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Coprophilous discomycetes from the Azores

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Summary. Coprophilous discomycetes from the Azores obtained in the field or from dung samples later incubated in the laboratory are reported based on two visits to the Islands in 1995 and 1996. Other species previously known from the Islands are also noted, making a total of 31 species, of which all except *Coprotus*, *Lasiobolus* and *Thelebolus* belong in the order *Pezizales*.

INTRODUCTION

The collections reported in this paper were obtained by the authors as part of a general mycological survey of the Azores archipelago undertaken during two visits to the Islands in April – May 1995 and October – November 1996. During these visits, fresh or recent samples of herbivore dung were collected in the field, air-dried and later incubated in damp chambers to study the succession of fungi present. In addition, coprophilous fungi were collected directly in the field when encountered on older dung samples, particularly those of cow. The present paper discusses the discomycetes obtained, all of which except *Coprotus*, *Lasiobolus* and *Thelebolus* belong to the order *Pezizales*. Other coprophilous species previously known from the Islands are also noted, making a total of 31 species.

The Azores archipelago, located on the Mid-Atlantic Ridge some 1250 km west of the nearest part of Europe, is of tertiary age and comprises nine main islands. These are volcanic in origin and have never been connected to any land mass. Colonisation by European settlers took place during the 15th century, since when the inevitable influence of human activity has had a significant and often severe influence on the native flora and fauna, including the mycological composition of the Islands (Dennis *et al.* 1977). The Islands have no native herbivorous mammals, although the rabbit (*Oryctolagus cuniculus*) has long been established (see Godman 1870) and is evidently now widely naturalised and fairly common. Dung samples obtained during these visits were, therefore, mainly from domesticated species, viz. donkey, horse, cow, goat and sheep, with several samples of rabbit dung and two of uncertain identification, perhaps either goat or sheep (samples no. 4 & 14 below).

METHODS

Fourteen samples of herbivore dung in fresh or near-fresh condition were obtained for later incubation. These were labelled and air dried in the field and, on return, were set up in damp chambers in the laboratory to study the succession of

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fungi obtained. Length of incubation varied, but samples were maintained for up to 3 months, until no further fungal species appeared. These samples are listed below, and numbered for citation under the appropriate species in the following account. Not all specimens obtained from these samples have been preserved in K. For species collected in the field, full locality details are given separately.

Collection code numbers for incubated dung samples:

1 Rabbit dung, Flores, nr Caldeira Comprida, 620 m, 5 May 1995.
2 Donkey/horse dung, Pico, c. 5 km E of São Caetano, 310 m, 1 May 1995.
3 Rabbit dung, São Miguel, Graminais, 900 m, 24 April 1995.
4 Indet. herbivore dung, Pico, 4 km SE of Madalena, c. 50 m, 1 May 1995.
5 Donkey dung, Pico, 4 km SE of Madalena, c. 50 m, 1 May, 1995.
6 Rabbit dung, São Miguel, Tronqueira road, viewpoint at Pico da Vara, 720 m, 22 April 1995.
7 Cow dung, Pico, c. 3 km S of São Roque do Pico, c. 150 m, 26 April 1995.
8 Rabbit dung, Terceira, Santa Barbara, 970 m, 23 October 1996.
9 Sheep dung, Flores, 1.3 km SW of Ponta Delgada, 340 m, 13 Nov. 1996.
10 Goat dung, Flores, nr Mosteiro, 300 m, 10 November 1996.
11 Horse dung, Graciosa, road S from Santa Cruz, nr Almas, 170 m, 26 Oct. 1996.
12 Donkey dung, Graciosa, Santa Cruz, 5 m, 24 Oct. 1996.
13 Rabbit dung, São Jorge, nr Ponta, 2.5 km NW of Rosais, 270 m, 2 Nov. 1996.
14 Goat/sheep dung, Graciosa, Caldeira region, Parque Florestal, 160 m, 25 Oct. 1996.

RESULTS

PEZIZALES

Ascobolaceae

Ascobolus furfuraceus *Pers.*, Observ. Mycol. 1: 33 (1796).

SPECIMEN EXAMINED. Flores, N of Caveira, nr Castelo, 110 m, cow dung, 7 May 1995 (AZ609c, K(M)30048).

Found at only a single site during the present survey, though previously reported from the Azores (Flores, Terceira) on cow dung by Korf & Zhuang (1991b). A common and widespread species.

Ascobolus immersus *Pers.*, Neues Mag. Bot. 1: 115 (1794).

SPECIMENS EXAMINED. Flores, N of Caveira, nr Castelo, 110 m, cow dung, 7 May 1995 (AZ609b, spores only); **4** (AZ718, K(M)29861); **10** (AZ1616, K(M)48859).

Known in Macaronesia from the Canary Islands (Korf & Zhuang 1991b) but not previously reported from the Azores. A widespread species, distinguished particularly by the very large spores (Brummelen 1967).

Saccobolus cf. **beckii** *Heimerl*, Jahrb. Ober-Realschule Bezirke Sechshaus Wien 15: 18 (1889).

SPECIMEN EXAMINED. **1** (AZ725, K(M)52846).

A single sample, tentatively referred to this species. *Saccobolus beckii* is characterised by the ascospore clusters being irregularly and coarsely warted due to thick development of pigment (Brummelen 1967). In this material, spore clusters measure 43 – 49 × 19 – 23 µm, individual spores c. 17 – 19 × 8 – 10 µm, within the typical range for this species. The pigment is less thickly developed (1.5 – 2 µm thick) than usual, and tends to form an irregular, broken crust over the spore cluster rather than discrete, wart-like patches, but it otherwise agrees closely with *S. beckii*. Although widely distributed, this species seems to be rarely collected or recorded, and has not previously been reported from Macaronesia.

Saccobolus citrinus *Boud. & Torrend*, Bull. Soc. Mycol. France 27: 131 (1911).

SPECIMENS EXAMINED. **5** (AZ1656, K(M)53634); **9**; **10** (AZ1617, K(M)48860); **12** (AZ1638, K(M)49718).

A fairly common and widely distributed species known from dung of various herbivores (Brummelen 1967), in the Azores obtained from that of cow, goat and donkey. The species is characterised by the yellow apothecia and the spores which are arranged in four rows of two, have truncate ends and a distinctly punctate epispore. In the Azores material spores measure 18 – 20.5 × 8 – 10 µm, spore clusters 48 – 50 × 18 – 20 µm.

Another collection (**10,** AZ1604, K(M)45434) has more finely punctate spores and was originally referred to *S. truncatus* Velen. However, the spores are truncate at the poles and measure 17 – 19.5 × 9 – 10 µm, and this probably also represents *S. citrinus*.

Not previously reported from Macaronesia.

Saccobolus depauperatus (*Berk. & Broome*) *E. C. Hansen*, Vidensk. Meddel. Dansk Naturhist. Foren. Kjøbenhavn 1876: 87 (1876).

SPECIMENS EXAMINED. **2**; **10** (AZ1618, K(M)48861); **11**; **12**.

