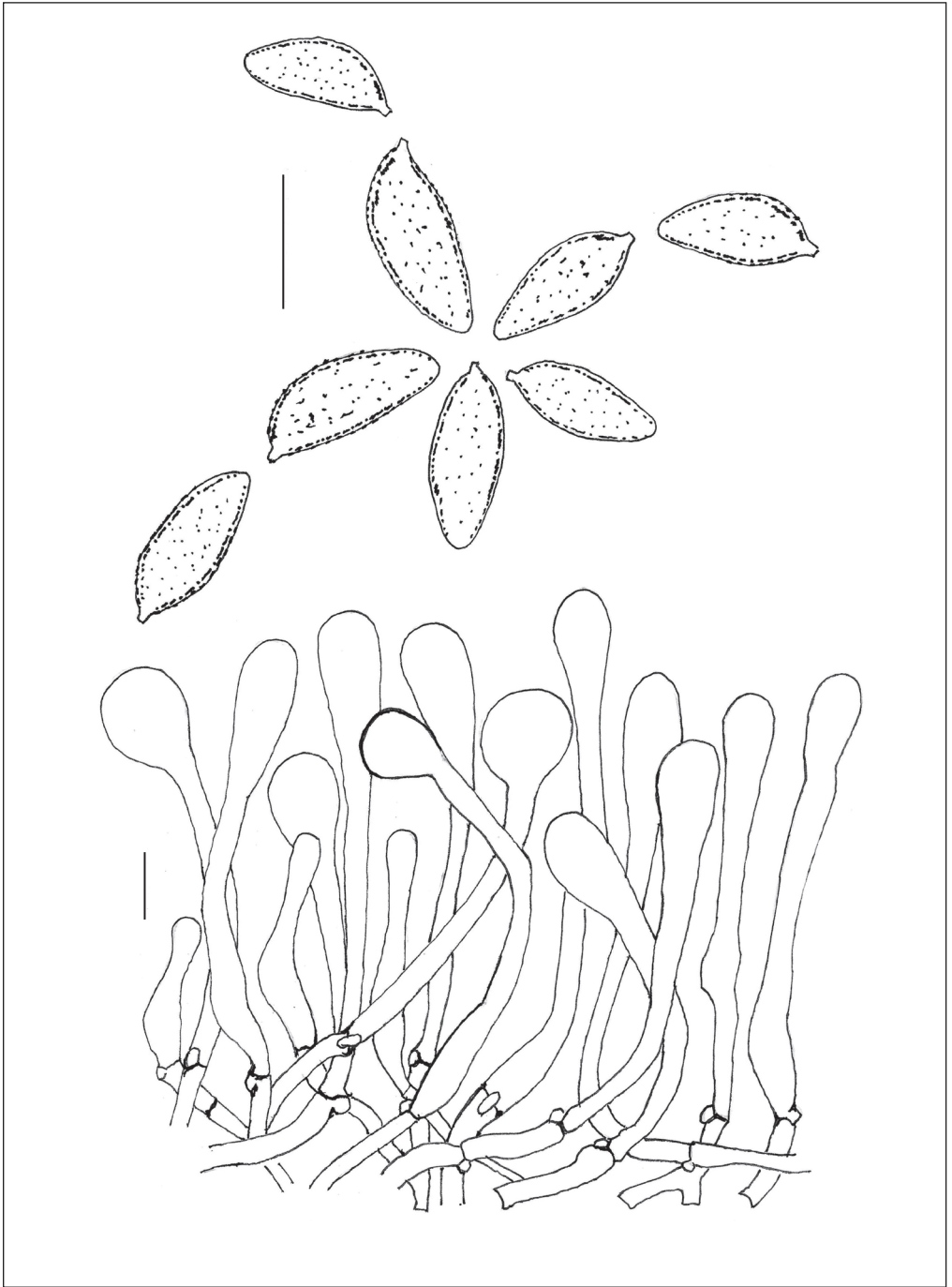


Fig. 5. *Hebeloma pusillum* (LY BR64-36, this is the type of *H. pusillum* var. *longisporum*). Spores and cheilocystidia. Scale bars 10 μ m.
Plate credit: Edmondo Grilli

