Coprophilous fungi from the Greek Aegean islands

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Abstract. Seventy-seven species of coprophilous fungi, including *Podospora macrodecipiens* sp. nov., were recorded from 43 herbivore dung samples collected from fifteen Aegean islands (from 35-41° N and 24-28° E) and subsequently incubated in moist chambers. Collections are described and the occurrence and distribution of species is discussed. The species richness of the Aegean coprophilous mycota is lower than might be expected from simple latitudinal considerations, possibly because of a reduced diversity of herbivores and the island nature of the collections.

Key words: ascomycetes, basidiomycetes, biogeography, diversity, ecology, fimicoles

Introduction

During various spring visits, from May 1998 to May 2007, 43 samples of herbivore dung were collected from fifteen islands in the Aegean Sea. They were incubated in damp chambers on return to the UK, and the coprophilous zygomycetes, ascomycetes and basidiomycetes that developed were recorded. Details of the fungi found are given, and their distribution and occurrence are discussed within the context of records from over 1000 samples providing over 10 000 records from samples collected worldwide in recent years by the author, and in relation to the observations of others, especially, van Brummelen (1967), Lundqvist (1972), Bell (1983) and Doveri (2004).

Materials and Methods

Collection details of samples are given in Table 1. Samples were dry when collected, and returned to the U.K. in paper envelopes. They were rehydrated and incubated, within 2 wk of collection, on moist paper towelling in plastic boxes with lightly fitting transparent lids, under ambient light and at room temperature (*ca* 15-18 °C). Care was taken to ensure that cultures were not too wet. Samples were generally of similar size, with incubation chambers 10 × 7 cm, which would accommodate approx. 2-4 g DW (= 15 sheep/goat pellets), or 13 × 8 cm for donkey (approx. 10-20 g DW). Samples were examined frequently at intervals of a few days, with a ×7-45 magnification stereomicroscope. Fruiting bodies were removed and mounted in water for examination and identification at higher magnification. Samples were incubated for 6 to 14 wk, with observations continuing whilst new fungi were being observed. Selected material has been placed in **E**, the herbarium of the Royal Botanic Garden, Edinburgh, and all notes made will be deposited as pdf files. In considering diversity, an estimate of species richness was made by constructing a cumulative species curve and deriving the equation for that curve ($y = ax^b$, where y = cumulative no. of species observed in x samples) and solving for $x = 50$ samples, and comparing with values obtained from a world-wide study of a similar range of substrates (Richardson 2001). While the use of cumulative frequency curves, in theoretical considerations of monitoring diversity, is best done by plotting the curve using random sequences of sample collection, from a practical point of view the derivation of a curve from a chronological sequence of samples is more useful since, once enough samples have been collected, sampling can cease.

Results and Discussion

The 43 samples yielded 334 records of coprophilous fungi, a mean of eight per sample, which is slightly lower than might be expected from earlier studies (Richardson 2001), and a total of 77 species. Fifteen species comprised the main elements of the coprophilous mycota, accounting for approximately 60 % of the records. These were, in order of frequency, *Schizothecium vesticola* [24], *Pilobolus crystallinus* [24], *Coprinopsis filamentifera* [19], *Sordaria fimicola* [19], *Ascobolus immersus* [18], *Podospora decipiens* [18], *Coprinopsis stercorea* [16], *Lasiobolus cuniculi* [15], *Podosordaria tulasnei* [12], *Arnium arizonense* [9], *Coprinopsis radiatus* [8], *Coprotus sexdecimsporus* [7], *Saccobolus versicolor* [7], *Sordaria humana* [7] and *Sporormiella intermedia* [6]. The cumulative species curve (Fig. 1) constructed from the 43 samples [excluding *Chaetomium* spp., which are not considered to be true coprophilous fungi, and which were excluded from the original diversity studies (Richardson 2001)] predicts 79 species per 50 samples. This value is lower than would be expected for dung samples from these latitudes (35-41° N), when the latitudinal gradient of species richness demonstrated by Richardson (2001) is considered, since well over 125 species/50 samples might have been anticipated at this latitude. It is possible that the relatively low diversity of species in this special habitat is due to the dung samples coming from a limited source of domestic animals, in the absence of wild native herbivores to provide a wider range of substrates. Islands generally have fewer species than larger land masses, and small islands have fewer species than larger islands. In the case of the islands sampled in this study, I do not think inter-island diversity would be greatly different in the case of coprophilous fungi, with their adaptations for airborne dispersal, and also a long history of inter-island trade, especially of domesticated animals.

It seems that the coprophilous mycota of Greece is underrecorded, since neither of two thorough and extensive monographs of typically coprophilous fungi [*Ascobolus* and *Saccobolus* (van Brummelen 1967), and Sordariaceae (Lundqvist 1972)], refers to any Greek material. This suggestion is further supported by the fact that none of the eleven basidiomycetes recorded are in the basidiomycete checklist of Zervakis *et al.* (1998), the ascomycete check-list (Zervakis *et al.* 1999) contains only 6 coprophilous taxa, and the Cybertruffle database (www.cybertruffle.org.uk) with over 685 000 records world-wide, only has just over 1100 Greek records.

