On two new taxa of Thecotheus

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On two new taxa of *Thecotheus*

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ABSTRACT

After mentioning the main features of ***Thecotheus***, the authors describe ***T. formosanus*** f. ***collariatus*** *f. nov.***,** comparing their European collections with the Far Eastern type and with similar species, and ***T. neoapiculatus*** *spec. nov.*, dwelling upon the differences between it and ***T. keithii***. An updated key to ***Thecotheus* spp.** is provided.

Key words: ***Ascobolaceae***, ***Pezizales***, ***Thecotheus***.

INTRODUCTION

Thecotheus Boud., in ***Pezizales*** Bessey - ***Ascobolaceae*** Boud. ex Sacc., is characterised by multiascal, angiocarpically developing, minute to medium, membranous-fleshy ascomata, with a rough or papillate disc at maturity. Asci are usually 8-spored, operculate, diffusely amyloid and congophilous, strongly protruding at maturity above the hymenial level. Spores are ellipsoidal, symmetrical to slightly or greatly inequilateral, hyaline to pale yellowish, thick-walled in the early stages, cyanophilous, smooth to verrucose, biapiculate or non-apiculate, rarely with a projecting collarette at the apiculus base, individually surrounded by a gelatinous perisporium. One or two kinds of paraphyses are observable.
The absence of a dark pigmented mature episporium separates ***Thecotheus*** from ***Ascobolus*** Pers. and ***Saccobolus*** Boud. and places it among the so called "*Ascobolei spurii*" (Boudier, 1869), whereas paraphyses lacking carotenoid pigments, together with a secondary spore ornamentation (Kimbrough & van Brummelen in Dissing & Schumacher, 1994), i.e. with a late wall deposition of epiplasmatic material, and a rarely present, not ***Oedocephalum***-like anamorph, are useful features to distinguish it from ***Iodophanus*** Korf, in ***Pezizaceae*** Dumort.
Most ***Thecotheus* spp.** are coprophilous, often with a specific dung preference. Their occurrence on faecal material is probably underestimated, particularly on natural conditions in the field, where the usually minute or small apothecia of species growing on this substrate escape the unaided eye or a low-magnifying lens, unlike the larger apothecia of non-coprophilous species. The early twenty-first century has been characterised by a newly increased interest in coprophilous fungi, whose study on incubation in damp chambers, with modern optical instruments, has allowed many mycologists to obtain useful taxonomic information by focusing on developmental steps of small or minute, often rare or even new species (Kutorga, 2000; Coué, 2003; Doveri, 2004; Bell, 2005). Four European finds on equine dung of a small ***Thecotheus***, very close to ***T. formosanus*** Y.-Z. Wang, have awakened our interest and suggested a comparison with the latter, which was described from cattle dung. Some distinct features induced us to consider this taxon to be a new form, which now we describe as ***Thecotheus formosanus*** f. ***collariatus***.
Another ***Thecotheus* sp.**, observed on cattle dung in the field, and characterised by unusually large ascomata for a coprophile, has additional distinguishing features, which induce us to describe it as a new species, ***Thecotheus neoapiculatus***.

MATERIALS AND METHODS

We separately studied fresh material of ***T. formosanus*** f. ***collariatus***, either on samples from the field or on samples kept moist by wet blotting paper, and mailed. Some immature specimens of the type collection were kept on dung and placed in a moist chamber, where they continued to develop. We later compared and combined our separate observations.
The holotype of ***T. neoapiculatus*** was studied on dried material, and the results were compared with those obtained by the collector (R. Cainelli) from fresh material.
The non-sterilised moist chamber was prepared following the methods suggested by Richardson & Watling (1997) and Richardson (2001), slightly modified by Doveri (2004).
The material was examined with a stereomicroscope (magnification x 7-45) and the microscopic study carried out with Prior and Nikon Alphaphot-2 binocular microscopes with 10x eyepieces and 4x, 10x, 40x (phase contrast), 100x (oil immersion) lenses, using water as mounting medium, Congo red, cotton blue in lacto-phenol and methyl blue as stains, Melzer's solution for determining the amyloid reactions.
The spore size (apiculi excluded) was measured on more than sixty spores from four ascomata of the holotype or syntypes and on about one hundred spores of the three (***T. formosanus*** f. ***collariatus***), or one (***T. neoapiculatus***), paratypes.

Thecotheus formosanus Y.-Z. Wang f. ***collariatus*** Doveri & Coué, *f. nov*.

Etym.: from the Latin " collare, is " = " collar " and " -atus " = " with ", referring to the spores of this form, which have a collarette at both ends.