Comparison tables

	Sp. length	Sp. width	Sp. Q	Ch. L	Ch. A	Ch. M	Ch. B
<i>H. salicicola</i>	11.1-13	6.0-7.5	1.64-2.00	44-63	8.0-10.7	3.7-5.0	3.4-6.0
<i>H. helodes</i>	9.1-11	5.0-6.3	1.61-2.02	42-68	8.0-11.4	3.7-5.1	3.0-5.4
<i>H. luteocystidium</i>	11.4-12.3	6.2-7.4	1.66-1.90	50-62	8.8-10.4	3.7-4.7	3.6-4.9
<i>H. pusillum</i>	11.4-13.6	5.6-7.5	1.69-2.22	41-70	7.4-10	3.8-4.8	3.6-7.0
LY BR64-36	11.4	5.8	1.96	55	8.7	4.2	3.9
EG221031.01	12.6	6.1	2.07	46	9.5	4.0	4.8

	Lam.	Spore Codes			Cheilocystidium Ratios		
	L	O	P	D	A/M	A/B	B/M
<i>H. salicicola</i>	28-55	O2 O3	P0 P1 (P2)	D2 D3	1.77-2.63	1.38-2.82	0.94-1.32
<i>H. helodes</i>	32-54	O2 O3	P0 P1 (P2)	D0 D1	1.90-2.86	2.02-3.38	0.76-1.17
<i>H. luteocystidium</i>	21-28	(O1) O2	P0 P1 (P2)	(D0) D1 D2	2.27-2.77	2.21-2.68	0.98-1.22
<i>H. pusillum</i>	20-48	O2 O3	(P0) P1 P2	(D0) D1 D2	1.66-2.71	1.10-2.52	0.94-1.63
LY BR64-36	35	O2	P1	D0 D1	2.28	2.48	0.94
EG221031.01	34-35	O2 O3	P0 P1	D2	2.37	2.19	1.20

Here and below (*H. subconcolor*), the quantitative data of all species in the tables are from the Database, repeatedly accessed during the drafting of the work. Since the ranges are subject to variation with the addition of new collections, a final check was made shortly before submission for publication. To give an idea of the reliability of the comparative data, there follows the number of collections, all checked molecularly, from which they are derived: *H. salicicola* 57, *H. helodes* 67, *H. luteocystidium* 12 and *H. pusillum* 38.

Hebeloma sect. *Velutipes* Vesterh.

Ann. Micol. A.G.M.T. 1: 60 (2004)

Hebeloma subconcolor Bruchet

Bull. Mens. Soc. Linn. Lyon 39, supplement 6: 127 (1970)

Types: FRANCE: Cirque du Vallonnet (Vanoise; Savoie) (approx. N45.45, E7.03, alt. approx. 2500 m a.s.l.) on acidic, mossy, sandy soil in alpine meadow riverside under *Salix herbacea* L., 9 Oct. 1969, G. Bruchet (Holotype. herbarium acc. no. LY BR69-12, HJB1000044, EG691009.01).

Homotypic synonyms: *Hebelomatis subconcolor* (Bruchet) Locq.; *Flore Mycologique Vol III - Text. Cortinariales A*: 146 (1979) [1977]

Original diagnosis

Cortina nulla; pileo parvo, circiter 16 mm lato, haud viscoso, subtiliter toto pruinato, concolore, e brunneolo vel brunneo murino, carne pallide brunnea vel e brunneola murina; stipite toto dense pruinoso,



Fig. 6.0. *Hebeloma subconcolor* (EG210818.01).