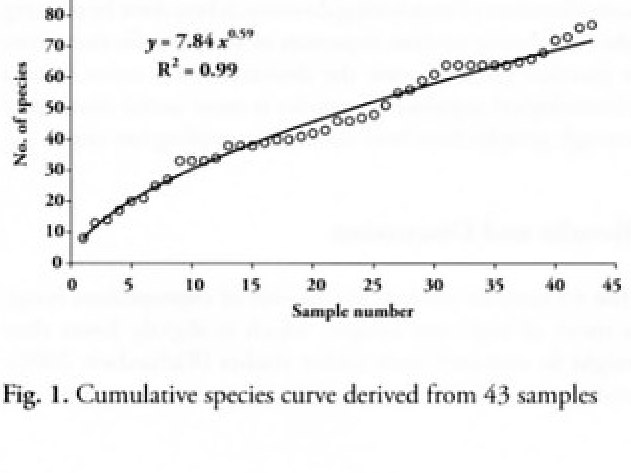

Fig. 1. Cumulative species curve derived from 43 samples

Records

The species observed are listed below, with a list of the samples (see Table 1 for origin of samples) on which they occurred. Notes on unusual or rarer species are given where appropriate. Nomenclature follows *Index Fungorum*, with the exception that I follow Lundqvist (1972) and Cai *et al.* (2005) by retaining *Schizothecium* as distinct from *Podospora*. Some material was not identifiable to specific level, but details have been included for completeness. The annotation (M) against a record indicates that dried material has been deposited in the Herbarium of the Royal Botanic Garden, Edinburgh (E). Of the species recorded here, three appear to have been recorded before from Greece, but only from the mainland, none from the islands. They are *Iodophanus carneus* and *Peziza vesiculosa* (Zervakis *et al.* 1999), and *Sordaria fimicola*, from soil (Vardavakis 1990); it is possible that the other records are new for Greece.

Zygomycetes

Mucorales

Pilobolus crystallinus (F.H. Wigg. : Fr.) Tode var. ***crystallinus***
MJR 40-42/98, 9-10/99, 22/00, 28-29, 31/01, 12-16/02, 19, 21/03, 29/04, 11-15/06, 11/07.

Pilobolus crystallinus var. ***kleinii*** (Tiegh.) R.Y. Zheng & G.Q. Chen
MJR 23/03.

Pilobolus oedipus Mont.
MJR 22/00.

Pilobolus roridus (Bolton) Pers. var. ***umbonatus*** (Buller) F.M. Hu & R.Y. Zheng
A characteristically umbonate, almost conical, sporangium, and small spores (5-8 × 3-5 µm) are diagnostic of this *Pilobolus*.
MJR 44, 46/98, 23/00.

Zoopagales

Piptocephalis lepidula (Marchal) P. Syd.
Piptocephalis species and related fungi are obligate parasites, mostly on members of the *Mucorales*. They are frequently observed in dung cultures, where they are parasitising *Mucor*, *Pilobolus* and *Pilaira* species, which commonly grow on dung (Richardson 2005). *P. lepidula* is characterised by 2-spored merosporangia produced over the surface of globose head cells, 5-6 µm diam, which terminate each of the branches of a complex dichotomous (4-chotomous at the lowest branch) sporangiophore. Complete units of head cell and immature merosporangia are *ca* 22 µm diam, dry-headed, detached immature merosporangia are dumb-bell shaped, and mature spores fusoid, 5-6 × 3 µm.
MJR 29/01.

Table 1. Details of Greek dung samples and collection localities

Sample no.[a]	Locality	Lat. (° N)	Long. (° E)	Date	Substrate
40/98	Road to Aghios Chrysotomos, Naxos	37.11	25.40	11 May 1998	donkey
41/98	Road to Aghios Chrysotomos, Naxos	37.11	25.40	11 May 1998	sheep
42/98	Kaloxylos – Mani road, Naxos	37.08	25.49	12 May 1998	sheep
43/98	Kaloxylos – Mani road, Naxos	37.08	25.49	12 May 1998	donkey
44/98	Byzantine road to Prodromos, Paros	37.05	25.24	16 May 1998	sheep
45/98	Antiparos – Spileo road, Antiparos	37.00	25.07	17 May 1998	donkey
46/98	Antiparos – Spileo road, Antiparos	37.00	25.07	17 May 1998	sheep
09/99	Filoti, Naxos	37.06	25.49	8 May 1999	donkey
10/99	Filoti, Naxos	37.06	25.49	8 May 1999	goat
11/99	Komiaki, Naxos	37.16	25.54	10 May 1999	donkey
12/99	Komiaki, Naxos	37.16	25.54	10 May 1999	goat
22/00	Potos, Thassos	40.62	24.58	23 May 2000	sheep
23/00	Panagia, Thassos	40.73	24.72	27 May 2000	sheep/goat[b]
27/01	Zakros Gorge, Crete	35.11	26.24	8 May 2001	goat
28/01	Malia Archaeological site, Crete	35.30	25.18	10 May 2001	goat
29/01	Elounda, pines trail, Crete	35.27	25.71	12 May 2001	goat
30/01	Elounda, pines trail, Crete	35.27	25.71	12 May 2001	donkey
31/01	Elounda, olive grove nr shore, Crete	35.26	25.73	13 May 2001	sheep
32/01	Elounda Island shore, Crete	35.26	25.74	13 May 2001	sheep
12/02	Coastal cliff, Mithymna, Lesvos	39.38	26.17	8 May 2002	sheep
13/02	Agiasos, Lesvos	39.07	26.36	10 May 2002	sheep
14/02	Mithymna – Petri track, Lesvos	39.31	26.19	13 May 2002	sheep
15/02	Near Vafios, Lesvos	39.34	26.22	15 May 2002	sheep
16/02	Vafios – Petra track, Lesvos	39.33	26.20	15 May 2002	sheep
19/03	Telendos	37.00	26.93	10 May 2003	sheep/goat
20/03	Telendos	37.00	26.92	10 May 2003	sheep
21/03	Kefalos Town, by windmill, Kos	36.74	26.97	14 May 2003	goat?
22/03	Kefalos – Kamari, Kos	36.74	26.97	14 May 2003	goat
23/03	Tigaki, Kos	36.89	27.18	15 May 2003	sheep?
24/03	Thermes, Kos	36.84	27.31	16 May 2003	sheep?
26/04	Mesta, Chios	38.27	25.93	12 May 2004	sheep/goat
27/04	Kardamila, Chios	38.54	26.09	15 May 2004	sheep/goat
28/04	Nagos, Chios	38.56	26.08	16 May 2004	goat
29/04	Marmaro, Chios	38.55	26.12	17 May 2004	sheep/goat
11/06	Gavrion, Andros	37.88	24.73	11 May 2006	sheep
12/06	Batsi, Andros	37.86	24.80	13 May 2006	goat?
13/06	Batsi, Andros	37.86	24.80	13 May 2006	goat?
14/06	Tinos	37.54	25.16	18 May 2006	horse
15/06	Pitrofos, Andros	37.82	24.89	19 May 2006	goat
10/07	Chora, Kimolos	36.79	24.58	16 May 2007	goat
11/07	Aghia Paraskevi, Sifnos	36.98	24.74	17 May 2007	sheep
12/07	Agios Nektarios, Milos	36.74	24.45	22 May 2007	goat
13/07	Apollonia road to Neochori, Milos	36.73	24.46	22 May 2007	goat