A typo differt extremis sporarum partibus parvo collare praeditis.
Holotypus hic designatus: CLSM 017.05, fere triginta solitaria specimina ex fimo asinino (Equus asinus)*, in Gallica terra invento, collecta. Leg. J. Fournier, 26.11.05.*
Paratypi hic designati: JF 05128, ex fimo asinino, Leg. J. Fournier, 10.10.05; BC 0112, ex fimo asinino, Leg. J. Fournier, 9.11.05, in Gallica terra inventis; CLSM 03598, ex fimo equino (Equus caballus) *in Italica terra invento, Leg. G. Medardi & C. Gallinari, 2.1.98.*

Ascomata 0.3-1.3 mm diam., sessile, sometimes very short-stalked, columnar to barrel-shaped in the early stages, expanding later to obconical or shallow cup-shaped, pulvinate to discoidal or lenticular at maturity, membranous, translucent. Outer surface rough, furfuraceous, pale greyish from the very beginning, finally with brown shades, with some anchoring hyphae at the base. Margin scarcely differentiated, even, rarely lobate. Disc the same colour, slightly concave at first, becoming plane or somewhat convex, papillate at maturity. **Subhymenium** of strongly confused, hardly definable hyphae. **Medullary excipulum** of a *textura intricata*, with pale, septate, thin-walled, cylindrical or cylindric-ellipsoidal hyphae, 5-7 µm diam., running perpendicular or oblique to the hymenial surface, often continuing their way up to the ectal excipulum, inside which they form a *textura porrecta*, ending outside by means of cylindrical to claviform or subcapitate enlargements, 4-14 µm diam. **Ectal excipulum** a *textura globulosa-angularis* of polygonal or roundish, yellowish, fairly thin-walled cells, 12-20 x 7-12 µm, with spots of pale purple-brownish intercellular pigment, of more elongated, cylindrical or claviform, sometimes fimbriate cells, 10-30 x 5-10 µm, near the apothecial margin. Anchoring hyphae 2-3 µm diam., septate, thin-walled, arising from the outermost cells, usually with an enlarged base. **Paraphyses** of two kinds, both exceeding the asci and embedded in a scarcely pigmented, amorphous material: 1) most cylindric-filiform, 1.5-3 µm diam., thin-walled, sometimes branched, closely septate, containing scarce colourless vacuoles, strongly crowded, straight, not- or slightly inflated at the tips; 2) some thick-

walled (particularly at the apex), 4-5 µm diam., cylindrical, unbranched, very sparsely septate, containing a brownish pigment, inflated up to 7 µm at the tips. **Asci** strongly amyloid, 200-240 x 15-18 µm, cylindric, 8-spored, roundish or hardly flattened at the apex, with a slight subapical constriction, rather long-stalked. **Spores** 17.2-20 (-21) x (7.2-) 7.6-8.6 (-9.1) µm [(15.8-) 16.3-18.2 (-19.2) x 7.2-8.1 (-8.6) in JF 05128; (16.3-) 16.8-19.2 x (7.6-) 8.1-8.6 (-9.1) in BC 0112], most (more than 85 %) inequilateral (amygdaliform to rarely suballantoid), the others equilateral, narrowly ellipsoidal (Q = 1.94-2.75; Q = 2.19), hyaline to pale yellowish, obliquely to vertically uniseriate, surrounded by an ephemeral gelatinous sheath, with granular contents in the early stages, evenly dotted to verruculose, with a strongly cyanophilous, 3-4 µm wide, up to 2 µm high, cylindrical collarette above each pole, supporting a congophilous and cyanophilous, hemispherical to subconical apiculus, 3-4 x 2-4 µm.

EXAMINED MATERIAL: FRANCE: 1) Las Muros, Rimont, Ariège (09), 480 m, *MEN : 2047B, about thirty superficial, scattered specimens, on donkey dung, J. Fournier, 26.11.05, **CLSM 017.05 (holotype). 2) Las Muros, Rimont, Ariège (09), 480 m, *MEN : 2047B, on donkey dung, J. Fournier, 10.10.05, **JF 05128 (paratype). 3) Las Muros, Rimont, Ariège (09), 480 m, *MEN : 2047B, on donkey dung, J. Fournier, 9.11.05, **BC 0112 (paratype). **ITALY**: Salò (BS), 200 m, on horse dung, G. Medardi & C. Gallinari, 2.1.98, **CLSM 03598 (paratype). **TAIWAN**: type of ***T. formosanus*** f. ***formosanus***.
*Maille Elémentaire Nationale ** Personal herbaria of the authors

Thecotheus neoapiculatus Doveri & Coué, *spec. nov.*

Etym.: from the Greek " νέος, α, ον " = " new " and from the Latin" -apiculatus " = " with apiculi ", referring to a new species, which has apiculate spores, resembling those of ***T. apiculatus*** (synonym of ***T. keithii***).