Photo credit: Alessandro Fellin



Fig. 6.1. *H. subconcolor* (EG210818.01). Particular of lamellar density.
Photo credit: Alessandro Fellin



Fig. 6.2. *H. subconcolor* (EG210818.01). Spore ornamentation.
Scale bar 10 μ m. Photo credit: Alessandro Fellin



Fig. 6.3. *H. subconcolor* (EG210818.01). Spores in Melzer's.
Scale bar 10 μ m. Photo credit: Alessandro Fellin



Fig. 6.4. *H. subconcolor* (EG210818.01). Cheilocystidia. Scale bar
10 μ m. Photo credit: Alessandro Fellin

pileo subconcolore, plerumque e breunneolo murino; lamellis crassis, parum stipatis, siccis, in juventute ad colorem murinum quoque vergentibus; odore nullo. Sporis 10–11 × 6–6,5 μm, ovatis, amygdaliformibus, non maximis, verrucosis vel verrucosis, ectospora s.m. opt. haud manifesta; pilis marginum summis paulatim dilatatis, usque ad 9–10 μm latis. Species alpina, inter Salices herbaceas crescit.

Macroscopic description (EG210818.01; HJB20678) (Figures 6.0 and 6.1)

Pileus 10-25 mm, at first convex, then plano-convex to subapplanate, at times with a broad low umbo, orbicular or slightly lobate, margin involute to inflexed, smooth bearing no universal veil remnants. Surface tacky when moist, smooth, occasionally ocellated, generally bicoloured, shades of dark brown or grey-brown (7.5YR4/2; 5/2) on the disc, mottled with shades of dull orangish-yellow (10YR7/6; 8/6) on the peridiscal area, lighter-coloured, pale brownish, yellowish-whitish or dingy whitish, towards the margin.

Lamellae adnate to emarginate, subventricose, 3-4 mm broad, density in the distant range (L 28-32), occasionally intervenose; edge whitish, fimbriate, dry but with sparse brown spots.

Stipe 20-35 × 2-4 mm, subcylindrical, slightly flaring upwards, dingy whitish, tending to discolour brownish towards the base, pruinose on the apical third, fibrillose-substrate below; stuffed to fistulose; no cortinate velar remnants.

Context firm, whitish discolouring brownish especially in the stipe base; smell strongly raphanoid, taste not recorded.

Microscopic description (Figures 6.2, 6.3, 6.4 and 6.5)

Sporos (10.4) 10.6 11.5 12.2 (12.8) × (5.6) 6.2 6.5 7.0 (7.2) μm; Q (1.57) 1.66 1.78 1.91, shape amygdaloid, often with blunt apex, often ovoid in front view. Ornamentation hypo- to subdistinct. Myxosporium undilating or rugulose. Dextrinoidity weak (4C5-6; 5B4; 5B/C5; 5C7)). Spore Code: **O1 O2; P0 P1; D2.**

Basidia 24-30 × 8.0-8.8 (10) μm, avg. Q 3.2, clavate or clavate-constricted, four-spored.

Cheilocystidia 40 56 76 (78) × (5.2) 5.6 7.3 9.0 (10.4) × 4.0 4.9 5.0 (6.4) × 3.2 4.9 7.8 (8.0) μm, lamellar edge sterile; main shape gently clavate, less frequently subclavate-stipitate, but a large number are clavate-lageniform or clavate-ventricose, rarely lageniform. Occurrence of special features: refringent wall thickening apical, rather frequent and conspicuous (up to 2 μm). Cheilocystidium Ratios: **A/M = 1.50; A/B = 1.61; B/M = 1.0.**

Pleurocystidia none noted.

Habit and habitat: scattered on acidic, mossy ground in a *Salix herbacea* mat with sparse shrubs of *Salix* sp., in a wet zone close to a glacial stream. **IUCN Habitat:** 5. Wetlands (Inland); 5.11 Alpine wetlands (Includes alpine meadows, seepages, temporary waters from snowmelt).

Italian Ecoregions: 1 Temperate Division; 1A Alpine Province; 1A2 Central and Eastern Alps Section; 1A2a Pre-Alps Subsection.

Italy: Lombardy, Rhaetian Alps, Stelvio National Park, Berni hut, Valfurva, Gavia pass (SO), N 46.35769, E 10.50063, alt. 2500 m a.s.l., *Salix herbacea* and scanty shrubs of *Salix* sp., Aug. 18 2021, A. Fellin (AF-018-2021; EG210818.01; HJB20678).