A widely distributed species (Brummelen 1967), known on dung of various animals. Reported from Macaronesia by Korf & Zhuang (1991b), though not previously known from the Azores. It differs from the similar *S. versicolor* in smaller apothecia and in ornamentation and size of the spores. In the cited material mature spores are almost smooth to finely ornamented and measure 12 – 13 × 5.5 – 6.5 µm, and clusters 29 – 33 × 11 – 13 µm.

Another specimen (**5**, AZ705, K(M)29840) with slightly larger, more fusoid and more coarsely ornamented spores 14 – 15.5 × 6.5 – 7.5 µm, with spore clusters measuring 35 – 38 × 14 – 16 µm, may also belong here.

Saccobolus versicolor (*P. Karst.*) *P. Karst.*, Acta Soc. Fauna Fl. Fenn. II, 6: 123 (1885).

SPECIMENS EXAMINED. **3; 6** (AZ064b, K(M)29866); **8**.

According to Brummelen (1967) the most common species of the genus, cosmopolitan in distribution. Reported from the Canary Islands (Tenerife) (Korf & Zhuang 1991b) but not previously from the Azores. Spores in this material are irregularly finely ornamented; spore clusters measure 48 – 51 × 17 – 18 µm, and individually the spores measure 17 – 19 × 8 – 9.5 µm, slightly larger than given by Korf & Zhuang (1991b) but well within the range for this species given by Brummelen (1967).

Thecotheus crustaceus (*Starbäck*) *Aas & N. Lundq.* in Aas, Univ. Bergen Bot. Inst. Thesis 4: 70 (1992).

SPECIMENS EXAMINED. **10, 12** (AZ1605, K(M)45436). Fig. 1G – H.

Although commonly referred to *Pezizaceae* due to the amyloid reaction of the ascus wall and hyaline spores, the position of the genus in *Ascobolaceae* was confirmed by Kimbrough (in Dissing & Schumacher 1994) based on ascospore ontogeny and structure of the ascus apex. Ascospores are thick-walled in common with other members of *Ascobolaceae*, which frequently also have an amyloid ascus wall.

Thecotheus crustaceus is characterised by the hyaline, thick-walled, smooth, non-apiculate, eguttulate spores, and by spore size. In the present material spores measure 19 – 21 × 9.5 – 10 µm, and some exhibit one or more small, irregular de Bary bubbles. The species occurs on various kinds of herbivore dung (Aas 1992), but apparently has not been previously reported from that of goat. Although not previously reported from Macaronesia, it is widely distributed (Aas 1992), being known from U.S.A. and Canada, from much of Europe, including the British Isles, from Argentina, Japan and New Zealand. It has also been reported from Taiwan (Wang 1995).

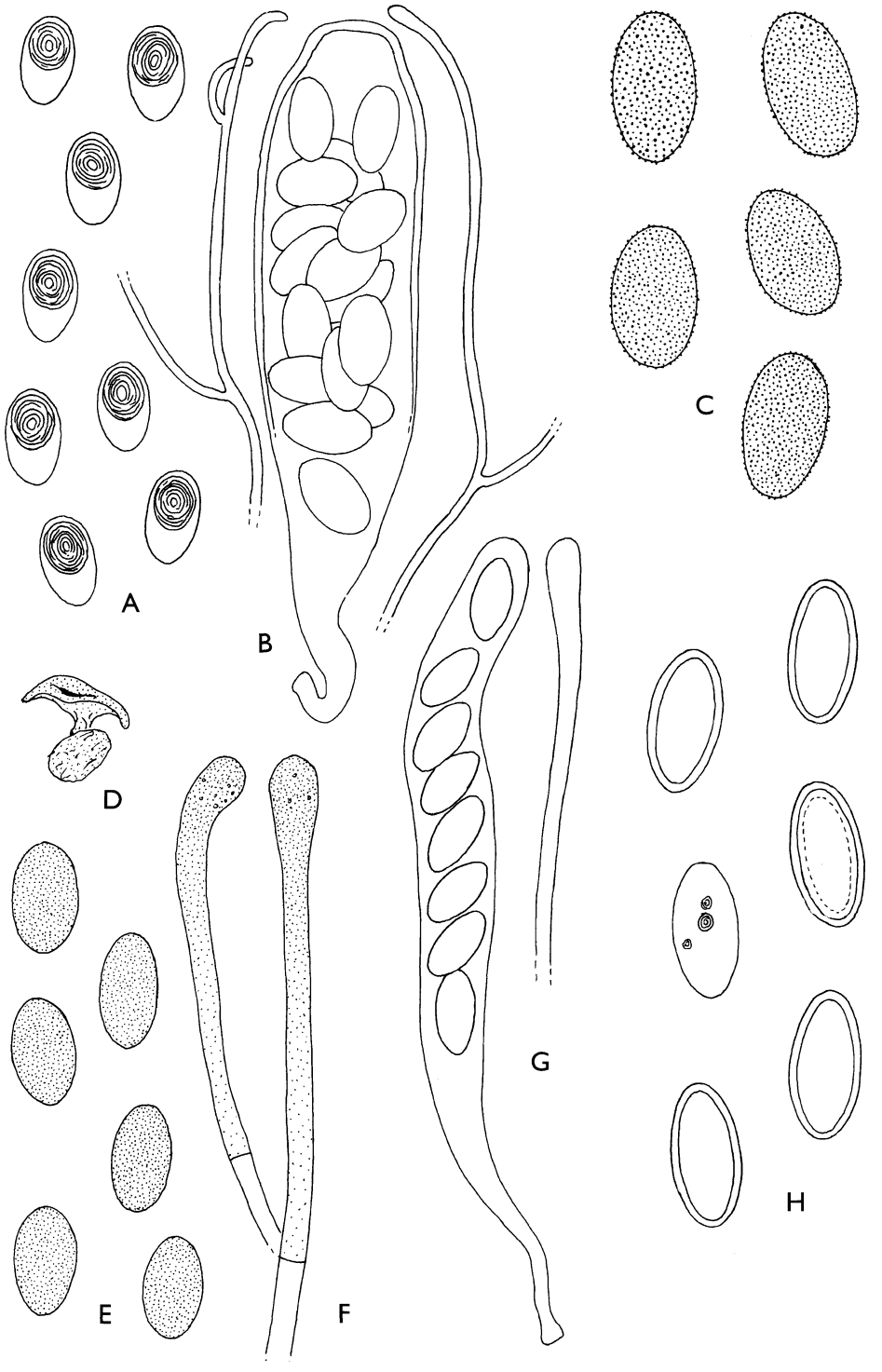
Thecotheus crustaceus was shown by Aas (1992) to have been misinterpreted by Le Gal (1963) and to provide an earlier name for the well known *T. agranulosus* Kimbr. (Kimbrough 1969) described from horse dung in U.S.A.

Thecotheus pelletieri (*H. Crouan & P. Crouan*) *Boud.*, Ann. Sci. Nat. Bot. V, 10: 236 (1869).