Ascomata superficialia, solitaria vel saepius gregaria, 0,5-5 mm diam., sessilia vel aliquando substipitata, subglobosa ab initio vel columnaria, usque ad turbinata, deinde orbiculata vel pulvinata vel etiam scutellata, membranacea, aliquando irregulari, initio involuto, deinde applanato, prominenti margine praedita. Receptaculum furfuraceum usque ad tomentosum, griseopallidum vel albidogriseum. Discus plus minusve concolor, fere concavus ab initio, deinde planus vel convexus, ex protrudentibus ascis granulatus. Medullare excipulum e textura intricata compositum, cum hyphis 4-16 µm latis. Excipulum ectale e textura globulosa-angulari, cum porrecta permixta, constitutum, cum rotundis vel angulatis, 9-25 x 5-14 µm, ad marginem cylindratis vel claviformibus cellulis. Paraphyses uniformes, filiformes, 1-2 µm diam., simplices vel furcatae, hyalinae, ascos excedentes, non- vel vix ad apicem inflatae. Asci copiose iodo caerulescentes, 250-300 x 19-27 µm, operculati, octospori, cylindrati, longicaudati. Sporae monostichae, (23,7-) 24,7-29 (-30) x 12,3-14 µm, anguste ellipsoideae (Q = 1,78-2,30; Q = 2,01), plerumque aequis lateribus constitutae, leves, hyalinae, crasse tunicatae, apiculatae, concrescente materia seorsum cinctae. Apiculi plerumque hemisphaerici vel subglobosi, 1-4 µm alti, 4-6 µm lati. Syntypi hic designati CLSM 001.06 atque GMC 3105, fere quinquaginta specimina ex fimo bovino (Bos taurus)*, in Italica terra invento, collecta. Leg. R. Cainelli, 24.08.05.*
Paratypus hic designatus: CLSM 045.00, ex fimo bovino in Italica terra invento, Leg. C. Losi, 20.08.89.

Ascomata 0.5-5 mm diam., sessile or sometimes substipitate, variable in shape at first, subglobose, columnar, turbinate or obconical, expanding with age and becoming discoidal, pulvinate or shallow

cup-shaped, membranous, with a well differentiated, somewhat involute to flattened, sometimes irregular or even lobate margin. Outer surface furfuraceous to tomentous, pale greyish or pale grey-whitish, with some anchoring hyphae at the base. Disc more or less the same colour, somewhat concave at first, plane or even convex later, dotted to papillate at maturity. **Subhymenium** of small, polygonal cells, 3-8 x 4-6 µm. **Medullary excipulum** a *textura intricata* of pale, septate, thin-walled, cylindrical or subellipsoidal hyphae, 4-16 µm diam., running perpendicular or oblique to the hymenial surface, often continuing their way up to the ectal excipulum, inside which they form a *textura porrecta*, ending outside by means of claviform or subglobose enlargements, up to 12 µm diam. **Ectal excipulum** a *textura globulosa-angularis* of roundish or polygonal, fairly thin-walled cells, 9-25 x 5-14 µm, of cylindrical or claviform cells, up to 25 x 8 µm, near the apothecial margin, with clusters of globose cells, 14-20 x 9-11 µm, along the apothecial flanks. **Paraphyses** of one kind only, cylindric-filiform, 1-2 µm diam., simplex or branched, septate, hyaline, not immersed in a gelatinous material, exceeding the asci, straight or hardly curved in the upper portion, non- or slightly enlarged at the apex. **Asci** diffusedly amyloid, 250-300 x 19-27 µm, cylindric, 8-spored, roundish to dome-shaped at the apex, sometimes with a slight subapical constriction, rather long-stalked. **Spores** obliquely to vertically uniseriate, (23.7-) 24.7-29 (-30) x 12.3-14 µm, narrowly ellipsoidal (Q= 1.78-2.30; Q= 2.01), symmetrical or exceptionally slightly inequilateral, rounded at the ends, smooth, hyaline, surrounded by a gelatinous sheath, thick-walled, apiculate. Polar apiculi mostly hemispherical or subglobose, 1-4 µm high, 4-6 µm wide, congophilous and cyanophilous.

EXAMINED MATERIAL: ITALY: 1) Bolzano, Sesto (Parco delle Dolomiti di Sesto- Torre di Toblin), 2400 m, about fifty superficial, scattered or mostly gregarious specimens, even deformed by mutual compression, on cattle dung, R. Cainelli, 24.08.05, CLSM 001.06 and ***GMC 3105 (syntypes). 2) Bolzano, Sesto (Valle Campo di Dentro), 1500 m, C. Losi, 20.08.89, CLSM 045.00 (paratype).
*** Herbarium of A.M.B.-Muggia group

RESULTS AND DISCUSSION

These are the first new taxa to be described in ***Thecotheus*** since Nagao *et al.* (2003) and Doveri (2004), the latter inspired by Aas (1992), published worldwide keys to the genus.
T. formosanus f. ***collariatus*** is characterised by growth on dung, comparatively small apothecia, two kinds of paraphyses, and inequilateral, verruculose, biapiculate spores, with a collarette at both ends. Projecting collarettes at the base of apiculi could place ***T. formosanus*** f. ***collariatus*** in the so called ***africanus***-group (Aas, 1992), which includes two other coprophilous species, ***T. africanus*** R.S. Khan & J.C. Krug and ***T. perplexans*** (Faurel & Schotter) J.C. Krug & R.S. Khan, collected in Africa ("tropical equatorial distribution", according to Aas, 1992) from elephant dung, exceptionally from cattle. Besides the collarettes, ***T. africanus*** also has paraphyses of two kinds (observed by Aas, 1992, but not by Krug & Khan in the protologue, 1987), and dotted spores with ***T. formosanus*** f. ***collariatus***, but differs in having yellowish to yellow-brown apothecia, symmetrical to slightly inequilateral, smaller spores (12-15 x 7.5-9 µm in Krug & Khan, 1987), and a medullary excipulum of a *textura globulosa* mixed with a *textura intricata*, i.e. somewhat different from all the other ***Thecotheus*** **spp**.
T. perplexans was originally placed in ***Ascophanopsis*** Faurel & Schotter (1965), a new genus erected on the basis of the presence of polar spore collarettes, considered later to be a synonym of ***Thecotheus*** by Krug & Khan (1987): in comparison with ***T. formosanus*** f. ***collariatus***, it has pure white apothecia, smooth and larger spores (20-22 x 10-12 µm in Faurel & Schotter, 1965). According to Aas (1992) its spore size, shape and ornamentations are similar to ***T. biocellatus*** (Petr.) Aas and ***T. rivicola*** (Vacek) Kimbr. & Pfister, but nothing can be said about the structure of its excipulum, because it was not described in the protologue and the original material was probably

