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COPROPHILOUS ASCOMYCETES ON DIFFERENT DUNG TYPES

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(With 2 Text-figures)

The occurrence of Ascomycetes on 137 samples of sheep, horse, cow, roe deer, rabbit and hare dung has been examined. *Lasiobolus ciliatus*, *Phomatospora coprophila* sp.nov., *Ascophanus microsporus*, *Podospora curvula*, *Coprobia granulata* and *Ascobolus immersus* were amongst the fungi associated predominately with ruminant dung. *Podospora appendiculata*, *Thelebolus stercoreus* and *Sporormia intermedia* occurred more frequently on lagomorph dung, whilst *T. nanus*, *P. vesticola*, *A. albidus* and *Saccobolus versicolor* were frequent on all dung types.

Evidence of association and antagonism between fungi was slight, and probably linked with the suitability of a particular sample for growth in general. Some samples were richer than others in species composition and abundance.

Notes on infrequent or interesting fungi include *Trichobolus zukalii*, *A. carletonii*, *A. brassicae*, *Sporormia bipartis*, *S. vexans*, *S. fimetaria*, *Zygospermella insignis*, *P. dagobertii* and *Mycorhynchus petchii*.

Coprophilous fungi are increasingly popular subjects for study, but little work has been published on the frequency of different species on the dung of different animals. Harper & Webster (1964) and Ikediugwu & Webster (1970*a*, *b*), however, reported the results of studies on the interaction and antagonism of some coprophilous fungi. From subjective observations certain fungi have become associated with the dung of particular animals (e.g. *Coprobia granulata* with cow dung). Other species are found on a wide variety of dung types and a study of numerous collections is necessary before possible substrate preferences are apparent. The dung of exotic animals received attention from earlier mycologists, but this often amounted to a study of dung collected from a local zoological garden, so that the food and environment were artificial. The result was that few collections were made for each species (Massee & Salmon, 1901).

From 1964 to 1969 dung samples were examined from different localities, incubated on moist blotting paper, and over a period of 2–3 months the developing fungi were recorded. Samples from the six commonest animal species collected totalled 137. The majority were from Scotland (95), others from England (38, mostly during forays of the Yorkshire Naturalist's Union), Eire (2), Yugoslavia (1) and New Zealand (1).

RESULTS

Comparisons included the relative frequency of any particular species on different dungs, and the occurrence of the commoner species on ruminant dung, i.e. sheep, cow and roe deer, as opposed to lagomorph

Table 1. *Overall frequency and χ^2 comparisons of relative frequency on different dung types*

Sporormia intermedia Auersw. – 53·3 %

		%	ro	ho	co	sh	ra
*a	Hare	70·0	×	1·35	(0·82)	×	×
a	Rabbit	68·8	**9·03**	3·07	1·98	0·03	
a	Sheep	63·9	**7·50**	2·08	1·18		
a b	Cow	45·0	1·55	0			
a b	Horse	40·0	0·87				
b	Roe deer	21·1					

Podospora vesticola (Berk. & Br.) Mirza & Cain – 50·4 %

		%	ho	ha	ro	co	ra
a	Sheep	72·2	**9·77**	×	**6·86**	**5·84**	0·11
a b	Rabbit	65·6	**6·58**	(**2·63**)	**4·26**	3·39	
b c	Cow	40·0	0·21	×	0		
c	Roe deer	31·6	0	×			
c	Hare	30·0	×				
c	Horse	25·0					

Lasiobolus ciliatus (Schmidt ex Fr.) Boud. – 46·7 %

		%	ha	ra	co	ho	ro
a	Sheep	61·1	(**3·78**)	**7·56**	0·27	0·03	0
a	Roe deer	57·9	(**2·43**)	**4·20**	0·03	0·02	
a b	Horse	55·0	(**2·05**)	3·57	0		
a b c	Cow	50·0	(1·41)	2·38			
b c	Rabbit	25·0	×				
c	Hare	20·0					

Ascobolus albidus Crouan – 43·1 %

		%	co	ro	ha	ra	sh
a	Horse	55·0	**5·38**	0·67	0·15	0·08	0·01
a	Sheep	52·8	**6·19**	0·71	0·13	0·06	
a	Rabbit	46·9	**4·21**	0·71	(0)		
a b	Hare	40·0	×	×			
a b	Roe deer	36·8	(1·43)				
b	Cow	15·0					

Thelebolus nanus Hiemerl – 38·0 %

		%	co	ho	ha	ro	ra
a	Sheep	66·7	**11·76**	**11·76**	(**5·17**)	**6·59**	1·96
a b	Rabbit	46·9	**4·21**	**4·21**	(1·30)	1·34	
b c	Roe deer	26·3	×	×	×		
b c	Hare	20·0	×	×			
c	Horse	15·0	×				
c	Cow	15·0					

