Coprophilous Fungi from Morocco

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Summary

Fifty-seven species of coprophilous fungi are recorded from 14 dung samples collected from the Souss Valley area of southern Morocco that were incubated in moist chambers. Several new records for Morocco are reported. Evidence for reduced diversity due to the severely degraded nature of the habitats in which the samples were collected is discussed.

Key words: diversity, coprophilous fungi, Morocco, Sous Valley.

Introduction

During a visit in June 2000 to the Souss Valley area of southern Morocco, fourteen samples of herbivore dung were collected and incubated, on return to the UK, in a damp chamber. The coprophilous fungi which developed were recorded. Apart from lists for various regions of Morocco by Malençon (1937, 1960) and Malençon & Bertault (1960a,b, 1961a,b, 1967, 1970a,b), which include about 50 coprophils, a few records in Maire & Werner (1937), and some unverified records of Sordariaceae listed by Lundqvist (1972), there appear to be few records of such fungi from Morocco. For neighbouring Algeria, where similar habitats and mycobiota might be expected to occur, the reports of Faurel & Schotter (1964a,b, 1965a,b) are useful for comparison, together with those of El-Buni & Rattan (1981) from Libya. Details of the fungi found from the current collection of samples are provided and discussed.

Material and methods

Samples were collected between 13 and 23 June 2000 (Table 1). Most were dry when collected, and were placed in paper envelopes. Samples were rehydrated and incubated on 26 June 2000 on moist paper towelling in plastic boxes with lightly fitting transparent lids, under ambient light and at room temperature (*c.* 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 D.W. (= 15 sheep/goat – 20 rabbit pellets), or 13 × 8 cm for ass and camel (approx. 10-20 g D.W.). Samples were examined frequently at intervals of a few days, with a ×7-45 magnification stereo-microscope. Fruiting bodies were removed and mounted in water for examination and identification at higher magnification. Samples were incubated for up to 11 wk, with observations continuing whilst new fungi were being observed. Localities (latitude and longitude, Unified European Geodesic Datum, IGN, Paris) were determined with a Magellan GPS 4000 XL satellite navigator, and place names given are according to the 1:50000 Carte du Maroc (Ministère de l'Agriculture et de la Réforme Agraire, Division de la Carte, Rabat). Selected material has been placed in the Herbarium of the Royal Botanic Garden, Edinburgh. In considering diversity, species were recorded from the same

Table 1. Collection localities and origin of dung samples.

Sample no.*	Locality and elevation	Date	Origin
32/00	Road 7025, Bou Ighir (Taroudannt, Agadir).† 805 m. 30.39°N, 8.58°W	13.6.00	goat
33/00	Tiout (Taroudannt, Agadir). 475 m. 30.39°N, 8.70°W	13.6.00	ass
34/00	Tazglimt, Tamaloukt (Taroudannt, Agadir). 450 m. 30.62°N, 8.81°W	15.6.00	sheep
35/00	Assif Ait Al Haj, Tamaloukt (Taroudannt, Agadir). 535 m. 30.65°N, 8.82°W	15.6.00	goat
36/00	Assif Ait Al Haj, Tamaloukt (Taroudannt, Agadir). 535 m. 30.65°N, 8.82°W	15.6.00	ass
37/00	Sidi Rbat, Souss-Massa NP (Biougra, Agadir). 15 m. 30.08°N, 9.67°W	17.6.00	ass
38/00	Sidi Rbat, Souss-Massa NP (Biougra, Agadir). 30 m. 30.08°N, 9.67°W	17.6.00	rabbit
39/00	Sidi Rbat, Souss-Massa NP (Biougra, Agadir). 15 m. 30.08°N, 9.67°W	17.6.00	goat
40/00	Road S501, Zawyat Si Abdallah Ou-Moussa, Oulad Barhil (Taroudannt, Agadir). 645 m. 30.73°N, 8.42°W	19.6.00	camel
41/00	Tizi-n-Test Pass (Taroudannt, Agadir). 2070 m. 30.86°N, 8.38°W	19.6.00	goat
42/00	Road 7002, Assif n'Tarhrat, Tamzargout (Agadir). 250 m. 30.58°N, 9.54°W	21.6.00	goat
43/00	Road 7002, Assif n'Tarhrat, Tamzargout (Agadir). 250 m. 30.58°N, 9.54°W	21.6.00	ass
44/00	Azni-n-Fad (Taroudannt, Agadir). 770 m. 30.62°N, 8.13°W	23.6.00	goat
45/00	Azni-n-Fad (Taroudannt, Agadir). 775 m. 30.62°N, 8.13°W	23.6.00	camel

* MJR sample no. and year identifier (year identifier omitted from collection details in text).
† Administrative Division in parenthesis.

assemblage in a world-wide study of a similar range of substrata (Richardson, 2001). An estimate of species richness of the Moroccan samples 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 that estimate with the value to be expected for the same latitude obtained from a world-wide study of a similar range of substrates (Richardson, 2001). Records of *Chaetomium* spp. are included for completeness but, for consistency with earlier work, were excluded from the diversity calculations, since they are not primarily coprophilous fungi.