SPECIMEN EXAMINED. **12** (AZ1639, K(M)49724).

Previously reported from the Azores by Dennis *et al.* (1977), on dung of ass. A widely distributed species (see Aas 1992), recognised by the very large, 32-spored asci (up to c. 490 × 80 µm in the present specimen) and large, smooth spores (32 – 39 × 15 – 21 µm).

FIG. 1. **A – B** *Coprotus sexdecimsporus* AZ1658. **A** ascospores × 1000; **B** ascus & paraphyses × 1000. **C** *Iodophanus carneus* AZ1607. Ascospores × 1000. **D – F** *Peziza* cf. *fimeti* AZ64h. **D** habit sketch × 1.5; **E** ascospores × 1000; **F** paraphyses × 1000. **G – H** *Thecotheus crustaceus* AZ1605. **G** ascus & paraphyses × 660; **H** ascospores × 1000.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Ascodesmidaceae

Ascodesmis nigricans *Tiegh.*, Bull. Soc. Bot. France 23: 275 (1877).

SPECIMENS EXAMINED. **9; 10** (AZ1597, K(M)44631).

Obtained on incubated dung of both sheep and goat. This is a widely distributed species (Brummelen 1981), though not previously known from the Azores or elsewhere in Macaronesia. It is recognised by the broadly ellipsoid spores which are ornamented with isolated or partly interconnected spines and, in the present material, measure (10 –)11 – 12 × 8 – 10 µm.

Pezizaceae

Iodophanus carneus (*Pers.*) *Korf* in Kimbrough & Korf, Amer. J. Bot. 54: 19 (1967).

SPECIMENS EXAMINED. Flores, nr Mosteiro, 300 m, goat dung, 10 Nov. 1996 (AZ1610, K(M)48061); **9** (AZ1607, K(M)48057); **13** (AZ1669, K(M)57725); **14** (AZ1670, K(M)57726). Fig. 1C.

Apothecia obtained from dung of goat, sheep and rabbit. All collections are similar, with apothecia < 1 mm diam., drying pale flesh-colour or pale buff, asci 150 – 175 × 30 – 35 µm and spores finely punctate. They appear referable to *I. carneus*, although the spores, in the range 18 – 21 × 10 – 12 µm, are slightly larger than usually given for this species (Kimbrough *et al.* 1969; Korf & Zhuang 1991c; Prokhorov 1997). However, the coprophilous habit and small, pale apothecia are unlike those of other species of the genus. *Iodophanus testaceus* (Moug.: Fr.) Korf in Kimbrough & Korf has similar though slightly broader spores, but differs in having apothecia which dry darker in colour (Kimbrough *et al.* 1969). It is usually also considered as non-coprophilous (Kimbrough *et al.* 1969), though coprophilous collections from the Canary Islands were cited by Korf & Zhuang (1991c). An Azores collection from rotten card (Graciosa, 27 Oct. 1996, AZ960, K(M)45086) has spores similar to the above cited collections (though apothecia slightly young), but differs in its apothecia being deep orange and more distinctly marginate when dry and is probably referable to *I. testaceus*.

Iodophanus carneus is a common and widespread species, though not previously reported from the Azores. The collection from the Canary Islands reported by Korf & Zhuang (1991c) has somewhat smaller spores and, as they have noted, may represent a different taxon.

Peziza azorica *Dennis & Spooner*, Kew Bull. 32: 109 (1977).

Described from damp soil, but potentially a coprophilous species as shown by Korf & Zhuang (1991c) who reported Macaronesian collections from dung of donkey and mule.

Peziza cf. **fimeti** (*Fuckel*) *Seaver*, N. Amer. Cup-fung., Operc.: 232 (1928) *sensu* Dennis.

SPECIMEN EXAMINED. **6** (AZ064h, K(M)29822). Fig. 1 D – F.

Apothecia developed singly on rabbit dung, 7 – 13 mm diam., fawn-brown to brown, paler beneath, with a depressed centre and margin recurved and irregularly 'dentate'. Receptacle irregularly shallow-cupulate, with narrowed, substipitate base. Spores ellipsoid, (13.5 -) 14 – 15 × 8 – 9.5 µm, eguttulate, appearing finely punctate under oil immersion lens. Paraphyses are simple, 2.5 – 4 µm diam., obtuse and somewhat clavate at the apex to 5.5 – 7 µm diam., and apically with brownish contents.

The identity of this collection is uncertain. It is tentatively assigned to *P. fimeti sensu* Dennis (Dennis 1978), based on spore size, but may prove distinct from that species for which the spores are described as smooth. In the present material the spores are finely punctate, though with the light microscope the ornament can be observed clearly only under oil immersion lens. It is similar to *P. moravecii* (Svrček) Donadini but that has sessile apothecia and narrower spores (7 – 7.5 µm wide) with a somewhat irregular ornament which is more conspicuous at the poles (Svrček 1968, Donadini 1979). *Peziza merdae* Donadini also has a finely punctate spore ornament, but differs in its somewhat larger spores (15 – 18 × 7 – 8.5 µm) and moniliform paraphyses (Donadini 1979). The present species may be referable to *P. fimetosa* Fr. (= *P. fimetaria* Schumach.) which, as figured by Bresadola (1892), similarly has short-stipitate apothecia with a dentate margin, but differs in its somewhat larger spores (16 – 18 × 8 – 10 µm). It is given as a possible synonym of *P. fimeti* by Seaver (1928), whose concept of the species, with larger spores, may differ from that of Dennis (1978).