Podospora curvula (De Bary) Niessl – 37·2 %

		%	ha	ra	sh	ho	ro
a	Cow	50·0	×	3·24	0·01	0	0·20
a	Roe deer	47·4	×	2·51	0·01	0·03	
a	Horse	45·0	×	2·10	0·06		
a	Sheep	44·4	×	2·91			
a	Rabbit	21·9	×				
a	Hare	0					

Table 1 (*cont.*)

Ascobolus immersus Pers. – 31·4%

		%	ho	ra	ro	ha	co
a	Sheep	69·4	**15·89**	**17·78**	**12·26**	**(5·98)**	**6·58**
b	Cow	30·0	(1·40)	(0·78)	(0·45)	×	
b	Hare	20·0	×	×	×		
b	Roe deer	15·8	×	×			
b	Rabbit	15·6	×				
b	Horse	10·0					

Podospora decipiens (Winter) Niessl – 28·5%

		%	ro	ha	sh	ra	ho
a	Cow	50·0	**5·39**	(1·41)	2·56	1·68	0·41
a b	Horse	35·0	(2·05)	×	0·24	0·05	
a b	Rabbit	28·1	(1·27)	×	0		
a b	Sheep	25·0	×	×			
a b	Hare	20·0	×				
b	Roe deer	10·5					

The figures in the % column are the percentages of samples of that dung type in which the fungus was found.

× = χ^2 comparison not made, expected values less than 5. Values in parentheses are χ^2 when one of the expected values was between 4 and 5; bold type indicates significance, or possible significance according to the trend, at $P = 0.05$ ($\chi^2 = 3.841$).

* Percentages on the dung types with the same letter to the left are not significantly different.

dung, i.e. rabbit and hare. The possibility of finding association or antagonism between species from the sample records was also investigated.

The basis of the analysis in all cases was χ^2 tests of 2 × 2 contingency tables. Since it is a condition of the test that none of the expected frequencies should be less than five, its application was limited to those species with relatively high levels of occurrence.

Relative frequency on different dung types

The occurrence of common species on each of the possible combinations, in pairs, of the six dung types were compared. When arranged in order of frequency of the fungus on them it was possible to construct a matrix of χ^2 comparisons. In this way missing or non-significant results can be seen in relation to the general trend. Matrices for the eight commonest species are given in Table 1. The occurrences of some of the less frequent species is given in Table 2.

Relative frequency on ruminant and lagomorph dung

The relative frequency of fungi on rabbit and hare dung is often similar, and many of the less frequent fungi seem to be found more often on either lagomorph or ruminant dung, e.g. *Ascozonus woolhopensis*, *Cheilymenia* spp., and *Sporormia bipartis* in Table 2. The results of comparisons for the more frequent species are given in Table 3.

Association and antagonism

There are numerous indices for testing for association or lack of it between different species in plant and animal communities (Southwood, 1966). Many are variations or modifications of the χ^2 test to overcome its limitations. One limitation is that it is not suitable for small numbers of samples, or for species which are rare, when any association tends to be exaggerated. The basis of these tests is the comparison of the number of joint occurrences of two species with the number which would be expected if they occurred independently of each other. Such tests showed that in general the same conclusions could be drawn, and for simplicity the results of the χ^2 tests are given. One hundred and fifty-nine comparisons were made between 26 species, and a further 32 in which an expected frequency was below five but above four. Of this total of 191 comparisons, 143 showed a positive association in that there was a higher proportion of joint occurrences than would have been expected. The marked difference between proportion of positive and negative association suggested a bias, possibly as a result of the commoner fungi all occurring with higher frequency on dungs more suitable for good overall fungal