[a]MJR sample no. and year identifier

[b]There is doubt about the identity of the source of some samples since, in the absence of the animals, it is not possible to differentiate with certainty dung from sheep and goats.

Ascomycetes

Pezizales

Ascobolus hawaiiensis Brumm.

Initially thought to be rare when first described from Hawai'i (van Brummelen 1967), *A. hawaiiensis* has been found to be widespread and worldwide in its distribution, with records from Iceland (Richardson 2004), UK (Richardson 1998), France (unpublished), Spain (Valldosera & Guarro 1985), Italy (Doveri 2004), Pakistan (van Brummelen 1990), New Zealand (Bell 1983), Australia, Chile and the Falkland Islands (unpublished). It does not appear to have been reported from Greece (Zervakis *et al.* 1999). It is a distinctive fungus, with small, white apothecia, discolouring with age, with clear purple, finely verrucose ellipsoid spores 16-19.5 × 9-9.5 µm, completely surrounded by a clear gel sheath.

MJR 14/02, 19/03.

Ascobolus immersus Pers. : Fr.

One of the commonest and most widespread coprophilous fungi world-wide, *A. immersus* was one of the most frequent in the Greek samples, with 18 occurrences, although it is not listed for Greece by Zervakis *et al.* (1999). The usual variation in spore number was observed, with 4- and 8-spored asci the most frequent, but asci with 2, 3 and 6 spores maturing were also observed.

MJR 40-41, 43, 46/98, 10/99, 28/01, 12(M), 14-16/02, 20, 21(M), 24/03, 11-15/06.

Ascobolus cf. ***michaudii*** Boud.

Apothecia yellowish-green, up to 1 mm diam × 550 µm deep, with a basal point of attachment *ca* 200 µm wide, furfuraceous with small groups of slightly darker globose cells. Asci and paraphyses embedded in yellow green mucilage, the asci 140-150 × 19-20 µm, with 8 uniseriate spores 16-17 × 10 µm, with exospore cracks not deep and relatively distant, and with a one-sided gel. The spores and asci of this material are at the lower end of the size range given by van Brummelen (1967), but otherwise it agrees well with van Brummelen's description.

MJR 23/03.

Coprotus cf. ***disculus*** Kimbr., Luck-Allen & Cain

Without a modern monograph of the genus, the identification of small white *Coprotus* species with 8-spored asci presents difficulties, a difficulty also discussed by Bell (2005). Seven collections identified here as *C. disculus* all had white apothecia 200-500 µm diam, cylindrical asci 65-125 × 16-26, with 1-2-seriate ellipsoid spores 9.5-13 × 6-8 µm, and curved, filiform, not or hardly inflated paraphyses. This identification is not entirely satisfactory, since three collections agreed well with the original description of *C. disculus,* while the other four varied in one feature or another, but not enough to be considered distinct with any certainty. Kimbrough *et al.* (1972) described *C. disculus* with asci 75-90 × 10-15 µm and uniseriate spores 12-13.5 × 5-8 µm, Doveri (2004) has asci 94-126 × 11-18 µm and 1-2 seriate spores 11.5-14.7 × 6.3-9 µm, while Aas's (1983) description is very different, with asci 60-85 × 13.5-20 µm and biseriate spores 10-13 × 6.5-8.5 µm.

MJR 40, 46/98, 23/00, 11/06, 10, 12(M)-13(M)/07.

Coprotus cf. ***dextrinoideus*** Kimbr., Luck-Allen & Cain

Apothecia pale, 200-500 µm diam, with yellowish or slightly ochraceous excipular cells, polygonal, 10 µm diam; asci cylindrical 110-140 × 16-19; spores 1-2 seriate 9.5-12.5 × 7-8 µm; paraphyses very dense, hyaline, curved and slightly swollen at the tip.

MJR 32/01.

Coprotus cf. ***glaucellus*** (Rehm) Kimbr.

Two collections with spores around 10 µm long, the boundary often used for separating two groups of species. One collection was limited (14/02), with a small white apothecium with <10 broad cylindrical asci, the other (22/03) had yellowish apothecia 250-320 diam, with an excipulum of globose/polygonal cells 10-16 µm diam. Asci, spores and paraphyses of both were similar, with broad asci 50-65 × 12-20 µm, biseriate spores 9-11.5 × 5-7 µm, and curved but not capitate paraphyses.