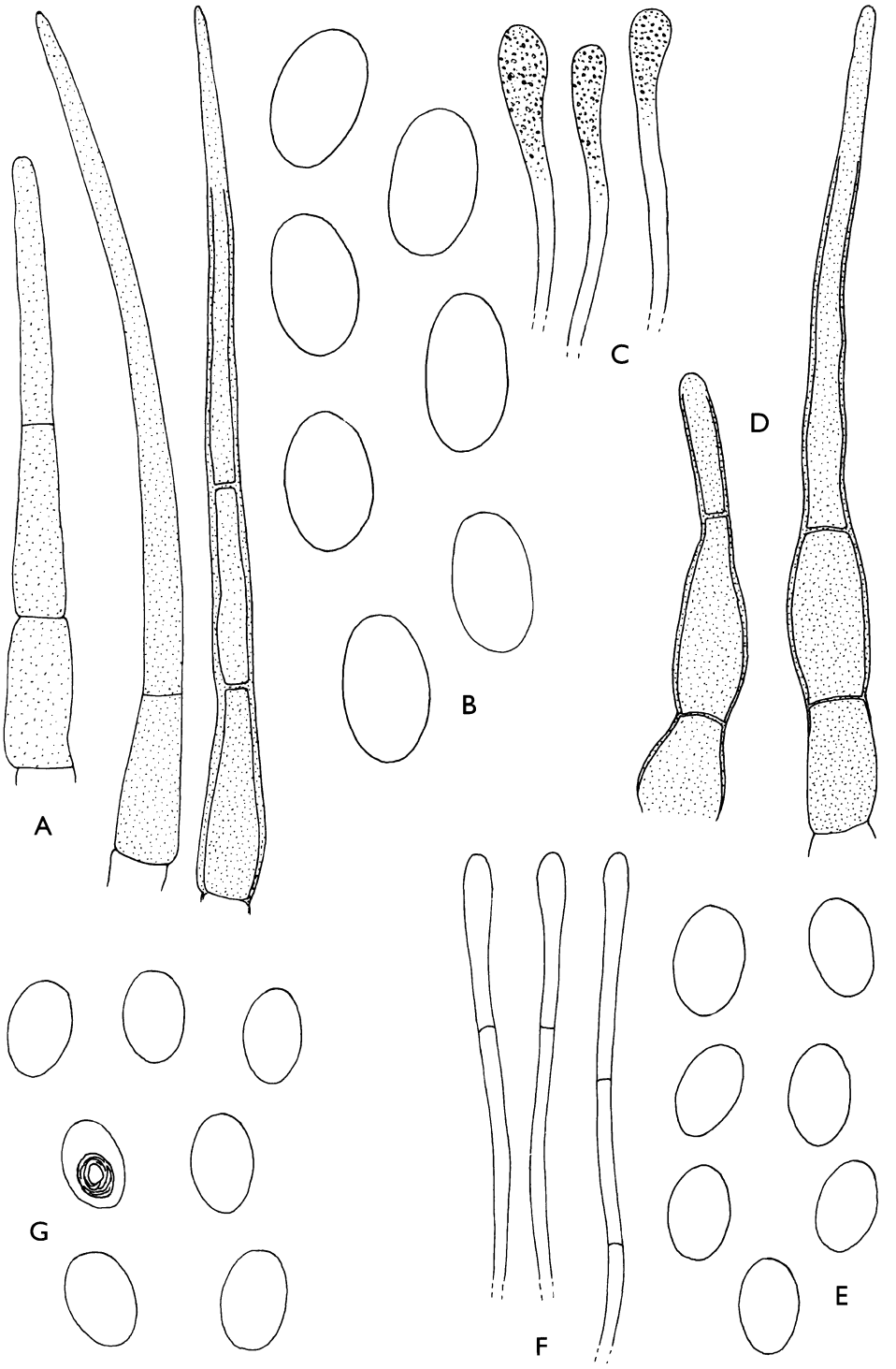
Other species on dung, such as *P. bovina* W. Phillips, have distinctly larger spores often over 20 µm long. *Peziza chlorophysa* (Clem.) Sacc. & D. Sacc., placed with a question mark as a synonym of *P. fimeti* by Seaver (1928), was shown by Pfister (1978) to have larger spores 20 – 21 × 11 – 12 µm. Donadini (1977) placed both *P. bovina* and *P. fimetaria* as synonyms of *P. fimeti*. This whole group is in need of critical revision.

Pyronemataceae

Cheilymenia aurantiacorubra *K. S. Thind & S. C. Kaushal*, Indian Phytopathol. 33: 428 (1981).

SPECIMENS EXAMINED. Flores, N of Caveira, nr Castelo, 110 m, cow dung, 7 May 1995 (AZ608b, K(M)30042); Flores, 1.3 km SW of Ponta Delgada, 340 m, cow dung, 13 Nov. 1996 (AZ1541a, K(M)52544); Flores, nr Pico da Casina, 410 m, cow dung, 10 Nov. 1996 (AZ1428, K(M)44918; slightly immature); São Jorge, E of Manadas, 280 m, cow dung, 1 Nov. 1996 (AZ1166, K(M)48947). Fig. 2 A – C.

The collections cited above match closely with the taxon reported by Korf & Zhuang (1991a) as *Cheilymenia* sp. 2771 on cow dung from the Canary Islands. This was subsequently identified by Moravec (1992) with *C. aurantiacorubra* K. S. Thind & S. C. Kaushal, described from India (Thind & Kaushal 1981). It is similar to *C. lundqvistii* but differs notably in its larger spores (range 16.5 – 21 × 10.5 – 12 µm in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the present collections), asci 16 – 19(– 20) µm wide, and paraphyses slightly broader at the apex (7 – 11 µm) and commonly with more distinctly granular content.

A further collection (Flores, c. 2 km SW of Ponta Ruiva, 310 m, cow dung, 6 May 1995, AZ576b, K(M)29878) may also belong here but has slightly larger spores (19 – 22(– 23) × 11 – 13 µm, approaching those of *C. pulcherrima* (H. Crouan & P. Crouan) Boud., redescribed by Moravec (1992).

Cheilymenia coprinaria (*Cooke*) *Boud.*, Icon. Mycol., Liste Prélim.: (3) [without pagination] (1904).

Not encountered during the present study, but reported from the Azores (Terceira) on cow dung by Korf & Zhuang (1991a).

Cheilymenia granulata (*Bull.: Fr.*) *J. Moravec*, Mycotaxon 38: 474 (1990).

SPECIMENS EXAMINED. **7** (AZ207a); Pico, c. 10 km E of Madalena, 260 m, cow dung, 28 April 1995 (AZ310a, K(M)29884); Flores, W of Santa Cruz, just W of Pico da Casina, 490 m, cow dung, 5 May 1995 (AZ509a, K(M)29872); Flores, c. 2 km SW of Ponta Ruiva, 310 m, cow dung, 6 May 1995 (AZ576a, K(M)29874); Flores, between Lagoa Funda and Lagoa Comprida, 570 m, cow dung, 10 Nov. 1996 (AZ1425, K(M)45094); Flores, SW area, nr Figueira, 420 m, cow dung, 10 Nov. 1996 (AZ1423a, K(M)47911); Flores, 0.5 km E of Pico da Casina, 380 m, cow dung, 12 Nov. 1996 (AZ1496a, K(M)48863); Flores, N of Caveira, nr Castelo, 110 m, cow dung, 7 May 1995 (AZ608a, K(M) 30041); São Jorge, 3 km W of Norte Pequeno, 450 m, horse dung, 1 Nov. 1996 (AZ1187, K(M)48862).

Frequent on cow dung, and previously reported from the Azores by Dennis *et al.* (1977, as *Coprobia*) and by Korf & Zhuang (1991a). This is a widely distributed species, recognised by the lack of hairs, the granular surface to the receptacle, capitate paraphyses and smooth spores.

Cheilymenia lundqvistii *J. Moravec*, Mycotaxon 44: 67 (1992).

SPECIMEN EXAMINED. Flores, 1.3 km SW of Ponta Delgada, 340 m, cow dung, 13 Nov. 1996 (AZ1541d, K(M)45090). Fig. 2 D – F.

