New Records of Fungi from Orkney and Shetland

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Summary

Sixty-four species of coprophilous fungi were recorded from 42 herbivore dung samples collected in Orkney and Shetland in summer 2005. One, *Ascobolus brantophilus*, a high latitude species, is newly recorded for the UK and 13 and 28 species are newly recorded for Orkney and Shetland, respectively. The data obtained, with other records, are used to provide support for an earlier demonstration that the latitudinal gradient of species richness, which declines with increasing latitude, can be observed by studying coprophilous fungi.

Key words: ascomycetes, British records, diversity, latitude gradient, *Selinia*, species richness.

Introduction

The mycobiotas of the Shetland and Orkney archipelagos are well documented, and compiled by Watling (1992) and Watling, Eggeling & Turnbull (1999), with additions for Shetland by Watling, King & Riddiford (2001) and Watling (2005), and for Orkney (Watling, 2002). In 2005 the author visited both island groups for four days each. Samples of herbivore dung were collected and subsequently incubated in damp chambers. The coprophilous fungi that developed were recorded. Some of the fungi observed, especially from Shetland, are new records for the islands, and one is a new record for Britain. Details of the fungi found are provided and discussed.

Material and Methods

Samples were collected between 3 and 11 August 2005. Those that were dry were collected into paper envelopes. Wet samples were first air-dried for 2-3 days. Samples were rehydrated and incubated on 23 August 2005 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 – 20 rabbit pellets), or 13 × 8 cm for a pony sample (approx. 10-20 g D.W.). 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 up to 15 weeks, with observations continuing whilst new fungi were being observed. Location coordinates, latitude and longitude (WGS 84 datum), are shown in Table 1. They were determined with a Magellan eXplorist GPS satellite navigator, except for samples from 63/05 onward, when grid references were taken and subsequently converted to latitude/longitude coordinates.

Results and Discussion

Sixteen samples were collected from Orkney and 26 from Shetland (Table 1). A total of 486 records of coprophilous fungi was made (168 for Orkney, 318 for Shetland), comprising 64 species (43 for Orkney, 54 for Shetland). There were few new species records for Orkney (13), possibly due to the fact that the author collected there in 1993, and the records from that visit were included in Watling, Eggeling & Turnbull (1999). The 28 new records for Shetland include one new British record, *Ascobolus brantophilus*. In the notes which follow, comments relating to earlier records annotated FFOO and FFOS refer to the compilations for Orkney and Shetland by Watling (1992) and Watling, Eggeling & Turnbull (1999), respectively. Voucher material of sample numbers suffixed by **E** has been deposited in the herbarium of the Royal Botanic Garden, Edinburgh. The records are presented in three sections: new records for Shetland, new records for Orkney, and additional records for the two archipelagos.

ORKNEY – New Records

Ascomycota, Pezizales
Coprotus disculus Kimbr., Luck-Allen & Cain
Mainland (O6**E**, 7, 10**E**).

Coprotus glaucellus (Rehm) Kimbr.
Mainland (O7).

Ascomycota, Helotiales
Unguiculella tityrii (Velen.) Huhtinen & Spooner
Mainland, Burray (O4, 8).

Ascomycota, Sordariales
Anopodium ampullaceum N. Lundq.
Mainland (O13**E**).

Podospora pilosa (Mouton) Cain
Mainland (O4**E**).

Podospora setosa (G. Winter) Niessl
Mainland (O11).

Schizothecium squamulosum H. Crouan & P. Crouan
Mainland (O5**E**).

Ascomycota, Xylariales
Hypocopra brefeldii (Zopf) Chenant.
Mainland (O13**E**, 14**E**).

Ascomycota, Pleosporales
Sporormiella dubia S.I. Ahmed & Cain
Mainland (O14).

Table 1. Collection details.