Results and discussion

The fourteen samples provided a total of 167 records of 57 species. Many of these are possibly new records for Morocco or north Africa. The mean species richness of 11.1 per sample is within the range of values of 9-12 obtained for various herbivore mammalian dungs in the world-wide survey (Richardson, 2001). These mean values mask the effects of a latitudinal gradient on species richness which was demonstrated by Richardson (2001), who showed that although individual samples from different latitudes, and from five different mammalian herbivore species, yielded a similar number of species per sample, the total number of species recorded increased with decreasing latitude. The number of species to be

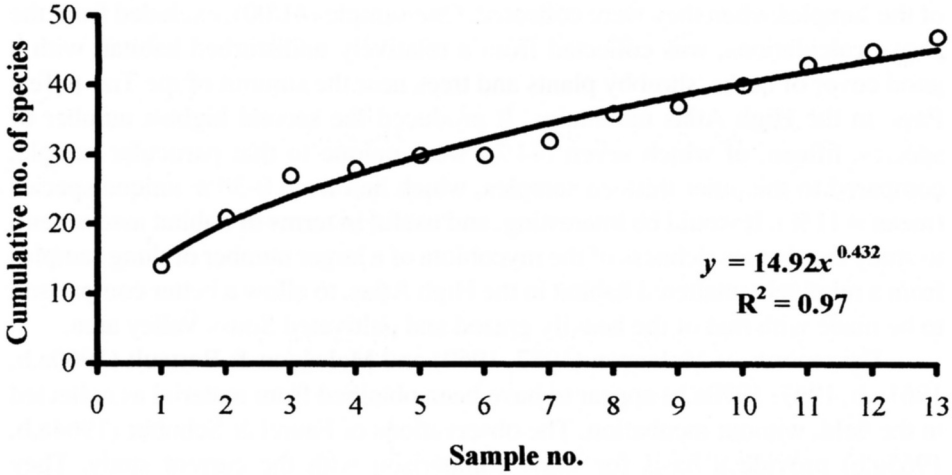


Fig. 1. Cumulative total of taxa observed in successive samples of mammalian herbivore dung from the Souss Valley area, Morocco. The equation for the line of best fit is given on the graph.

expected from 50 Moroccan samples, based on the equation for the cumulative frequency curve (Fig. 1), is only 81, much lower than expected for that latitude. From the data for different latitudes in Richardson (2001) one would have expected approximately 145 species per 50 samples from samples collected at 30°N. By comparison, Richardson (2002) obtained 67 species from 21 samples collected from a range of habitats in southern USA (California, Utah and Colorado) in 2001 from 36-37°N. Their cumulative frequency curve predicted 126 species per 50 samples, which is close to an expected value of 132 species per 50 samples for that latitude obtained from the relationship between species richness and latitude in Richardson (2001). The low number of Moroccan samples on which the estimate is based is not ideal. Richardson (2001) showed that the estimate of species richness derived from cumulative frequency curves stabilises with a sample size of around 40-50, although for substrates with lower diversity a smaller sample size of 30-40 is adequate.

An explanation of the apparently poor diversity of Moroccan coprophils in the Souss Valley may lie in the type of environment from which they were obtained. The majority of samples for the world-wide study of Richardson (2001) were obtained from areas which supported reasonable amounts of natural or cultivated vegetation - pasture, grassland, woodland or mountain vegetation. In contrast, all but one of the Moroccan samples were collected from areas with little vegetation, badly affected by grazing sheep and goats, firewood collection, and depletion of water reserves through the demands of development and tourism. They were either dry river beds or low density argan (*Argania spinosa* (L.) Skeels) forest on dry stony soil, with the understorey replaced by wheat and barley crops, which had been harvested and cultivated at the time of sampling. The extremely hot (daytime temperatures 30-40°C) and dry climate (little or no rain for long periods) would also not be conducive to the occurrence and development *in situ* of fungi on dung, although seven species were present on six

of the samples when they were collected. One sample (41/00), excluded from the above calculations, was collected from a relatively undisturbed habitat, with a good cover of herbs, shrubby plants and trees near the summit of the Tizi-n-Test Pass, in the High Atlas mountains. It produced the second highest number of species, fifteen, of which seven (44%) were unique to that particular sample, compared to the other thirteen samples, which had from 0-30% unique species (mean = 11%). It would be interesting, and useful in terms of habitat assessment, to study the species richness of the mycobiota of a larger number of dung samples from a relatively unaltered habitat in the High Atlas, to allow a better comparison to be made with that of the heavily grazed and cultivated Souss Valley area.

The records of Malençon (1937, 1960) and Malençon & Bertault (1960a,b, 1961a,b, 1967, 1970a,b) appear to have been obtained from material as collected in the field, without incubation. The observations of Faurel & Schotter (1964a,b, 1965a,b) provide a basis for some comparison with the current study. They reported on the fungi on 48 samples collected in Algeria in 1955-56, from around Algiers, the Atlas Mountains south of Algiers, and the Ahaggar Mountain area of southern Algeria. They recorded fungi on samples, as collected and after incubation, from a similar environment and latitude, but 3-5° further east longitude, and also in north Africa. The Algerian mycota was very similar in composition, but relatively species poor. This may be due to that fact that some of the samples were not incubated until over a year after collection, and then for only one or two months. Very few of the fungi recorded on collection appeared on incubation, and the majority of those that did develop after rehydration were not observed until at least 2-3 weeks after the start of incubation, which is most unusual. It is to be expected that there would be a decline in viable mycota in dung samples subjected to such a long period of storage before incubation, and it is my experience that fungi in samples which have been thoroughly dried, and kept for a period before incubation take longer to grow and fruit, so it is likely that Faurel & Schotter's records of the mycota of their samples is incomplete.