Table 2. *Occurrences of less frequent fungi*

	Dung type						
	Horse	Sheep	Cow	Roe deer	Rabbit	Hare	Total no.
No. of samples ...	20	36	20	19	32	10	137
Saccobolus versicolor (Karst.) Karst.	4	15	2	2	10	0	33
Ascophanus carneus (Pers.) Boud.	4	14	6	2	5	0	31
Sphaeronaemella fimicola Marchal	1	8	0	8	10	1	28
Ascobolus stictoideus Speg.	0	9	2	6	4	1	22
Ascophanus microsporus (Berk. & Br.) Hansen	0	9	5	7	1	0	22
Ascobolus furfuraceus Pers. ex Fr.	1	2	9	7	3	0	22
Rhyparobius polysporus (Karst.) Speg.	3	7	1	2	6	2	21
Coniochaeta scatigena (Berk. & Br.) Cain	1	7	6	0	2	4	20
Phomatospora coprophila Richardson	0	14	2	2	0	0	18
Thelebolus stercoreus Tode	0	2	0	4	9	3	18
Sporormia ambigua Niessl	5	3	3	1	4	2	18
Podospora appendiculata (Auersw.) Niessl	1	3	1	0	4	7	16
Coprobia granulata (Bull. ex Fr.) Boud.	0	4	8	4	0	0	16
Trichodelitschia bisporula (Crouan) Hansen	1	10	1	0	0	3	15
Cheilymenia coprinaria (Cooke) Boudier	1	9	2	1	0	0	13
Coniochaeta discorspora (Auersw.) Cain	1	2	2	0	4	4	13
Podospora setosa (Winter) Niessl	1	1	0	2	8	1	13
Ascozonus woolhopensis (Renny) Schroet.	0	0	0	2	9	0	11
Sporormia minima Auersw.	0	2	5	0	2	1	10
Rhyparobius sexdecimsporus (Crouan) Sacc.	3	6	0	1	0	0	10
Ascobolus crenulatus Karst.	0	2	0	1	5	1	9
Sporormia gigantea Hansen	1	4	2	0	0	1	8
Coniochaeta hansenii (Oud.) Cain	0	0	1	0	2	5	8
Sordaria fimicola (Rob.) Ces. & de Not.	2	2	0	1	1	0	6
Sporormia bipartis Cain	0	0	0	0	6	0	6
Cheilymenia stercorea (Pers.) Boud.	2	0	4	0	0	0	6
Saccobolus glaber (Pers.) Lamb.	2	1	0	0	0	0	3

development. Therefore the value of 3·841 for significance of χ^2 could not be used without adjustment to make allowance for this bias. The percentage associations for all the comparisons were plotted against their χ^2 values.

Table 3. *Relative frequency and χ^2 comparisons of 25 species on the dung of ruminants and lagomorphs*

	χ^2	% samples with fungus: Ruminant	% samples with fungus: Lagomorph	% difference
Lasiobolus ciliatus	10·90	57·3	23·8	33·5
Phomatospora coprophila	10·14	24·0	0	24·0
Ascophanus microsporus	9·96	28·0	2·4	25·6
Podospora curvula	9·27	46·7	16·7	30·0
Coprobia granulata	8·65	21·3	0	21·3
Ascobolus immersus	8·50	45·3	16·7	28·6
Cheilymenia coprinaria	5·85*	16·0	0	16·0
Ascobolus furfuraceus	4·11	24·0	7·1	16·9
Ascophanus carneus	3·68	29·3	11·9	17·4
Ascobolus stictoideus	1·40	22·7	11·9	10·8
Trichodelitschia bisporula	0·82	14·7	7·1	7·6
Coniochaeta scatigena	0·03	17·3	14·3	3·0
Thelebolus nanus	0·00	42·7	40·5	2·2
Podospora decipiens	0·00	28·0	26·2	1·8
Saccobolus versicolor	0·00	25·3	23·8	1·5
Podospora vesticola	0·04	53·3	57·1	3·8
Sphaeronaemella fimicola	0·14	21·3	26·2	4·9
Ascobolus albidus	0·25	38·7	45·2	6·5
Sporormia ambigua	0·26*	9·3	14·3	5·0
Rhyparobius polysporus	0·31	13·3	19·0	5·7
Sporormia intermedia	4·01	48·0	69·0	21·0
Coniochaeta discospora	4·11*	5·3	19·0	13·7
Podospora setosa	7·09*	4·0	21·4	17·4
Thelebolus stercoreus	7·24	8·0	28·6	20·6
Podospora appendiculata	8·69	5·3	26·2	20·9

$\chi^2(1)$ 3·841 = P0·05.
* Cases in the χ^2 test where one of the expected values was between 4 and 5.

Table 4. *Associations between species*

		A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
A. stictoideus	A		.	.	.	o	o	o	o	o	.	o	—	o	o	o	.	.	.
C. granulata	B			.	.	o	o	o	.	o	.	o	o	o	—	.	.	.	.
A. microsporus	C				.	+	o	o	o	o	.	o	o	—	o	o	.	.	.
P. coprophila	D					+	o	o	o	o	.	o	o	o	o	o	.	.	.
A. immersus	E						+	o	+	+	o	o	+	+	+	o	—	—	—
L. ciliatus	F							+	+	+	+	+	o	o	o	o	o	o	—
P. curvula	G								+	o	+	o	o	o	o	o	—	o	—
A. carneus	H									o	o	o	o	o	o	o	o	.	.
T. nanus	I										o	+	o	o	o	o	—	o	o
A. furfuraceus	J											o	o	o	o	o	.	.	.
A. albidus	K												o	o	+	o	o	o	o
P. decipiens	L													o	+	o	o	.	o
S. intermedia	M														+	+	o	o	o
P. vesticola	N															o	o	o	o
S. versicolor	O																o	.	.
S. ambigua	P																	.	.
C. discospora	Q																		.
P. appendiculata	R																		

o = no association; + = positive association; — = negative association; . = no test possible.