lost. Consequently Aas (1992) has lectotypified ***T. perplexans***, designating the illustration drawn in the protologue, in which we can observe some slightly inequilateral spores, unmentioned in the text.
Outside the ***africanus***-group, three species show a certain affinity to ***T. formosanus*** f. ***collariatus***, i.e. ***T. formosanus*** f. ***formosanus***, ***T. biocellatus*** and ***T. rivicola***, all lacking collarettes but with more or less inequilateral and finely warted spores.
T. biocellatus, of which only the original collection from horse dung is known (Petrak, 1925), is close to ***T. formosanus*** f. ***collariatus*** in its spore size (16-19 x 7-9 µm in Aas, 1992), but differs in having larger apothecia (more than 1.5 mm diam.) and paraphyses of only one kind.
T. formosanus f. ***formosanus*** and ***T. rivicola*** are even closer to ***T. formosanus*** f. ***collariatus***, not only for having paraphyses of two kinds but also spores similar in size, 18-20 x 7.5-9 µm in the former (Wang, 1994), 16-23 x 7-9 (-9.5) µm in the latter (Vacek, 1949; Pfister, 1972; Graddon, 1979; Aas, 1992; Yao & Spooner, 2000; Dougoud, 2002). According to Yao & Spooner (2000) there is no difference between ***T. formosanus*** f. ***formosanus*** and ***T. rivicola*** except for the habitat: the former is coprophilous, isolated from cattle and goat dung (Wang, 1994; 1999), the latter non-coprophilous, collected from bare soil, twigs and vegetable debris. After Aas (1992) we can state, however, that ***T. rivicola*** is distinguishable from both forms of ***T. formosanus*** by its larger apothecia (the largest in ***Thecotheus***), non- or very scarcely protruding asci, and a thicker, multicellular excipulum. On the contrary, we have not noticed any substantial difference between ***T. formosanus*** f. ***collariatus***, and ***T. formosanus*** f. ***formosanus***, except for the presence of collarettes in the former. We had the opportunity to study the type material of ***T. formosanus***, kindly sent us by Wang from Taiwan: in an original slide we observed several spores, the majority of which we prefer to call "clearly" rather than "slightly" asymmetrical, as declared in the protologue. The spores we measured are slightly smaller (16-18 x 7-8 µm; Q = 2.12-2.40; Q = 2.26) than reported by Wang (1994).
Surprised by the great resemblance between our French collections of ***T. formosanus*** and that described by us (Doveri, 2004) from Italy under the same name, we have reviewed the slides of the latter and noticed the presence of spore collarettes (clearly visible in lactic cotton blue), which previously passed unnoticed, and we conclude that both French and Italian collections belong to ***T. formosanus*** f. ***collariatus***.
The formation of projecting collarettes rises from a wall thickening at both spore ends, appearing, on oil immersion, as small, slightly sunken cylinders, which are even more cyanophilous than the apiculi subtended by them. Wang (pers. comm.), re-examining, on our request, dried specimens of the type of ***T. formosanus***, has not observed collarettes, but found that most apiculi had disappeared, so doubting whether the latter are a stable taxonomic character. We also note that the formation of collarettes can be a variable feature, even in the same taxon, possibly linked to climatic differences between Central Europe and Taiwan, and/or to environmental differences between bovine and equine dung. Mycological literature is full of examples confirming our opinion: according to Lundqvist (1972) macroclimate, particularly temperature and moisture, is responsible for the distribution of pyrenomycetes, whose morphological features, the presence or absence of an ostiole for instance, can be changed modifying the microclimatic conditions of a culture (von Arx, 1973); van Brummelen (1967) affirmed the negligible taxonomic value of the tip shape in paraphyses of ***Ascobolus*** Pers. and ***Saccobolus*** Boud., as too influenced by environmental conditions; Guzmán & Stamets (in Stamets *et al.*, 1980) erected ***Psilocybe liniformans*** var. ***americana***, which differs from the European var. ***liniformans*** Guzmán & Bas in growing on soil and lacking a gelatinous layer on the gill edge.
T. neoapiculatus was already described by Doveri (2004) under ***Thecotheus.*** *aff.* ***keithii*** as, in author's opinion, a single small collection was inadequate to erect a new species. A second abundant finding in Italy and probably another in France (also the latter on cattle dung, with symmetrical, smooth, apiculate spores, 22.5-25.5 x 12.5-13 µm, according to M.J. Richardson, pers. comm.) allow us more confidence to describe it as a new taxon, whose main features resemble those of ***T. keithii*** (W. Phillips) Aas except for the presence, in ***T. neoapiculatus***, of larger asci and

spores with mostly hemispherical apiculi, and paraphyses of one kind only. ***T. keithii*** has spores 14-22 x 7-12 µm (data from Karsten, 1870; Phillips in Stevenson, 1879; Phillips & Plowright, 1880; Kimbrough, 1969; Minoura & Yamada, 1976; Aas, 1992), apiculi variable in shape, ranging from long and narrow (Kimbrough, 1969) to "hemispherical to pulvinate to papillate, to acute, even pad-like" (Aas, 1992), and paraphyses of two kinds.

