
Occurrence of coprophilous *Agaricales* in Italy, new records, and comparisons with their European and extra-European distribution

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This work is the successor to a recent monograph on coprophilous ascomycetes and basidiomycetes from Italy. All Italian identifications of coprophilous *Agaricales*, which the author has personally studied over an 18 year period, are listed and categorized depending on the dung source. All collections were subjected to the same procedure and incubated in damp chambers and an estimate of occurrence of fungal species on various dung types is made. A second collection of *Coprinus doverii* is described and discussed, while the southern most finding of *Panaeolus alcis* is listed. An additional collection of *Psilocybe subcoprophila*, a species previously reported from Italy, is described and illustrated with colour photomicrographs. The morphological features of each species is briefly described, and substrate preferences compared with those reported from previous data.

Key words – *Coprinus doverii* – damp chambers – fimicolous basidiomycetes – frequency – natural state – *Panaeolus alcis* – *Psilocybe subcoprophila* – survey.

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Introduction

The commencement of our systematic studies on the dung fungi of Italy started in 1992 resulting in Doveri (2004) and Doveri et al. (2005) reporting and describing 83 coprophilous basidiomycetes. Since these publications more species have been collected throughout Italy and faecal material has been received from colleagues. The increase in species found is lower than expected, possibly owing to their differing nutritional requirements; coprophilous basidiomycetes are noticeably fewer than ascomycetes. Unlike ascomycetes, and with the exception of several *Coprinus s.l.* species, coprophilous basidiomycetes hardly grow or do not develop at all in damp chamber cultures. However, new collections of *Coprinus doverii* L. Nagy, *Panaeolus alcis* M.M. Moser, and *Psilocybe subcoprophila* (Britzelm.) Sacc. from dung

have recently been made and despite a relatively slow increase in the numbers of coprophilous basidiomycetes known from Italy and the inability to use field records for statistical analysis, I have obtained useful information from abundant cultured material and have been able to calculate the frequency of occurrence of the commonest species on several types of dung.

I therefore consider it timely to update the list of coprophilous basidiomycetes from Italy and provide details on their ecology.

Materials and Methods

Samples of dung were collected intermittently from January 1992 to December 2009 and incubated in non-sterilised damp chambers within a few days, or dried and subsequently cultured within 3 months. Other samples were not incubated, but simply listed as substrates of

species collected in the field by the author or colleagues.

The design of the damp chambers followed that suggested by Richardson & Watling (1997) and Richardson (2001), slightly modified by Doveri (2004), utilising both the lower and the upper third of a 0.5 or 1.5 l (depending on the size of dung to be contained) mineral water plastic bottles. The bases were filled with sheets of filter or blotting paper wetted with tap water, and the dung placed on them was in turn wetted by tap water. The upper third of a bottle functioned as a lid, and its cap was replaced with a cotton wool plug. The incubating samples were placed under natural light at room temperature (18°–25°) and were observed from day to day for 5 weeks with the unaided eye and at $\times 7$ –45 magnification using a stereomicroscope. The macroscopic features of species appearing on incubated dung were described, and the microscopic characteristics were studied from fresh material with a binocular light microscope, using water, Congo red and Melzer's reagent as mounting media. The macroscopic features of species collected from dung in the field were reported by the respective collectors, while the microscopic characteristics were studied by the author, usually from dried material. Spore size was measured in water and calculated on a minimum of 20 mature samples, excluding any ornamentations from the measurements. The desiccation of small *Agaricales*, the majority of *Coprinus s.l.* included, was performed in a few minutes with an artificial light, whereas that of larger species was done with an electric desiccator. All collections have been preserved in the author's personal herbarium (CLSM) as dried material or, exceptionally, as slides.

Results

I recorded 522 collections of 86 *Agaricales* species from 700 dung samples in Italy – 285 records of 82 species came from 285 samples detected and identified in the field, listed as substrate sources, but not incubated. It is difficult to use records from the field for a statistical survey but the samples provide a view of substrate preferences. Thus, data is limited to findings of each *Agaricales* genus and species on different dung types (Table 1).

Leaving out 29 records from unidentified herbivores, most findings (96%) were made on bovine (54%) and equine (42%) dung, the remaining 4% on dung of other herbivores, with a marked preponderance of *Coprinus s.l.* (47% of records). The preference for bovine and equine dung is typical for all genera, although a reverse ratio can be noticed in *Bolbitius* Fr. (67% of findings on equine, 28% on bovine dung) and *Psathyrella* (Fr.) Quel. (75% on equine), but findings of the latter are scarce at present. Another 415 dung samples of 36 animal species were cultured in damp chambers. No growth of *Agaricales* was observed on dung of badger (*Meles meles*, 2 samples), beech marten (*Martes faina*, 3), dormouse (*Glis glis*, 3), duck (*Anas* sp., 2), fox (*Vulpes vulpes*, 7), gecko (*Tarentola mauritanica*, 1), hedgehog [*Erinaceus europaeus* (12)], insect [various (9)], lizard [*Lacerta* sp. (3)], mouse [*Mus musculus* (2)], polecat [*Mustela putorius* (5)], porcupine [*Hystrix cristata* (1)], rat [*Rattus rattus* (1)], snail [*Helix* sp. (3)], squirrel [*Sciurus* sp. (3)], toad [*Bufo* sp. (2)], weasel [*Putorius nivalis* (1)] and wolf [*Canis lupus* (1)].

The remaining 353 samples provided 237 collections of 30 *Agaricales* species (Table 2).

Samples of chamois (*Rupicapra rupicapra*), marmot (*Marmota marmota*), marten (*Martes martes*), pig (*Sus scrofa domesticus*), and tortoise (*Testudo* sp.) dung with their respective records, have been left out of statistics owing to the small number (five or less) of incubations. No *Agaricales* developed on tortoise dung apart from a few collections of *Coprinus s.l.*

Samples of the remaining animals—bird (various), cattle (*Bos taurus*), donkey (*Equus asinus*), horse (*Equus caballus*), deer (*Cervus elaphus*), fallow deer (*Dama dama*), roe deer (*Capreolus capreolus*), goat (*Capra hircus*), hare (*Lepus* sp.), rabbit (*Oryctolagus cuniculus*), rock goat (*Capra ibex ibex*), sheep (*Ovis aries*), and wild pig (*Sus scrofa*)—have been included to estimate the frequency of occurrence of *Agaricales* species on different dung types (Table 3).

Coprophilous species of *Agrocybe* Fayod, *Conocybe* Fayod, *Lepista* (Fr.) W.G. Sm., *Leucocoprinus* Pat., and *Volvarellia* Speg. Did

Table 1. Records from Italy of coprophilous *Agaricales* in the natural state.

	cattle	equine				deer	fallow deer	roe deer	rabbit	wild pig	unidentified herbivore
		donkey	horse	mule							
<i>Agrocybe molesta</i>			1								
<i>Agrocybe pediades</i> s. Watling	4		1								1
<i>Agrocybe praecox</i>			1								
<i>Agrocybe subpediades</i> s. Watling	2										
<i>Agrocybe temulenta</i> s. Watling	1		1								
Total <i>Agrocybe</i>	7	0	4	0	0	0	0	0	0	0	1
<i>Bolbitius coprophilus</i>			4								
<i>Bolbitius vitellinus</i> var. <i>titubans</i>	1										
<i>Bolbitius vitellinus</i> var. <i>variicolor</i>			8								
<i>Bolbitius vitellinus</i> var. <i>vitellinus</i>	4	1									
Total <i>Bolbitius</i>	5	1	12	0	0	0	0	0	0	0	0
<i>Conocybe alboradicans</i>			2								
<i>Conocybe antipus</i>	2										
<i>Conocybe aurea</i>	1										
<i>Conocybe brunneidisca</i>	5										
<i>Conocybe cettoiana</i>	1										
<i>Conocybe coprophila</i>	6										
<i>Conocybe fuscimarginata</i>	4										
<i>Conocybe gigasperma</i>			1								
<i>Conocybe pubescens</i>			2								
<i>Conocybe rickenii</i>	4	1	2								
<i>Conocybe siennophylla</i>	4		1								
<i>Conocybe siliginea</i>			2								
<i>Conocybe singeriana</i>	1										
Total <i>Conocybe</i>	28	1	10	0	0	0	0	0	0	0	0
<i>Coprinellus bisporus</i>	2		1					1			3
<i>Coprinellus brevisetulosus</i>	3										
<i>Coprinopsis cinerea</i>	4	1	1								5

Table 1. (Continued). Records from Italy of coprophilous *Agaricales* in the natural state.

	cattle	equine			deer	fallow deer	roe deer	rabbit	wild pig	unidentified herbivore
		donkey	horse	mule						
<i>Coprinellus congregatus</i>	3		2					1		1
<i>Coprinopsis cothurnata</i>	4		1							
<i>Coprinellus curtus</i>			2							
“ <i>Coprinus</i> ” <i>doverii</i>										1
“ <i>Coprinus</i> ” <i>ephemeroides</i>	1		3							
<i>Coprinellus ephemerus</i>	5		2							1
<i>Coprinellus flocculosus</i>	1		1							
<i>Coprinellus heptemerus</i>	5						1	1		
<i>Coprinellus heterosetulosus</i>			2							
<i>Coprinopsis luteocephala</i>			1							
<i>Coprinopsis macrocephala</i>	1		1							
<i>Coprinellus marculentus</i>	1		2							
<i>Parasola misera</i>			2							
<i>Coprinopsis nivea</i>	10	1	4							
“ <i>Coprinus</i> ” <i>patouillardii</i>	2		3							
<i>Coprinellus pellucidus</i>	1									
<i>Coprinopsis poliomallus</i>			1							
<i>Coprinopsis pseudocortinata</i>			1							
<i>Coprinopsis pseudonivea</i> var. <i>pseudo-nivea</i>	2									
<i>Coprinopsis pseudoradiata</i>	1		1							
<i>Coprinopsis radiata</i>	1		8						1	
<i>Coprinellus sassii</i>			1							
<i>Parasola schroeteri</i>	2									
<i>Coprinus spadiceisporus</i>						2				
<i>Coprinopsis stercorea</i>	1							1		
<i>Coprinus sterquilinus</i>			2							
<i>Coprinopsis tuberosa</i>			1							2

Table 1 (Continued). Records from Italy of coprophilous *Agaricales* in the natural state.

	cattle	equine				deer	fallow deer	roe deer	rabbit	wild pig	unidentified herbivore
		donkey	horse	mule							
<i>Coprinopsis utrifer</i>					1						
<i>Coprinopsis xenobia</i>	4										
Total <i>Coprinus s.l.</i>	54	2	43	0	1	2	1	4	1	13	
<i>Lepista sordida</i>	1										
<i>Leucocoprinus cretaceus</i>			4								
<i>Panaeolus acuminatus</i>	4										
<i>Panaeolus alcis</i>										1	
<i>Panaeolus antillarum</i>	5										
<i>Panaeolus cinctulus</i>	2		1							1	
<i>Panaeolus fimicola</i>										1	
<i>Panaeolus guttulatus</i>	1										
<i>Panaeolus papilionaceus</i>	2		3							1	
<i>Panaeolus retirugis</i>	2			1							
<i>Panaeolus semiovatus</i>	3			1						1	
<i>Panaeolus sphinctrinus</i>	6		3	1							
<i>Panaeolus subfirmus</i>			2								
Total <i>Panaeolus</i>	25	0	9	3	0	0	0	0	0	5	
<i>Psathyrella hirta</i>	1		1								
<i>Psathyrella lacrymabunda</i>			1								
<i>Psathyrella prona</i> var. <i>prona</i> f. <i>prona</i>			1								
Total <i>Psathyrella</i>	1	0	3	0	0	0	0	0	0	0	
<i>Psilocybe coprophila</i>	2		3	1				1		5	
<i>Psilocybe crobulus</i>	1										
<i>Psilocybe cyanescens</i>										1	
<i>Psilocybe inquilina</i>			1								
<i>Psilocybe liniformans</i>	1										

Table 1 (Continued). Records from Italy of coprophilous *Agaricales* in the natural state.

	cattle	equine			deer	fallow deer	roe deer	rabbit	wild pig	unidentified herbivore
		donkey	horse	mule						
<i>Psilocybe subcoprophila</i>								1		
Total <i>Psilocybe</i>	7	0	4	1	0	0	0	1	1	6
<i>Stropharia dorsipora</i>	1		6							1
<i>Stropharia luteonitens</i>										1
<i>Stropharia semiglobata</i>	9		3							2
Total <i>Stropharia</i>	10	0	9	0	0	0	0	0	0	4
<i>Volvariella gloiocephala</i>			1							