Records

Information on the dung samples and their origin is given in Table 1. Notes on species, and the sample numbers on which they were recorded, are given below. Species already recorded for Morocco by Malençon (1937, 1960) and Malençon & Bertault (1960a,b, 1961a,b, 1967, 1970a,b) are indicated as 'recorded by M&B', and those by Maire & Werner (1937) as 'M&W'. With little other information about the coprophilous mycota of Morocco, records which may be new to Morocco are indicated. Details of incompletely identified taxa are provided for future reference. Dried material (M) and/or slides (S) have been placed in the Herbarium of the Royal Botanic Garden, Edinburgh.

ZYGOMYCOTINA

Helicostylum pyriforme Tiegh.

No apical sporangia were seen, but sporangioles *c.* 16 μm diam., with circinate pedicels *c.* 50 μm long, and ellipsoid spores 6-7 × 4-5 μm were typical. MJR 35/00.

Pilobolus crystallinus (F.H. Wigg.) Tode
MJR 43/00. Recorded by M&W.

ASCOMYCOTINA
Pezizales
Ascobolus furfuraceus Pers.
MJR 39/00(M). Recorded by M&B and M&W.

Ascobolus immersus Pers.
MJR 41/00. Recorded by M&B and M&W.

Ascobolus stictoideus Speg.
MJR 42/00(M). Van Brummelen (1967) observes that this species appears to be cosmopolitan, but I have seen no records from Africa.

Coprotus sexdecimsporus (P. Crouan & H. Crouan) Kimbr.
An easily recognised species characterised by white apothecia with 16-spored asci 100 x 20-26 μm, and hyaline ellipsoid spores 11-13 x 8 μm. MJR 34,39/00. Recorded by M&B, as *Ascophanus sexdecemsporus*.

Coprotus spp.
Coprotus is in need of revision, and there is no good treatment which allows confident identification of many of the species which, unlike *C. sexdecimsporus* above, have few distinguishing features. Four other species were recorded on the Moroccan material as follows:

Coprotus sp. A. Apothecia white, becoming pale brownish when older, 100-300 μm diam., with excipulum of globose to polyhedral cells <15 μm diam. Asci cylindrical-clavate, slightly tapering below, to an abruptly narrowed base, (55-)75-90 $\times$ (14-)16-23 μm. Spores obliquely biseriate, ellipsoid hyaline, 9.5-12.5 $\times$ 6-8 μm. Paraphyses filiform, uncinate, not or only very slightly inflated at the tip, 1-2 μm diam. MJR 32-34,35(S),39,41,42,44/00. Individual collections of this 'species' from different samples showed some variation, particularly in ascus size, and colour of apothecium and paraphyses, but overlapping and merging from one to another, so they are considered as a single taxon.

Coprotus sp. B. Microscopically similar to *Coprotus* sp. A, but with brownish-orange and distinctly larger apothecia, 500-600 μm diam. Asci 75-95 $\times$ 18-20 μm. Spores biseriate, 9.5-11 $\times$ 7 μm. Paraphyses thin, uncinate at the tips. MJR 39/00.

Coprotus sp. C. Apothecia white, *c.* 200 diam. Asci cylindrical *c.* 85 $\times$ 12 μm, not bluing in KI. Spores initially alternately uniseriate, becoming biseriate, almost globose, 7.5-9 μm. Paraphyses crowded, hyaline, slightly yellowish. MJR 41/00.

Coprotus sp. D. Apothecia white to pale ochraceous, 200-500 μm diam. Asci 8-spored, cylindrical-clavate above, tapering to a stalk, 110-140 $\times$ 19-22 μm. Spores biseriate, hyaline, ellipsoid, 10.5-13 $\times$ 7.5-8 μm. Paraphyses dense, not inflated, straight or slightly uncinate at the tips, 1-2 μm diam., pale yellowish or brown en masse. MJR 32,41/00.

Iodophanus carneus (Pers.) Korf
All collections examined agreed broadly with Kimbrough, Luck-Allen & Cain's (1969) interpretation of *I. carneus*, with uniformly-ornamented spores (13-)16-20(-23) × (8-)10-11.5(-13) μm. MJR 39,42,44,45/00. Recorded by M&B, as *Ascophanus carneus*.

Lasiobolus ciliatus (J.C. Schmidt : Fr.) Boud.
MJR 42,44/00.

Lasiobolus cuniculi Velen.
MJR 39/00.

Lasiobolus lasioboloides Marchal
MJR 32,41,45/00. Recorded by M&B.

Saccobolus depauperatus (Berk. & Broome) E.C. Hansen
MJR 32,37,39,41-44/00. Recorded by M&B, as *Saccobolus neglectus*.

Saccobolus truncatus Velen.
MJR 39,41,45/00(S). Van Brummelen (1967) observes that this species is widely distributed but easily overlooked. There appear to be no records from Morocco, but it has been recorded from Libya (El-Buni & Rattan, 1981).

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 4-spored asci. Moroccan collections had clavate asci 290-320 × 32-38 μm, and spores 41.5-51.5 × 21-25 μm, with tapering gelatinous appendages up to 200 μm long × 8-10 μm wide at their base, inserted asymmetrically at each end of the spore. MJR 34(M),35(S),36/00.