The curve was an inverted parabola, with its lowest point passing through nil association when χ^2 was zero. The mean percentage association for all the comparisons was found to be 1·6. The percentage associations which were significant, from the graph, for the various levels of significance of χ^2 were adjusted by the addition of 1·6, so that they became 5·3 and −2·1 % at the 5 % level of significance, and 6·5 and −3·3 % at the 1 % level. Twenty positive and ten negative associations were found, and these are indicated in Table 4. In general, they reflect the results of Table 3, with positive associations between the ruminant fungi, and negative associations between ruminant and lagomorph fungi.

DISCUSSION

Many dung fungi are cosmopolitan, and Webster (1970) remarked how catholic they were in terms of substrate requirements. Their occurrence, or absence on any particular sample seems to depend greatly on the nature of the substrate with which the spores are voided. Three factors are of importance: the physical nature of the dung, its consistency, its moisture content and its moisture holding capacity: the chemical nature of the dung: and the biological nature of the dung, the other organisms which develop on and in it. With a large number of samples it might be expected that these variables would even out and that any differences observed would indicate the suitability of the dung from a particular animal for the growth of particular species or groups of species. From this study such groups have emerged, largely confirming subjective observations. *Cheilymenia* spp., *Coprobia granulata*, *Ascobolus immersus*, *A. furfuraceus*, *Ascophanus microsporus*, *Lasiobolus ciliatus* and *Podospora curvula* are the main members of the ruminant group, whilst the main members of the lagomorph group are *Sporormia bipartis*, *Coniochaeta* spp., *Thelebolus stercoreus*, *Podospora appendiculata* and *P. setosa*. Others including *Ascobolus albidus*, *Thelebolus nanus*, and *Podospora vesticola* (≡ *P. minuta* (Fuckel) Niessl) are more general in their occurrence.

The fact that these differences exist suggest the use of experimental ecological methods to determine their cause. As well as culturing possible associates or antagonists on sterile dung or nutrient media, an additional method would be to alter the physical nature of the substrate. For instance lagomorph dung is much coarser, and possibly better aerated than ruminant dung, so a study of the succession on hare or rabbit pellets which have been reduced to the smooth consistency of sheep dung would be of value. Similarly, investigations could include the competitive ability of the lagomorph fungi under conditions of reduced oxygen tension, or on ruminant dung with its texture or nutrient status altered, or of ruminant fungi on lagomorph dung.

TAXONOMY

ASCOBOLUS CARLETONII Boudier

This fungus was previously known only from the type collection on capercailzie dung from Scotland (Boudier, 1913). The species developed well on grouse dung collected in 1966 and was identified by Van Brummelen (1967). It was found again on grouse dung in 1967, indicating the possibility that it is not uncommon on that and similar substrates. Boudier gave his type locality as 'Dunkeld, Inverness-shire', but I can find no Dunkeld in that county. Dunkeld, Perthshire, is 16 km from my first collection. That Boudier's citation of the county was a mistake is a possibility, so both recent collections may be near the type locality.

Specimens examined: on grouse dung, Glen Quaich, Amulree, Perthshire, 20. xi. 1966 (**L**); on grouse dung, Ben Ledi, Callander, Perthshire, 19. xi. 1967.

ASCOBOLUS BRASSICAE Crouan

The dung of small mammals is collected as infrequently as that from grouse. Droppings of a bank-vole were collected in 1966 and *A. brassicae* developed on incubation. The fungus was collected again in 1970 from bank-vole droppings.

Specimens examined: on bank-vole dung, from bank of R. Derwent, Buttercrambe Wood, Yorkshire, North Riding, 6. v. 1966 (det. J. Van Brummelen); on bank-vole dung, from bank of Ingleby Beck, Ingleby Greenhow, Yorkshire, North Riding, 10. v. 1970.