Table 2. Records from Italy of coprophilous *Agaricales* in damp chamber cultures (n° of dung samples in brackets).

	bird (27)	cattle (54)	chamois (4)	equine		deer (24)	fallow deer (10)	roe deer (37)	goat (16)	hare (18)	marmot (5)	marten (2)	pig (5)	rabbit (18)	rock goat (8)	sheep (51)	tortoise (2)	wild pig (10)
				donkey (6)	horse (56)													
<i>Bolbitius coprophilus</i>					1													
<i>Coprinellus brevisetulosus</i>		1																
<i>Coprinopsis candidolanata</i>						1			1								1	
<i>Coprinopsis cinerea</i>	3	1													1			
<i>Coprinellus congregatus</i>		1																
<i>Coprinellus curtus</i>					5			1	2	3				3				
“ <i>Coprinus</i> ” <i>ephemeroides</i>		1																
<i>Coprinellus ephemerus</i>		2			2			1								2	1	
<i>Coprinopsis filamentifera</i>		1			1		1	1	2				1		1	3		
<i>Coprinellus heptemerus</i>		4	1		1	1	3	2	7	2	1			1	2	9		
<i>Coprinellus heterosetulosus</i>		2			14												1	
<i>Parasola misera</i>		6			5	3	1							1	2	5		
<i>Coprinopsis nivea</i>		1			1										1			
“ <i>Coprinus</i> ” <i>patouillardii</i>		4			1	13												
<i>Coprinellus pellucidus</i>		2					1	1	1								2	
<i>Coprinopsis poliomallus</i>		1																

Table 2 (Continued). Records from Italy of coprophilous *Agaricales* in damp chamber cultures (n° of dung samples in brackets).

	bird (27)	cattle (54)	chamois (4)	equine		deer (24)	fallow deer (10)	roe deer (37)	goat (16)	hare (18)	marmot (5)	marten (2)	pig (5)	rabbit (18)	rock goat (8)	sheep (51)	tortoise (2)	wild pig (10)
				donkey (6)	horse (56)													
<i>Coprinopsis pseudocortinata</i>		1			1													
<i>Coprinopsis pseudoradiata</i>					1	1										1		
<i>Coprinopsis radiata</i>		5		4	17									2		6		
<i>Coprinopsis stercorea</i>		8				2	2	7	3							9		1
<i>Coprinus sterquilinus</i>					1													
<i>Coprinopsis tuberosa</i>														1				
<i>Coprinopsis utrifera</i>		1				1	1	1						1		3		
<i>Coprinopsis vermiculifera</i>															1			
Total	3	43	1	5	62	10	8	14	16	5	1	0	1	9	8	42	1	1
<i>Coprinus s.l.</i>																		
<i>Panaeolus papilionaceus</i>					1													
<i>Psathyrella coprinoides</i>								1						1				
<i>Psilocybe coprophila</i>					1													
<i>Stropharia dorsipora</i>					1													
<i>Stropharia semiglobata</i>		1																
Total <i>Stropharia</i>		1			1													

Table 3. Frequency (%) of *Agaricales* on different dung types (n° of samples in brackets).

	bird (27)	cattle (54)	equine (62)	deer (24)	fallow deer (10)	roe deer (37)	goat (16)	hare (18)	rabbit (18)	rock goat (8)	sheep (51)	wild pig (10)
<i>Bolbitius coprophilus</i>			2									
<i>Coprinellus brevisetulosus</i>		2										
<i>Coprinopsis candidolanata</i>				4			6				2	
<i>Coprinopsis cinerea</i>	11	2								12		
<i>Coprinellus congregatus</i>		2										
<i>Coprinellus curtus</i>			8			3	12	37	17			
“ <i>Coprinus</i> ” <i>ephemeroides</i>		2										
<i>Coprinellus ephemerus</i>		4	3			3					4	
<i>Coprinopsis filamentifera</i>		2	2		10	3	12			12	6	
<i>Coprinellus heptemerus</i>		7	2	4	30	5	44	11	6	25	18	
<i>Coprinellus heterosetulosus</i>		4	23								2	
<i>Parasola misera</i>		11	8	12	10				6	25	10	
<i>Coprinopsis nivea</i>		2	2							12		
“ <i>Coprinus</i> ” <i>patouillardii</i>		7	23									
<i>Coprinellus pellucidus</i>		4		4		3	6				4	
<i>Coprinopsis poliomallus</i>		2										
<i>Coprinopsis pseudocortinata</i>		2	2									
<i>Coprinopsis pseudonivea</i> var. <i>pseudonivea</i>		2										
<i>Coprinopsis pseudoradiata</i>			2	4							2	
<i>Coprinopsis radiata</i>		9	34						11		12	
<i>Coprinopsis stercorea</i>		15		8	20	19	19				18	10
<i>Coprinus sterquilinus</i>			2									
<i>Coprinopsis tuberosa</i>									6			
<i>Coprinopsis utrifera</i>		2		4	10	3			6		6	
<i>Coprinopsis vermiculifera</i>										12		
Total	11	50	80	25	60	30	56	22	33	75	61	10
<i>Coprinus s.l.</i>												

Table 3 (Continued). Frequency (%) of *Agaricales* on different dung types (n° of samples in brackets)

	bird (27)	cattle (54)	equine (62)	deer (24)	fallow deer (10)	roe deer (37)	goat (16)	hare (18)	rabbit (18)	rock goat (8)	sheep (51)	wild pig (10)
<i>Panaeolus papilionaceus</i>			2									
<i>Psathyrella coprinoides</i>						3						
<i>Psilocybe coprophila</i>			2									
<i>Stropharia dorsipora</i>			2									
<i>Stropharia semiglobata</i>		2										
Total <i>Stropharia</i>		2	2									

not grow in the non-sterilised damp chambers (unlike in a natural state), and species of *Bolbitius*, *Panaeolus* (Fr.) Quél., *Psathyrella*, *Psilocybe* (Fr.) P. Kumm., and *Stropharia* (Fr.) Quél. rarely developed. Their low frequency of occurrence (1.4%), calculated based on all incubated samples, slightly rises (to 1.7%) when samples of dung types not developing any Agaricales species (see above) are excluded, but rises (to 9%) when only bovine and equine dung are considered. This increase confirms their preference for cattle and horse dung as in the natural state (99% of records).

The occurrence of *Coprinus s.l.* on incubated samples is much higher (55% to 65%) than other genera, and higher (86%) on dung of domestic (cattle, equine, goat, pig, rabbit, sheep) rather than of wild animals (chamois, deer, fallow deer, roe deer, hare, marmot, rock goat, wild pig, = 41%).

Twenty four *Coprinus* species were recorded from incubated dung, 32 from the field, and *Coprinopsis candidolanata* (Doveri & Uljé) Keirle et al., *C. filamentifera* (Kühner) Redhead et al., and *C. vermiculifera* (Joss. ex Dennis) Redhead et al. were observed in damp chambers only. The most frequent species (each recorded more than 30 times) were *Coprinellus heptemerus* (M. Lange & A.H. Sm.) Vilgalys et al., *Coprinopsis radiata* (Bolton) Redhead et al., and *C. stercorea* (Fr.) Redhead et al., together representing 43% of all records from cultures in their group, each with a ca. 10% occurrence.

Taxonomy

Coprinus doverii L. Nagy, Mycotaxon 98: 148, 2006. Figs 1–4

*“*Pileus* up to 1.5 × 2 mm when still closed, mainly broadly elliptical to obtusely conical, hemispherical to campanulate later, flattened when fully mature, up to 5 (7) mm diam., dark olive-brown in primordial stages, with brown olive-brown centre and pale ochraceous margin later, uniformly dark ochraceous with faint olive tint when old; surface strongly translucently striate when young, becoming radially sulcate, shortly pilose. Veil macroscopically not observable, see below under microscopical features. Lamellae free, crowded, strongly ventricose, up

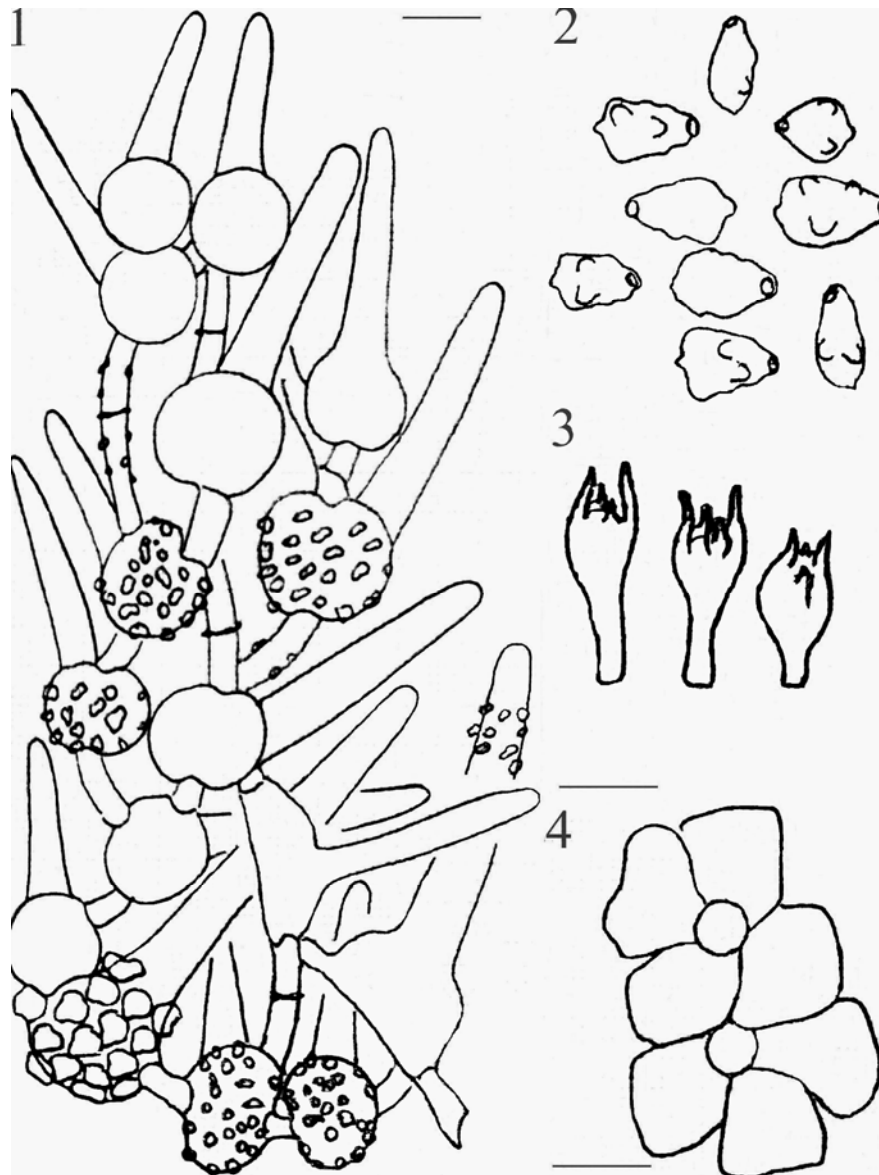
to 0.3 mm broad, at first white, then blackish. Stipe 0.2–0.6 × 10–25 mm, slender, whitish also when old, pilose all over.” Spores (5.2–) 5.8–7.3 × 4.2–4.7 × 3.7 μm, mitriform in frontal view (Q = 1.20–1.75; Q = 1.46), subamygdaliform in side view, knotted with low, roundish warts, reddish brown, with a well developed apiculum and an eccentric, about 1 μm wide, germ pore. Basidia 4-spored, 15–20 × 6–7.5 μm, dimorphic, spheropedunculate or claviform. “*Cheilocystidia* very sparse, globose to balloon-shaped, 10 – 14 μm diam.; *Pleurocystidia* absent; *Pileocystidia* short, lageniform with a tapering neck and a narrow, more or less acute tip, rarely somewhat encrusted, 35–65 × 6–13 μm; *Sclerocystidia* absent, but some *pileocystidia* with slightly thickened walls are observable; Veil on pileus made up of 11–25 μm wide, globose elements, often covered with coarse, strongly refringent crystals; *Pileipellis* a hymeniderm.” Caulocutis with the outermost hyphae encrusted at intervals, 2–4 μm diam., supporting numerous, sometimes crowded, often encrusted (particularly at their bases), lageniform caulocystidia, 25–75 × 13–21 μm, with a bulbous base, and a tapering, exceptionally cylindrical neck, 4–8 μm diam. at its base, 2.5–4.5 μm upwards. Clamp-connections observed in the caulocutis.

*In inverted commas and italics, Nagy’s description from Hungary (pers. comm., and Mycotaxon 98, 2006). In normal type Doveri’s description from Italy (see also under “Discussion”).