Lundqvist (1972) identifies *A. arizonense* as a temperate species. The records he cites from California and Arizona, and that from Libya (El-Buni & Rattan, 1981) (all from 32-33°N) are probably the lowest latitude ones until these slightly more southern records from Morocco (30.6°N), and two I have from Tenerife in the Canary Islands, Spain (Teno Alto, 28.34°N, 16.88°W, goat dung, leg. M.J. Richardson, 22.11.1999, MJR 81/99; Tafada, 28.58°N, 16.15°W, goat dung, leg. M.J. Richardson, 13.11.2002, MJR 63/02).

Arnium(?) sp.
Perithecia immersed except for the neck, pyriform,700-1100 μm high × 500-700 μm diam. Neck dark, opaque, with nonseptate, acute, rough setae <65 μm long. Perithecial wall below neck olivaceous, translucent. Asci 8-spored, fusiform, *c.* 290-350 × 29-32 μm, with no distinct apical structure. Spores obliquely uniseriate, ellipsoid, 32-45 × 19-23 μm, with bipolar germ pores seen in one spore. Polar appendages with little form or structure, tapering, <125 μm long.

On some spores what was thought to be a pedicel, *c.* 6-10 × 2 μm or papilla, 2 × 2 μm, was seen, but this was not a consistent feature and on more careful examination it was decided that this was a central 'canal or striation' in the basal appendage. MJR 41/00(S,M).

Even the generic identity of this collection is doubtful, with different specimens showing contradictory characters – primary appendage absent or indistinct; one observation of a spore with a germ pore at each end; the fusiform ascus shape, characteristic of *Podospora*, rather than the ampullate shape which is often observed in *Arnium*. It is nearest to *A. hirtum* but descriptions of that species do not mention the characteristically rough and acute cervical setae of this collection.

Chaetomium bostrychodes Zopf
MJR 41,42,44/00

Chaetomium indicum Corda
MJR 32/00

Chaetomium murorum Corda
MJR 32,33,34,36,39,42/00

Coniochaeta ligniaria (Grev.) Massee
MJR 41/00.

Podospora australis (Speg.) Niessl
This distinctive species is characterised by its relatively large perithecia, with dense, short setae (<80 μm long) at the neck, obtuse and hyaline at the tip, four-spored asci, and large spores (48-51.5 × 24-26 μm) with a minute basal pedicel. It has been recorded from SW Africa (Namibia) and Tenerife (Lundqvist, 1972). MJR 44/00.

Podospora communis (Speg.) Niessl
One of a small group of species which has four apical secondary appendages. Spores are biseriate, 29-32 × 19-19.5 μm, with an apical germ pore and basal primary appendage, which is slightly clavate and often curved, 22-26 × 6 μm. The four apical secondary appendages are curved, claw-like, 12-15 μm long. MJR 33/00. Recorded by M&B, as *Pleurage vestita*.

Lundqvist (1972) observed that *P. communis* prefers dung of domestic animals, particularly cattle and horse, and that it seems to be world-wide in its distribution, but that verified records from the tropics are few. From 763 samples collected worldwide since 1994, I have 25 records of *P. communis*, all except one from low latitude areas between 32°N and 32°S. Eight were from cattle, six each from sheep and *Equus* spp., two from goat and one each from deer, rabbit and capybara. Of the 47 cattle, horse, sheep and goat samples collected from between 32°N and 32°S, 24 (51%) have yielded *P. communis*, compared to only one record from the 201 samples collected outwith those latitudes (MJR 105/01, on sheep dung, Falkland Islands, 51.7°S, 58.0°W. Leg. T. Eggeling, 19.9.01).

Podospora curvicolla (G. Winter) Niessl
Perithecia with an asymmetric tuft of setae, composed of aggregated but non-inflated cells. Asci polyspored (128+?), spores 14.5-16 × 11 μm, with small and indistinct secondary appendages. MJR 43/00.

There is a group of 'polyspored' *Podospora* spp. which have been recorded as *P. setosa* by various authors – *P. setosa*, *P. curvicolla*, *P. granulostriata*, *P. bifida* and *P. tarvisina*. Their taxonomy and identity has been discussed in detail by Lundqvist (1972). M&B recorded *P.* (as *Pleurage*) *setosa* in Morocco, but without any details, so it is not possible to determine whether their record refers to *P. setosa s. str.* or *s. lato*. *P. setosa* has larger spores (18-21.5 × 11-13 μm), and a tendency to have more evenly distributed and less aggregated setae (Lundqvist, 1972).

Podospora decipiens (G. Winter ex Fuckel) Niessl
One of the commoner *Podospora* species, especially on dung of cattle and other domesticated animals in temperate regions. MJR 41/00. Recorded by M&B, as *Pleurage decipiens*, and known from Morocco & Algeria (Lundqvist, 1972), and Libya (El-Buni & Rattan, 1981).

Podospora pauciseta (Ces.) Traverso
Perithecia with setose neck. Asci 4-spored, fusoid-clavate, tapering to a long sinuous stalk, 190-250 × 23-29μm. Spores 31-38 × 16-20 μm, with primary appendage 19-30(45) × 4-5 μm. MJR 33,34,36,39,44/00. Several records from African countries in Lundqvist (1972), but not previously recorded for Morocco.