Sample no.†		Locality	Longitude (°W)	Latitude (°N)	Date	Dung
MJR	**Local**	**Orkney**				
36/05	O1	Skara Brae, Mainland	3.339	59.049	3.8.05	rabbit
37/05	O2	Skara Brae, Mainland	3.339	59.049	3.8.05	sheep
38/05	O3	Ring of Brodgar, Mainland	3.233	59.000	3.8.05	rabbit
39/05	O4	Ring of Brodgar, Mainland	3.233	59.000	3.8.05	hare (brown)
40/05	O5	Ring of Brodgar, Mainland	3.228	59.003	3.8.05	vole
41/05	O6	Yesnaby, Mainland	3.361	59.022	3.8.05	rabbit
42/05	O7	Yesnaby, Mainland	3.361	59.022	3.8.05	hare (brown)
43/05	O8	Little Quoy, Burray	2.948	58.856	4.8.05	sheep
44/05	O9	Little Quoy, Burray	2.948	58.856	4.8.05	rabbit
45/05	O10	Marwick Head, Mainland	3.356	59.102	5.8.05	rabbit
46/05	O11	Marwick Head, Mainland	3.350	59.109	5.8.05	rabbit
47/05	O12	Warebeth, Stromness, Mainland	3.33	58.96	6.8.05	rabbit
48/05	O13	Birsay Moors, Evie, Mainland	3.138	59.102	6.8.05	rabbit
49/05	O14	Birsay Moors, Evie, Mainland	3.138	59.102	6.8.05	hare (brown)
50/05	O15	Brough of Deerness, Mainland	2.706	58.962	6.8.05	rabbit
51/05	O16	Brough of Deerness, Mainland	2.706	58.960	6.8.05	vole
		Shetland				
52/05	S1	Brettabister, Mainland	1.143	60.291	7.8.05	sheep
53/05	S2	Sound, Yell	1.174	60.530	7.8.05	pony
54/05	S3	Roadside by Lunga Water, Yell	1.164	60.592	7.8.05	rabbit*
55/05	S4	Whalefirth, near Windhouse, Yell	1.113	60.606	7.8.05	sheep
56/05	S5	Head of Gutcher, Yell	0.998	60.678	7.8.05	goose
57/05	S6	Lund standing stone, Unst	0.942	60.709	8.8.05	rabbit
58/05	S7	Lund standing stone, Unst	0.942	60.709	8.8.05	sheep
59/05	S8	Winnaswartadale, Hermaness NNR, Unst	0.902	60.827	8.8.05	sheep
60/05	S9	Winnaswartadale, Hermaness NNR, Unst	0.902	60.827	8.8.05	rabbit*
61/05	S10	NE of Toolie, Hermaness NNR, Unst	0.894	60.830	8.8.05	rabbit
62/05	S11	Herrnaness Hill, Hermaness NNR, Unst	0.887	60.837	8.8.05	rabbit*
63/05	S12	Hermaness Hill. Hermaness NNR, Unst	0.88	60.83	8.8.05	rabbit*
64/05	S13	Keen of Hamar NNR, Unst	0.82	60.77	8.8.05	rabbit
65/05	S14	Burravoe cliff walk, Yell	1.04	60.50	9.8.05	rabbit
66/05	S15	Burravoe cliff walk, Yell	1.04	60.50	9.8.05	sheep
67/05	S16	Noss Hill, Mainland	1.35	59.93	10.8.05	sheep
68/05	S17	Noss Hill, Mainland	1.35	59.93	10.8.05	rabbit
69/05	S18	Fitful Head, Mainland	1.38	59.91	10.8.05	sheep
70/05	S19	Fitful Head, Mainland	1.38	59.91	10.8.05	rabbit
71/05	S20	Levenwick, Mainland	1.26	59.98	10.8.05	rabbit
72/05	S21	Ward of Scousburgh, Mainland	1.26	59.95	11.8.05	rabbit
73/05	S22	Ward of Scousburgh, Mainland	1.26	59.95	11.8.05	hare (blue)?
74/05	S23	St Ninian's Isle, Bigton, Mainland	1.35	59.97	11.8.05	rabbit
75/05	S24	St Ninian's Isle, Bigton, Mainland	1.35	59.97	11.8.05	hare (blue)?
76/05	S25	Near broch, Mousa	1.18	59.99	11.8.05	goose
77/05	S26	Near broch, Mousa	1.18	59.99	11.8.05	sheep

* There is some doubt about the identity of rabbit/hare samples from Shetland. The blue hare (*Lepus timidus*) is known to occur there, and samples of larger pellets, deposited on trails rather than in middens, as is often the case for rabbit, were initially identified as from hare. Such samples were collected on both Yell and Unst, but I subsequently learnt (Mary Odie and SNH staff, pers. comm.) that blue hares are not known on the two northernmost islands. My initial identification of those samples as from hare is, therefore, suspect and probably wrong. There must, therefore, be a similar suspicion about samples of hare from both Shetland Mainland and, possibly, Orkney (where, on Mainland, they wonld be *L. europaeus*).

† For easier reference in the text, the Orkney and Shetland samples have been renumbered from 1, with O and S prefixes, respectively. The MJR numbers are part of a continuing series, and identify the material as deposited at RBGE.

Sporormiella grandispora (Speg.) S.I. Ahmed & Cain
Mainland, Burray (O8**E**, 14).

Basidiomycota, Agaricales
Coprinus vermiculifer Joss. ex Dennis
Mainland (O15).

Mitosporic Fungi
Volutella ciliata (Alb. & Schwein.) Fr.
Mainland (O12).

Zygomycotina, Mucorales
Pilobolus oedipus Mont.
Mainland (O12).