Material examined – Italy, Livorno, Livorno city, 0 m a.s.l., one specimen on dung of an unidentified animal, F. Doveri, 16 Apr 2004, 283.1-Livorno, CLSM 016.04.

Panaeolus alcis M.M. Moser, Mycologia 76: 551, 1984 (as “*alcidis*”). Figs 5–14

*Cap 6 mm high, 3 mm diam., cylindrical-conical, grey, neither striate nor umbonate. Cuticle smooth, not hygrophanous, lacking any veil remnant on the margin. Stem filiform, somewhat paler and much longer than cap height, lacking a ring. Spores 18–20 × 10–11 μm, ellipsoidal to narrowly ellipsoidal in frontal view (Q = 1.71–1.90; Q = 1.80), exceptionally slightly angular, narrowly ellipsoidal to subamygdaliform in side view, dark maroon to dark brown, opaque or sometimes



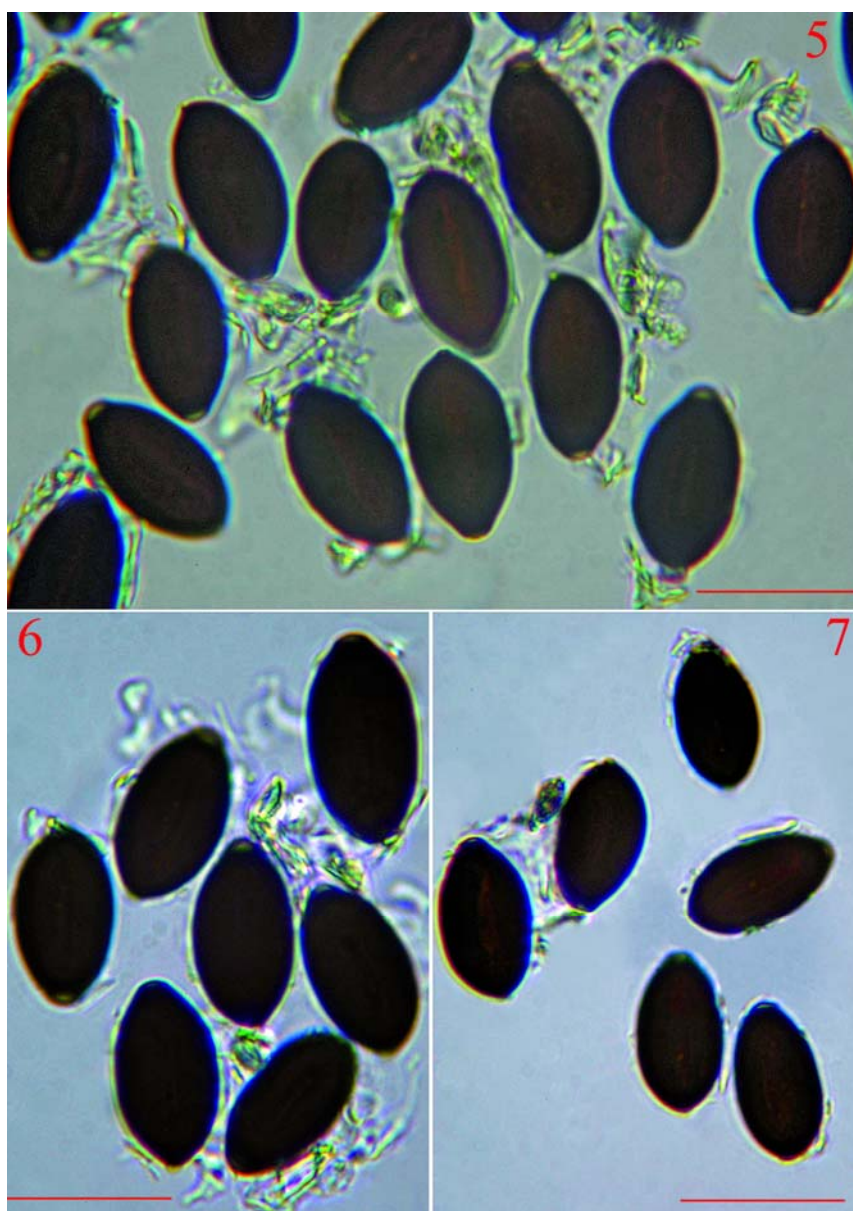
Figs 1–4 – Original drawing of *Coprinus doverii* microscopical features from Italy. **1** Caulocytis. **2** Spores. **3** Basidia. **4** Detail of hymenium in frontal view. Bars = 10 μ m.

semitransparent, smooth, thick-walled, apiculate, with a prominent, central to slightly eccentric (in side view) germ pore, more than 2 μ m diam. Basidia 30–35 \times 12–15 μ m, clavate with a slight middle constriction, usually 4-spored, rarely 2-spored, with thorn-shaped sterigmata, short-stipitate or sessile. Gill-trama regular, with hyphae 5–15 μ m diam. Cheilocystidia abundant (gill edge sterile to subfertile), 19–31 \times 4–9 μ m, polymorphous (subcylindric, lageniform, utriform), often with an enlarged base, with a slightly to strongly wavy, rarely subcapitate neck, 2–3 μ m diam. Pleurocystidia absent. Epicutis hymenidermal, several layers of clavate or globose, short-stalked, quite thick-walled, somewhat en-

crusted cells, 15–30 \times 14–20 μ m, interspaced with scarce, deformed pileocystidia. Caulocytis of parallel, somewhat encrusted hyphae, the outermost 1.5–3 μ m diam., supporting many cystidia, very close to cheilocystidia but usually larger. Clamp-connections observed on caulocytis.

*Unfortunately notes on macroscopic features are from the field, and are scarce but enough to identify this species when combined with the microscopic characteristics.

Material examined – Italy, Sardinia island, Ogliastra, Gairo Taquisara-Lepercei, 950 m a.s.l., three specimens on dung (possibly cattle), L. Arras, 2 Dec 2006, 531.3-Ussàssai, CLSM 009.06.



Figs 5–7 – Italian collection of *Panaeolus alcis*. **5, 6, 7** Spores from different specimens. Bars 5, 6 = 15 μm , 7 = 20 μm .

Psilocybe subcoprophila (Britzelm.) Sacc.,
Syll. Fung. 11: 72, 1895. Figs 15–29

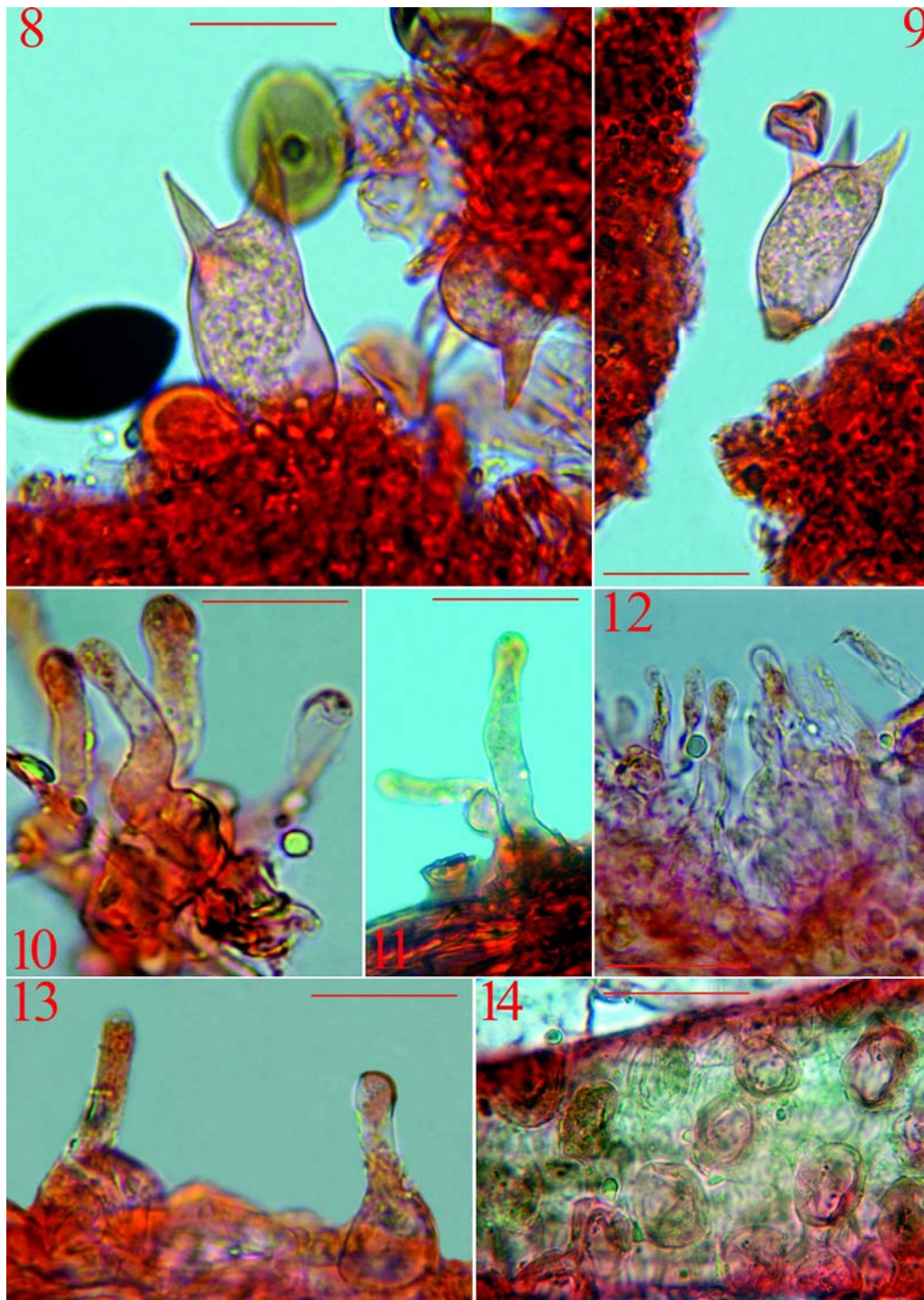
≡ *Agaricus subcoprophilus* Britzelm.,
Hymenomyc. Südbayern 8: 9, 1891.

≡ *Geophila coprophila* var. *subcoprophila*
(Britzelm.) Kühner & Romagn., Fl. Anal.
Champ. Sup.: 338, 1953 (inval. publ.).

≡ *Deconica subcoprophila* (Britzelm.) E.
Horak, Darwiniana 14: 363, 1967.

Cap 5–20 mm diam., subglobose in the
early stages, becoming convex, finally convex-
plane, sometimes with a small papilla. Cuticle
smooth, slightly viscous, hygrophanous, in
moist conditions more or less translucently

striate, evenly brown to reddish brown or
somewhat darker at the disc, with a paler
margin due to scarce veil remnants, expallant
in dry conditions and becoming yellowish
cream with a pale brown disc. Gills quite dense,
interspaced with lamellulae ($L/l = 1/3$), broadly
adnate to slightly decurrent, broad, thin,
ochreous at first, greyish later, greyish brown
with purple shades at maturity, with a paler,
furfuraceous edge. Stem 20–30 \times 2–3 mm,
usually straight, cylindrical, hollow, somewhat
enlarging at the apex and base, lacking an
annulus, the same colour or slightly darker than
cap, indistinctly striate, white furfuraceous in



Figs 8–14 – Italian collection of *Panaeolus alcis*. **8, 9** Basidia. **10, 11** Caulocystidia. **12, 13** Cheilocystidia. **14** Epicutis. Bars 8 = 15 μm , 9, 10, 11, 12 = 20 μm , 13 = 10 μm ; 14 = 30 μm .

the upper third. Context pale brown, inodorous. Spores (12.7–) 15.5×19.8 (22.6) × (7.2–) 9.1–10.7 μm , narrowly ellipsoidal to subcylindrical in frontal view ($Q = 1.71\text{--}1.91$; $Q = 1.82$), slightly flattened at one side in lateral view, thick-walled, smooth, pale greyish brown in water, containing numerous vacuoles, with a central, slightly flattened germ pore, about 2 μm diam. Basidia 28–35 × 12–13 μm , 4-spored,

cylindrical or cylindric-claviform, often with a slight median constriction, short-stalked. Subhymenium of small polygonal cells. Gill trama regular, with slightly encrusted hyphae, 5–12 μm diam. Gill edge sterile. Cheilocystidia 27–49 × 8.3–11.7 μm , predominantly lageni-form, sometimes subutriform or fusiform, with an usually long and flexuous neck, 4–6 μm diam., and a roundish or clavate or even (sub)



Figs 15–18 – Italian collection of *Psilocybe subcoprophila*. **15, 16** Fruitbodies in the natural state. **17** Ixocutis. **18** Spores. Bars 15 = 5 μm , 16 = 20 μm , 17 = 50 μm , 18 = 15 μm .

capitate apex. Pleurocystidia absent. Epicutis of elongated, indistinct hyphae, embedded in a hyaline gelatinous material (*ixocutis*). Subcutis of interwoven and branched, encrusted, yellowish ochreous hyphae, 6–12 μm diam. Caulocutis with yellowish-ochreous, more or less parallel, quite thick-walled, encrusted outermost hyphae, 2–3 μm diam., supporting, numerous, often crowded caulocystidia, 32–80 \times 12–20 μm , similar to cheilocystidia. Clamp-connections present, widespread.