THELEBOLUS NANUS Heimerl and *T. STERCOREUS* Tode

These two fungi are often considered synonymous (Kimbrough & Korf, 1967). My experience is that there are at least two distinct monoascal theleboli. One I believe to be *T. stercoreus* has asci 180–250 μm long when ripe, and excipular cells up to 20 μm diam (Fig. 1 A). It is relatively infrequent (Table 2), and not gregarious in its apothecial production. The other is much smaller, with asci 60–100 μm long when ripe and with excipular cells no greater than 10 μm diam (Fig. 1 B). The ascus is smaller than the measurements given by Rehm (1896) for *T. nanus*, but it is possibly that fungus. It is very gregarious and one of the commonest coprophilous ascomycetes (Table 1). When ripe the protruding pearly asci of *T. stercoreus* can just be seen with the unaided eye; those of *T. nanus* cannot, but a light scrape of the dung surface with a needle after 2 or 3 days incubation will readily reveal the globose immature apothecia and some undamaged mature asci if *T. nanus* is present.

If these are two forms of the same fungus it is difficult to explain their difference in size when occurring on the same dung sample, the difference in their frequency of occurrence, and the fact that it is possible to find one in the absence of the other.

It has been suggested that *T. nanus* is a reduced form of *Rhyparobius polysporus*. From a morphological viewpoint such a synonymy would be more acceptable than the synonymy of *T. nanus* and *T. stercoreus*. Solutions to these especially difficult problems of the Thelebolaceae and allied fungi can be expected from the critical studies of the group which are in progress (Kimbrough, 1966*a*, *b*; Kimbrough & Korf, 1967).

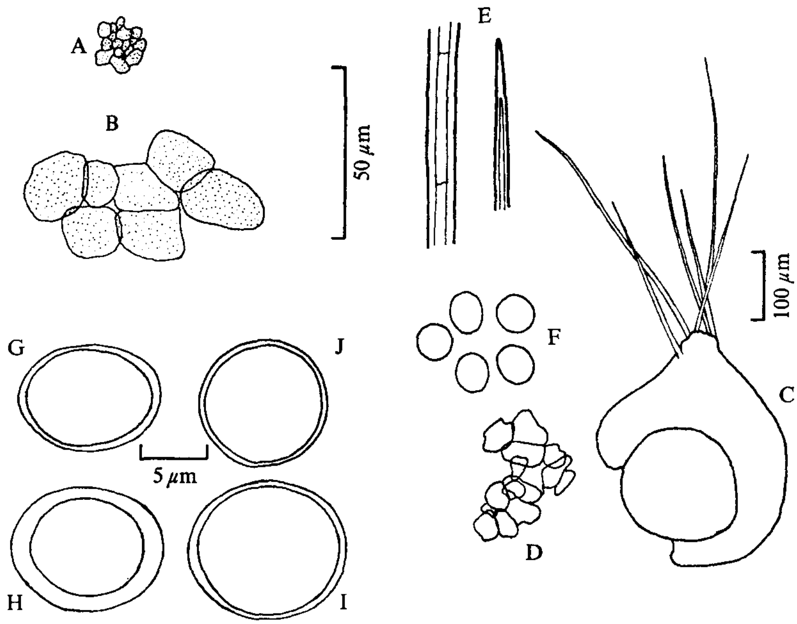

Fig. 1. *Thelebolus nanus*. A, Excipular cells; *T. stercoreus*. B, excipular cells; *Trichobolus zukalii*. C, Apothecium, squashed, with ascus. D, excipular cells. E, detail of hair. F, ascospores. G–J, ellipsoids based on the minimum and maximum ascospore sizes for *T. zukalii* as given by Kimbrough and Rehm, for the Scottish collection, and for *T. sphaerosporus* respectively.

TRICHOBOLUS ZUKALII (Heimerl) Kimbrough (Fig. 1 C–F)

T. zukalii was collected for the first time in Britain from roe deer dung in 1967. Kimbrough (in Kimbrough & Korf, 1967) separated *T. sphaerosporus* from *T. zukalii* by its rounder ascospores. The ellipsoids in Figs. 1 G–J are derived from measurements of *T. zukalii* ascospores given by Rehm (1896) with a width/length ratio of 0·74, Kimbrough (in Kimbrough & Korf, 1967) with a ratio of 0·72, of *T. sphaerosporus* as described by Kimbrough, with a ratio 0·94, and the Scottish collection, with a ratio of 0·88. The differences between the ellipsoids, especially bearing in mind the absolute sizes of the ascospores, are slight, and it is possible that the subspherical spores of *T. sphaerosporus* and the more ellipsoid ones he refers to *T. zukalii* are the extremes of the range of ascospore shape for the species. The Scottish material appears to be intermediate. In the circumstances I prefer to identify the Scottish material as *T. zukalii*.