Podospora sp.
Although this is an unsatisfactory record, with limited observation of what may have been atypical material, it is included for completeness, since no other *Podospora* sp. was recorded on this particular sample. Perithecia brown, tomentose. Asci 8-spored, fusoid, *c.* 350 × 32-38 μm, with a small ring at the apex. Spores 1-2-seriate, maturing irregularly, and not all spores maturing, 35-37 × 21-22 μm, with a large clavate pedicel, 26-32 × 6 μm, expanded at the tip to 10 μm diam. No secondary appendages were seen. MJR 45/00.

Schizothecium tetrasporum (G. Winter) N. Lundq.
MJR 42/00. A common species, especially on lagomorph and small rodent droppings, and noted by Lundqvist (1972) as having been reported from Algeria.

Schizothecium vesticola (Berk. & Broome) N. Lundq.
MJR 36,44/00. This is one of the commonest coprophilous fungi, and is recorded by M&B, as *Pleurage minuta*, and noted by Lundqvist (1972) as also having been reported from Algeria, and from Libya by El-Buni & Rattan (1981).

Sordaria fimicola (Roberge ex. Desm.) Ces. & De Not.
MJR 33,35-37,40,42,43,45/00. Recorded by M&B.

Sordaria humana (Fuckel) G. Winter
Perithecia semi-immersed, often with thin white mycelial vestiture. Ascospores broad ellipsoid to obovate, 19.5-22 × 16-19 μm, papillate at the base, with gel absent or thin and inconspicuous. MJR 33,34,36,40,43/00. Lundqvist (1972) has unverified records from sub-Saharan Africa, but these records may be new to Morocco.

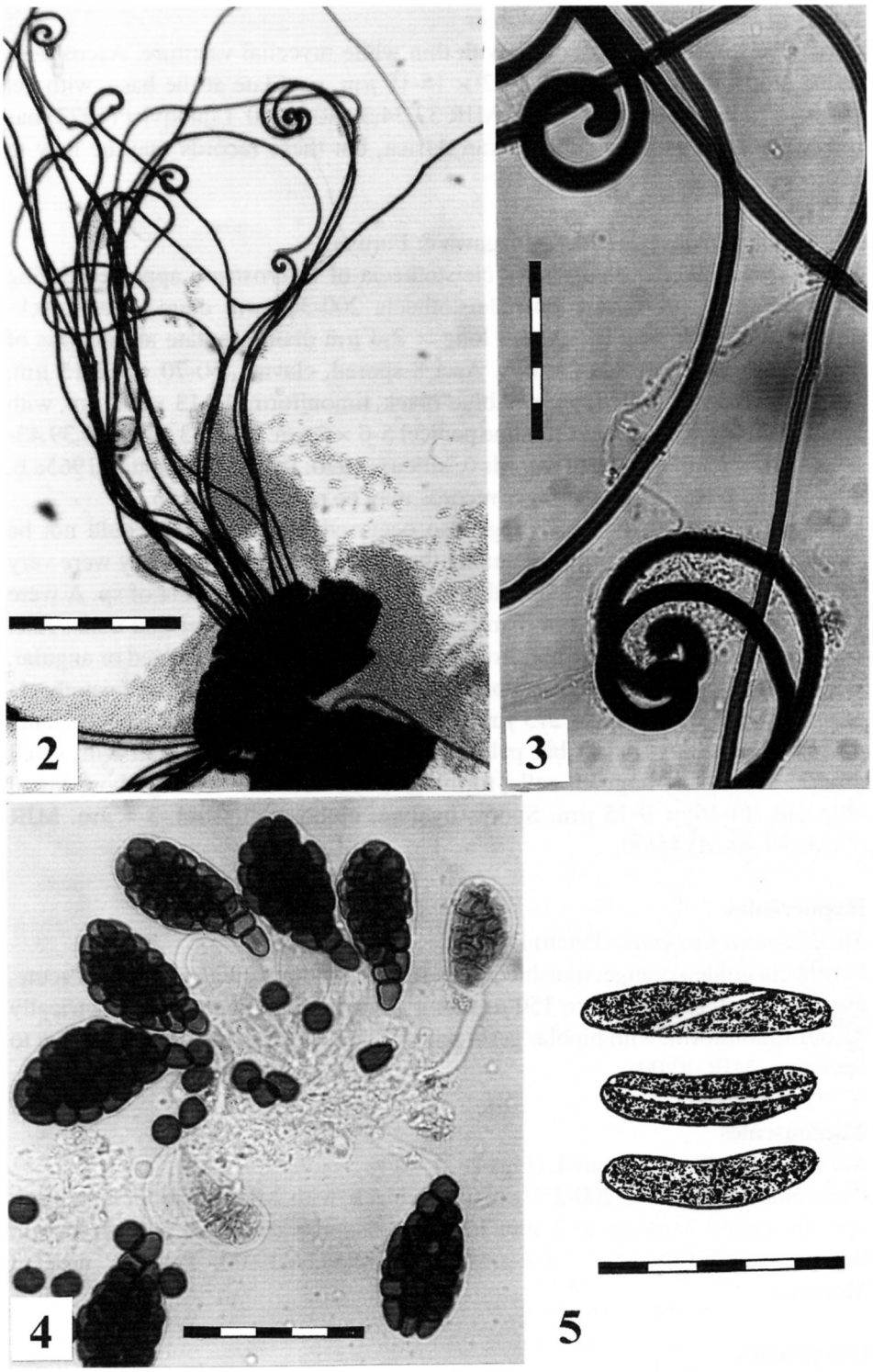
Zopfiella erostrata (Griffiths) Udagawa & Furuya
Small, dark, spherical long-hairy cleistothecia of *Z. erostrata* appeared during the later stages of incubation. Cleistothecia 200-300 μm diam., with black-grey flexuous hairs up to 1.5 mm long × 3-4 μm diam., septate at intervals of 40-60 μm, paler towards the tips. Asci 8-spored, clavate, 50-70 × 12-15 μm. Spores biseriate, 2-celled, one cell blue-black, limoniform, 11-13 × 6-7 μm, with apical germ pore, the other a hyaline pedicel 5-6 × 2 μm. MJR 33,37(S,M),39,43-45/00. Quite a lot of African records (Cailleux, 1970; Faurel & Schotter, 1965a,b, 1966; Lundqvist, 1969), but these records may be new to Morocco.