Additional collections cited: **France,** Vanoise, Savoie, approx. N 45.45, E 7.03, approx. alt. 2500 m a.s.l., *Salix herbacea*, Oct. 09 1969. G. Bruchet (LY BR69-12; HJB1000044; EG691009.01). This is the holotype of *H. subconcolor*.

Notes and comments

The small basidiome size, low lamellar density, gently clavate main cheilocystidium shape and mycorrhizal association with dwarf willows clearly indicate that the best match among the

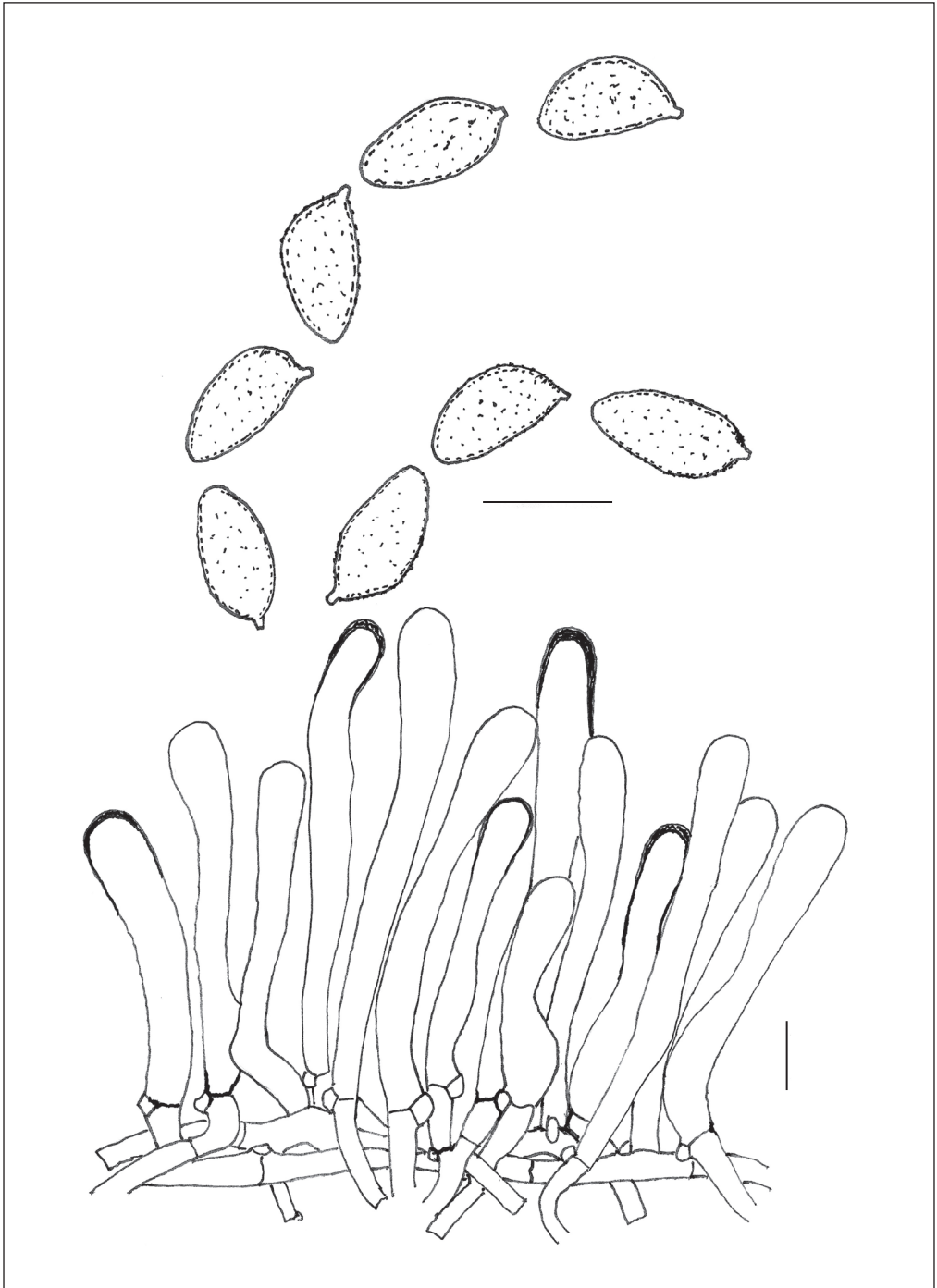


Fig. 6.5. *Hebeloma subconcolor* (EG210818.01). Spores and cheilocystidia. Scale bars 10 μ m.