MJR 14/02, 22/03.

Coprotus cf. ***lacteus*** (Cooke & W. Phillips) Kimbr., Luck-Allen & Cain

Apothecia white, 200-300 µm diam, excipulum of more or less rectangular cells; asci broad cylindrical, 74-80 × 19-22 µm; spores biseriate, 9-10 × 4.5-6.5 µm, not perfectly elliptical but straight-sided; paraphyses filamentous, 2-3 µm wide, curved and slightly broader at the apex.

MJR 12(M)/07.

Coprotus sexdecimsporus (P. Crouan & H. Crouan) Kimbr. & Korf

A readily identifiable species on account of its 16-spored asci. Apothecia white to glaucous, small, up to 500 µm diam. Asci broad cylindrical, 100-110 × 25-26 µm, spores ellipsoid, hyaline, 11-13 × 7-8 µm. A species which tends to appear relatively late in the incubation period (Richardson 2002) and, in the case of the Greek samples, the first appearance varied from 16-37 days after the samples were set to incubate.

MJR 40, 43/98, 10/99, 23/00, 16/02, 11/06, 10/07.

Iodophanus carneus (Pers. : Fr.) Korf

MJR 12, 14, 16/02, 19/03.

Lasiobolus cuniculi Velen.

MJR 41/98, 12/99, 22/00, 27-28, 30/01, 19/03, 28-29/04, 13, 15/06, 10-13/07.

Lasiobolus lasioboloides Marchal

MJR 20/03.

Peziza vesiculosa Bull. : Fr.

Apothecium 1 cm diam × 1 cm high, pale creamy buff, scurfy. Asci 300-350 × 19-21 µm. Spores ellipsoid, hyaline, non-guttulate, 21-22.5 × 11-11.5 µm. This species is recorded from mainland Greece (Diamandis 1985).

MJR 21(M)/03.

Saccobolus citrinus Boud. & Torrend

Both collections were similar, with yellow apothecia, up to 420 µm diam. Asci 96-130 × 20-32 µm. Spores arranged in 4 overlapping pairs (van Brummelen's pattern I), the spore mass 35-42 × 12.5-15 μm, with individual spores minutely verrucose, trapezoid-truncate, 14.5-16 × 6.5-8.5 μm. The asci, spore masses and spores are all slightly smaller than described by van Brummelen (1967) for *S. citrinus,* but in all other respects agrees better with that than with the other smaller-spored *Saccobolus* sect. *Saccobolus* species.

MJR 22/03, 14(M)/06.

Saccobolus depauperatus (Berk. & Broome) E.C. Hansen

MJR 19/03, 13/07.

Saccobolus versicolor (P. Karst.) P. Karst.

MJR 41, 46/98, 32/01, 12, 14/02, 22/03, 12/07.

Thecotheus holmskjoldii (E.C. Hansen) Chenant.

Apothecia cylindrical and pale at first, becoming turbinate and greyish, up to 1200 μm diam × 800 μm high, with a base *ca* 300 × 300 μm, not expanding as the apothecia develop, so large apothecia are more obviously stalked. Apothecia subtended by a fine weft of brownish hyphae, which comes away from the substrate when the apothecium is removed. Excipulum of inflated isodiametric cells up to 25-30 μm diam, light brown pigmented in places, and lightly furfuraceous with globose cells. Hymenial region *ca* 300 μm deep, and asci 300-340 × 32-40 μm, protruding from the hymenial surface by 60-70 μm when mature. Spores 1-2 seriate, ellipsoid, hyaline, thick-walled, minutely verrucose, 29-33 × 14-16 μm, with a hyaline apiculus at each end, 5 μm diam × 3 μm long. The spore ornamentation was consistently fine and uniform all over the spore – Aas (1992) noted that in some collections the ornamentation is coarser and denser towards the poles. Spores within the ascus have fibrils radiating from the ends, around the apiculus, up to 40 μm long, but they are not visible in discharged spores. Spores completely surrounded by a broad gel, which narrows at the apiculi. Paraphyses filamentous, branched below and clavate to 8 μm at the tips. Aas (1992), in monographing the genus, studied about 450 collections in total, and 109 out of 145 finds of *A. holmskjoldii,* with no records of any *Thecotheus* from Greece, so the collections reported here may well be the first from Greece. Plentiful material was deposited in E.

MJR 44(M)/98, 23(M)/00, 11, 13(M), 14(M)/06.

Thecotheus lundqvistii Aas

Apothecia pale, almost white, pedicellate, 0.75-2.25 mm diam, with ascal tips protruding above the hymenial surface when mature. Spores ellipsoid, rough, 25.5-32 × 14.5-16 μm, with a hyaline apiculus 2-3 μm at each pole, and completely surrounded, except at the apiculi, by a broad gel. Aas (1992) considers *T. lundqvistii* to be closely related to *T. holmskjoldii,* and is distinguished by its spores tending to be smaller and evenly ornamented all over.

MJR 11(M)/07.

Trichobolus zukalii (Hiemerl) Kimbr.

Apothecia cleistohymenial and immersed at first, with a single polyspored ascus and sparse, septate setae up to 300 μm long × 4 μm diam. Spores 500+ per ascus, broadly ellipsoid, 8.5-11 × 8-9.5 μm.

MJR 23/00, 31/01, 26(M)/04.

Thelebolales

Thelebolus stercoreus Tode : Fr.

Apothecia immersed, cleistohymenial, up to 110-160 μm diam, with an excipulum of polygonal cells 7-12 μm diam. Asci up to 20-25 in an apothecium, broadly clavate, 70-75 × 22-24 μm, with a faint sub-apical ring, 64(?)-spored. Spores ellipsoid, hyaline, 5 × 3 μm. Paraphyses hyaline, slightly clavate at the tip.