We can, therefore, draw the following conclusions:
1) ***T. perplexans*** should be regarded as a doubtful species, as the original description is meagre and the type material was possibly lost.
2) ***T. africanus*** should be considered a distinct species, even if we do not take into account or set a low taxonomic value on the presence of collarettes, because no other ***Thecotheus*** **sp.** has overlapping features.
3) The worldwide key to ***Thecotheus*** can be updated and revised as follows, with a lower emphasis on spore collarettes:

Worldwide key to *Thecotheus*

(partly based on Aas, 1992 and Doveri, 2004)

1) Asci 8-spored. **4**
1*) Asci containing a different number of spores. **2**

2) Asci 32-spored, sometimes 16- or 64-spored. Spores smooth and non-apiculate, 32-42 x 15-22 µm (17-25 in 64-spored asci). Coprophilous. ***Thecotheus pelletieri*** (H. Crouan & P. Crouan) Boud. (1869)
2*) Asci 3-8-spored. **3**

3) Asci usually 4-spored, but sometimes 3-, 5-, 8-spored. Spores smooth, non-apiculate, symmetrical, 30-37 x 15-16.5 µm. On moist soil or vegetable debris. ***Thecotheus phycophilus*** Pfister (1981)
3*) Asci 4-8-spored. Spores finely warted or reticulate, non-apiculate, slightly asymmetrical, 16-20 x 6-8 µm. Coprophilous. ***Thecotheus viridescens*** E. Ludw. in Hohmeyer *et al.* (1989)

4) Spores smooth. **5**
4*) Spores ornamented. **13**

5) Spores apiculate. **6**
5*) Spores non-apiculate. **9**

6) Spores 13-16 x 7-8.5 µm, ellipsoidal, strongly asymmetrical. Coprophilous. ***Thecotheus inaequilateralis*** Aas (1992)
6*) Spores larger, usually symmetrical. **7**

7) Spores 24.7-29 x 12.3-14 µm, narrowly ellipsoidal. Apiculi usually hemispherical. Paraphyses thin and hardly enlarged at the apex. Coprophilous. ***Thecotheus neoapiculatus***
7*) Spores smaller. Paraphyses of two kinds or unknown. **8**

8) Spores (14-) 17-22 x 7-12 µm, ellipsoidal to narrowly ellipsoidal, lacking end collarettes. Apiculi variable in shape. Paraphyses of two kinds (thin-walled and only slightly enlarged at the apex or thick-walled and claviform at the apex). Coprophilous. ***Thecotheus keithii*** (W. Phillips) Aas (1992)
8*) Spores 20-22 x 10-12 µm, ellipsoidal, symmetrical to slightly inequilateral, with end collarettes. Paraphyses unknown. Coprophilous.
Thecotheus perplexans (Faurel & Schotter) J.C. Krug & R.S. Khan (1987) (doubtful species)

9) Spores 12-16.5 x 6-8 µm, ellipsoidal, symmetrical. On rotting litter debris, treated with urea.
Thecotheus urinamans Nagao, Udagawa & Bougher in Nagao *et al.* (2003)
9*) Spores larger. **10**

10) Spores 19-23.6 x 8.5-11 µm, ellipsoidal-subfusiform, asymmetrical. Coprophilous.
Thecotheus crustaceus (Starbäck) Aas & N. Lundq. in Aas (1992)
10*) Spores larger, symmetrical. **11**

11) Spores 36-42 x 13-17.5 µm, fusiform. On moist soil. ***Thecotheus pallens*** (Boud.) Kimbr. (1969)
11*) Spores non-fusiform. Coprophilous. **12**

12) Spores 32-41 x 14-18 µm, ellipsoidal or cylindric-ellipsoidal. Apothecia greyish.
Thecotheus cinereus (H. Crouan & P. Crouan) Chenant. (1918)
12*) Spores 28-32 x 14-16 µm, ellipsoidal. Apothecia pale yellowish.
Thecotheus flavidus Y.-Z. Wang & Kimbr. (1993)

13) Spores apiculate. **14**
13*) Spores non-apiculate. **21**

14) Spores more or less asymmetrical, finely warted, up to 23 µm long. **15**
14*) Spores larger, symmetrical, finely or coarsely warted. **19**

15) Spores 12-16 x 7-9.5 µm, ellipsoidal to subfusiform, hardly inequilateral, with end collarettes. Coprophilous.
Thecotheus africanus R.S. Khan & J.C. Krug in Krug & Khan (1987)
15*) Spores longer. **16**