This species is typified by material from the Canary Islands, Tenerife, on cow dung, reported by Korf & Zhuang (1991a) as *Cheilymenia* sp. 2573. It is characterised by small, gregarious apothecia less than 0.5 mm diam., with small, smooth-walled spores which in the present collection measure 11.5 – 13 × 7.5 – 9 µm, cylindric asci 11 – 12 µm wide, and non-rooting, brown to pale-brown and mostly thin-walled, tapered, often obtuse hairs up to c. 200 µm long, 10 – 20 µm wide towards the base and with 0 – 2 thin septa. It was placed by Moravec (1992) in section *Paracheilymeniae*,

FIG. 2. **A – C** *Cheilymenia aurantiacorubra* AZ1166. **A** marginal hairs × 660; **B** ascospores × 1000; **C** paraphyses × 1000. **D – F** *Cheilymenia lundqvistii* AZ1541d. **D** marginal hairs × 660; **E** ascospores × 1000; **F** paraphyses × 1000. **G** *Coprotus disculus* AZ1603. Ascospores × 1000.

characterised by short, non-rooting hairs and smooth ascospores (Moravec 1990). The single collection cited below agrees closely with the type description. The species is known otherwise only from the holotype.

Cheilymenia raripila (*W. Phillips*) *Dennis*, Kew Bull. 14: 428 (1960).

SPECIMENS EXAMINED. Pico, north coast road, 2 km E of Santo Amaro, 310 m, cow dung, 29 April 1995 (AZ364b, K(M)29889); Flores, N of Caveira, nr Castelo, 110 m, cow dung, 7 May 1995 (AZ609g, K(M)30047).

The two collections cited match well with this species as described and illustrated, for example by Rifai (1968). The species is characterised by large spores, up to c. 27 × 15 µm, asci up to c. 30 µm wide, and rather sparse, pale brown hairs with bulbous, usually unforked base. It has not been previously reported from the Azores, or elsewhere in Macaronesia, but is a widely distributed species known from both northern and southern hemispheres.

Cheilymenia theleboloides (*Alb. & Schwein.: Fr.*) *Boud.*, Icon. Mycol., Liste Prélim.: (3) [without pagination] (1904), *sensu* Korf & Zhuang.

This species was reported from three localities in the Azores, on 'stercoreated sacking' and on cow dung, by Korf & Zhuang (1991a), although the identification was tentative. Their species differs in having comparatively large spores up to 22 × 14 µm, unlike the neotype selected by Denison (1964) and discussed by Rifai (1968), which has smaller spores not over 11 µm wide.

Cheilymenia theleboloides var. **microspora** *Dennis,* Kew Bull. 32: 111 (1977).

Known only from the holotype collection, on cow dung from Terceira (Dennis *et al.* 1977) and differing from the typical variety in smaller spores 12 – 13 × 7 – 8 µm.

Ryparobius cf. **pachyascus** *Zukal* in Rehm, Hedwigia 27: 167 (1888).

SPECIMEN EXAMINED. **1** (AZ1651, K(M)52848, with *Saccobolus* cf. *beckii*).

Ryparobius was placed as a synonym of *Thelebolus* by Kimbrough & Korf (1967), characterised by cleistothecial ascomata, iodine-negative, often polysporous asci which do not stain apically in congo red, and small, smooth-walled spores lacking guttules. However, the taxonomy of many of the species referred to *Ryparobius* remains inadequately known. Species delimitation and even their appropriate generic placement is often unclear in the absence of modern taxonomic treatments, and identification commonly presents problems. The present specimen has small ascomata containing few asci. The asci are polysporous and measure 75 – 103 × 37 – 40 µm, with spores ellipsoid, 6 – 7 × 3 – 3.5 µm. The asci are longer and narrower than those of *Thelebolus polysporus* (P. Karst.) Y. Otani & Kanzawa (50 – 70 × 40 – 52 µm; Otani & Kanzawa 1970), and are closer to those described for *R. pachyascus* (77 – 90 × 38 – 40 µm; Rehm 1888) to which it is tentatively referred. This epithet is not yet combined in *Thelebolus*. However, the species has received no

recent taxonomic revision and further study is required before this is proposed; it is for this reason here retained in *Pyronemataceae.*

The species has not been previously reported from Macaronesia.

ERYSIPHALES

Thelebolaceae

Although commonly referred to *Pezizales* (e.g. Eriksson & Hawksworth 1993; Hawksworth *et al.* 1995) the true affinities of *Thelebolus* have been uncertain, and morphological and ultrastructural data suggest it belongs elsewhere (see Momol *et al.* 1996). A relationship with *Erysiphales* was suggested by Zukal (1886) and by Cooke & Barr (1964), who referred *Thelebolaceae* to this order, and this is supported by molecular sequence data as shown by Momol *et al.* (1996).

A relationship between *Erysiphales* and *Leotiales* is indicated from molecular data (Saenz *et al.* 1994; Momol *et al.* 1996) and is reflected in the classification proposed by Eriksson & Winka (1997) who place both these orders in the new class *Leotiomycetes* O. E. Erikss. & Winka. *Thelebolaceae* is placed with a question mark in *Erysiphales* by Eriksson & Winka (1998).

The genera *Coprotus* Korf & Kimbr. and *Lasiobolus* Sacc. have been referred to *Thelebolaceae* (see Eriksson & Hawksworth 1998), but molecular studies are required to confirm their affinities.

Coprotus aurora (*H. Crouan & P. Crouan*) *Kimbr., Luck-Allen & Cain*, Canad. J. Bot. 50: 961 (1972).

SPECIMENS EXAMINED. **6** (AZ064e, K(M)29868); Flores, N of Caveira, nr Castelo, 110 m, cow dung, 7 May 1995 (AZ609e, K(M)54690). Fig. 3 A – C.

A widespread species, described from France and reported from the British Isles (Henderson & Watling 1978), from the U.S.A. and Canada (Kimbrough *et al.* 1972) and from Venezuela (Jeng & Krug 1977). In the Azores specimens, apothecia are pale orange, c. 200 µm diam. when dry, with asci cylindric, mostly 85 – 89 × 12 – 14 µm, and spores uniseriate or slightly overlapping in the upper part of the ascus, ellipsoid to slightly ovate, 11 – 14 × 6.5 – 8 µm; most spores contain a single de Bary bubble. Paraphyses are obtuse and commonly branched, particularly in the upper part. The material matches well with the description of *C. aurora* given by Kimbrough *et al.* (1972) except that the apothecia are rather pale. *Coprotus sarangpurensis* K. S. Thind & S. C. Kaushal, from India, seems similar but differs in broader spores and grey-brown apothecia (Thind *et al.* 1978). *Coprotus dhofarensis* Gené, El Shafie & Guarro (Gené *et al.* 1993), on goat dung from Oman, is also similar but has a compact marginal fringe to the disc not present in *C. aurora.*

Coprotus breviascus (*Velen.*) *Kimbr., Luck-Allen & Cain*, Canad. J. Bot. 50: 961 (1972).

SPECIMEN EXAMINED. Flores, c. 2 km SW of Ponta Ruiva, 310 m, cow dung, 6 May 1995 (AZ576c, K(M)29879). Fig. 3 D – E.