SHETLAND – New Records

Ascomycota, Pezizales
Ascobolus brantophilus Dissing
This was described by Dissing (1989) from a large number of collections of goose dung from Canada, Greenland and Norway, and found in two out of five collections of goose dung from Iceland (Richardson, 2004). As far as I know, there have been no other records, so it is not surprising that this first British record was collected from the same substratum and from almost as far north as it is possible to be in the British Isles. Apothecia are pure white at first, discolouring brownish as they mature, 0.5-1.5 mm diam. Asci cylindrical, 200-260 × 25-29 μm. Spores ellipsoid, 1-2 seriate, clear purple, 19-22.5 × 9.5-10 μm, with a smooth exospore broken by a few distant cracks and a partial gel on one side. Paraphyses are hyaline, 2.5-3 μm wide, with no coloured contents.
Yell (S5**E**, and **K(M)134328**).

Ascobolus hawaiiensis Brumm.
This is not a common species but, despite its specific name, it is cosmopolitan in distribution. I have recorded it on material collected from Scotland, including Orkney, Iceland, France, Greece, Australia, Chile and the Falkland Islands, and it has also been recorded from New Zealand, Spain, Pakistan, and various Central Asian and Transcaucasian states of the old USSR.
Unst (S13**E**).

Coprotus disculus Kimbr., Luck-Allen & Cain
Yell, Unst (S5, 6, 7**E**).

Lasiobolus cuniculi Velen.
Frequent on Mainland, Yell and Unst, and also on Mousa (S1, 2, 4, 6-8, 11, 15, 18, 20, 24, 26).

Ascomycota, Thelebolales
Thelebolus microsporus (Berk. & Broome) Kimbr.
Mainland, Unst and Mousa (S7, 13, 16, 24, 26**E**).

Ascomycota, Sordariales
Coniochaeta scatigena (Berk. & Broome) Cain
Yell (S15).

Podospora decipiens (G. Winter: Fuckel) Niessl
Frequent, on samples from Mainland, Yell and Unst (S1, 6, 7, 13, 15, 22, 24).

Podospora intestinacea N. Lundq.
Unst (S13**E**).

Podospora setosa (G. Winter) Niessl
Yell (S5). Note that *Podospora curvicolla* is reported in FFOS from Mainland and Yell. It is not always easy to distinguish between *P. curvicolla*, *P. setosa*, and other related polyspored species.

Schizothecium glutinans (Cain) N. Lundq.
Unst (S6**E**, 7**E**).

Schizothecium tetrasporum (G. Winter) N. Lundq.
One of the commoner *Schizothecium* species, so surprisingly unrecorded from Shetland. Frequent, on samples from Mainland, Yell and Unst (S10, 14, 17, 19, 20**E**, 21, 22**E**, 23, 24).

Sordaria superba De Not.
The commonest *Sordaria* on Shetland samples, present on samples from Mainland, Yell and Unst (S1**E**, 3, 4**E**, 8, 10E, 17-18). Note that *S. macrospora* is recorded in FFOS. This is similar to *S. superba* but with distinctly larger spores.

Ascomycota, Xylariales
Hypocopra antarctica (Speg.) Furuya & Udagawa
Unst (S13**E**).

Hypocopra brefeldii (Zopf) Chenant.
Unst, Yell (S6**E**, 15**E**).

Hypocopra equorum (Fuckel) G. Winter
Unst, Yell (S3**E**, 9**E**, 12**E**).

Hypocopra merdaria (Fr.: Fr.) J. Kickx f.
Unst (S7**E**).

Hypocopra parvula Griff.
Unst (S7**E**, 12**E**).

Podosordaria tulasnei (Nitschke) Dennis
Podosordaria ?pedunculata is recorded in FFOS, but not *P. tulasnei*, which is common and produces sterile stromata on pellets. Mainland and Yell (S3, 17**E**, 21-23).

Ascomycota, Hypocreales
Melanospora brevirostris (Fuckel) Höhn.
Mainland (S7, 9-10, 20**E**, 23**E**, 24).

Selinia pulchra (G. Winter) Sacc.
A striking coprophilous fungus, which produces perithecia in orange stromata. Spores are large, thick walled and fusoid, 45-55 × 19.5-24 μm. It is relatively infrequent, but widespread. From over 900 samples collected over the last 12 years I have 13 other records, from Iceland, UK, France, Dominica, Puerto Rico, St Helena, Brazil, Australia and the Falkland Islands.
Mousa (S26**E**).
The spores of the Shetland material are rather smaller than the range normally reported for *S. pulchra* (*e.g.* 48-64 × 20-26 μm (Dennis, 1978); 48-64 × 20-26 μm (Rossmann *et al*., 1993); 56.7-63 × 22-25.2 μm (Doveri, 2005)). *S. intermedia* Speg. was described with slightly shorter spores (45-50 × 20-25 μm (Rossmann *et al*., 1993)), with little variation in length and little overlap with the larger spores of S *pulchra*, and Rossmann *et al*. (1993) suggest that the two may be synonymous. The spore lengths of the 14 collections referred to above are represented by a continuum of overlapping values (Fig. 1), which would support the suggestion of synonymy.