16) Ascomata large, up to 7 mm diam. Excipulum thick, multicellular. Asci non- or hardly protruding at maturity. Spores 16-23 x 7-9 µm. On bare soil, twigs, vegetable debris.
Thecotheus rivicola (Vacek) Kimbr. & Pfister in Pfister (1972)
16*) Ascomata smaller, less than 4 mm diam. Excipulum thin. Asci protruding at maturity. Coprophilous. **17**

17) Ascomata 1.5-4 mm diam. Spores 16-19 x 7-9 µm, broadly ellipsoidal. Paraphyses of one kind.
Thecotheus biocellatus (Petr.) Aas (1992)
17*) Ascomata up to 1.3 mm diam. Spores narrowly ellipsoidal, 16.3-20 x 7.2-9 µm. Paraphyses of two kinds. **18**

18) Spores lacking collarettes. Far Eastern, on cattle dung. ***Thecotheus formosanus*** Y.-Z. Wang (1994) f. ***formosanus***
18*) Spores with collarettes. European, on equine dung. ***Thecotheus formosanus*** f. ***collariatus*** Doveri & Coué *f. nov.*

19) Spores 28-38 x 13.5-18 µm, usually biseriate, coarsely warted. Paraphyses often brownish and encrusted. Coprophilous. ***Thecotheus holmskjoldii*** (E.C. Hansen) Chenant. (1918)
19*) Spores smaller, uniseriate. Paraphyses hyaline. **20**

20) Spores 23-28 x 12-13.5 µm, coarsely warted. Presence of a fringe of elongated appendages overarching the apothecia. Coprophilous. ***Thecotheus harasisus*** Gené, El Shafie & Guarro (1993)
20*) Spores 25-30.5 x 12.5-14.5 µm, finely granulose. Overarching appendages absent. Coprophilous.
Thecotheus lundqvistii Aas (1992)

21) Spores ellipsoidal or narrowly ellipsoidal, symmetrical. Asci strangulate. Paraphyses uncinate, of one kind. **22**
21*) Spores narrowly ellipsoidal to subfusiform, finely warted, asymmetrical, 14-16 x 6-7 µm. Asci non-strangulate. Paraphyses straight, of two kinds. Coprophilous. ***Thecotheus himalayensis*** S.C. Kaushal (1980)

22) Spores 14-17 x 7-9 µm, finely warted, with larger polar warts. Coprophilous. ***Thecotheus uncinatus*** Aas (1992)
22*) Spores 22-26 x 11.5-16 µm, coarsely warted. Coprophilous.
Thecotheus strangulatus (Velen.) Aas & N. Lundq. in Aas (1992)

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LEGEND OF THE FREEHAND DRAWING OF ***THECOTHEUS FORMOSANUS*** f. ***COLLARIATUS***.

a = ascomata; b-c = paraphyses; d = ascus; e = medullary excipulum; f-g = ectal excipulum (f = at the base; g = at the apothecial margin); h = mature spores; i = immature spore.

LEGEND OF THE COLOUR PLATE OF ***THECOTHEUS FORMOSANUS*** f. ***COLLARIATUS***.