Plate credit: Edmondo Grilli

current alpine/arctic species is with *Hebeloma subconcolor*, the low lamellar density excluding the possibility of an alpine collection of *H. velutipes*. In comparison with the data in the Database, to be noted only a negligible difference in average spore width (see the **Comparison table** below).

Hebeloma subconcolor is one of the taxonomic novelties erected by BRUCHET (1970). It was first described as a species of *Hebeloma* sect. *Denudata* subsect. B, including the species the lamellae of which are dry or only indistinctly beaded (droplets visible only through a magnifying glass), as opposed to those of subsect. A, in which were placed the species with lamellae “*franchement larmoyantes puis tachées par les spores*”. A few years ago, it was transferred into *H.* sect. *Velutipes* by GRILLI *et al.* (2016), on morphological and molecular grounds. The mostly gently clavate shape of the cheilocystidia, in fact, does clearly characterize *H. subconcolor* as a typical member of this section. The type revision of *H. subconcolor* was included in GRILLI (2008) (**Figure 6.6**). In Europe, its occurrence appears to be restricted to arctic tundra and alpine meadows mostly in association with dwarf *Salix*, another possible occasional associate being *Polygonum*.

The only species inviting a comparison is *Hebeloma aurantioumbrinum* Beker, Vesterh. & U. Eberh. Most of the quantitative data of the material being discussed does, in fact, fit the latter species, which, however, is a member of *Denudata* subsect. *Crustuliniformia* and, consequently, the main shape of its cheilocystidia is clavate-stipitate, with apices at times capitate or spathulate, rather different from the mostly gently clavate ones of *H. subconcolor*.

Thus far, *Hebeloma subconcolor* has been reported from Europe and Northern America (Greenland and Northwestern U.S.A.). Within Europe, there are records from Faroe Islands, Finland, France, Italy, Norway and Switzerland.

JAMONI (1993 and 2006) reported occurrences of *H. subconcolor* from Bocchetta delle Pisse, Alagna Valsesia (VC) and from Val d’Olen, in Piedmont, but his various collaborative attempts to locate the related *exsiccata* were regrettably unsuccessful. Therefore, for the time being, in Italy the only confirmed occurrence is in Lombardy.

Comparison tables

	Sp. length	Sp. width	Sp. Q	Ch. L	Ch. A	Ch. M	Ch. B
<i>H. aurantioumbrinum</i>	10.1-11.8	6.0-7.0	1.60-1.85	45-63	7.0-8.5	3.7-4.9	4.0-5.4
<i>H. subconcolor</i>	10.6-12.4	6.6-7.2	1.57-2.34	48-70	6.7-8.9	4.9-6.2	4.8-6.4
LY BR69-12	10.6	6.7	1.59	69	8.3	5.5	5.0
EG210818.01	11.5	6.5	1.78	56	7.3	4.9	4.9

	Lam.	Spore Codes				Cheilocystidium Ratios		
	L	O	P	D	A/M	A/B	B/M	
<i>H. aurantioumbinum</i>	26-39	(O1) O2	P0 P1	D1 D2	1.57-2.34	1.59-2.46	0.89-1.18	
<i>H. subconcolor</i>	20-32	O1 O2	P0 (P1)	D2 D3	1.37-1.71	1.36-1.86	0.92-1.13	
LY BR69-12	30	O1 O2	P0	D2	1.55	1.71	0.92	
EG210818.01	28-32	O1 O2	P0 P1	D2	1.50	1.61	1.0	

Number of collections in the Database from which the comparative data are derived: *H. aurantioumbrinum* (91), *H. subconcolor* (22).