Ascomycota, Microascales
Viennotidia fimicola (Marchal) P.F. Cannon & D. Hawksw.
Mainland, Yell and Unst (S3, 8, 15, 18, 21).

Ascomycota, Onygenales
Gymnosacus reessii Baran.
Yell (S2**E**).

Ascomycota, Pleosporales
Sporormiella australis (Speg.) S.I. Ahmed & Cain
One of the commoner *Sporormiella* species, but not previously recorded from Shetland, present on samples from Mainland, Yell and Unst (S1, 3, 6, 8-12, 15, 17, 19, 21, 22).

Sporormiella dubia S.I. Ahmed & Cain
Unst (S9).

Sporormiella grandispora (Speg.) S.I. Ahmed & Cain
Mainland, Yell and Unst (S6, 13, 15, 22).

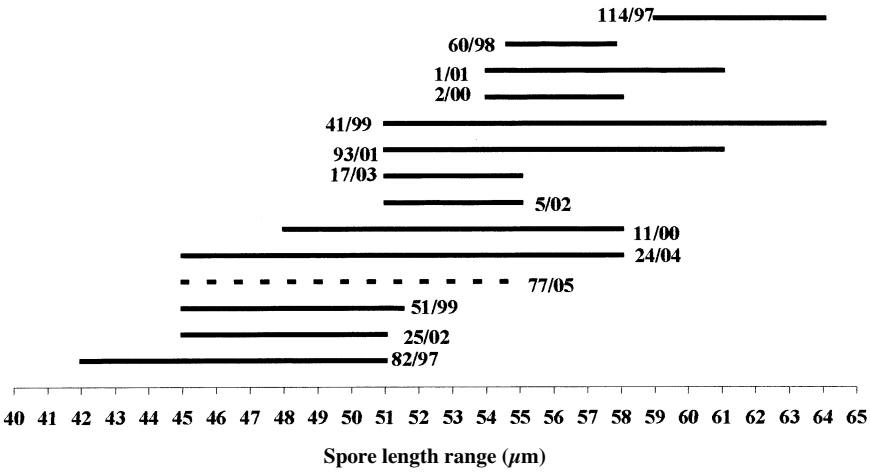

Fig. 1. Range of spore length observed in 14 collections of *Selinia pulchra*. Each collection is identified by its sample number (see text, details not provided). The Shetland collection is indicated by a broken line.

Basidiomycota, Agaricales
Coprinus vermiculifer Joss. ex Dennis
One of the commonest *Coprinus* on the samples collected, present on Mainland, Yell, Unst and Mousa (S1, 4**E**, 6, 7**E**, 8**E**, 9, 15, 18, 26).

Mitosporic Fungi
Volutella ciliata (Alb. & Schwein.) Fr.
Mainland, Unst (S13, 20).

Zygomycotina, Mucorales
Chaetocladium brefeldii van Tiegh.
A partial parasite, frequently occurring in association with mucoralean fungi, present on Mainland (S23).

Additional Records for Species in FFOO and FFOS, with New Island Records in Brackets

Ascomycota, Pezizales
Ascobolus albidus H. Crouan & P. Crouan O3**E**, 8, 9, 14, 15 (Burray), S1-4, 6-10, 11**E**, 12, 15, 18, 19, 22, 26 (Unst, Mousa).
Ascobolus furfuraceus Pers.: Fr. O12**E**, 13.
Ascobolus hawaiiensis Brumm. O12**E**.
Ascobolus immersus Pers.: Pers. S13-14, 18-19, 26 (Unst, Mousa).
Ascobolus stictoideus Speg. O6, S1, 5**E**, 6-7, 10-11**E**, 15-24, 26 (Unst, Mousa).
Cheilymenia fimicola (De Not. & Bagl.) Dennis S9**E** (Unst).
Coprotus sexdecimsporus (H. Crouan & P. Crouan) Kimbr. & Korf O6, 10, 12**E**, S7**E**, 13**E**, 15**E**, 24 (Unst, Mainland).

Iodophanus carneus (Pers.: Fr.) Korf O3**E**, 8-9, 11**E**-12 (Burray), S2, 6, 7, 13, 15, 16**E**, 17**E**, 20-21, 26.
Lasiobolus ciliatus (J.C. Schmidt: Fr.) Boud. (S2). Listed in FFOS under *L. papillatus*.
Saccobolus versicolor (P. Karst.) P. Karst. O6-7, 10, 13, 15, S1-4, 6-9, 10**E**, 11-12, 14-15, 19-24 (Mainland, Yell and Unst; only recorded for Whalsay and Fair Isle in FFOS).