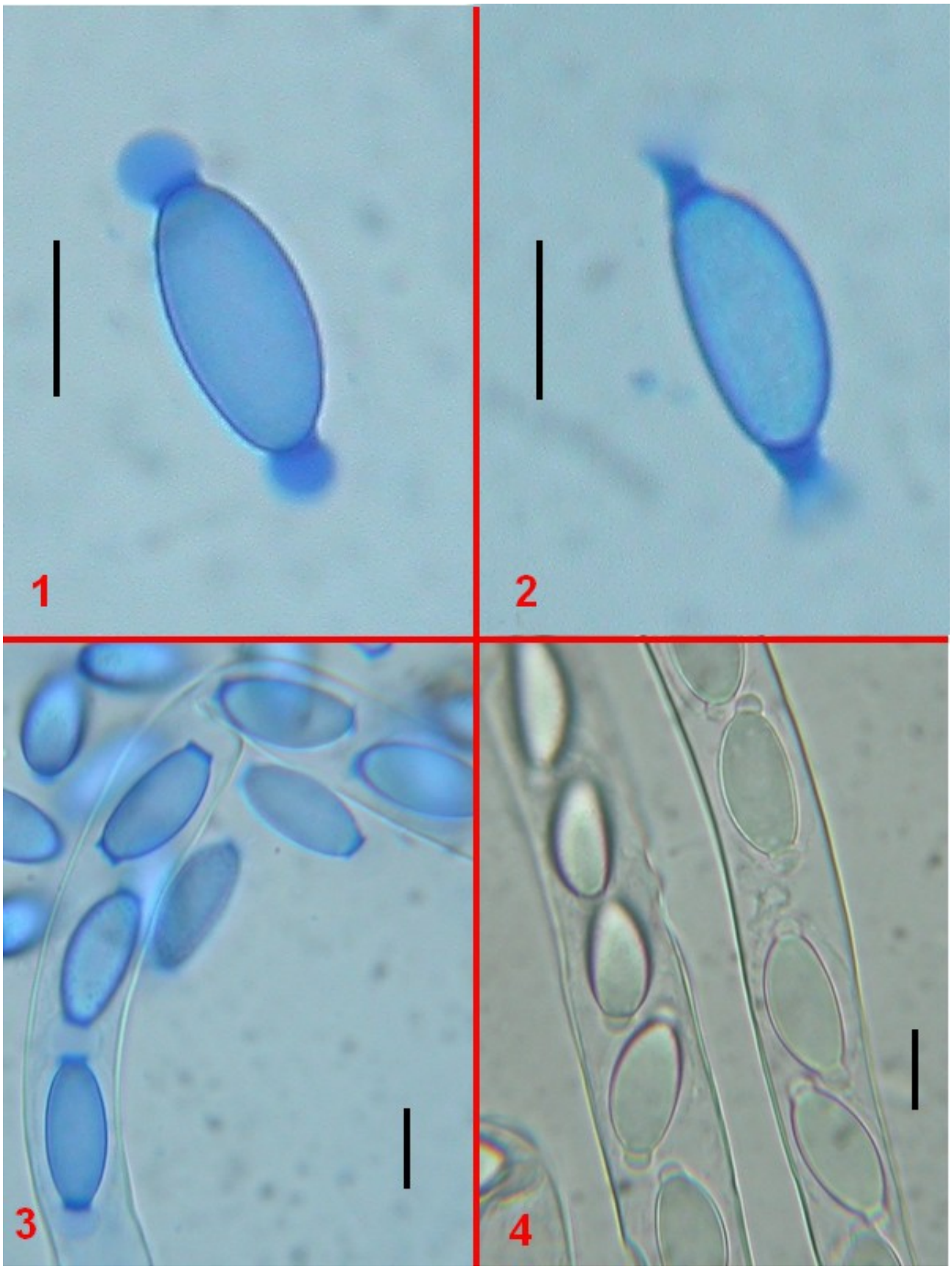


Plate 1. ***Thecotheus formosanus*** f. ***collariatus***: 1-2 = mature spores in lactic cotton-blue; 3 = mature spores and ascus in lactic cotton-blue; 4 = mature spores and asci in water. Scale bars = 10 µm.

LEGEND OF THE COLOUR PLATES OF ***THECOTHEUS NEOAPICULATUS***.