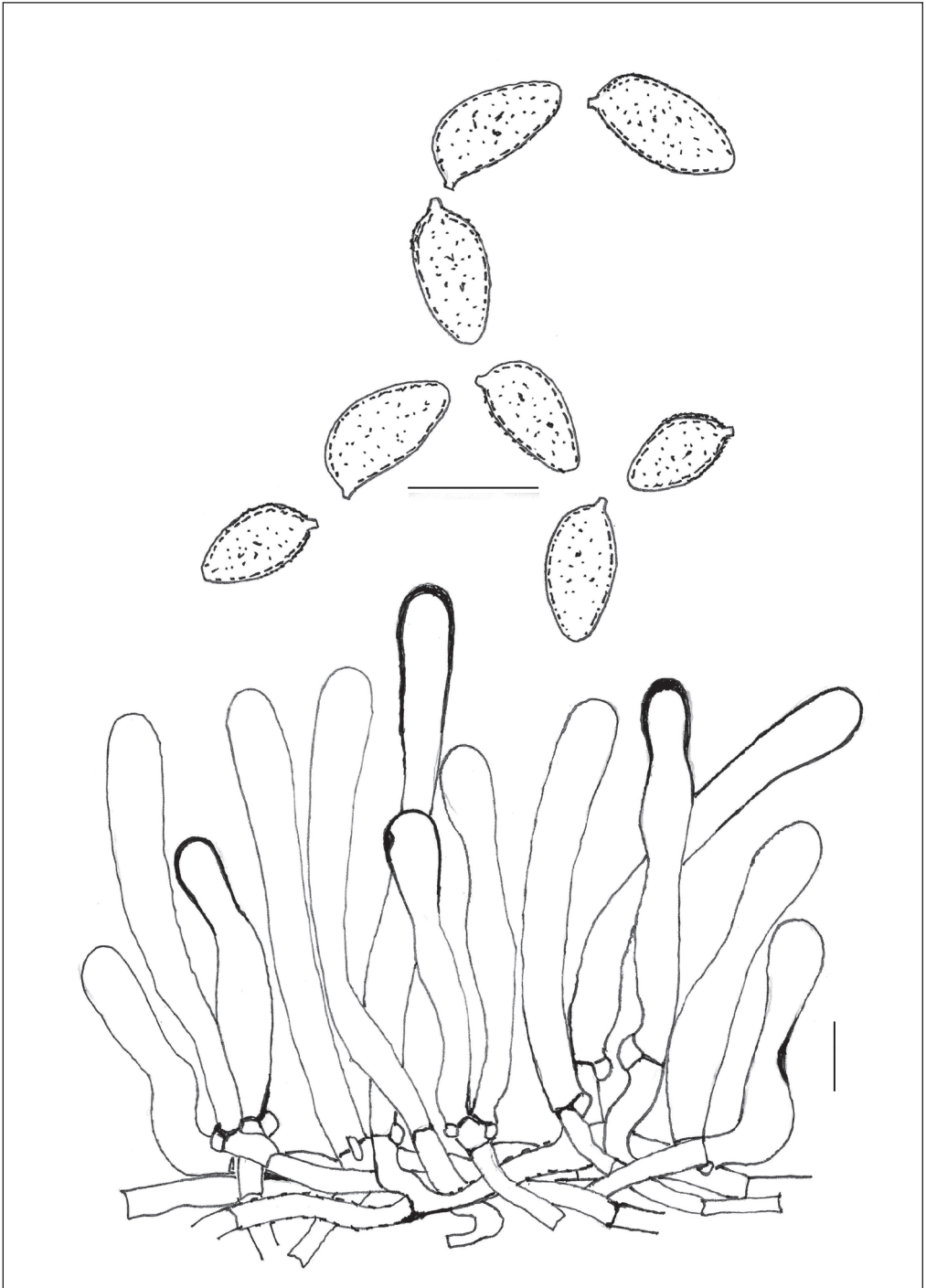


Fig. 6.6. *Hebeloma subconcolor* (LY BR69-12, this is the type). Spores and cheilocystidia. Scale bars 10 μ m. Plate credit: Edmondo Grilli

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