Specimen examined: on roe deer dung, Darnaway Forest, Forres, Moray, 6. v. 1967.

Phomatospora coprophila sp.nov. (Fig. 2A–C)

Perithecia globosa, 100–150 μm, immersa. Peridium membranaceum, cellulis angulatis 5–10 μm diam. Asci 50–70 × 2–2·5 μm, 8-spori cylindracei, longe stipitate. Ascosporae uniseriatae, hyalinae, 3·5–4·5 × 1·75–2·5 μm.

Typus in stercorem ovis, Ben Ledi, Callander, Perthshire, 19. xi. 1967, **IMI** 155368.

Perithecia globose-pyriform, 100–150 μm diam, immersed with a short protruding conical beak. Peridium membranous, of angular cells 5–10 μm, diam. Asci 50–70 × 2–2·5 μm, 8-spored, cylindrical, long-stalked. Ascospores uniseriate, hyaline, 3·5–4·5 × 1·75–2·5 μm.

Additional specimens examined: on sheep dung – Selmmuir, Midlothian, 27. xi. 1965; Callander, Perthshire, 25. i. 1966; Harlaw, Currie, Midlothian, 27. ii. 1966; Mull of Galloway, Wigtown, 2. iv. 1966; Sunart, Argyll, 17. x. 1966; Glen Almond, Fowlis Wester, Perthshire, 20. xi. 1966; Hirta, St Kilda, Inverness-shire, ix. 1967; Threipmuir, Currie, Midlothian, 31. xii. 1968; Crosswood Burn, Cobbinshaw, Midlothian, 19. i. 1969; Pentland Hills, Midlothian, 11. i. 1969; Malham Tarn, Yorkshire, West Riding, 10. v. 1969; Bridge of Balgie, Perthshire, 5. x. 1969; on cow dung – Selmmuir, Midlothian, 7. x. 1967; Kindrogan, Pitlochry, Perthshire, viii. 1968; on roe deer dung – Selmmuir, Midlothian, 13. i. 1967; Bannockburn, Stirling, 24. ix. 1966.

Apart from *P. hyalina* (Griff.) Cain (syn. *P. minutissima* Cr. & Cr. sensu Lundqvist, pers. comm.), *Phomatospora* spp. are not coprophilous, but found on plant tissues, to which dung has an obvious affinity, inasmuch as herbivore dung contains much undigested or partially digested plant remains. The smallness of the ascospores of *P. coprophila*, their cylindrical form, and end-to-end arrangement in the ascus distinguish this species from *P. hyalina* which has ellipsoid ascospores, 4·5–5 × 2·5–3 μm, arranged obliquely in the ascus. I have found *P. coprophila* frequently, especially on dung from ruminants, but only after relatively long periods of incubation.

MYCORHYNCHUS PETCHII Breton & Faurel (Fig. 2D, E)

On several occasions small, *Sphaeronaemella*-like fungi with fusoid, 1-septate spores have been found on dung. Asci were not seen, but the fructifications gave the impression of being perithecial rather than pycnidial. They were eventually identified as belonging to *Mycorhynchus* Sacc. (Breton & Faurel, 1967). A good collection from Yorkshire in 1969 was identified by M. Breton as *M. petchii*. This is the fungus identified by Petch (1943) as *M. marchalii*, and it has not been reported since.

Specimen examined: on rabbit dung, Malham Tarn House, Malham, Yorkshire, West Riding, 10. v. 1969.

PODOSPORA DAGOBERTII Moreau (Fig. 2F, G)

A *Podospora* with apically directed primary appendages was identified as *P. dagobertii* on account of that feature, which according to Moreau (1953) was unique at that time. Lundqvist (1964) created *Anopodium* for such fungi, with two species, *A. ampullaceum* and *A. epile*. *P. dagobertii* was not transferred because of the paucity of information concerning the species. Lundqvist (personal communication) has commented that my collection, judging from camera lucida drawings, could be either *A. ampullaceum* or *P. dagobertii*, and that in view of the ascospore size, possibly *P. dagobertii*. Unfortunately material was scarce and insufficient to deter-