Material examined – Italy, Teramo, San Biagio-Rocca Santa Maria, 1200 m a.s.l., about ten specimens on wild pig dung, B. de Ruvo, 5 Jun 2007, 339.3-Teramo, CLSM 010.07.

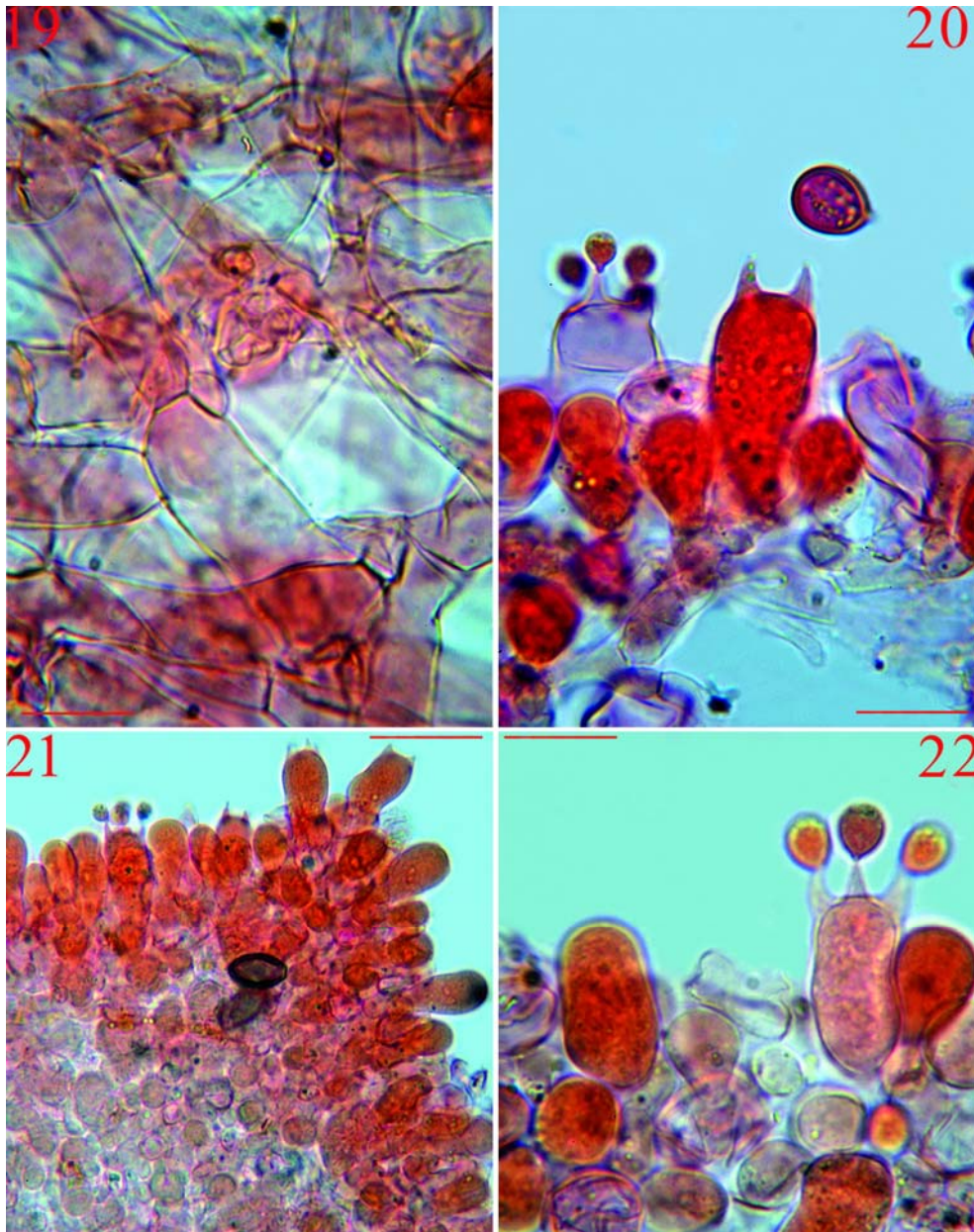
Discussion

I have recorded from Italy one species of all those *Agaricales* genera (*Agrocybe*, *Bolbitius*, *Conocybe*, *Coprinus s.l.*, *Panaeolus*, *Psathyrella*, *Psilocybe*, *Stropharia*) commonly regarded as potentially coprophilous (Wicklow, 1992), and some others, like *Lepista*, *Leucocoprinus*, *Volvariella*, that occasionally occur on dung. They need to be briefly discussed:

Agrocybe, placed in *Strophariaceae* Singer & A.H. Sm. after molecular studies by Moncalvo et al. (2002), includes about 100 species, a few of which are regarded as

coprophilous. They are distinguishable from other *Strophariaceae* on dung especially by their hymeniform pileipellis, from *Conocybe* spp. by usually more fleshy, collybioid or tricholomatoid fruitbodies, and absence of lecythiform cheilocystidia.

Agrocybe pediades (Fr.) Fayod s. Watling; *A. subpediades* (Murrill) Watling s. Watling; *A. temulenta* (Fr.) Singer s. Watling: I separately described (Doveri 2004) *A. pediades* s. Watling and *A. subpediades* s. Watling (1982), which also now are listed as independent taxa in our tables (see above). These species, characterised by comparatively small fruitbodies, absence of pleurocystidia and coarse veil remnants on the cap edge, are very similar to each other and described by Nauta (in Noordeloos et al. 2005) as an aggregate taxon under *A. pediades*. Nauta (2004; in Noordeloos et al. 2005) also described *A. pediades* var. *fimicola* (Speg.) Nauta, different from *A. pediades* var. *pediades* in occurring on cattle and horse dung, patent coarse veil remnants on the cap edge, also when mature, and a late areolate cap centre. Nauta (2004) chose a Consiglio's (1999a) colour photo from cattle dung in Italy (*sub nomine A. subpediades*) as a significant picture of the var. *fimicola*. Nauta (2004) also described the new species *A. ochracea* Nauta, which possibly is the same



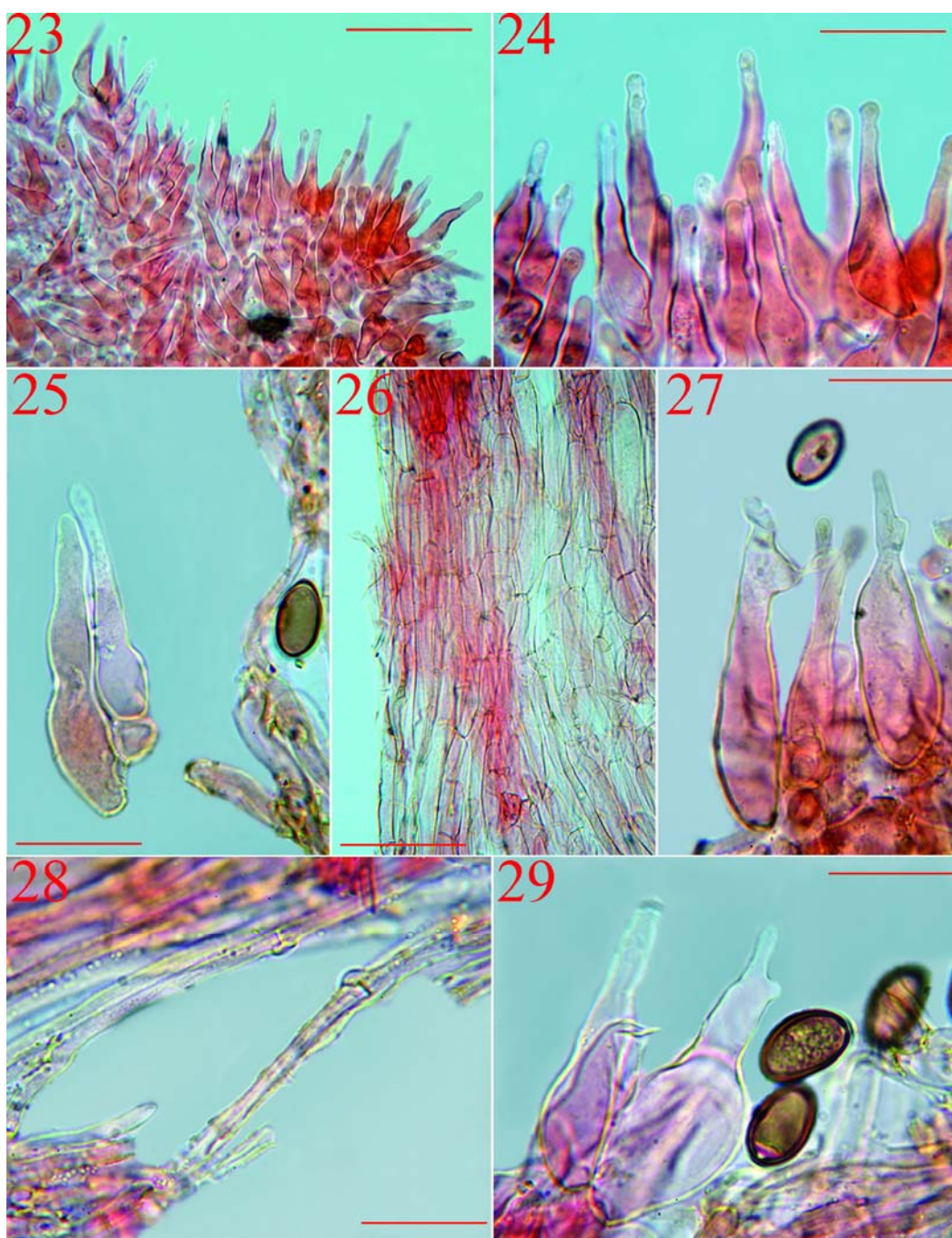
Figs 19–22 – Italian collection of *Psilocybe subcoprophila* (Congo red). **19** Subcutis. **20–22** Basidia. Bars 19 = 10 μm , 20, 22 = 15 μm , 21 = 30 μm .

as *A. temulenta* s. Watling (an ambiguous name in her opinion), and differs from *A. pediades* var. *pediades* particularly in having pleurocystidia, well differentiated from cheilocystidia.

Dealing with these species as a whole, I have recorded them from Italy, always in the field, particularly from cattle (78% of all records), but also from horse dung. A species belonging to the *pediades*-group, possibly *A. fimicola*, was described by Contu (2006) in Italy on unspecified excrements. Other findings worldwide (Watling 1992, De Meulder 2001) confirm the preference for cattle and horse dung.

Agrocybe molesta (Lasch) Singer: it has already been expounded (Cacialli et al. 1997) why this name is kept, although it was regarded by Nauta (in Noordeloos et al. 2005) as a later synonym of *A. dura* (Bolton) Singer. Like *A. praecox*, but unlike *A. pediades* s.l., it has large fruitbodies and very coarse veil remnants, often in the shape of an annulus. Habitat: in rich soils, but no records known by us, except our own, from dung or manure.

Agrocybe praecox (Pers.) Fayod: with less stout fruitbodies than *A. molesta*, a more membranous and persistent annulus, a mealy smell, and never a coarsely cracked cap. Like the latter, it has never been recorded from dung.



Figs 23–29 – Italian collection of *Psilocybe subcoprophila* (Congo red). **23, 24** Cheilocystidia. **25, 27, 29** Caulocystidia. **26** Caulocutis. **28** Detail of caulocutis. Bars 23 = 50 μm , 24, 25, 27, 29 = 20 μm , 26, 28 = 40 μm .

Nauta (in Noordeloos et al. 2005) mentions, however, also compost-heaps as substratum.

Bolbitius, in *Bolbitiaceae* Singer, includes several coprophilous species, which sometimes can be mistaken for some *Conocybe* spp. on dung, although they are recognisable by more or less deliquescent fruitbodies with a glutinous cap, usually free gills, a constantly coprinoid hymenium, and polymorphous, not lecythiform, cheilocystidia.