MJR 26/04.

This material would not, until recently, have been identified as *T. stercoreus.* De Hoog *et al.* (2005), however, on the basis of molecular studies, accept only four species of *Thelebolus: T. stercoreus, T. microsporus,* and two new species described from biomats in Antarctica. They found that many cultures from phenotypically very different teleomorphs, including cultures from uniascal and polyascal types, with small to large asci, and few to very many-spored types, are molecularly indistinguishable from each other and from cultures of *T. stercoreus* from material with the classical morphological criteria of a single large ascus with 2000+ spores, and ecological preference for lagomorph dung.

Sordariales

Arnium arizonense (Griffiths) N. Lundq. & J.C. Krug

Arnium is distinguished from related genera by having gelatinous appendages on the ascospores, but no pedicel or primary appendage. *A. arizonense* is so far unique in having consistently 4-spored asci and it has relatively large semi-immersed perithecia, usually with long, pointed, rigid tufts of septate hairs, often inserted laterally on one side of the neck (no hairs or setae were present on perithecia from 19/03, and 40/98 had short papillate hairs around the neck as in *Podospora* sect. *Rhypophila*). The spores of the Greek collections were 45-54 × 24-27 μm, with gelatinous appendages up to 300 μm long, inserted asymmetrically at each end of the spore.

Lundqvist (1972) observed that *A. arizonense* may be widespread in temperate areas and preferably grows on domestic herbivore dung, and he cites records from Siberia, Sweden, France, Germany, Hungary and Bulgaria. I associate it more with low latitude rather than high latitude temperate areas – the latitudinal range of the 23 records I have is from 28-45°, nine of them from Greek islands, the others from Morocco, mainland southern France and Corsica, Sicily, Tenerife and S. Australia, and none from the UK. Further analysis of the records suggests that it may be a Mediterranean species. Doveri (2004) lists details of eighteen Italian collections, and *A. arizonense* occurred on 21 (13 %) of my 158 collections from 'Mediterranean' localities: S. France (south of 44° N), Sicily, Aegean Islands, Egypt, Tunisia, Morocco and the

Canary Islands – these last two not strictly Mediterranean, but in the same general region and with similar habitats. In contrast, only two (0.2 %) occurrences were recorded from 912 samples from non-Mediterranean regions: many from Europe north of 44° N (Iceland, Faroe Islands, Sweden, Finland, UK, northern France and Spain), North, Central and South America, Australia, and the Falkland, Kerguelen and St Helena islands in the southern ocean. This difference in occurrence is highly significant (χ^2 = 109, p<0.0005).

MJR 40, 44, 46/(M)98, 28(M)/01, 19(M), 23/03, 14/06, 10-11/07.

Arnium* cf. *hirtum (E.C. Hansen) N. Lundq. & J.C. Krug

In addition to the collections of *A. arizonense*, two undetermined *Arnium* developed, which on balance may be aberrant forms of *A. hirtum*. In one (20/03) perithecia were immersed, *ca* 550-600 µm diam, with a few short hairs (<65 µm) at the neck, or none at all. Immature asci were long stalked, fusoid, 290-310 × 30 µm, with no apical ring or an only just discernible brightness and thickening at the apex. Asci were consistently 4-spored in one perithecium, but with signs in some of aborted initials of additional spores, up to 8 in total. Another perithecium had mostly 4-spored asci, but some with only three pigmented spores and one less pigmented or 2-celled. Mature, pigmented spores 45-48 × 23-26 µm, with apparently solid appendages inserted slightly off-centre at the ends of the spore. The other (14/06) had pyriform perithecia up to 900 µm high, with no setae or tomentum. Asci *ca* 500 × 65 µm, with no marked apical structure and a long tapering base, consistently 8-spored; spores variable in size, and some unusually large, 41-64 × 19-26 µm, symmetrical, slightly tapered towards the poles, and with very broad appendages, 20 µm wide at their origin, then broader, and then sharply tapering to a thin extension, about 80 µm long in total. Lundqvist (1972) notes that the morphological variation in *A. hirtum* is considerable, and his comments on Hansen's observations on the variation of spore number and size in *A. hirtum* are also relevant to the possible identity of these two collections.

MJR 20/03, 14/06.

Cercophora* cf. *silvatica N. Lundq.

MJR 10(M)/99.

Cercophora* cf. *coprophila (Fr. : Fr.) N. Lundq.

MJR 15/(M)06.

Coniochaeta ligniaria (Grev.) Massee

MJR 10(M)/07.

Coniochaeta saccardoi (Marchal) Cain

MJR 24(M)/03.

Podospora* cf. *argentinensis (Speg.) J.H. Mirza & Cain

This is an infrequently recorded member of *Podospora* sect. *Rhypophila*, the commonest member of which is *P. decipiens*. *P. argentinensis* has 8-spored asci and differs from *P. decipiens* in having smaller spores and, as well as the typical secondary appendages arising from the tip of the spore and the base of the pedicel, is reported to have a single appendage at the tip of the appendage, which is fugacious and rarely seen (Mirza & Cain 1969). The spores of the Greek material were larger, 29-35 × 16-19 µm, than recorded from three other collections I have seen [29 × 16 µm (Brazil, 64/98), 26-29 × 16 µm (Malaysia, 10/01), and 27-29 × 16 µm (Florida, USA, 4/03)], but very close to the measurements given for the type (30-34 × 18-20 µm, Spegazzini 1912), and markedly smaller than the ranges given for *P. decipiens* by Lundqvist (1972, 36-42 × 20-22 µm) and (Mirza & Cain 1969, 35-46 × 19-23 µm, Table 3).