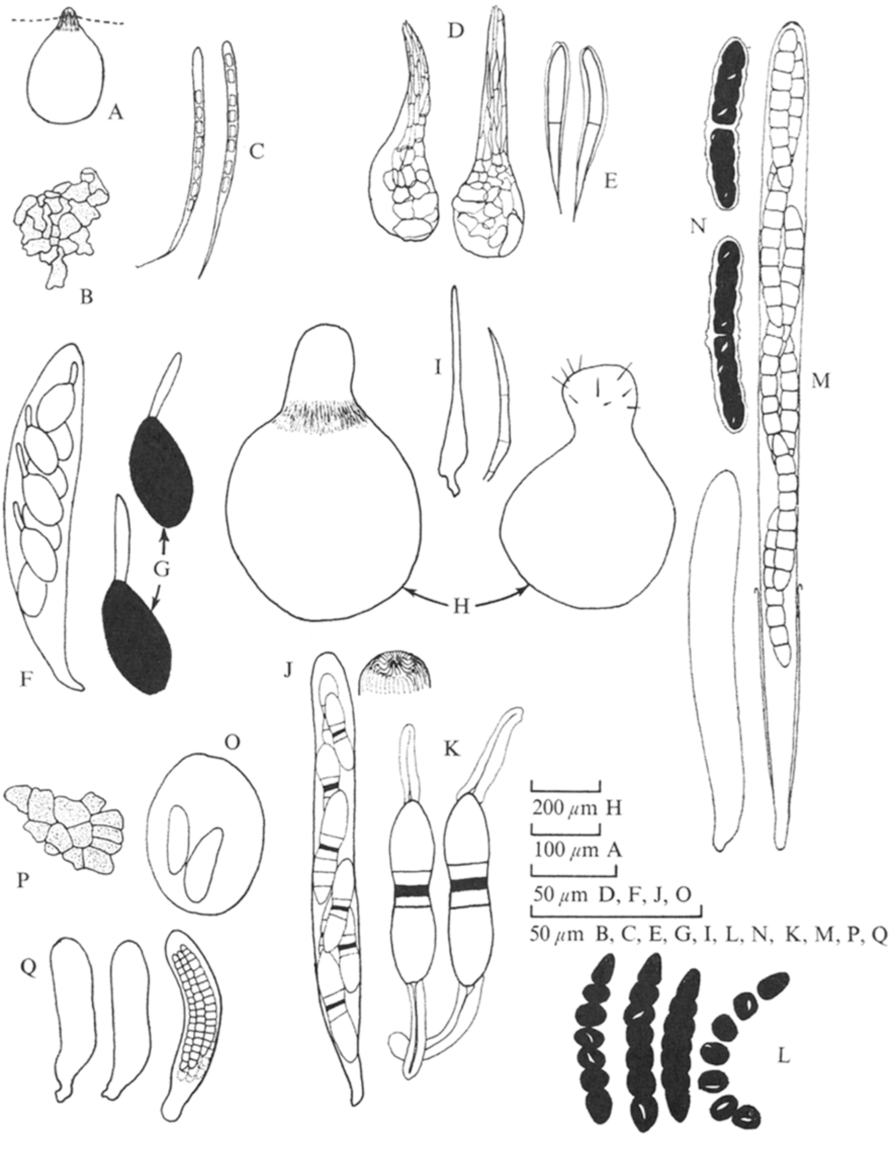

Fig. 2. *Phomatospora coprophila*. A, Perithecium. B, cells of peridium. C, asci and ascospores; *Mycorhynchus petchii*. D, Perithecia. E, ascospores; *Podospora dagobertii*. F, Ascus. G, ascospores; *Zygospermella insignis*. H, Perithecia. I, setae. J, ascus, with an impression of the form of the ascus tip. K, spores; *Sporormia vexans*. L, Ascospores; *S. bipartis*. M, Asci before and after elongation. N, ascospores; *S. fimetaria*. O, Pseudothecium, with two asci. P, cells of peridium. Q, asci and ascospore bundle.

mine the critical character of perithecial hairs. None were observed during the initial examination.

Specimen examined: on rabbit dung, Darnaway Forest, Forres, Moray, 6. v. 1967 (**UPS**).

ZYGOSPERMELLA INSIGNIS (Mouton) Cain (Fig. 2H–K)

On four occasions single perithecia producing what appeared to be atypical *Podospora* spores were found. Insufficient material prevented further study. A fifth collection developed in sufficient quantity on cow dung in 1968 to be identified by Lundqvist (1969) as *Z. insignis*. Notes on the earlier collections were re-examined and the fungi also identified as *Z. insignis*. It has been reported once before in Britain by Walkey & Harvey (1965).

Specimens examined: on cow dung, Stirling University grounds, Stirling, 5. x. 1968 (**UPS**); on sheep dung, Selm Muir forest, Kirknewton, Midlothian, 27. xi. 1965; on horse dung, Kindrogan, Pitlochry, Perthshire, 20. viii. 1966; on sheep dung, Strathyre, Callander, Perthshire, 25. i. 1966.