Bolbitius coprophilus (Peck) Hongo: refer to Cacialli et al. (1995) and Doveri (2004) for comment about the synonymy between *B. coprophilus*, *B. demangei* (Qué.) Sacc. & D. Sacc. and *B. incarnatus* Hongo. In subgen. *Bolbitius* (species with a hymeniderm of non-articulate claviform cells), it is microscopically very similar to *B. vitellinus* s.lat., but with somewhat stouter fruitbodies and clear pinkish shades on the cap. A widespread species

worldwide, in Italy always recorded from horse dung (Narducci & Petrucci 1994, Cacialli et al. 1995). Most records are from equine dung (Quélet 1901, Hübsch 1985, Täglich 1991, Hausknecht & Krisai-Greilhuber 2003), but also from cattle (Watling 1995, Enderle 1996) and elephant (Thomas et al, 2001, Manimohan et al. 2007).

Bolbitius vitellinus (Pers.) Fr. var. *vitellinus* and *B. vitellinus* var. *titubans* (Bull.) Bon & Courtec.: described by Doveri 2004 as independent taxa at variety rank, and distinguished from each other by slight habit and colour differences, they were regarded by Arnolds (2003a in Noordeloos et al. 2005) and Hausknecht & Vesterholt (in Knudsen & Vesterholt 2008) as synonyms under the single taxon *B. titubans* (Bull.) Fr. They grow particularly on dung, manured soil, and rotten hay. Our Italian fimicolous records are especially from cattle dung. Widespread all over the world, with most records of fimicolous collections from equine (Persoon 1801, Jossierand 1936, Dennis 1970, Pegler 1983) and bovine (Jamoni 1994, 2001, De Meulder 2001, Welt & Heine 2007) dung, but also from elephant (Pegler 1977) and water vole (Sengupta & Laessøe 2004).

Bolbitius vitellinus var. *variicolor* (G.F. Atk.) Krieglst.: differs from var. *vitellinus* and var. *titubans* in having a ridged cap with olive tinges. Described by Arnolds (2003a, in Noordeloos et al. 2005) as a synonym of *B. titubans* var. *olivaceus* (Gillet) Arnolds, and by Hausknecht & Vesterholt (in Knudsen & Vesterholt 2008) as *B. variicolor* G.F. Atk. Recorded from Italy always on horse dung in the natural state. Although mentioned worldwide as facultatively coprophilous, with an habitat similar to *B. titubans* var. *titubans*, there is a single record (Jamoni 1997) from cattle.

Conocybe, in *Bolbitiaceae*, proportionally includes fewer coprophilous species than *Bolbitius*, from which they can usually be recognised in the field by their duller and less delicate fruitbodies. Usually lecythiform cheilocystidia and an exceptionally coprinoid hymenium help to recognise *Conocybe*. Our concept of *Conocybe* is wide and follows Watling & Gregory (1981) and Watling (1982), also including *Galerella* Earle and *Pholiotina* Fayod, but Arnolds (in Noordeloos et al. 2005)

and Hausknecht (2009) regard *Conocybe* and *Pholiotina* as distinct, the former characterised by absence of a partial veil, constantly lecythiform cheilocystidia and a hymenophoral trama with a thin mesostratum.

Conocybe alboradicans Arnolds: in sect. *Conocybe* (pruinose stem with strongly dominant caulocystidia), it is distinguishable by its rooting stem, large, ellipsoidal spores, and 2-spored basidia. Recorded in Italy from horse dung in the natural state, it is also reported elsewhere from manured pastures (Arnolds in Noordeloos et al. 2005), rarely from pure or mixed dung (Hausknecht 1996, 2009).

Conocybe antipus (Lasch) Fayod: with a rooting stem in sect. *Conocybe*, it differs from *C. alboradicans* in having 4-spored basidia and smaller, angular to submitriform spores. Two records from cattle dung in Italy. Collections from unspecified dung types are also mentioned (Svrček 1959, Hausknecht 1996, 2009, Hausknecht et al. 2005, Arnolds in Noordeloos et al. 2005).

Conocybe aurea (Jul. Schäff.) Hongo: in sect. *Conocybe*, recognisable by its vivid egg yellow pileic cuticle. A single collection in Italy from old cattle dung. Widespread throughout Europe, but exceptionally recorded from old dung (Bon 1992, Hausknecht & Vesterholt in Knudsen & Vesterholt 2008).

Conocybe brunneidisca (Murrill) Hauskn.: previously described by Doveri (2004) under *C. lenticulispora* Watling, which Hausknecht (2009) has stated to be a later synonym. In section *Pilosellae* Kühner ex Singer (a pubescent stem with variable, often hairy caulocystidia, sometimes with additional, sparse lecythiform), it is distinguishable by its habitat and large, lentiform, and slightly angular spores. All collections from cattle dung in Italy. Widespread throughout Europe, and most fimicolous records are from horse dung (Watling 1980, 1982, Enderle 1993, Hausknecht 1995, Arnolds in Noordeloos et al. 2005).

Conocybe cettoiana Hauskn. & Enderle: in sect. *Mixtae* Kühner ex Singer (lecythiform caulocystidia mixed with polymorphous ones), stands out for often having fasciculate fruitbodies with rooting stems. Recorded from cattle dung (Cetto 1994, Doveri 2004, Hausknecht et al. 2005) and horse dung (Hausknecht

2003), and manured meadows grazed by sheep (Arnolds in Noordeloos et al. 2005).

Conocybe coprophila (Kühner) Kühner: described by Hausknecht (2009) under *Pholiotina coprophila* (Kühner) Singer, belongs to subgen. *Piliferae* (Kühner ex Singer) Watling (veil absent, cheilocystidia polymorphous, pileocystidia well developed), and is distinguishable by its habitat, a non-striate, viscid cap, comparatively large spores, and long filiform pileocystidia. All records from Italy on cattle dung. There are numerous records, some from unspecified dung (Singer 1950, Watling 1982, 1985, Hausknecht et al. 2009), most from cattle and horse (Kühner 1926, 1935, Singer 1953, Moreno 1976, Moser 1978, Bon 1992, Jamoni 1992, Contu 1997, Consiglio 1999a, Arnolds in Noordeloos et al. 2005, Hausknecht 2007, 2009, Welt & Heine 2007, Hausknecht & Vesterholt in Knudsen & Vesterholt 2008), with a preponderance of cattle (60%), rarely from sheep (Hausknecht & Vesterholt in Knudsen & Vesterholt 2008).

Conocybe fuscimarginata (Murrill) Singer: in sect. *Pilosellae*, with a hemispheric to conic-convex, non-striate cap and ellipsoidal spores, it differs from the very similar *C. rickenii*, particularly in having 4-spored basidia. Widespread worldwide and also growing on very rich soil, in Italy fimicolous collections were always recorded from cattle dung in the natural state. Most records of fimicolous collections are from cattle dung (Watling 1988, Enderle 1993, Consiglio 1999a, Karasch 2002, Fernández Sasía 2008, Suárez & Suárez-Gracia 2009), some from horse (Enderle 1991a, Sammler 1998, Hausknecht 2009), one from goat (Kaşık et al. 2004).

Conocybe gigasperma Enderle & Hauskn.: in sect. *Pilosellae* is distinguished by its thimble-like cap, 2-spored basidia, and very large spores. It is very rare, and does not grow on pure dung, but has always been found in rich soils, especially when strongly manured (Hausknecht & Enderle 1992).

Conocybe pubescens (Gillet) Kühner: in sect. *Mixtae*, it differs from *C. cettoiana* in lacking fasciculate fruitbodies and having bulbous, not rooting stems and larger spores. A common species worldwide, mainly on pure dung. Our two Italian collections are from horse dung. Besides records from unspecified

dung, there are many others from equine and bovine dung (Gillet 1877, Kühner 1949, Singer & Digilio 1952, Singer 1953, Pegler 1977, Watling & Taylor 1987, Watling 1988, 1992, Bon 1992, Enderle 1993, Fernández Sasía 2001, Arnolds in Noordeloos et al. 2005).

Conocybe rickenii (Jul. Schäff.) Kühner: in sect. *Pilosellae*, is distinguished by its habitat, a cap with olive shades, 2-spored basidia, and large, ellipsoidal spores. A common species throughout Europe. All records from Italy are on bovine and equine dung. Many records from Europe on unspecified dung, but findings, especially on cattle and horse dung are known (Watling 1988, Bon 1992, Hausknecht & Passauer 1997, Enderle & Hübner 1999, De Meulder 2001).

Conocybe siennophylla (Berk. & Broome) Singer: in section *Pilosellae*, with a small, striate, conical cap, and small, ellipsoidal spores. It is facultatively coprophilous. It is rarer in Europe generally than in Italy, where it is recorded particularly from cattle dung. There are also records from unspecified dung, some from cattle and horse (Hausknecht 2005).

Conocybe siliginea (Fr.) Kühner: close to *C. rickenii*, but with paler, smaller, and more delicate fruitbodies, and it never grows on pure dung, preferring rich soils. In Italy it was found on a manured soil.

Conocybe singeriana Hauskn.: in sect. *Pilosellae*, with large fruitbodies, a long, bulbous stem, 4-spored basidia, and large, ellipsoidal spores. Mainly recorded from dung, in Italy from cattle, elsewhere in Europe from cattle and horse (Hausknecht & Krisai-Greilhuber 1997, 2003, Hausknecht 1998, 2005, Enderle & Hübner 1999, Arnolds in Noordeloos et al. 2005, Hausknecht et al. 2005).

Coprinus s.l. is the commonest *Agaricales* genus on dung (Bell 1983, Richardson 2001), confirmed by surveys in Italy. It is a heterogeneous assemblage (Reijnders 1979) of non-monophyletic species (Hopple & Vilgalys 1994, 1999, Johnson 1999) few of which are retained in *Coprinus s.str.* by Redhead et al. (2001), and the remaining transferred in *Coprinellus* P. Karst., *Coprinopsis* P. Karst. and *Parasola* Redhead et al.

Coprinellus bisporus (J.E. Lange) Vilgalys et al.: similar to *C. sassii* in having 2-

spored basidia, but with smaller spores, and without pleuro- and sclerocystidia. It usually grows fasciculate. Rarely recorded from Italy, in the natural state only. There are no recent records other than that of Jamoni (2007) from Italy on unidentified dung.

Coprinellus brevisetulosus (Arnolds) Redhead et al. (= *Coprinus stellatus* Buller in Bisby et al.): our experience allows us to identify it also in the field, as it is hardly pubescent (very small setulae on cap and stem), and to distinguish it from *C. pellucidus* (P. Karst.) Redhead et al., which has quite smaller fruitbodies and a more variable habitat. Four records only (three in the field) from Italy, all from cattle dung. Also recent records from France (Cheype 2008) and Spain (Rubio & Miranda 2008), both on cattle dung in the natural state.

Coprinopsis candidolanata (Doveri & Uljé) Keirle et al.: close to *C. pseudoradiata*, but also with diverticulate, narrower hyphae of the veil, and ellipsoidal to ovoid spores. Very rare worldwide. Recorded only four times, from Italy and the Netherlands (Uljé et al., 2000), respectively on fallow deer and sheep dung, from Germany (Melzer, 2009) on alpaca, and from the Hawaiian Islands (Keirle et al., 2004) on goat.

Coprinopsis cinerea (Schaeff.) Redhead et al.: similar to *C. candidolanata*, but with somewhat larger spores and the filamentous veil of only broad hyphae in chains. Common in Italy in the natural state (66% of records from cattle dung), less common in our cultures (three records out of five from bird). Common in Europe and widespread worldwide on dung heaps or manured straw (Orton & Watling 1979, Uljé in Noordeloos et al. 2005). There are two records from cattle dung (Vila & Rocabrana 1996, Schafer 2001).

Coprinellus congregatus (Bull.) P. Karst.: very similar to *C. ephemerus* (Bull.) Redhead et al., in comparison with which it tends to be caespitose, in the field, rather than scattered or gregarious. It preferably grows in the natural state in Italy, on cattle and horse dung. Recent records are from Belgium (Wuilbaut 2006) and Spain on cattle dung (Rubio & Miranda 2008).

Coprinopsis cothurnata (Godey) Redhead et al.: close to *C. nivea*, but easily distinguishable by having hexagonal spores.

Never grown in our cultures, but recorded from the field particularly on cattle dung. Recorded from The Netherlands (Uljé & Noordeloos 1993, Uljé in Noordeloos et al. 2005) and Scandinavia (Vesterholt in Knudsen & Vesterholt 2008) on cattle and horse dung. Always recorded in association with cattle dung from Hawaiian Islands (Keirle et al. 2004).