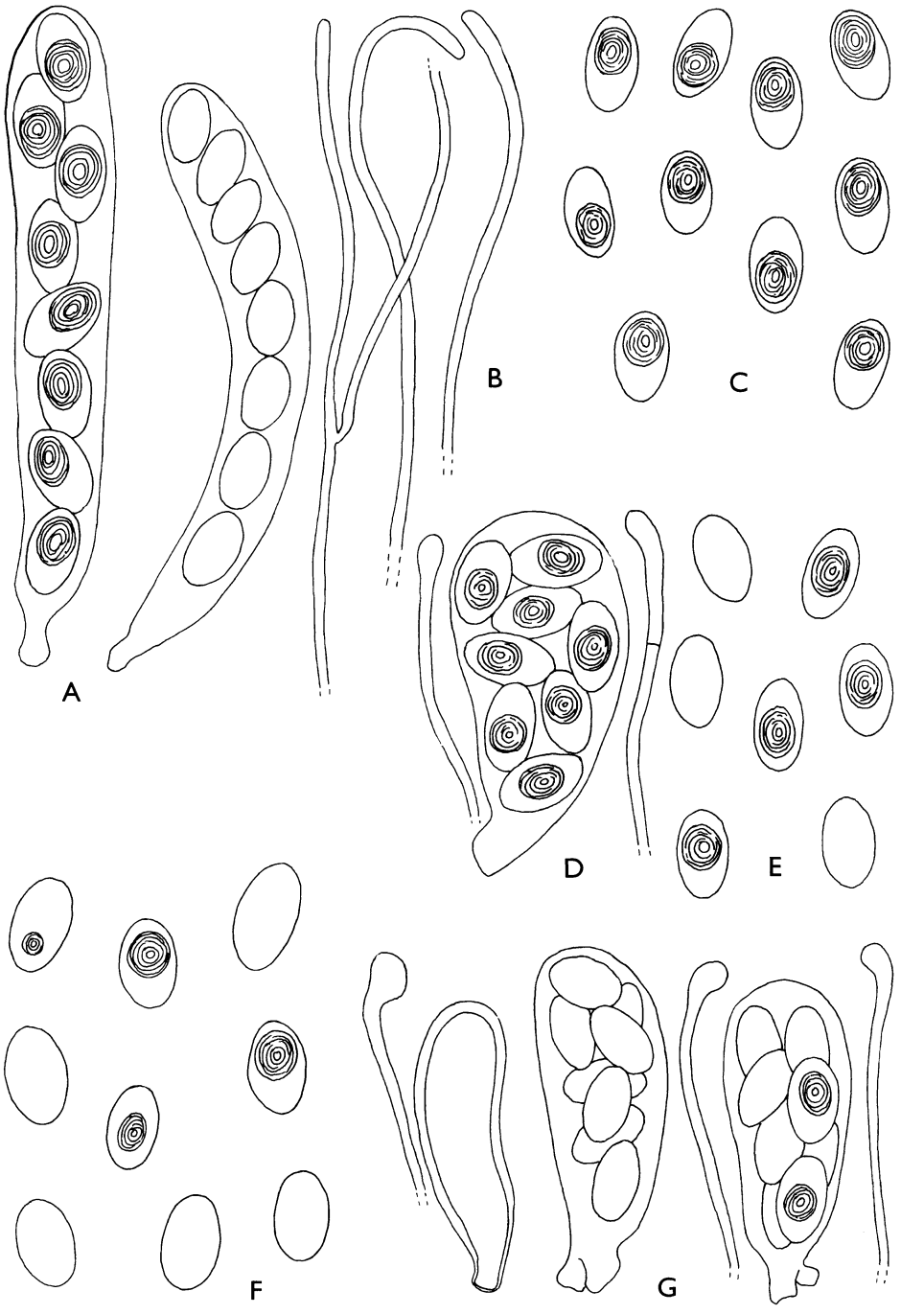


FIG. 3. **A – C** *Coprotus aurora* AZ64e. **A** asci × 1000; **B** paraphyses × 1000; **C** ascospores × 1000. **D – E** *Coprotus breviascus* AZ576c. **D** ascus & paraphyses × 1000; **E** ascospores × 1000. **F – G** *Coprotus granuliformis* AZ609i. **F** ascospores × 1000; **G** asci (including one immature ascus) & paraphyses × 1000.

Reported from the Azores (Flores, Terceira) by Korf & Zhuang (1991b), as well as from Madeira and the Canary Islands. The cited specimen is tentatively referred here based on the yellowish apothecia, spore size (11 – 12 × 6.5 – 7.5 µm), broadly clavate asci (45 – 50 × 20 – 23 µm), and paraphyses only slightly broader (3 – 3.5 µm) at the apex. However, the species is closely similar to *C. granuliformis* and differences between them require clarification. See further under the latter species below.

Coprotus disculus *Kimbr., Luck-Allen & Cain*, Canad. J. Bot. 50: 962 (1972).

SPECIMENS EXAMINED. **9** (AZ1603, K(M)45433); **10**. Fig. 2G.

The species was reported from the Azores (Terceira) on cow dung by Korf & Zhuang (1991b), and is characterised by hyaline apothecia, cylindrical, 8-spored asci and uniseriate spores. Material from two localities in the present study, on sheep and goat dung, appear referable to this species, although apothecia are small, c. 200 µm diam., with asci up to c. 110 × 12 µm, slightly longer than given by Kimbrough *et al.* (1972). Ellipsoid spores 12 – 13.5 × 6.5 – 8.5 µm are typical of the species. *Coprotus disculus* is widely distributed in the northern hemisphere (see Aas 1983).

Coprotus granuliformis (*H. Crouan & P. Crouan*) *Kimbr.*, Amer. J. Bot. 54: 22 (1967).

SPECIMENS EXAMINED. **5**; Flores, N of Caveira, nr Castelo, 110 m, cow dung, 7 May 1995, (AZ609i, K(M)54689). Fig. 3 F – G.

Reported from the Azores (Terceira) on cow dung by Korf & Zhuang (1991b). The species is characterised by the whitish apothecia, broadly clavate asci, (42 – 50 × 16 – 18 µm in the present material), and spore size ((10.5-) 12 – 14.5 × 6 – 8.5 µm), but is similar to both *C. breviascus* and *C. trichosuri* A. E. Bell & Kimbr. (Bell & Kimbrough 1973). The paraphyses of *C. granuliformis* are described as clavately enlarged at the apex (Aas 1983; Kimbrough *et al.* 1972; Korf & Zhuang 1991b). However, this character is not constant in the present material, some paraphyses being apically enlarged up to 5.5 µm diam., whilst others are not or only slightly broader at the apex. The distinction from *C. breviascus* and *C. trichosuri*, which are similar with respect to ascus and spore characters, but differ in simple or uncinate, non-clavate paraphyses, is critical and may need clarification.

Coprotus cf. **luteus** *Kimbr., Luck-Allen & Cain*, Canad. J. Bot. 50: 966 (1972).

SPECIMENS EXAMINED. **12** (with *Saccobolus citrinus*, AZ 1638).