Ascomycota, Thelebolales
Thelebolus stercoreus Tode: Fr.
The fungi under this entry would normally have been recorded as several different species, differing in size, morphology and ecology (*e.g. T. nanus*, *T. polysporus*, *T. crustaceus* and others, as well as what was considered to be 'typical' *T. stercoreus*. De Hoog *et al*. (2005), however, on the basis of molecular studies, found that many cultures from phenotypically very different teleomorphs are indistinguishable. The range of species found to be molecularly indistinguishable from *T. stercoreus* as typically described, with a large single ascus with thousands of spores, included cultures from uniascal and polyascal types, with small to large asci, and few to very many-spored types. It may, however, be useful to distinguish between the morphospecies, since there do appear to be ecological distinctions. *T. stercoreus* is very frequent on hare dung (on 51% samples), but was observed on less than 10% of sheep (Richardson, 2001a), while *T. nanus* was almost twice as frequent on sheep than hare dung (43% vs 26%). *T. polysporus* occurs on about 20% of rabbit and hare pellets, but on less than 10% of sheep, deer and cattle, and some of the other poorly characterised and less frequent species, *e.g. T. caninus*, *T. crustaceus* and *T. dubius*, are often reported from the droppings of herbivorous birds. The Orkney and Shetland forms recorded from the current collection would have been identified as:
T. nanus Heimerl O3, 13, S4, 6-8, 10, 12, 15, 18-20.
T. polysporus (P. Karst.) Otani & Kanzawa O1, 3-7, 9, 11-15, S1, 6-16, 19-24, 26.
T. stercoreus O14.

Ascomycota, Sordariales
Chaetomium cf murorum Corda S2 (Yell).
Coniochaeta vagans (Carestia & De Not.) N. Lundq. O14, S2, S7, S9 (Yell, Unst).
Recorded as *C. discospora* in FFOS, and as both *C. discospora* and *C. ligniaria* in FFOO. There is still considerable discussion over the correct name for this fungus, with some considering that *C. discospora* on dung and *C. ligniaria* on wood are synonymous, in which case *C. ligniaria* is the priority name. If, however, the species on wood and dung are distinct, then *C. vagans* has priority over *C. discospora* (Doveri, 2005).
Podospora decipiens (G. Winter: Fuckel) Niessl O1, 3**E**-4, 8-12, 15**E** (Burray).
Schizothecium conicum (Fuckel) N. Lundq. O3**E**-4, 9-10, 14 (Burray), S1**E**, 7-8, 13, 15-18, 24, 26.
Schizothecium tetrasporum (G. Winter) N. Lundq. O1, 3**E**, 5-7, 9-11, 12**E**, 13-15**E**, 16**E** (Burray).

Schizothecium vesticola (Berk. & Broome) N. Lundq. O6**E**, 7, 8**E**-10, 12-15**E** (Burray), ST-2, 4**E**, 6-9, 10**E**, 11-21, 22**E**, 26 (Unst, Mousa).
Sordaria fimicola (Roberge) Ces. & De Not. O1**E** (Mainland), S2, 6, 9.
Sordaria humana (Fuckel) G. Winter O1**E**, 4, 12, 14, S12 (Unst).

Ascomycota, Xylariales
***Hypocopra* sp.** O9 (Burray). Immature material that was not seen again on this collection. Recorded here for completeness, as no *Hypocopra* spp. are recorded for Burray.
Podosordaria tulasnei (Nitschke) Dennis O4**E**, 9-10, 15 (Burray).

Ascomycota, Hypocreales
Melanospora brevirostris (Fuckel) Höhn. Mainland (O7**E**, 12**E**). The record of *Sphaerodes fimicola* on rabbit dung, Iron Hellia, Deerness in FFOO was a misidentification of *M. brevirostris*.

Ascomycota, Microascales
Viennotidia fimicola (Marchal) P.F. Cannon & D. Hawksw. O3, 6.

Ascomycota, Pleosporales
Sporormiella australis (Speg.) S.I. Ahmed & Cain O6, 9, 13-14, 16 (Burray).
Sporormiella intermedia (Auersw.) S.I. Ahmed & Cain O1, 3, 6-11, 13-15 (Burray), S1, 5-7, 11**E**-15, 17, 19, 21-23, 26.