Two other cleistothecial fungi also occurred frequently but could not be identified. Superficially, when scanning the substrate for material, they were very like *Z. erostrata*, but microscopically very different. Cleistothecia of sp. A were black, spherical, 150-200 μm diam., with narrow elongate peridial cells. Asci clavate, 19-20 × 9-10 μm. Spores reddish-brown, thickwalled, ridged or angular, 5 × 4.5 μm, with an apical germ pore. MJR 32,35(M),42, 44,45/00. Cleistothecia of sp. B were black, up to 275 μm diam., covered with straight, septate hairs up to 700 μm long, black, but paler towards the tips. Peridial wall with small groups of darker, angular cells forming small areolae. Asci globose-broad ellipsoid, 14-15 × 9-15 μm. Spores hyaline, globose-ellipsoid, 3-4 μm. MJR 35(M),39,40(M),45/00.

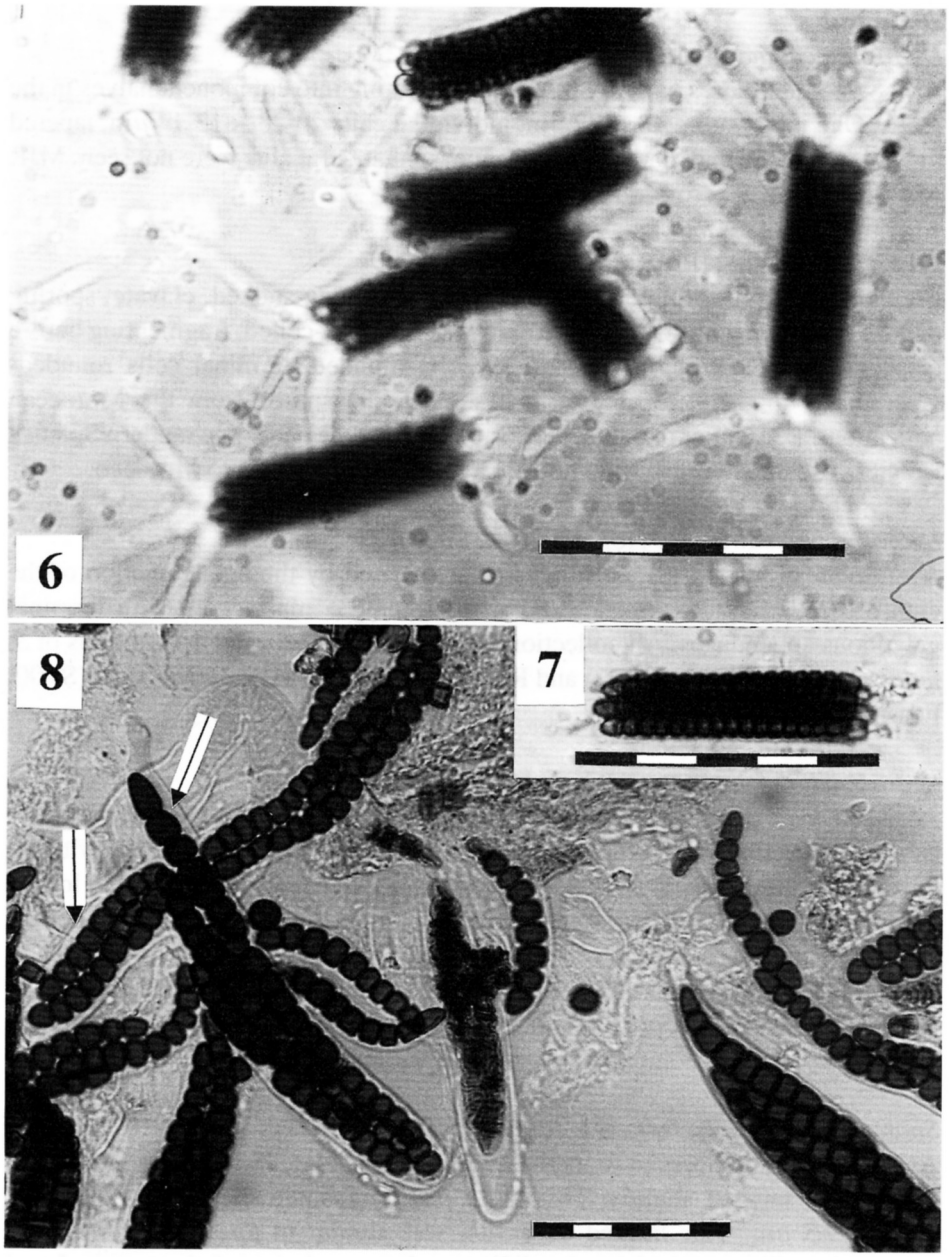
Hypocreales
Melanospora fusispora (Petch) Doguet
Perithecia golden orange, translucent, up to 350 μm diam., with a crown of acute, aseptate, hyaline setae up to 150 μm long at the ostiole. Spores asymmetrically fusoid-limoniform, with bipolar germ pores, 21-23 × 9.5-11 μm. Possibly new to Morocco. MJR 40/00.