Coprinellus curtus (Kalchbr.) Vilgalys et al.: recognisable for its habitat, ochreous yellowish sphaerocysts, and subcapitate pileo- and caulocystidia. It was stated to be present in Italy on horse dung only (Doveri, 2004), but now its substrate preference appears to be wider, in culture at least. It was reported from Great Britain (Orton & Watling 1979) and the Netherlands (Uljé & Bas 1991, Uljé in Noordeloos et al. 2005) on horse dung only. Most records are from equine dung (Lange 1915, Buller 1920, Rea 1922, Nathorst-Windahl 1961, Hausknecht & Krisai-Greilhuber 2003, Richardson 2008a, Vesterholt in Knudsen & Vesterholt 2008), but some are from deer (Keirle et al. 2004) and sheep (Richardson 2008b).

Coprinus doverii Nagy: This was originally discovered by Doveri (unpublished) and confirmed as distinct by Uljé (pers. comm.), but the material was inadequate for a proper description. Subsequently Nagy, studying Uljé's material, recognised that it was the same as a species found by him from Hungary, from deer dung, and described as *Coprinus doverii* (Nagy 2006; pers. comm.).

According to the systematics suggested by Redhead et al. (2001) *Coprinus doverii* is undoubtedly a *Coprinellus* species, although it has not been transferred to this genus. In *Coprinellus*, only *C. angulatus* (Peck) Redhead et al. has similar, but larger spores. The latter, besides, is carbonicolous, has pleurocystidia and larger fruitbodies (Nagy 2006).

Coprinus ephemeroideus (Bull.) Fr.: in comparison with *C. patouillardii* it has an annulate stem and always lacks lageniform cheilocystidia. Recorded from Italy in the natural state, once from our cultures, from cattle and horse dung. Mentioned as quite common all over Europe, particularly on equine dung (Uljé & Noordeloos 1993, Richardson 2008a,b, Vesterholt in Knudsen &

Vesterholt 2008). Sporadic records from cattle (Rubio & Miranda 2008), mouflon (Richardson 2008b), and elk (Vesterholt in Knudsen & Vesterholt 2008) dung.

Coprinellus ephemerus (Bull.) Redhead et al.: it can be distinguished from *C. congregatus* not only by its scarce tendency to be caespitose, but also by the presence of clamp-connections and somewhat larger spores (Uljé in Noordeloos et al. 2005). Quite frequent in Italy, where it prefers cattle dung in the natural state, but with a wider substratum choice for fruiting in culture. These data only partly match those from France (Josserand 1933, Locquin 1947, Kühner & Romagnesi 1953) and the Netherlands (Uljé & Bas 1991, Uljé in Noordeloos et al. 2005), where it prefers cattle dung.

Coprinopsis filamentifera (Kühner) Redhead et al.: well recognisable in *Coprinopsis* particularly by its subrectangular spores. Recorded from Italy in culture only, where it quite frequently grows (ca. 5% of total *Coprinus s.l.* records) on a variety of dungs, and there are numerous records from Europe (Kühner & Romagnesi 1957, Moreno & Calonge 1975, Orton & Watling 1979, Cacialli et al. 1999, Doveri 2004, Richardson 2005, 2008a, b, Uljé in Noordeloos et al. 2005, Nagy 2007, Vesterholt in Knudsen & Vesterholt 2008).

Coprinellus heptemerus: a very distinctive species with its minute fruitbodies, velar sphaerocysts, strongly tapering, pointed pileocystidia, and ellipsoidal spores with an eccentric germ pore. Very common in Italy, both in the field, where it seems to prefer cattle dung, and in culture (15% of all *Coprinus s.l.* records, with ca. 10% occurrence on all dung samples), where its preferences are more variable.

Coprinellus heterosetulosus (Locq. ex Watling) Vilgalys et al.: growth on dung, cap with reddish shades, and the contemporaneous presence of lepto- and scleropileocystidia help its identification. The sclerocystidia, smaller than leptocystidia and variable in number, can easily be missed. It grows with the highest frequency on equine dung (82% of our records from cultures). A confirmation of the preference for this substratum type comes from France (Locquin 1947) and the Netherlands

(Uljé & Bas 1991), whereas a greater variability is recorded from Great Britain (Orton & Watling 1979) and Scandinavia (Vesterholt in Knudsen & Vesterholt 2008) and Castro (2006) has recorded it from cattle from Spain.

Coprinellus flocculosus (DC.) Vilgalys et al.: owing to its floccose-scaly veil of ellipsoidal or subglobose, sometimes thick-walled and pigmented hyphae, it belongs to *Coprinus s.l.* subsect. *Domestici* Singer, and is regarded as a facultatively coprophilous species, and the few records known by us are from straw mixed with dung (Orton & Watling 1979) or manured soil (Lanconelli 1997).

Coprinopsis luteocephala (Watling) Redhead et al.: is the latest *Coprinus s.l.* described by Doveri et al. (2005) from Italy. The lemon yellow veil, and its preference for equine dung (Watling 1972, Orton & Watling 1979, Uljé & Noordeloos 1997, Doveri et al. 2005), distinguishes *C. luteocephala* from *C. xenobia*, which prefers bovine dung (Orton 1976, Bender 1991, Cacialli et al. 1995, 1996, Uljé in Noordeloos et al. 2005).

Coprinopsis macrocephala (Berk.) Redhead et al.: see also under *C. radiata*. Commoner on straw and manure rather than in pure dung. Our few records in Italy, from the field only, are from bovine and equine dung.

Coprinellus marculentus (Britzelm.) Redhead et al.: the whole of a cap with purple shades, hexagonal spores, and pileocystidia with a swollen, but not capitate tip, characterises this taxon. Few records from Italy on cattle and horse dung in the natural state. Other records known by us are from equine dung (Smith 1948, Richardson 2008c).

Parasola misera (P. Karst.) Redhead et al.: the small, glabrous, orange caps on dung allow this species to be readily identified in the field. It is frequent in our cultures (10% of *Coprinus s.l.* records) on dung of several herbivores. It appears to be one of the commonest *Coprinus* spp. on various dung types, as confirmed by numerous records from Europe and Africa (Richardson 2004a,b, 2005, 2008a,b).

Coprinopsis nivea (Pers.) Redhead et al.: another coprophilous species easily recognisable by its snow white, pruinose veil and large, limoniform spores. Rarely developed in

our cultures, but fairly common in the natural state in Italy, particularly on cattle dung (66% of its records from the field). Recorded as a species particularly frequent on cattle and horse dung (Orton & Watling 1979, Uljé & Noordeloos 1993, Vesterholt in Knudsen & Vesterholt 2008), and from horse dung by Miranda & Rubio (2000) in Spain and Poumarat (2008b) in France.

Coprinus patouillardii QuéL.: it also includes *C. cordisporus* Gibbs, the latter considered a later synonym (see Doveri 2004). It is identifiable by its finely granulose veil and angular to cordate spores with an apical papilla. Common in Italy, where almost all records come from cattle and horse dung, more frequently from the latter. Common also in other European countries, where it is recorded from several dung types (Richardson 2004a, 2005, 2008a, Uljé in Noordeloos et al. 2005).

Coprinellus pellucidus: see also under *C. brevisetulosus*. Not very common in Italy, where it grows on different dung types. Reported to be common on cattle dung from Great Britain (Orton & Watling 1979), the Netherlands (Uljé & Bas 1991, Uljé in Noordeloos et al. 2005) and Scandinavia (Vesterholt in Knudsen & Vesterholt 2008), it is also recorded from various dung types elsewhere in Europe (Beyer 2004, Coué 2004, Richardson 2004a, 2008a). Outside Europe, it appears frequent on cattle and horse dung (Malençon & Bertault 1970, Keirle et al. 2004, Richardson 2008c).

Coprinopsis poliommallus (Romagn.) Doveri et al.: recognisable on dung by its minute fruitbodies with a pruinose (mainly formed of sphaerocysts), greyish veil, and small, ellipsoidal spores. Very rare in Italy on cattle and horse dung. Most records from Europe on cattle dung (Romagnesi 1945, Kühner & Romagnesi 1953, Moreno & Barrasa 1977, Orton & Watling 1979, Enderle & Bender 1990, Uljé & Noordeloos 1993, Uljé in Noordeloos et al. 2005, Vesterholt in Knudsen & Vesterholt 2008), and only one record from sheep (Coué et al. 2004).

Coprinopsis pseudocortinata (Locq. ex Doveri et al.) Doveri et al.: close to *C. poliommallus*, but with a white veil and even smaller spores. Perhaps the smallest fruitbodies

in *Coprinus s.l.* Rare in Italy on cattle and horse dung. Possibly rare also in Europe, judging by the few published records (Locquin 1947, Uljé & Noordeloos 1993, Cacialli et al. 1999). A recent collection from Spain (Rubio & Miranda, 2008) from roe deer dung.

Coprinopsis pseudonivea (Bender & Uljé) Redhead et al. var. *pseudonivea*: close to *C. nivea*, but with smaller spores and patent pinkish shades on the veil. *Coprinopsis pseudoniveus* var. *tenuicystidiatus* Chalange (not recombined yet in *Coprinopsis*) differs from var. *pseudonivea* in having smaller fruitbodies, velar sphaerocysts, and pleurocystidia. The type variety has been recorded only three times in Italy, always from cattle dung. Other records also from Europe on cattle dung (Vila & Rocabrana 1996, Hausknecht et al. 1999, Vesterholt in Knudsen & Vesterholt 2008).

Coprinopsis pseudoradiata (Watling) Redhead et al.: among *Coprinopsis* spp. with a fibrous-floccose veil of broad, more or less parallel hyphae, it can be recognised by its small fruitbodies and small, ellipsoidal to oblong spores. Few collections from Italy, recorded from different dung types. Other records in Europe from various types (Richardson 2004a, 2008a, b, Rubio & Miranda 2008, Vesterholt in Knudsen & Vesterholt 2008).

Coprinopsis radiata (Bolton) Redhead et al.: differs from *C. pseudoradiata* usually in having larger fruitbodies and spores, and from *C. macrocephala* in somewhat narrower spores. Very common in Italy, both in the natural state (80% of records from horse dung) and in our cultures, where 62% of records are from equine, with 34% of occurrence on this dung type. It is also common on horse dung in Europe (Orton & Watling 1979, Miranda & Rubio 2000, Richardson 2008b) and elsewhere (Keirle et al. 2004, Richardson 2004b).

Coprinellus sassii (M. Lange & A.H. Sm.) Redhead et al.: very close to *C. heterosetulosus* with the presence of sclerocystidia, but distinguishable by its 2-spored basidia and larger spores. It is rare both in Italy and elsewhere, with few collections reported, all from horse dung (Sass 1929, Lange & Smith 1953, van de Bogart 1975, Doveri et al. 2005).

Parasola schroeteri (P. Karst.) Redhead et al.: differs from *P. misera* in having larger,

cream-yellowish fruitbodies, larger spores, and presence of pleurocystidia. Rare in Italy, where it has been recorded from cattle dung in the field (Cacialli et al. 1995). Recorded from Europe on cattle and horse dung (Karsten 1879, Orton 1972, Orton & Watling 1979), and it has also been reported as terrestrial (Ulje & Bender 1997, Consiglio 2005).

Coprinus spadiceusporus Bogart: in *Coprinus s.str.*, it is close to *C. sterquilinus* from which it differs in having smaller fruitbodies and smaller, submitriform to rhomboid spores. It is a North American species (van de Bogart 1976), which grows on cervine dung. Few records from Italy, all from the same place on fallow deer dung in the natural state (Ulje et al. 1998). There is a single non-fimicolous collection from Sardinia (Contu 2007) and one other record from Europe, from Spain on rabbit dung (Tabarés & Rocabrana 2002).

Coprinopsis stercorea (Scop. ex Fr.) Redhead et al.: with its habitat on dung and a mealy-pruinose veil of diverticulate sphaerocysts, it is similar to *C. tuberosa*, but it has a faecal smell and smaller spores. Common in our Italian cultures (14% of all *Coprinus s.l.* records, with a ca. 9% frequency of occurrence on all samples), where it develops on various dung types. Widespread in Europe and one of the commonest *Coprinus s.l.* in culture worldwide (Richardson, 2004b), on dung of several herbivores (Keirle et al. 2004, Richardson 2004a,b, 2005, 2008a,b,c). Additional, quite recent records from Spain (Moreno-Arroyo et al. 2005, Siquier & Salom 2005b, Moreno et al. 2008), Austria (Dämon 2005), and Germany (Melzer 2009).