Basidiomycota, Agaricales
Coprinus cordisporus Gibbs O11, 13-14, S6, 9, 11-12 (Unst).
Coprinus ephemerus? (Bull.) Fr. O14 (Mainland). Material limited and mature, so positive features for confirmation not seen, but spore features best fit those of *C. ephemerus*.
Coprinus heptemerus M. Lange & A.H. Sm. O1-2, 4, 9 (Burray), S1, 16, 18, 22, 24, 26 (Mousa).
Coprinus miser P. Karst. O9**E**-10, 12 (Burray), S1, 6-8, 12-13, 15, 17, 19 (Unst, Yell).
Coprinus radiatus (Bolton) Gray O7**E**, 9-10 (Burray), S23-24**E**, 26 (Mousa).
Coprinus stercoreus Fr. O2-3, 7, 9, 12-13 (Burray), S8, 9, 20, 22, 24 (Unst, Mainland).
Psilocybe coprophila (Bull.) P. Kumm. O11**E**.
Psilocybe merdaria (Fr.) Ricken O1**E**, 4**E**, 6**E,** 9**E**-10**E,** 13**E**-14**E** (Burray). S6**E**, 11**E**, 12, 17**E** (Unst).
Psilocybe subcoprophila (Britzelm.) Sacc. S8**E** (Unst).

Zygomycotina, Mucorales
Pilaira anomala Schroet. O9 (Burray).
Pilaira moreaui Ling O1, 3, 6-7, 10-12, 15, S2, 5, 10, 14, 17-24 (Unst).
Pilobolus crystallinus (Wigg.) Tode O2-3, 9-10, 13, S4, 8-11, 14, 20, 24, 26 (Unst, Mousa).
Pilobolus kleinii van Tiegh. S16.

Table 2. Estimates of species richness at different latitudes.

Country/area	Latitude (°N or °S)	No. of samples	No. of species expected§	Reference
Iceland	64-65	32	100	Richardson, 2004
Canada/USA	61-64	14	92	Richardson, unpublished
Faroe Islands	62	20	94	Richardson, 2005
Finland	62	28	102	Richardson, unpublished
Shetland	60	26	73	This study
Orkney	59	16	87	This study
Northern Britain*	55-58	370	93	Richardson, 2001a, and additional data
Southern Britain	50-55	78	99	
France	42-45	66	115	
USA	36-40	21	126	Richardson, 2003
Tropical area†	23N-**23S**	33	117	Richardson, 2001a, and additional data
Australia	**28-39**	45	142	Richardson, 2001a
Southern Ocean area‡	**49-52**	47	81	Richardson, 2001a, and additional data

* Excluding Orkney and Shetland.
† Brazil, Costa Rica, Puerto Rico, US Virgin Islands, Dominica, St Lucia, St Helena and Malaysia.
‡ Falkland and Kerguelen Islands, Chile.
§ From 50 samples.

Aspects of Diversity

Studies of coprophilous fungi recorded from regional and general collections of samples of dung have established some base lines for what might be expected in terms of diversity and species richness, both from individual samples and in the estimates of overall diversity derived from them (Richardson, 2001a). The samples from Orkney and Shetland yielded an average of 11.5 species per sample, which is in accordance with the findings of the earlier studies from other areas. Cumulative species curves, for the number of coprophilous ascomycetes, zygomycetes and *Coprinus* spp. recorded with the increasing number of samples studied, can be constructed. It is possible to standardise the estimation of diversity by calculating, from the equation for the curve, the number of species to be expected in, for example, a standard set of 50 samples (Richardson, 2001a). The cumulative frequency curves for the Orkney and Shetland samples give estimates of 87 and 73 species per 50 samples, respectively. These values are compared in Table 2 with values from other collections from various parts of the world (Richardson, 2001a,b, 2003, 2004, 2005, and additional values from unpublished data). The coprophilous mycobiotas of Orkney and Shetland are as diverse as those from areas of similar latitude. The Richardson (2001a) study also showed that there is a decrease in species richness with increasing latitude, and the additional data subsequently obtained provide further support for the view that coprophilous fungi can be used to demonstrate the latitudinal gradient of species diversity (Fig. 2).

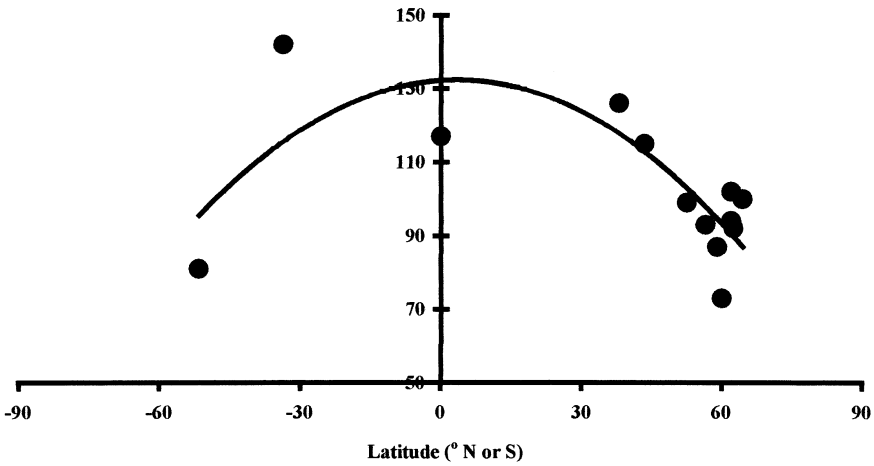

Fig. 2. Estimates of diversity (no. of species per 50 samples) calculated for collections from different latitudes (negative latitude values are °S). Equation for line of best fit: $y = 132.2 + 0.086x - 0.012x^2$; $R^2 = 0.53$.