Obtained from a single locality on donkey dung, and only tentatively referred to this species as apothecial pigmentation is uncertain. *Coprotus luteus* has yellowish apothecia, but is otherwise closely similar to *C. lacteus* (Cooke & W. Phillips) Kimbr., Luck-Allen & Cain, especially with regard to ascus and spore dimensions. The latter differs in its whitish apothecia and mostly uniseriate spores (Kimbrough *et al.* 1972; Aas 1983). Characteristics of the present specimen agree well with *C. luteus* as usually described: asci are 8-spored and measure c. 70 × 15 µm, with spores biseriate above and uniseriate below, and spores are ellipsoid, 9 – 10 × 5.5. – 6 µm, each with a de Bary bubble.

Coprotus luteus has been reported from the Canary Islands (Tenerife) by Korf & Zhuang (1991b), but not previously from the Azores. It is a widely distributed species on various kinds of herbivore dung (Aas 1983).

Coprotus sexdecimsporus (*H. Crouan & P. Crouan*) *Kimbr.*, Amer. J. Bot. 54: 22 (1967).

SPECIMENS EXAMINED. **4** (AZ1658, K(M)54698); **9** (AZ1655, K(M)53633); **13** (AZ1623, K(M)49098). Fig. 1 A – B (p. 545).

A widespread and evidently common species previously reported from the Azores by Dennis *et al.* (1977), and from the Canary Islands by Korf & Zhuang (1991b). The clavate, 16-spored asci, spore size (11.5 – 13 × 7 – 8 µm in the cited material) and filiform, sometimes branched paraphyses are diagnostic.

Lasiobolus ciliatus (*J. C. Schmidt*) *Boud.*, Hist. Classific. Discomyc. Europe: 78 (1907).

This species was not found during the present study. It was reported from the Azores by Dennis *et al.* (1977), but revision of the material shows it to have comparatively small spores 16 – 19 × 9 – 11.5 µm and narrow setae 17 – 23 µm wide near the base. Following the monograph of the genus by Bezerra & Kimbrough (1975) it seems better referred to *L. intermedius*. *Lasiobolus ciliatus* differs in larger spores and broad setae, to 42 µm broad *teste* Bezerra & Kimbrough (1975). The species was also reported from the Azores (Terceira) by Korf & Zhuang (1991a) who note, however, that Macaronesian material may be taxonomically distinct, having spores which are consistently narrower than given by Bezerra & Kimbrough (1975), as well as broader setae.

Lasiobolus cuniculi *Velen.*, Monogr. Discomyc. Bohem. 1: 413 (1934).

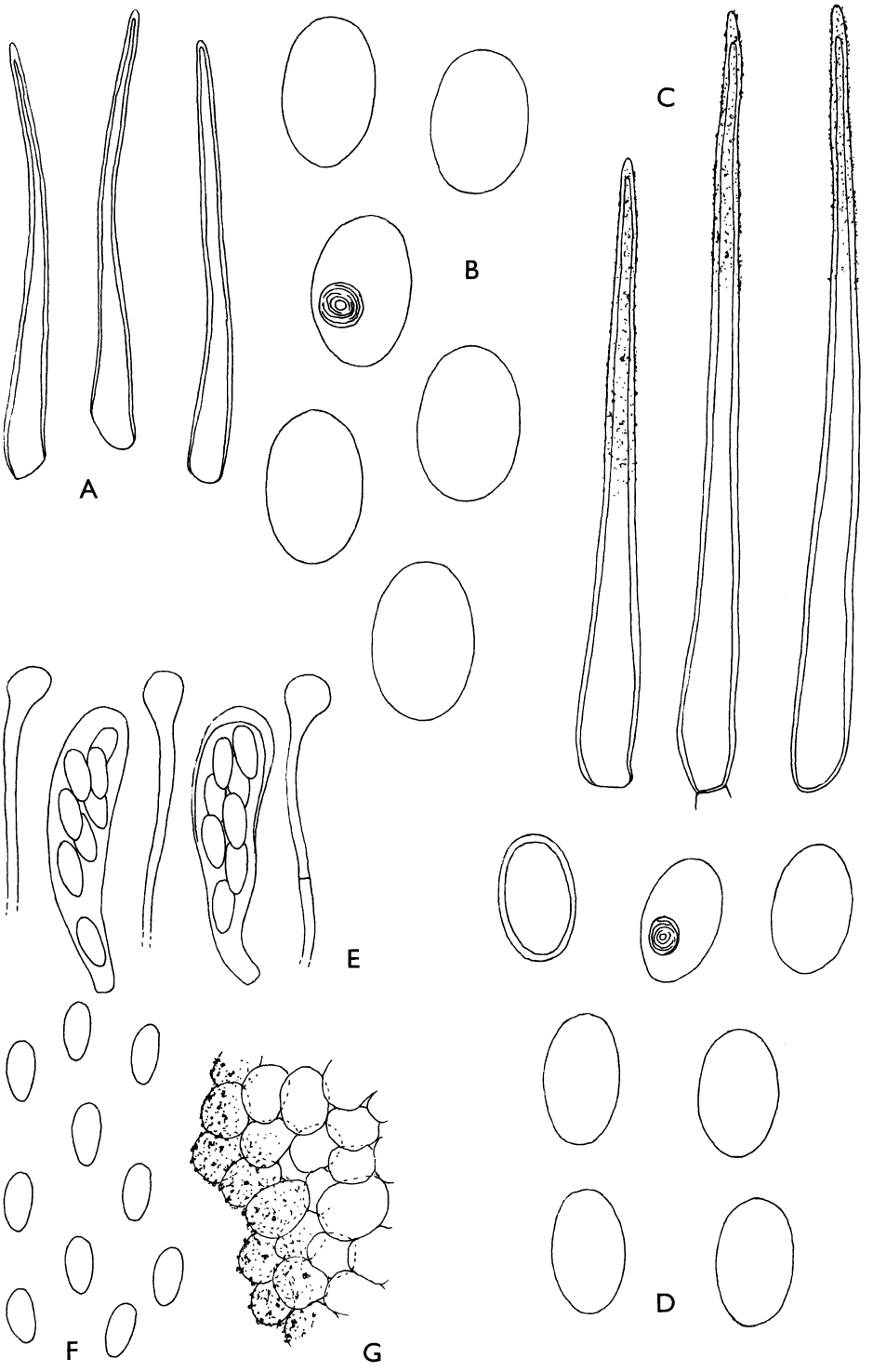
SPECIMENS EXAMINED. **4** (AZ716, K(M)29859); **5** (AZ1672, K(M)58748); **6**; **7** (AZ208, K(M)38980); **9**; **10** (AZ1601, K(M)44757); Flores, c. 2 km SW of Ponta Ruiva, 310 m, cow dung, 6 May 1995 (AZ576e, K(M)29881); Flores, N of Caveira, nr Castelo, 110 m, cow dung, 7 May 1995 (AZ609l, K(M)30050). Fig. 4 A – B.