Coprinus sterquilinus (Fr.) Fr.: in *Coprinus s.str.* (species with an annulate stem and an adherent veil of filamentous hyphae), it usually has, unlike *C. spadiceusporus*, a pseudovolva, and grows on equine dung, as reported from Italy (Cacialli et al. 1995) and other European (Orton & Watling 1979, Justo et al. 2005, Ulje in Noordeloos et al. 2005) or extra-European (Keirle et al. 2004, Richardson 2004b) localities. Rarely found on excrements of different herbivores (Orton & Watling 1979, Babos 2004).

Coprinopsis tuberosa (Qué.) Doveri et al.: often with a sclerotium and a rooting stem,

it differs from *C. stercorea* in having larger spores and lacking a disagreeable smell. Unlike the latter, it is very rare in Italy, known from only one recent record on dung of an unidentified herbivore (Jamoni 2007). There are three recent records from Europe (Miranda & Rubio 2000, Roux 2006, Melzer 2009) on cattle, unspecified, and alpaca dung, respectively. Orton & Watling (1979) mention it particularly on horse dung, like our record from the field.

Coprinopsis utrifera (Watling) Redhead et al.: close to *C. poliommallus* and *C. pseudocortinata*, but with somewhat larger fruitbodies, subcylindrical spores, and a veil formed both of sphaerocysts and diverticulate hyphae. In Europe few records from sheep (Orton & Watling 1979), horse (Ulje in Noordeloos et al. 2005), and cattle (Richardson 2008a). Our Italian findings extend the substratum to rabbit and cervine dung.

Coprinopsis vermiculifera (Dennis) Redhead et al.: in comparison with *C. filamentifera* it has somewhat larger spores and ascending, very thick-walled, and pigmented end hyphae of the veil. In Italy recorded only once from rock goat dung in culture. Less rare in Europe and particularly recorded from sheep (Orton & Watling 1979, Richardson 2005, 2008a, b) or dung of various herbivores (Moreno 1976, Enderle et al. 1986, Vesterholt in Knudsen & Vesterholt 2008).

Coprinopsis xenobia (P.D. Orton) Redhead et al.: see under *C. luteocephala*.

Lepista (Fr.) W.G. Sm. is recognisable in *Tricholomataceae* R. Heim ex Pouzar especially by its often tricholomatoid fruitbodies with crowded, easily separable gills, non-amyloid, ornamented, strongly cyanophilous spores, presence of clamp-connections, and absence of veil and cystidia. Often in rich soils but exceptionally fimicolous. *L. sordida* has a striate, strongly hygrophanous pileic cuticle, violet gills and stem, and a faint fruity smell. There are a few records from specified dung, in Italy from cattle (Consiglio & Contu 2003).

Leucocoprinus Pat. in *Agaricaceae* Chevall. has coprinoid fruitbodies with pale gills, a strongly striate cap and a well developed veil, pale, dextrinoid and metachromatic spores, and presence of pseudoparaphyses. *L. cretaceus* (Bull.) Locq. has a

large, white, furfuraceous-floccose cap and comparatively large spores with a germ pore. It has often been recorded from rich soils or compost heaps but, besides a record from horse (Doveri 2004), it is not known directly from pure dung or manures.

Panaeolus, in *Bolbitiaceae* after molecular studies by Moncalvo et al. (2002) and in agreement with Petersen & Knudsen (in Knudsen & Vesterholt 2008), differs from the other genera of this family in having darker spores in mass. It includes non-deliquestent, often hygrophanous species with a cellular pileipellis, spotted gills, and spores non-discolouring in H₂SO₄. Most have a direct or indirect connection with dung.

Panaeolus acuminatus (Schaeff.) Quél.: distinguishable by its dark, slender, and non-fasciculate fruitbodies lacking a veil, with a conic-paraboloid, hygrophanous cap and a very long, exannulate stem, microscopically for lacking sulphidia and having limoniform or mitriform, flattened spores. All our fimicolous findings are directly on cattle dung. Also recorded from manured or rich soils (Gerhardt in Knudsen & Vesterholt 2008). Most fimicolous collections from cattle dung (Maire 1937, Jamoni 1994, Pegler 1977, Ortega et al. 1997, De Meulder 2001, Hausknecht & Krisai-Greilhuber 2009), fewer from equine (Yokoyama 1979, Pegler 1983, Hausknecht & Krisai-Greilhuber 2009) and elephant (Vrinda et al. 1999, Manimohan et al. 2007).

Panaeolus alcis M.M. Moser: Moser (1984), in the protologue, compared *P. alcis* with *P. sphinctrinus* var. *minor* (Fr.) Singer, with fruit-bodies similar in size, shape and colour. The latter, however, has patent veil remnants on the cap edge, clearly angular spores in frontal view (in these respects it belongs to sect. *Panaeolus* ss. Gerhardt 1996), is widespread and usually grows on horse (Singer 1960) or cattle (Guzmán & Pérez-Patracca 1972), occasionally on moose (Moser 1984) dung, while *P. alcis* lacks veil remnants, both on the stem and cap edge (it belongs to sect. *Laevispora* Ew. Gerhardt), and has ellipsoidal, exceptionally slightly angular, and more tapered (Q = 1.80 versus 1.50, personal data) spores. Besides it grows on moose, rarely on roe-deer and reindeer dung (Moser 1984, Noordeloos 1998, Gerhardt in Knudsen &

Vesterholt 2008), in Canada and Scandinavia. But recently it has spread southwards, up to France and Spain on horse dung (Poumarat 2008c), and Italy (Hausknecht & Krisai-Greilhuber 2009) on unidentified dung. Ours in Sardinia is the southernmost finding so far known.

Panaeolus antillarum (Fr.) Dennis: in subgen. *Anellaria* (P. Karst.) Ew. Gerhardt, with its fleshy and pale fruitbodies, a viscid and non-hygrophanous cap, and a constant presence of sulphidia, it differs from *P. semiovatus* particularly in having an hemispheric-campanulate cap and lacking a veil. All our Italian collections from cattle dung. Recorded from cattle (Dennis 1961, Guzmán & Pérez-Patracca 1972, Guzmán & Johnson 1974, Yokoyama 1979, Pegler 1983, Young 1989, Grgurinovic 1997, Reid & Ecker 1999), frequently from horse (Yokoyama 1979, 1984, Pegler 1983, Young 1989, Stijve & Meijer 1993, Alves & Cavalcanti 1996, Grgurinovic 1997, Consiglio 1999a, Cortés & Montón 2002, Hausknecht & Krisai-Greilhuber 2003, Mir & Melis 2008), sometimes from elephant dung (Pegler 1977, Natarajan & Raman 1983, Manimohan et al. 2007).

Panaeolus cinctulus (Bolton) Sacc.: it lacks veil, weeping gills, and ornamented spores, i.e. is placed in sect. *Laevispora* (Gerhardt 1996), where it is distinguished in having often fasciculate fruitbodies, broad, even capitate cheilocystidia, and no sulphidia. Facultatively fimicolous, it has been recorded in Italy and elsewhere both from cattle (Saccardo 1916, Christiansen 1941, Enderle 1982, Stijve & Meijer 1993) and horse dung (Parker-Rhodes 1951, Calonge & Menezes de Sequeira 2003). One record from elephant dung (Natarajan & Raman 1983).

Panaeolus fimicola (Fr.) Gillet: in sect. *Laevispora*, it differs from *P. acuminatus* in having less slender fruitbodies, a greyish-brown pileic cuticle, and much less flattened spores. Fimicolous records are not so numerous as those from rich soils. In Italy there is only one fimicolous collection, from an unidentified herbivore. Elsewhere there are records from unspecified dung (Gillet 1877, Morgan 1907a, Christiansen 1941, Guzmán & Pérez-Patracca 1972, Pegler 1977, Stamets 1996, Ludwig 2001), cattle (Britzelmayr 1883, De Meulder

2001, Richardson 2008a) and horse dung (Hongo 1959, Hausknecht & Krisai-Greilhuber 2009).

Panaeolus guttulatus Bres.: easily recognisable by its weeping gills, secreting cheilocystidia, and small spores. Our Italian collections are the only fimicolous ones known, but it has been reported on manured soil (Gerhardt 1996).

Panaeolus papilionaceus (Bull.) Quél., *P. retirugis* (Fr.) Gillet, *P. sphinctrinus* (Fr.) Quél.: all described (Gerhardt 1996 in Knudsen & Vesterholt 2008), together with *P. campanulatus* (Bull.) Quél., as synonyms under the prior *Panaeolus papilionaceus*, which so is conceived as a species with a variable cap in colour and shape. It can be recognised by its abundant veil on the cap margin (sect. *Panaeolus*), particularly in the young specimens, and growth on dung or manures, sometimes on strongly manured soils. This aggregate taxon has been recorded several times from Italy from cattle and horse dung in the natural state, once from horse dung in culture (the only *Panaeolus* sp. developing in our damp chambers). Widely recorded with levels of occurrence very close to ours on bovine (Gillet 1877, Maire 1937, Christiansen 1941, Singer 1960, Dennis 1961, Ola'h 1970, Guzmán & Pérez-Patracá 1972, Guzmán & Johnson 1974, Blanco & Moreno 1986, Moreno et al. 1990, Treu 1996, Ortega et al. 1997, De Meulder 2001, Jamoni 2001, Poumarat 2008b, Richardson 2008a, Hausknecht & Krisai-Greilhuber 2009) and equine dung (Gillet 1877, Romagnesi 1937, Christiansen 1941, Guzmán 1961, Miller 1968, Guzmán & Pérez-Patracá 1972, Young 1989, Enderle 1991a,b, Siquier & Lillo 1994, Treu 1996, Grgurinovic 1997, Siquier & Salom 2005a, Poumarat 2008a, b, Hausknecht & Krisai-Greilhuber 2009). Isolated records from sheep, guanaco (Horak 1979), and rabbit dung (Arnolds 1982).

Panaeolus semiovatus (With.) S. Lundell: in subgen. *Anellaria*, distinguished by its semiovate cap and patent veil remnants on its margin or in the shape of an annulus. Worldwide in occurrence, recorded in Italy and elsewhere, especially from bovine or equine dung (Spegazzini 1881, 1925, Maire 1937, Christiansen 1941, Lacaze 1953, Hongo 1959,

Dennis 1961, Miller 1968, Bon 1970, Ola'h 1970, Calonge 1971, Guzmán & Pérez-Patracá 1972, Pilát 1972, Watling & Gregory 1980, Bon & Marchand 1987, Robich 1992, Stamets 1996, Ortega et al. 1997, Jamoni 2001, Gerhardt in Knudsen & Vesterholt 2008, Poumarat 2008a, Hausknecht & Krisai-Greilhuber 2009) in the natural state.

Panaeolus subfirmus P. Karst.: in sect. *Laevispora*, distinguishable by its pale buff cap and large, opaque, subhexagonal, lenticular spores. It is a particularly northern European species, but recorded in Italy from horse dung (2004), and elsewhere from heavily manured soils or cattle (Noordeloos 1998), horse and sheep dung (Ludwig 2001).

Psathyrella, in *Psathyrellaceae* Vilgalys et al., includes species with a habit similar to many *Coprinus s.l.* in the same family, and to some *Panaeolus* spp. in *Bolbitiaceae* but, unlike the former, it lacks deliquescent gills and a regular coprinoid hymenium (basidia surrounded by brachycystidia), unlike the latter, usually it has unmottled gills and ellipsoidal spores that discolour in H₂SO₄. Usually terricolous or graminicolous, but some species are fimicolous.

Psathyrella coprinoides Delannoy et al.: distinguishable on dung by its small fruitbodies, a granulose-pubescent cap with pileocystidia and veil sphaerocysts (sect. *Cystopsathyra* (Singer) Kits van Wav.) and very small spores. Together with *Psathyrella minima* Peck, *P. berolinensis* Ew. Gerhardt, *P. granulosa* Arnolds, and *Coprinus parvulus* P.-J. Keiser & Uljé, it also has been synonymised under *Psathyrella tenuicula* (P. Karst.) Örstadius & Huhtinen *s.l.* (Larsson & Örstadius 2008). A rare species, twice recorded in Italy from our cultures of marten and roe deer dung, but never from the field, rare also elsewhere, and recorded from cervine (Peck 1888, Delannoy et al. 2002), cattle (Arnolds 2003b), horse, and wild boar (Larsson & Örstadius 2008) dung, always in the natural state.