References

De Hoog, G.S., Göttlich, E., Platas, G., Genilloud, O., Leotta, G. & van Brummelen, J. (2005). Evolution, taxonomy and ecology of the genus *Thelebolus* in Antarctica. *Studies in Mycology* **51**, 33-76.

Dennis, R.W.G. (1978). *British Ascomycetes*. Vaduz: J. Cramer.

Dissing, H. (1989). Four new coprophilous species of *Ascobolus* and *Saccobolus* from Greenland (Pezizales). *Opera Botanica* **100**, 43-50.

Doveri, F. (2005). *Fungi Fimicoli Italici*. Vicenza, Italy: Fondazione Centro Studi Micologici dell'AMB.

Richardson, M.J. (2001a). Diversity and occurrence of coprophilous fungi. *Mycological Research* **105**, 387-402.

Richardson, M.J. (2001b). Coprophilous fungi from Brazil. *Brazilian Archives of Biology and Technology* **44**, 283-389.

Richardson, M.J. (2003). Coprophilous fungi from the United States. *Inoculum, Supplement to Mycologia* **54**, 3-4.

Richardson, M.J. (2004). Coprophilous fungi from Iceland. *Acta Botanica Islandica* **14**, 77-103.

Richardson, M.J. (2005). Coprophilous Fungi from The Faroe Islands. *Fróðskaparrit* **53**, 67-81.

Rossmann, A.Y., Samuels, G.J., Rogerson, C.T. & Lowen, R. (1999). Genera of Bionectriaceae, Hypocreaceae and Nectriaceae (Hypocreales, Ascomycetes). *Studies in Mycology* **42**, 1-148.

Watling, R. (1992). *The Fungus Flora of Shetland*. Edinburgh: Royal Botanic Garden.

Watling, R. (2002). New Fungal Records from Orkney. *Bulletin 2002, Orkney Field Club*, 23-27.

Watling, R. (2005). New Fungal Records from Shetland. *Shetland Naturalist* **2**, 51-55.

Watling, R., Eggeling, T. & Turnbull, E. (1999). *The Fungus Flora of Orkney*. Edinburgh: Royal Botanic Garden.

Watling, R., King, R. & Riddiford, N. (2001). New and interesting records of fungi from Shetland. *Botanical Journal of Scotland* **51**, 57-64.

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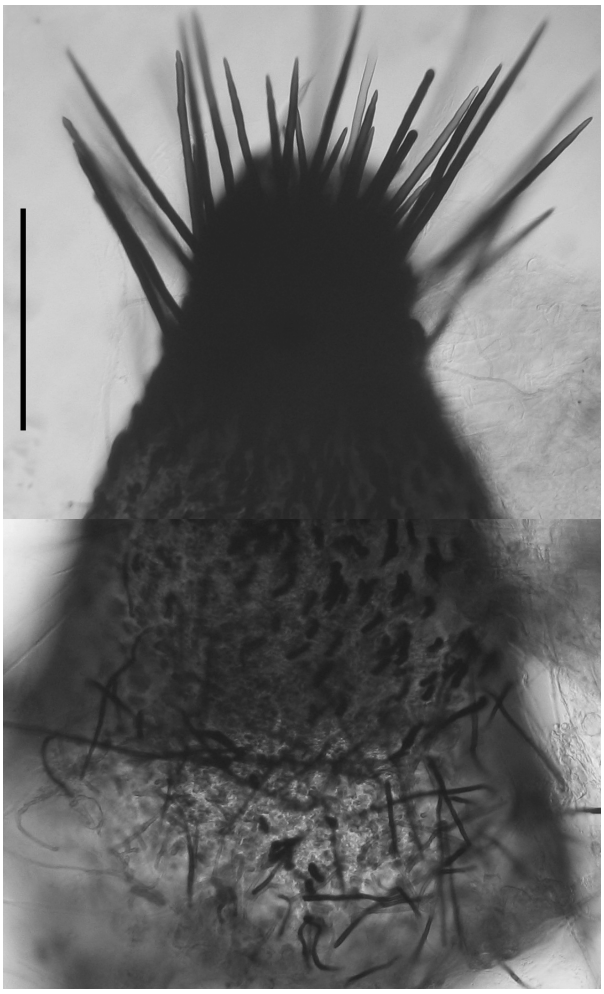