Microascales
Kernia nitida (Sacc.) Nieuwl. (Figs 2, 3)
Cleistothecia spherical, 200-250 μm diam., black, with 2-3 fascicles of long black apically coiled hairs up to 1 mm long. Ascospores golden to reddish-brown, limoniform-ellipsoid, 5 × 3-4 μm. MJR 32(S),34,39/00. Possibly new to Morocco.

Onygenales
Gymnoascus reesii Baran.
MJR 33,35,36(M),39,44/00. Possibly new to Morocco.



Figs 2-5. **Figs 2, 3.** *Kernia nitida*. **Fig. 2.** Perithecium with spores and one tuft of setae. **Fig. 3.** Detail of tips of setae. **Fig. 4.** *Preussia funiculata*, asci and mature spores. **Fig. 5.** Abnormal spores of *Sporormiella australis/intermedia*. Scale bars: Fig. 2, 200 μm; Figs 3-5, 50 μm.



Figs 6-8. **Figs 6, 7.** *Sporormia fimetaria*. **Fig. 6.** Spore clusters mounted in Indian ink to show apical appendages. **Fig. 7.** Spore cluster mounted in water, showing 16-celled nature of spore more clearly. Appendages not visible. **Fig. 8.** *Sporormiella* sp., asci and spores from one pseudothecium. Note 8- and 9-celled spores adjacent in the same ascus (LH arrow), and 7-celled spore (RH arrow). Scale bars 50 μm.

Dothideales

Delitschia canina Mouton

Asci 8-spored. Spores partially biseriate, separating into component halves in the ascus. One intact spore 48 × 22 μm, individual cells 20-23 × 13-14 μm, tapered towards the distal end, dark brown opaque, so that germ slits were not seen. MJR 45/00. Possibly new to Morocco.

Preussia funiculata (Preuss) Fuckel (Fig. 4)

Pseudothecia non-ostiolate, <275μm diam. Asci long-stalked, clavate, sporing part 50 × 25 μm, with stalk *c.* 50-80 × 5 μm. Spores 4-celled, fragmenting before dispersal, 25-28 × 8 μm. Intercalary cells rounded, terminal cells rounded-tapered. As in the case of a British sample, the spores from the Moroccan collections are smaller than those reported for the type and some modern Spanish isolates (Richardson, 1998). MJR 32,42(S)/00. Possibly new to Morocco.

Sporormia fimetaria (De Not.) De Not. (Figs 6, 7)

A widespread but infrequent fungus, characterised by the amalgamation of the eight 16-celled spores into a bundle, resembling a maize cob, with terminal gelatinous appendages. All collections agreed well with earlier descriptions of *S. fimetaria sensu* Dissing (1992) and Richardson (1998). MJR 34(M),35,44(S)/00. Possibly new to Morocco.

Sporormiella cf. americana (Griffiths) S.I. Ahmed & Cain

Asci 190 × 22 μm. Spores consistently 7-celled, 55-64 × 10-11 μm, the intercalary cells isodiametric, with oblique germ slits, constricted at the septa, with the third cell from the distal apex wider than the others, and the apical cells longer than broad, slightly tapered. Spores eventually separating into their component cells. This collection agrees well with Ahmed & Cain's (1972) description, apart from the fact that they noted that the cells were not easily separable. MJR 41/00(S). See also *Sporormiella* sp. (below), which was also recorded from this sample, but which has smaller spores and a variable number of cells per spore.

Sporormiella cf. anisomera S.I. Ahmed & Cain

Asci short stalked, tapered to the base. Spores biseriate, 38.5-41.5 × 11 μm, the apical cells tapered slightly, 11.25-12.5 μm long, intercalary cells noticeably shorter, 9.5 μm. This limited collection was similar to *Sp. lageniformis* (see below), but distinguished by the different shape and size of the terminal and intercalary cells of the spores, which is a characteristic feature of *Sp. anisomera*. The spores were also wider (11 μm) than those of typical *Sp. lageniformis* (<9.5 μm). MJR 41/00.

Sporormiella australis (Speg.) S.I. Ahmed & Cain

One of the commonest species found, with 10 occurrences on the 14 samples. Ascospores 4-celled, 38-48 × 8-10(11) μm, end cells rounded, not tapering, each cell with a diagonal germ slit. MJR 32-34,38(M),40,41/00(S),42-45/00. Not previously recorded from Morocco. One pseudothecium from 44/00 contained asci with eight non-septate, slightly curved spores, 45-50 × 11 μm, with one

diagonal germ-slit along the length of the spore (Fig. 5), which was assumed to be an aseptate mutant of either *S. australis* or *S. intermedia*.