Psathyrella hirta Peck: in subgen. *Psathyrella*, sect. *Atomatae* Romagn. ex Singer (small and delicate fruitbodies, not rooting stems, gills with pinkish shades, comparatively large and smooth spores, and broad, spheropedunculate and often 2-spored basidia), it is regarded as a constantly fimicolous species,

which is recognisable, in the early stages at least, by its fibrillose veil strongly developed both on the cap and stem. Widespread in Europe and recorded from cattle (Kits van Waveren 1972, 1985, Heykoop & Esteve-Raventós 1994, Tassi 1997, De Meulder 2001, Vašutová 2006, Larsson & Örstadius 2008) and horse dung (Kits van Waveren 1972, 1985, Perez Losantos & Bascones Carretero 1981, Enderle & Christan 1992, Tassi 1997, Larsson & Örstadius 2008, Siquier & Salom 2008) in the natural state, but also in culture (Hugueney 1965, Esteve-Raventós & Barrasa 1989), unusually from roe deer dung (Derbsch & Schmitt 1987).

Psathyrella lacrymabunda (Bull.) M.M. Moser: in subgen. *Lacrymaria* (Pat.) Singer & A.H. Sm. (fleshy fruitbodies with an abundant cortiniform veil and an appendiculate cap margin, weeping gills, and verrucose spores), it is distinguishable by its ochreous brown cap and a long stem. According to phylogenetic analyses (Hopple & Vilgalys 1999, Larsson & Örstadius 2008, Padamsee et al. 2008) *P. lacrymabunda* and allied species should be described under the distinct genus *Lacrymaria* Pat. Exceptionally fimicolous; I have studied numerous Italian collections, but only one from horse manure; reported elsewhere from rich nitrogenous (Ortega Díaz & Gálan Márquez 1981) or manured soils (Esteve-Raventós & Barrasa 1989).

Psathyrella prona (Fr.) Gillet: some forms and varieties are known of this facultatively fimicolous species, which can be distinguished from *P. hirta* (both in sect. *Atomatae*) particularly by its hardly developed veil and larger spores. I have revised several collections from Italy, only one from pure dung (horse). Reported on rich soils or rotten wood, rarely recorded from manure (Saccardo 1816) or dung (Larsson & Örstadius 2008, Örstadius & Knudsen in Knudsen & Vesterholt 2008). There are also records on cattle (Esteve-Raventós & Barrasa 1989) and horse dung (Kits van Waveren 1985).

Psilocybe in *Strophariaceae* includes species with a hyphal pileipellis (*cutis* or *ixocutis*) and purple or purple-brown spores in mass, which can be distinguished from coprophilous *Stropharia* spp. by constantly lacking chrysocystidia and a glutinous stem

and annulus. According to Noordeloos (2009), following phylogenetic studies (Moncalvo et al. 2000) and a proposal to conserve the name *Psilocybe* (Redhead et al. 2007), the hallucinogenic (bluing) species must be kept in *Psilocybe*, whereas the non-hallucinogenic ones must be accommodated in *Deconica* (W.G. Sm.) P. Karst.

Psilocybe coprophila (Bull.) P. Kumm.: in sect. *Merdariae* (Fr.) Singer (coprophilous, not bluing, with a central stem and comparatively large, thick-walled spores), it is similar to and macroscopically mistakable for *P. subcoprophila*, in the same section, and *P. liniformans*, in sect. *Semilanceatae* Guzmán. It differs from the former in having hexagonal rather than ellipsoidal spores, from the latter in lacking a gelatinous gill edge and not bluing by handling. Common in Italy, particularly on cattle and horse dung in the natural state, and once isolated in culture. One of the commonest *Psilocybe* spp. from all continents, particularly from cattle (Bresadola 1931, Christiansen 1941, Hongo 1965, Guzmán et al. 1977, Pegler 1977, Watling & Gregory 1980, Stamets 1996, De Meulder 2001, Calonge & Menezes de Sequeira 2003, Gularte Cortez & Coelho 2004) and horse dung (Christiansen 1941, Dennis 1961, Guzmán et al. 1977, Bigelow 1978, Yokoyama 1979, 1987, Stamets 1996, Granito & Lunghini 2004, Gularte Cortez & Coelho 2004, Siquier & Salom 2005a) but, as supposed by Guzmán (1983), also growing on other dung types, e.g. hare (Hongo 1959, Richardson 2008a), sheep (Watling & Gregory 1987, Johnston & Buchanan 1995), elephant (Thomas & Manimohan 2002, Manimohan et al. 2007), and marmot (Jamoni 1990).

Psilocybe crobulus (Fr.) Singer: in sect. *Psilocybe* (not bluing fruitbodies with a central stem and comparatively small, usually flattened spores), it is distinguishable by a well developed veil, particularly at the cap margin, a viscid cuticle, and thin-walled spores. Usually growing on vegetable debris, it has occasionally been recorded on unspecified dung (Guzmán 1983, Watling & Gregory 1987, Ludwig 2001, Vesterholt in Knudsen & Vesterholt 2008) or sawdust mixed with dung (Noordeloos in Kuyper et al. 1999). Besides our Italian records there are other records from

cattle dung (Breitenbach & Kränzlin 1995, Consiglio 1999b).

Psilocybe cyanescens Wakef.: in sect. *Cyanescentes* Guzmán (bluing species with a convex cap and thick-walled, ellipsoidal to mitriform, flattened spores), it is distinguishable from *P. semilanceata* by stouter fruitbodies with a different cap shape, more flattened spores, and presence of pleurocystidia. It usually grows on rotten wood and among leaves on nitrogenous soils. Apart from our Italian records there appear to be no other coprophilous collections.

Psilocybe inquilina (Fr.) Bres.: similar to *P. crobulus*, from which it differs in having a less developed veil and slightly larger spores. Occasionally fimicolous, it has been described on horse dung (Høiland 1978, Ludwig 2001), rabbit (Vila & Llimona 1998), unspecified dung (Moreno-Arroyo et al. 2005), and meadows grazed by cattle and sheep (Watling & Gregory 1987).

Psilocybe liniformans Guzmán & Bas: in sect. *Semilanceatae* Guzmán (bluing, umbonate species with ellipsoidal, hardly flattened spores, and no pleurocystidia), it is macroscopically closer to *P. coprophila* and *P. subcoprophila* than to *P. semilanceata* (the latter in the same section). It is distinguished by a strongly gelatinised gill edge. Recorded only from horse dung (Guzmán & Bas 1977, Guzmán 1983, Stamets 1996, Noordeloos 1998, in Kuyper 1999, Esteve-Raventós et al. 2001, Fernández-Sasia 2001, Guzmán et al. 2006, Siquier & Salom 2008, Vesterholt in Knudsen & Vesterholt 2008).

Psilocybe merdaria (Fr.) Ricken: like *P. coprophila*, it has hexagonal, but slightly smaller spores, and differs also in having a paler, usually non-striate cap, and patent veil remnants, often in the shape of an annulus. Twice recorded on cattle dung from Italy, and widespread elsewhere, especially on bovine dung (Pegler 1977, Guzmán 1978, Jamoni 1993, Ortega et al. 1997, De Meulder 2001, Ludwig 2001, Pirlot 2003), and also from other domestic herbivores (Pilát 1972, Bigelow 1978, Watling & Gregory 1987, Noordeloos 1998, in Kuyper et al. 1999, Richardson 2005, 2008b, Vesterholt in Knudsen & Vesterholt 2008), occasionally from hare (Richardson 2005),

water vole (Sengupta & Laessøe 2004), and elk (Vesterholt in Knudsen & Vesterholt 2008).

Psilocybe semilanceata (Fr.) P. Kumm.: type species of sect. *Semilanceatae*, it stands out for having a hardly expanding, typical campanulate to conic-paraboloid, umbonate cap, almost free, not gelatinised gills, and not strongly bluing tissues. It is a worldwide temperate species, especially recorded from grazed meadows and fields, exceptionally from manure (Morgan 1907b), cattle (Doveri 2004), or unspecified dung (Castro 2005).

Psilocybe subcoprophila (Britzelm.) Sacc.: very close to and indistinguishable in the field from *P. coprophila*, but with ellipsoidal, somewhat larger spores. It also resembles *P. angustispora* A.H. Sm., a North American fimicolous species both on domestic and wild animal dung (Guzmán 1983), but it differs in having wider cheilocystidia, and larger, especially broader spores (Guzmán 1983, Guzmán & Trappe 2005). Widespread but not so common as *P. coprophila*, with a single collection from our studies from wild pig dung, and another Italian record from horse (Granito & Lunghini 2004). Elsewhere especially observed on horse (Svrček 1959, Orton 1969, Høiland 1978, Noordeloos 1998, Guzmán & Trappe 2005, Poumarat 2008b), but also recorded from sheep (Orton 1969, Watling & Gregory 1987, Ludwig 2001), cattle (Horak 1979, Poumarat 2008b), hare (Noordeloos 1998), and from dung of unspecified domestic herbivores (Guzmán 1983, Noordeloos in Kuyper et al. 1999, Vesterholt in Knudsen & Vesterholt 2008).

Stropharia, in *Strophariaceae*, includes usually annulate species with a viscid cap and acanthocytes in the basal mycelium, sharing a hyphal pileipellis with *Psilocybe*, from which they particularly differ in having pleurochrysocystidia. Most coprophilous species are accommodated in sect. *Stercophila* (Romagn.) Singer, which further differs from *Psilocybe* in having glutinous veil, cap, lower portion of stem, and annulus. *Stropharia* has also been regarded as a later synonym of *Psilocybe* (Noordeloos in Kuyper et al., 1999; Kirk et al., 2008). All three species observed by us in Italy belong to sect. *Stercophila*.

Stropharia dorsipora Esteve-Rav. &

Barrasa: except for its always well developed annulus, it is practically indistinguishable in the field from *S. semiglobata*, from which it also differs in having spores with an eccentric germ pore, and a variable presence of cheilochrysocystidia and caulochrysocystidia. Usually recorded by us from horse dung, once in culture, rarely from cattle, it appears to be quite common in Europe and possibly overlooked. Besides some records from unspecified dung, there are records from horse and cattle dung (Esteve-Raventós & Barrasa 1995, Kytövuori 1999, Noordeloos in Kuyper et al. 1999, Hausknecht & Krisai-Greilhuber 2003, Gularte Cortez & Silveira 2008, Rubio & Miranda 2008, Ryman in Knudsen & Vesterholt 2008).

Stropharia luteonitens (Vahl) Quél.: the only species in sect. *Stercophila* without pleurochrysocystidia, easily recognisable also by its slender fruitbodies, a conic-campanulate and papillate-umbonate cap with yellowish shades, large spores, and 2-spored basidia. Although it can grow in pastures and rich soils (Baş Sermenli & Işiloğlu 2006), it has been recorded from dung-rich soils (Clemençon & Roffler 2003), sometimes from unspecified dung, and from horse or cattle dung (Spegazzini 1899, Cleland & Cheel 1918, Hongo 1959, Granito & Lunghini 2004).

Stropharia semiglobata (Batsch) Quél.: unlike *S. dorsipora*, it has a rudimentary annulus, spores with a central germ pore, and a constant presence of cheilo-, pleuro- and caulochrysocystidia. A common, widespread coprophilous species worldwide, it has been reported from herbivore dung in general (Noordeloos in Kuyper et al. 1999), but most Italian records come from cattle and horse dung in the field, and one record also from cattle dung in culture. There is a noticeable preference for cattle and horse dung (Spegazzini 1899, Buller 1922, Spegazzini 1925, Christiansen 1941, Romagnesi 1937, Hongo 1959, Dennis 1961, Calonge 1968, Bon 1970, Pilát 1972, Watling & Gregory 1980, Yokoyama 1984, Jamoni 1994, Esteve-Raventós & Barrasa 1995, Mayoral & Angel 1995, Stamets 1996, Ortega et al. 1997, Kytövuori 1999, De Meulder 2001, Cortez & Coelho 2004, Welt & Heine 2007, Gularte Cortez & Silveira 2008, Ryman in Knudsen & Vesterholt 2008). There are other records from

sheep (Arnolds 1982, Watling & Gregory 1987, Richardson 2005, Ryman in Knudsen & Vesterholt 2008), elk (Kytövuori 1999, Ryman in Knudsen & Vesterholt 2008), other cervid (Batsch 1783) and hare dung (Richardson 2008a).

Volvariella, in *Pluteaceae* Kotl. & Pouzar (free gills, an inverse hymenophoral trama, smooth spores without a germ pore), is characterised by a volvate stem, pink gills, a hyphal pileipellis, and pink spores in mass. They usually grow on soil, wood and compost, and are rarely fimicolous. *Volvariella gloiocephala* (DC.) Boekhout & Enderle: recognisable by having robust fruitbodies with a viscid, dirty white to grey cap, a raphanoid smell, and comparatively large spores. Widespread in temperate zones. It usually grows on straw, sawdust, humus, manured soils. Besides our Italian record from horse dung, it has also been reported from dung-hills (Massee 1893, Rea 1922).

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