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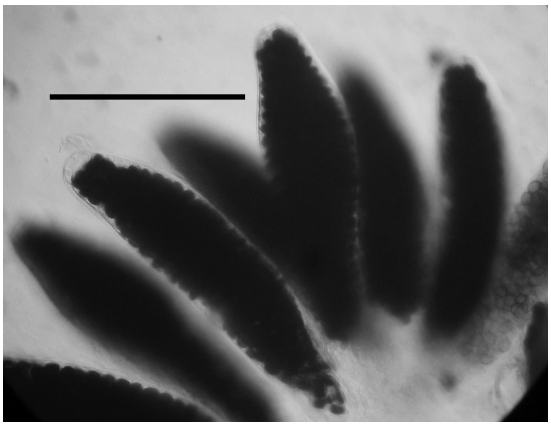

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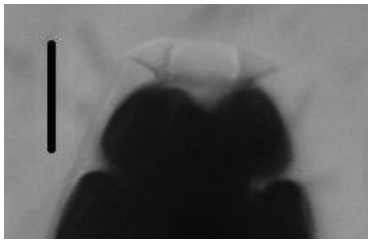

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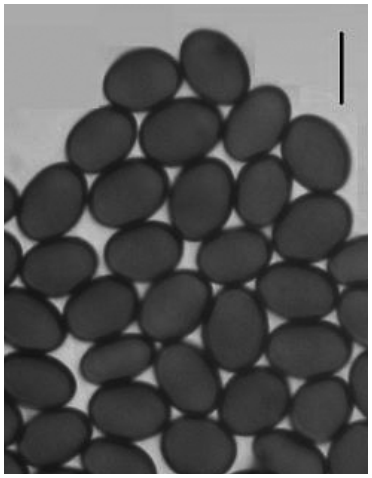

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Figs 1-5. *Coniochaeta burtii*. **Fig. 1.** Perithecium – habit. **Fig. 2.** Perithecium with detail of ostiolar seta, sub-ostiolar papillae and lower part of perithecium with flexuous hairs. **Fig. 3.** Fascicle of asci. **Fig. 4.** Ascus tip, showing broad pore. **Fig. 5.** Spores, in flat face view, and after drying and rehydration, so that gel is not apparent. Scale bars: figs 1-3, 100 μm; figs 4-5, 10 μm.

6.5-12.8 (mean 8.5 μm, $n = 100$) $\times$ 5-6.5 μm, with germ slit around the perimeter, and a surrounding gel. Fimicolous

Holotype: on deer dung (roe?), the Colin Burt Reserve for Wildlife Conservation, Old Mill, Glen Dochart, Perthshire, UK (NN514289, 56.44°N, 4.41°W), coll. R. Watling, 17 June 2006, rehydrated and incubated in a moist chamber by M.J. Richardson, 18 August 2006 (MJR 19/06, **E**).

Of the five currently described species of coprophilous *Coniochaeta* that have asci with more than eight spores per ascus, four have much smaller spores, less than 10 μm in their largest dimension, while *C. polymegasperma* has larger spores, 13-16.5 μm in their largest dimension, 64-spored asci, and a different perithecial structure which lacks the papillae and flexuous hairs on the mid and lower part of the perithecial wall. The setae of *C. polymegasperma* are also different, shorter and stouter (*cf.* Richardson, 2005, fig. 8). The description of *C. burtii* as 512-spored is based on the counts of spores in seven asci, which were isolated, squashed under a cover slip into a single layer of spores and then photographed with a digital camera. The images were downloaded to a computer and spore counts made from prints of the images. The actual counts were 266+, 410, 437, 486, 498, 500, and 504, so it is assumed that the maximum number of spores would be 512, reduced from the hypothetical 512 by some failed mitotic divisions.

References

Cain, R.F. (1934). Studies of Coprophilous Sphaeriales in Ontario. *University of Toronto Studies, Biological Series*, No. 38. (Reprinted 1968 in Bibliotheca Mycologica, Band 9, by Cramer, Lehre.)

Furuya, K. & Udagawa, S. (1976). Coprophilous pyrenomycetes from Japan IV. *Transactions of the Mycological Society of Japan* **17**, 248-261.

Mahoney, D.P. & LeFavre, J.S. (1981). *Coniochaeta extramundana*, with a synopsis of other *Coniochaeta* species. *Mycologia* **73**, 931-952.

Richardson, M.J. (1998). *Coniochaeta polymegasperma* and *Delitschia trichodelitschioides*, two new coprophilous ascomycetes. *Mycological Research* **102**, 1038-1040.

Richardson, M.J. (2005). Coprophilous Fungi from The Faroe Islands. *Fróðskaparrit* **53**, 67-81.

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