MJR 23/03.

Podospora comata Milovtz.

Perithecia up to 550 µm tall × 400 µm diam, with brown, straight, non- or partially aggregated setae <130 µm long at the neck. Asci 4-spored, 240 × 25 µm; spores ellipsoid, 29-35.5 × 16-18 µm, with pedicel 19-25 × 4.5-6 µm; secondary appendages *ca* 50 µm long, at the spore apex and pedicel tip, with additional small appendages at the base of the pedicel. Mirza & Cain (1969) note that this species is very close to *P. pauciseta*, but the spores are smaller [35-40 × 18-19 µm in Lundqvist (1972), and 34-40 × 18-20 µm in three Greek collections (q.v.)], and the secondary appendages appear to be much less robust. It would appear to be uncommon, with few reports.

MJR 26(M)/04.

Podospora communis (Speg.) Niessl

Lundqvist (1972) comments that this species appears to have a world-wide distribution, with few verified records from the tropics. In my experience it is a low latitude species, with 28 of my 30 records from between 37° N and 32° S, and 24 of those from the tropics. The high latitude exceptions are from Finland (62° N) and the Falkland Islands (52° S).

MJR 14/06.

Podospora curvicolla (G. Winter) Niessl

Lundqvist (1972) treats the 'polyspored' species of sect. *Malinvernia* in great detail, especially *P. curvicolla*, *P. setosa*, and the two new species he described, *P. bifida* and *P. granulostriata*. The main distinguishing taxonomic criteria are the nature of the perithecial setae (simply setose or asymmetrical tufts of aggregated hyphae), ascus shape (fusiform or saccate), presence or absence of structure at the ascus apex, spore size, and size and shape of the pedicel. It is, however, still difficult to be positive about the identity of some collections, since unusual combinations of these characters occur. Two collections agreed best with Lundqvist's (1972) concept of *P. curvicolla*, with asymmetric tufts of setae at the perithecial neck, asci with no apical structure and relatively small spores, pigmented cells 16-17 × 8-11.5 µm, pedicels collapsing, not readily visible, 7-9 × 2 µm. There were, however, some differences, especially in the shape of the asci, which were more clavate-fusiform than saccate.

MJR 13/02, 19/03.

Podospora decipiens (G. Winter ex Fuckel) Niessl

The commonest species in sect. *Rhypophila*. Lundqvist (1972) commented that it 'is one of the commonest and probably most widely distributed pyrenomycetes in temperate regions', and these observations are borne out by analysis of the 288 records I have from 1070 samples world-wide (Table 2). It is somewhat more frequent in this set of 43 samples from Greek islands than might have been expected.

MJR 43/98, 10/99, 23/00, 28/01, 13(M), 14-15, 16(M)/02, 20-21(M), 23/03 11-13/06.

Podospora macrodecipiens M.J. Richardson, **sp. nov.**

MycoBank # MB 511600.

Etymology: referring to the larger spores, when compared with *Podospora decipiens*.

Diversus ex Podospora decipiente tantum valde maioribus sporis, (41–) 51-58 × 22,5-27,3 µm.

Different from *Podospora decipiens* only in the much larger spores, (41–) 51-58 × 22.5-27.3 µm.

Holotype: on sheep dung, **GREECE:** Antiparos, Antiparos to Spileo road, 37.00° N, 25.07° E, 17 May 1998, coll. B.A. Richardson & K. Birchall (MJR 46/98) (E). **Paratypes:** Naxos, Kaloxylos to Mani road, on donkey dung, 37.08° N, 25.49° E, 12 May 1998, B.A. Richardson & K. Birchall (MJR 43/98); Crete, Zakros Gorge, on goat dung, 35.11° N, 26.24° E, 8 May 2001, B.A. Richardson & K. Birchall (MJR 27/01); Kos, path from Kefalos to Kamari, on goat dung, 36.74° N, 26.97° E, 14 May 2003, B.A. Richardson & K. Birchall (MJR 22(M)/03).

Distribution: Europe (Greece).

In addition to the records of *P. decipiens* reported above, material with much larger spores was observed on four collections. Such large spores, both in length and width, have only been observed in samples from Greece, and I consider them to be sufficiently distinct from *P. decipiens* to describe them as a separate species. Details of spore sizes for all Greek collections of *Podospora* sect. *Rhypophila* are given in Table 3.

Podospora* cf. *mexicana Mirza & Cain

Perithecia hairy, but not setose. Asci 320-350 × 50-60 µm, with no apical structure, mostly 4-spored, but some with up to eight, and some with aborted spores. Spores obliquely biseriate, pigmented cells 25-30.5 × 17.5-19.5 µm, pedicel 24-29 µm long, 5.5-6 µm at the base, 7 µm at the widest point, appendages simple, appearing solid, up to 50 µm long.

MJR 20(M)/03.

Podospora pauciseta (Ces.) Traverso

Characterised by perithecia with asymmetrical tufts of setae composed of agglutinated but non-inflated hyphae, 4-spored asci, and spores, in the Greek collections, with the pigmented cell 29-38.5 × 16-19.5 µm and a pedicel 15-25 × 3-4 µm, the apical appendage appears to be solid and is asymmetrically inserted at the tip of the spore.

MJR 23/00, 13/02, 23/03.

Podospora pleiospora (G. Winter) Niessl

Similar to *P. decipiens*, but with 16- or 32-spored asci. All the Greek specimens were 16-spored, with spores of four samples in the normal range of 32-38 × 19-23 µm (Table 3). The fifth sample (13/02) had larger spores than is usual, 38.5-42 × 21-25 µm.