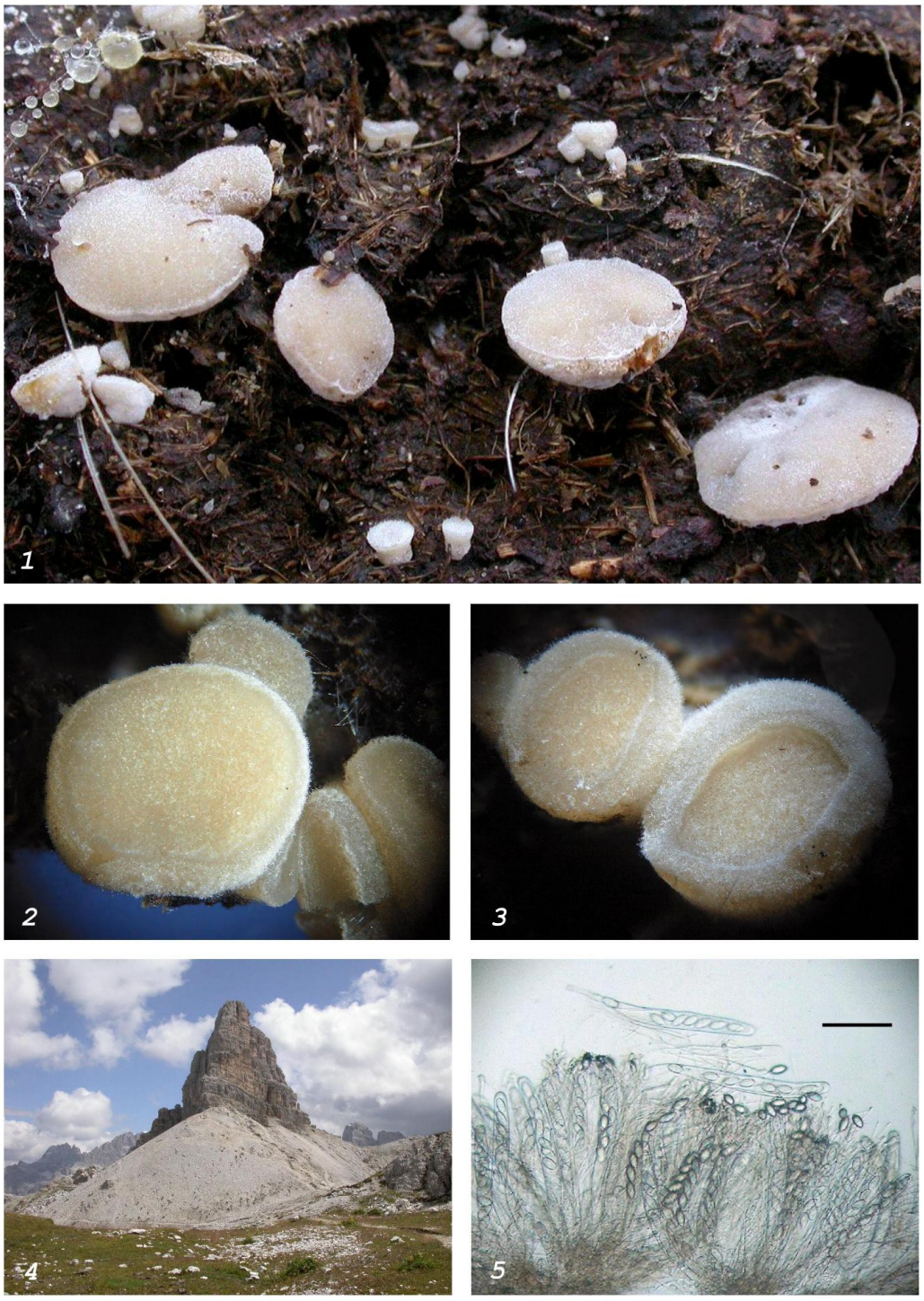
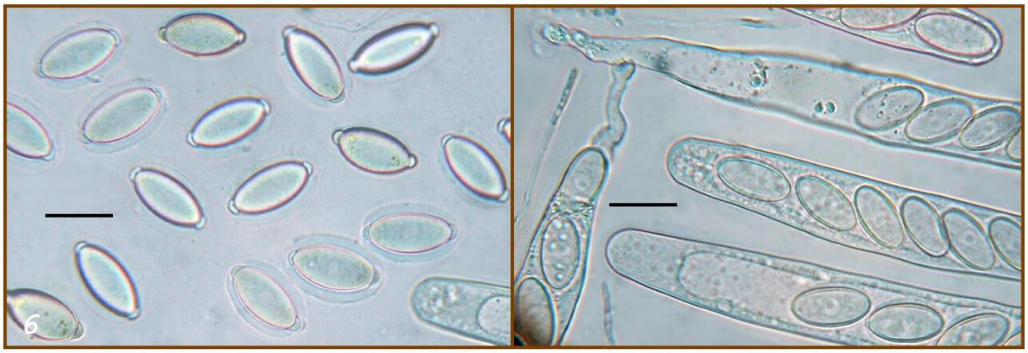
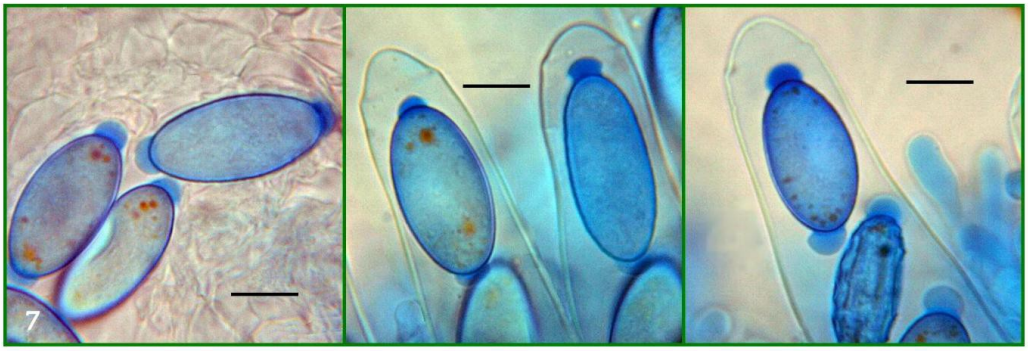


Plate 2. ***Thecotheus neoapiculatus***: 1-3 = ascomata; 4 = Toblin Tower (place of collection); 5 = hymenium. Scale bar = 50 µm (photographs by R. Cainelli).


6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8

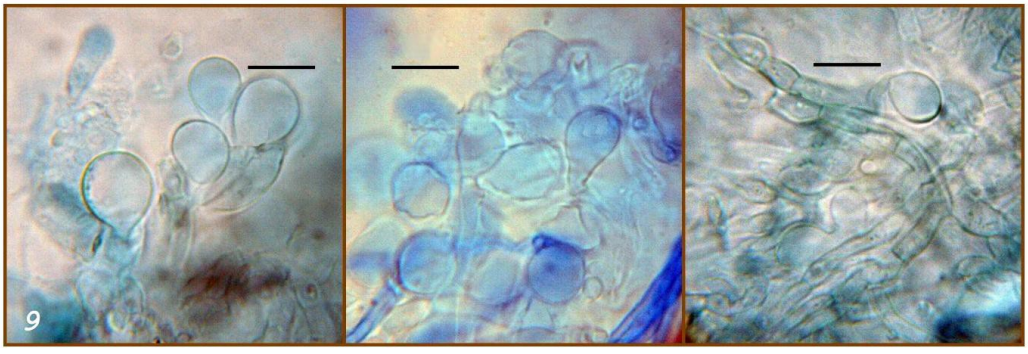
9

Plate 3. ***Thecotheus neoapiculatus***: 6 = mature spores (on the left) and asci with immature spores in water (on the right); 7 = mature spores and asci in lactic cotton-blue; 8 = spores and asci in Melzer's solution; 9 = end cells of ectal excipulum. Scale bars: 6 and 9 = 20 µm; 7-8 = 10 µm (photographs by R. Cainelli).