Sporormiella grandispora S.I. Ahmed & Cain
Asci long stalked, tapering towards the base, 190 × 20 μm before expansion. Ascospores 4-celled, 51-58 × 11-14 μm, with tapered terminal cells and parallel to oblique germ slits. MJR 32,38(M)/00. Possibly new to Morocco.

Sporormiella intermedia (Auersw.) S.I. Ahmed & Cain
One of the commoner *Sporormiella* species. Asci before expansion 125-175 × 20-29 μm. Ascospores 4-celled, (47-)50-55 × 9.5-11.5μm, each cell with a diagonal germ slit. MJR32(S),35,41,42(S),44/00. Recorded by M&B.

Sporormiella lageniformis (Fuckel) S.I. Ahmed & Cain
Asci long stalked, tapering towards the base. Ascospores 4-celled, 42-45 × 9-9.5 μm, with tapered terminal cells and very slightly oblique germ slits. MJR 44,45/00. Possibly new to Morocco.

Sporormiella cf. macropulchella R.S. Khan & Cain
Asci before expansion *c.* 120 × 16 μm. Ascospores biseriate, 4-celled, fragmenting at maturity, with rounded intercalary cells and tapered apical cells, 26-30 × 6-7 μm. Germ slits diagonal on intercalary cells, more longitudinally arranged on the apical ones. MJR 38/00(M). This collection is also near to *S. pulchella* (E.C. Hansen) S.I. Ahmed & Cain, which has smaller uniseriate spores, and to *S. cymatomera* S.I. Ahmed & Cain, which has larger biseriate spores, but on balance, especially in relation to spore size and morphology as illustrated by Ahmed & Cain (1972) and Khan & Cain (1979), it is nearer to *S. macropulchella*, described as having uniseriate to biseriate arranged spores. Neither *S. macropulchella* or *S. pulchella* appear to have been recorded from Morocco, but Faurel & Schotter (1964b, 1965a,b) recorded *S. pulchella* from several samples from Algeria.

Sporormiella minima (Auersw.) S.I. Ahmed & Cain
One of the commonest species found, present on ten of the fourteen samples. Characterised by small (29-32 × 4-5 μm) cylindrical, 4-celled ascospores which tend to break into 2-celled halves in the ascus or after liberation. A relatively common species world-wide, with a tendency to occur more frequently at lower latitudes. MJR 32,34,35(S),36,37,39,40,43,45/00. Khan & Cain (1979), have numerous records from Kenya, Tanzania and Uganda, and it is recorded from Libya by El-Buni & Rattan (1981), but this is possibly a new record for Morocco.

Sporormiella sp. (Fig. 8)
This distinctive *Sporormiella* occurred on two samples, and is possibly undescribed. Asci before expansion 145-200 × 19-23 μm. Spores bi/triseriate, (7-)8-9(-10)-celled (33% 8-celled, 57% 9-celled, mean = 8.5, SEM = 0.06, n = 110), (42-)45-53 × 8-10 μm, septation of spores variable within an ascus. Spores are slightly curved, fusiform, with apical and basal cells longer than wide,

tapered, and intercalary cells wider than long, with the third cell from the apical end of the ascus the broadest (or in 10-celled spores, the fourth cell), with diagonal germ slits. There are few *Sporormiella* spp. with a variable number of cells in the spore. These collections are nearest to *S. commutata* of the four in Ahmed & Cain (1972) but that has larger spores (50-60(-65) × 8-10.5 μm) and predominantly 9-celled spores. The other species have 10-16-celled spores and much larger spores (*Sp. herculea*, 100-160 μm long, and *Sp. calomera* and *Sp. polymera*, *c.* 60-80 μm long), The differences from *Sp. commutata* are sufficient to distinguish it from that species. MJR 32(S,M),41(S)/00.

Trichodelitschia munkii N. Lundq.
All three collections, with relatively small spores, 18-22 × 6-8μm, were determined as *T. munkii*, rather than *T. bisporula* (= *T. minuta*), which is generally considered to have larger spores, although there is quite a lot of variation and overlap in spore size among collections of these two species, which may be segregates at either end of a range. MJR 38(M),41(S),42(S)/00. Possibly new to Morocco.

BASIDIOMYCOTINA
Coprinus curtus Kalchbr.
MJR 33,37(M),43(M)/00. Recorded by M&B and M&W.

Coprinus filamentifer Kühner
MJR 34,36,40,43,44. Recorded by M&B.

Coprinus miser P. Karst.
This *Coprinus* is common world-wide on a wide range of dung types. It is characterised by a completely smooth, orange pileus, and basidiospores which are elliptical in one view, angular-cordate in another, 7-10 × 7-9 × 5-6 μm. Two and 4-spored basidia occur. MJR 32,44,45/00. Possibly new to Morocco.

Coprinus radiatus (Bolton) Fr.
MJR 36,37/00. Recorded by M&B.

Coprinus stercoreus (Bull.) Fr.
This is the commonest *Coprinus* species developing on dung world-wide when incubated in moist chambers, characterised by its bright white veil of globose cells and small ellipsoid spores. MJR 34,35,40,42,44,45/00. Recorded by M&B, as *C. stercorarius*.

Coprinus sterquilinus Fr.
MJR 43/00(M). Recorded by M&B.

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