MJR 10/99, 23(M)/00, 13(M)/02, 22/03, 15/06.

Podospora setosa (G. Winter) Niessl

See the comments under *P. curvicolla* above. These two collections, with larger spores, 17.7-19.4 × 11-11.5 µm (pedicels 12 × 2-3 µm), in that respect fit *P. setosa* better than *P. curvicolla*, but are otherwise very similar to the collections determined as *P. curvicolla* above, with fusoid-clavate asci with no apical structure, but with setae only lightly aggregated and tending to be asymmetrically arranged around the neck, and with additionally some small dark papillate hairs on the upper part of the perithecial body.

MJR 21-22/03.

Table 2. Frequency of occurrence of *Podospora decipiens* in samples from different latitudes

Latitude (deg.)	No. of samples	Frequency (%)
>60 N	168	30
50-60 N	561	30
40-50 N	100	27
23.5-40 N (Greece)	43	33
23.5-40 N (others)	66	11
23.5 N – 23.5 S (tropics)	38	3
23.5-40 S	46	33
49-60 S[a]	48	8

[a]Including samples from the Kerguelen (9) & Falkland Islands (36), in the southern Indian and Atlantic Oceans respectively, which may have a limited mycota.

Table 3. Spore size (μm) of various collections of *Podospora* sect. *Rhypophila* from Greece, compared with measurements from literature

	P. decipiens	*P. macrodecipiens*	*P. pleiospora* (16-spored)	*P. argentinensis*
Type description	48 × 22		33 × 19	30-34 × 18-20
Mirza & Cain (1969)	35-46 × 19-23		31-36 × 19-24	(23–) 26-34 × 12-20
Lundqvist (1972)	36-42 × 20-22		30-37 × 18-23	
Doveri (2004)	33-42 × 19-25.2		29.4-38.8 × 17.8-21	
23/03	34-40 × 19.3-19.5			29-35 × 16-19
43/98	35-41.5 × 18-19.5	51-52 × 25-26		
46/98		48-58 × 22.5-27.3		
27/01		(45–) 48-54.5 × 25-26		
22/03		(41–) 51-56 × 22.5-27	32-35.5 × 19-23	
10/99	35-38 × 21		32-38 × 21	
13/02	38.5-41.5 × 19.5-20		38.5-42 × 21-25	
23/00	38.5 × 19			
14/02	35-41.5 × 21-22.5			
15/02	38-39 × 19-20			
16/02	36-39 × 19-19.5			
20/03	35-48 × 17.5-22			
21/03	41.5-45 × 19.5-21			

Schizothecium inaequale (Cain) N. Lundq.

A relatively infrequently recorded species, with small perithecia, 190-210 μm high × 110-125 μm diam, the upper part rugose with inflated schizothecioid cells. Asci 4-spored, 90 × 12-14 μm, spores asymmetrical, 19-21 × 10 μm, with an apical germ pore, pedicel 6 × 1-2 μm, and no gelatinous appendages.

MJR 13/(M)07.

Schizothecium miniglutinans (J.H. Mirza & Cain) N. Lundq.

MJR 24(M)/03, 10/07.

Schizothecium tetrasporum (G. Winter) N. Lundq.

MJR 10, 12/99, 28/04, 12, 15/06.

Schizothecium vesticola (Berk. & Broome) N. Lundq.

MJR 42-44, 46/98, 9-10/99, 27-28, 32(M)/01, 12-15, 16(M)/02, 20-21, 23/03, 12-15/06, 10-12/07.

Sordaria fimicola (Roberge ex Desm.) Ces. & DeNot.

MJR 43, 45-46/98, 9-12/99, 23/00, 30/01, 12-14/02, 22/03, 26, 28-29/04, 11, 15/06, 11, 13/07.

Sordaria humana (Fuckel) G. Winter

MJR 44-45/98, 11/99, 27/01, 19, 21, 23/03, 13/07.

Sordaria macrospora Auersw.

MJR 46/98.

Sordaria superba De Not.

MJR 16/02, 24/03, 26(M)/04, 12-13(M)/07.

Thielavia wareingii Seth

MJR 40(M), 46(M)/98.

Xylariales

Podosordaria tulasnei (Nitschke) Dennis

Characteristic stromata develop in culture, but they do not usually produce perithecia, and none of the Greek stromata were positively identified by perithecial or ascospore characters.

MJR 10, 12/99, 22/00, 27/01, 12(M), 16(M)/02, 20, 24/03, 27, 29/04, 15/06, 11(M)/07.

Hypocreales

? ***Selinia*** sp.

Orange stromata with perithecia developed on this material after about four weeks incubation, but did not mature before the culture became overgrown and deteriorated, so a positive identification was not possible. From familiarity with *Selinia*, especially *S. pulchra* (G. Winter) Sacc., there is a strong likelihood that that is what it was, but confirmation is necessary.

MJR 9/99.

Onygenales

Gymnoascus reessii Baran.

MJR 21, 24(M)/03, 15(M)/06, 11(M)/07.

Microascales

Cephalotrichum stemonitis (Pers. : Fr.) Nees

Occurring as the anamorphic form, *Doratomyces stemonitis* (Pers.) F.J. Morton & G. Sm.

MJR 15/06.

Microascaceae sp. 1

Black smooth cleistothecia, with a few sparse septate hairs <100 μm long. Some thecia hairier than others.

Asci subglobose 16-20 µm diam, 8-spored. Spores subglobose, 8-10.5 µm, golden reddish-brown, with a germ pore at the slightly pointed pole.
MJR 13-14/06.