The most frequently encountered species of the genus in the samples obtained. It was redescribed by Bezerra & Kimbrough (1975) and is distinguished from the similar *L. ciliatus* by broader asci, 25 – 37 µm wide in the present material, mostly biseriate spores, and narrower setae, 12 – 23 µm diam. in the cited specimens.

Two collections with dextrinoid setae and excipular elements and setae with thicker walls 3 – 4 µm thick (2 – 3 µm thick in above specimens) may represent a different, undescribed taxon:

9 (AZ1620, K(M)48943); **7** (AZ207b, K(M)29921).

FIG. 4. **A – B** *Lasiobolus cuniculi* AZ576e. **A** marginal hairs × 400; **B** ascospores × 1000. **C – D** *Lasiobolus intermedius* AZ310b. **C** marginal hairs × 400; **D** ascospores × 1000. **E – G** *Thelebolus microsporus* AZ57b. **E** asci & paraphyses × 1000; **F** ascospores × 1000; **G** excipular cells × 1000.


A
B
C
D
E
F
G

Lasiobolus intermedius *J. L. Bezerra & Kimbr.*, Canad. J. Bot. 53: 1218 (1975).

SPECIMENS EXAMINED. Pico, c. 10 km E of Madalena, 260 m, cow dung, 28 April 1995 (AZ310b, K(M)29885); Flores, N of Caveira, nr Castelo, 110 m, cow dung, 7 May 1995 (AZ609a, K(M)30046). Fig. 4 C – D.

A widely distributed species (Bezerra & Kimbrough 1975), distinguished by spore size (16 – 18 × 9 – 12 µm in the cited specimens), cylindrical asci with spores uniseriately arranged, and setae which are sometimes roughened with weakly cyanophilous markings towards the apex, and are enlarged towards the base, 16 – 24 µm diam. in the present collections.

Not previously reported from the Azores but, as noted above, material reported by Dennis *et al.* (1977) as *L. ciliatus* seems better referred here.

Lasiobolus cf. **monascus** *Kimbr.*, Mycologia 66: 909 (1974).

SPECIMENS EXAMINED. **1** (AZ696a, K(M)29824).

Obtained in the present study from a single sample of rabbit dung, and tentatively referred to this species. *Lasiobolus monascus*, described from Florida (Kimbrough 1974), occurs typically on this substrate and is unique in the genus hitherto in having a single, polysporous ascus. In this respect and in its setose apothecia it is similar to species of *Trichobolus*, but differs from members of that genus in ascus structure (Kimbrough 1974).

Apothecia in this material are whitish, cylindrical, 340 – 380 × 175 – 190 µm, and bear hyaline, thick-walled setae measuring c. 50 – 200 × 12 – 27 µm and occasionally forked near the base. The setae are usually bulbous at the base, frequently have 1 – 2 (– 3) thin septa in the lower part, and the lumen often occluded above. Excipular cells are hyaline, thin-walled, angular, to c. 20 × 16 µm, and spores are ellipsoid, 9 – 11 × 5 – 6 µm, and lack de Bary bubbles. It matches closely with this species as described (Kimbrough 1974), but differs in the somewhat smaller apothecia and larger spores and in the apparent absence of de Bary bubbles, the latter said to be 'infrequent' in the type collection. Unfortunately, asci have not been clearly observed, so that the operculate dehiscence has not been confirmed. However, the material cannot be referred to known species of *Trichobolus*, which differ notably in spore characters (Krug 1973), and seems best referred to *Lasiobolus*.

Not previously known from the Azores, or elsewhere in Macaronesia.

Thelebolus microsporus (*Berk. & Broome*) *Kimbr.* in Kobayasi, Rep. (Annual) Inst. Ferment. Res. Osaka 1965 – 66, 3: 50 (1967).

SPECIMENS EXAMINED. **7** (AZ207b, K(M)54691); **9** (AZ1602, K(M)45426); **10**; **12** (AZ1659, K(M)54699); Flores, W of Santa Cruz, just W of Pico da Casina, 490 m, cow dung, 5 May 1995 (AZ509b, K(M)29873); Flores, c. 2 km SW of Ponta Ruiva, 310 m, cow dung, 6 May 1995 (AZ576f, K(M)29883); Flores, N of Caveira, nr Castelo, 110 m, cow dung, 7 May 1995, (AZ609h, K(M)54700); Flores, 1.3 km SW of Ponta Delgada, 340 m, cow dung, 13 Nov. 1996 (AZ1541c, K(M)52545); São Miguel, 3 km W of Lagoa, road from Ponta Delgada, cow dung, 510 m, 21 April

1995 (AZ057b, K(M)54693); Pico, north coast road, 2 km E of Santo Amaro, 310 m, cow dung, 29 April 1995 (AZ364a, K(M)29887). Fig. 4 E – G.

Found frequently, on various kinds of herbivore dung. May be similar to some species of *Coprotus*, such as *C. glaucellus* (Rehm) Kimbr., but can be recognised by the small, whitish apothecia and small, narrowly ellipsoid spores which lack de Bary bubbles. The paraphyses are commonly inflated and clavate or capitate at the apex, but this character is not constant, and simple, filiform paraphyses are also present in most collections. In the cited material, spores measure (7.5 –)8 – 9 × 3.5 – 4(– 4.5) µm. The walls of the outer excipular cells are commonly somewhat encrusted with an irregular, brownish or yellowish-brown pigment.

Not previously reported from Macaronesia.

Thelebolus nanus *Heimerl*, Jahrb. Ober-Realschule Bezirke Sechshaus Wien 15: 30 (1889).

SPECIMENS EXAMINED. **1** (AZ696b, with *Lasiobolus monascus*); **5**.

Distinguished by the tiny, subglobose, hyaline apothecia containing a single, multisporous ascus. Asci in the present material measure 75 – 80 × 38 – 42 µm, with spores 4.5 – 6 × 2.5 (– 3) µm.

Not previously reported from Macaronesia.

DISCUSSION

A total of 27 species of coprophilous discomycetes was recorded during the present study, of which twenty are reported for the first time from the Azores. Ten of these species also represent new records for Macaronesia and, furthermore, the genera *Ascodesmis*, *Ryparobius* and *Thelebolus* are reported for the first time from the region.

A total of 36 coprophilous species was included by Korf & Zhuang (1991a, 1991b, 1991c, 1991d) as known from Macaronesia. Of these, members of the genera *Pseudombrophila* Boud. (= *Fimaria* Velen.), *Mycoarctium* K. P. Jain & Cain and *Trichobolus* (Sacc.) Kimbr. & Cain have yet to be recorded from the Azores, as have several species of *Ascobolus*, *Cheilymenia*, *Coprotus*, *Peziza*, *Saccobolus* and *Thecotheus*. Several further species of these genera are currently unknown in the region, but are likely to occur, as are members of *Ascozonus* (Renny) E. C. Hansen and *Ascophanus* Boud. Also, none of the comparatively few known coprophilous members of the *Helotiales* are yet recorded from the Azores, or elsewhere in Macaronesia, and clearly there is much scope for further work to investigate coprophilous discomycetes in the Azores.

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