Microascaceae sp. 2
Black cleistothecia, <500 µm diam, with polygonal parenchymatous excipular cells, *ca* 15 × 15 µm, and with long septate hairs <600 µm long × 4.5-5.5 µm wide, paler towards the tip. Asci globose 12.5-14.5 µm diam. Spores smooth, globose to very slightly ellipsoid, 4.5-5 µm, hyaline to very slightly brownish *en masse*.
MJR 21(M)/03, 22(M)/03.

Microascaceae sp. 3
Black cleistothecia, <350 µm diam, with long radiating hairs <700 µm long × 6-7 µm wide, with a cephalothecioid base. Excipular cells polygonal, greyish transparent with a darker outline. Asci globose 12-13 µm diam. Spores smooth, subglobose, 6-6.5 × 5 µm, light golden brown.
MJR 12(M)/07.

Dothideales

Delitschia perpusilla Speg.
MJR 10/07.

Delitschia winteri (W. Phillips & Plowr.) Sacc.
The Naxos collection was typical *D. winteri*. The collection from Kimolos (10/07) had spores intermediate between *D. winteri* and *D. patagonica*, with spores too narrow for the former – 19-22.5 µm cf. 23-28 (–31.5) µm (Luck-Allen & Cain 1975; Doveri 2004), but too long for the latter – 48-61 µm cf. (–40) 42-55 µm (Luck-Allen & Cain 1975; Doveri 2004). Since Luck-Allen & Cain (1975) note that on the holotype packet of *D. patagonica* Spegazzini described the spores as even smaller, 35 × 16 µm, the Kimolos collection is considered to be nearer to *D. winteri*. An interesting feature of the Kimolos material, subsequently observed on other collections of *D. winteri*, is that the germ slit on each cell of the spore is circumpolar, i.e. it can be traced from its origin at the septum, along the length of the cell to the tip, and round to the septum on the other side. Bell (2005) describes this as a 'wrap around' germ slit, and she appears to be the only observer to have recorded the feature, in at least three species (*Delitschia* sp. 'A163', *D. gigaspora* and *D. furfuracea*), although not *D. winteri*. The fact that this feature had not been mentioned, before Bell (2005), suggests it may be unusual since, if it was a common feature, one would have expected it to feature in the descriptions and abundant illustrations of Luck-Allen & Cain (1975), Jeng *et al.* (1977) or Doveri (2004). They, however, all illustrate many spore cells with no apparent germ slit, which would only be the case if spores were aligned so that the germ slit plane was perpendicular to the field of view, i.e. invisible because it was around the edge of the spore. Such an alignment is unlikely to be as frequent as suggested by the proportion of 'one side only' germ slits illustrated.
MJR 41/98, 10/07.

Sporormiella australis (Speg.) S.I. Ahmed & Cain
MJR 23/00, 30, 32/01, 13/02, 12/07.

Sporormiella grandispora S.I. Ahmed & Cain ex J.C. Krug
MJR 10/99.

Sporormiella intermedia (Auersw.) S.I. Ahmed & Cain ex Kobayasi
MJR 40, 46/98, 32/01, 24/03, 10, 12(M)/07.

Sporormiella lageniformis (Fuckel) S.I. Ahmed & Cain
MJR 10/07.

Sporormiella megalospora (Auersw.) S.I. Ahmed & Cain
MJR 41/98, 12(M)/07.

Sporormiella minima (Auersw.) S.I. Ahmed & Cain
MJR 46/98, 23/00, 23/03, 12/07.

Trichodelitschia minuta (Fuckel) N. Lundq.
MJR 46/98, 32(M)/01.

Trichodelitschia munkii N. Lundq.
MJR 10(M)/07.

Basidiomycetes

Agaricales

Coprinellus curtus (Kalchbr.) Vilgalys, Hopple & Jacq. Johnson
MJR 45/98, 30/01, 26/04.

Coprinellus heptemerus (M. Lange & A.H. Sm.) Vilgalys, Hopple & Jacq. Johnson
MJR 23/00, 15/06.

Coprinellus heterosetulosus (Locq. ex Watling) Vilgalys, Hopple & Jacq. Johnson
A single specimen seen, with tapered pilocystidia <60 µm long, no pleurocystidia, 4-spored basidia and ellipsoid spores 11.2-12.8 × 6.4 µm. Although no sclerocystidia were seen, the specimen was determined as *C. heterosetulosus*, since the spores were too large for the alternative identification of *C. pellucidus*.
MJR 26/04.

Coprinopsis filamentifer (Kühner) Redhead, Vilgalys & Moncalvo
MJR 40-41, 43, 46/98, 10/99, 27-30/01, 19-22/03, 26, 28/04, 11, 15/06, 11, 13/07.

Coprinopsis pseudoradiata (Kühner & Joss. ex Watling) Redhead, Vilgalys & Moncalvo
MJR 14/02.

Coprinopsis radiata (Bolton : Fr.) Redhead, Vilgalys & Moncalvo
MJR 40, 43-44/98, 9, 11/99, 15/02, 23/03, 14/06.

Coprinopsis stercorea (Fr.) Redhead, Vilgalys & Moncalvo
MJR 41-43/98, 10/99, 22/00, 27-28, 31/01, 12-16/02, 19/03, 12, 15/06.

Coprinopsis vermiculifera (Joss. ex Dennis) Redhead, Vilgalys & Moncalvo
MJR 10/99, 19/03, 12-13/06.

Coprinus ephemeroides (Bull. : Fr.) Fr.
MJR 9, 11/99.

Parasola misera (P. Karst.) Redhead, Vilgalys & Hopple
MJR 23/00, 10/07.

Psilocybe merdaria (Fr. : Fr.) Ricken
MJR 30(M)/01.

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