SPORORMIA VEXANS Auerswald (Fig. 2L)

Pseudothecia immersed, globose, with a short neck, up to 250 μm diam. Asci 150–200 × 20–25 μm before expansion. Ascospores 7-celled, 45–55 × 8–9 μm, readily disarticulating, fusoid in overall outline, with the five central cells broader than long, the terminal cells longer than broad and slightly conical, all with diagonal germ slits. *S. vexans* has not previously been reported from Britain.

Specimen examined: on rabbit dung, Darnaway Forest, Forres, Moray, 6. v. 1967.

SPORORMIA BIPARTIS Cain (Fig. 2M, N)

Pseudothecia immersed, cylindrical to globose, dark brown to black, 250 × 150–200 μm with a short neck. Asci 150–190 × 15–20 μm before expansion, expanding to 220–370 μm long. Ascospores dark brown, 2–3 seriate at first, becoming mainly biseriate after expansion of the ascus, 45–60 × 5–7·5 μm, with a clear sheath expanding in water to a thickness of 5 μm, 8-celled, each cell with a diagonal germ slit. Before or soon after liberation from the ascus the two halves of the spore separate slightly at the junction of the middle pair of cells. Rougher handling causes complete disarticulation of the component cells.

This fungus was first identified by me as *S. octomera* Auerswald but the distinction between it, *S. bipartis* and a third unnamed species was pointed out by Lundqvist (personal communication). It has been reported as *S. octomera* in foray reports of the Yorkshire Naturalists Union for 1966–70 and the Botanical Society of Edinburgh in 1968, and in Richardson & Watling (1968).

Specimens examined: from rabbit dung: Buttercrambe Moor, Yorkshire, North Riding, 6. v. 1966; Cloughton, Yorkshire, North Riding, 16. ix. 1966; Darnaway Forest, Forres, Moray, 6. v. 1967; Spa Gill Woods, Ripon, Yorkshire, West Riding, 11. v. 1968; Ochtertyre, Kincardine, Stirling, 19. x. 1968; Clapham, Yorkshire, 11. v. 1969.

SPORORMIA FIMETARIA (de Not.) de Not. (Fig. 2 O–Q)

This fungus was obtained from hare dung in 1967 and appears to be the first record from Britain since those of Massee & Salmon (1901). The ascospores are 16-celled, and the eight ascospores adhere tightly together in a bundle which proved impossible to separate with physical force on a microscope slide. Pseudothecia up to 100 μm diam. Asci cylindrical-clavate, 50–60 × 10–12 μm, ascospores 16-celled, 35 × 3 μm.

Specimen examined: on mountain hare dung, Ben Ledi, Callander, Perthshire, 27. xi. 1967.

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REFERENCES

BOUDIER, E. (1913). Sur deux nouvelles espèces de Discomycetes d'Angleterre. *Transactions of the British Mycological Society* **4**, 62–63.

BRETON, A. & FAUREL, L. (1967). Etudes des affinités du genre *Mycorhynchus* Sacc. et description de plusiers espèces nouvelles. *Revue de Mycologie* **38**, 229–258.

HARPER, J. E. & WEBSTER, J. (1964). An experimental analysis of the coprophilous fungus succession. *Transactions of the British Mycological Society* **47**, 511–530.

IKEDIUGWU, F. E. O. & WEBSTER, J. (1970*a*). Antagonism between *Coprinus heptamerus* and other coprophilous fungi. *Transactions of the British Mycological Society* **54**, 181–204.

IKEDIUGWU, F. E. O. & WEBSTER, J. (1970*b*). Hyphal interference in a range of coprophilous fungi. *Transactions of the British Mycological Society* **54**, 205–210.

KIMBROUGH, J. W. (1966*a*). Studies in the Pseudoascobolaceae. *Canadian Journal of Botany* **44**, 685–704.

KIMBROUGH, J. W. (1966*b*). The structure and development of *Trichobolus zukalii*. *Mycologia* **52**, 289–306.

KIMBROUGH, J. W. & KORF, R. P. (1967). A synopsis of the genera and species of the tribe Thelebolae (= Pseudoascobolaceae). *American Journal of Botany* **54**, 9–23.

LUNDQVIST, N. (1964). *Anopodium*, a new genus of coprophilous pyrenomycete with apically pedicellate spores. *Botaniska Notiser* **117**, 355–365.

LUNDQVIST, N. (1969). *Zygopleurage* and *Zygospermella* (Sordariaceae s. lat., Pyrenomycetes). *Botaniska Notiser* **122**, 353–374.

MASSEE, G. & SALMON, E. S. (1901). Researches on coprophilous fungi. *Annals of Botany* **15**, 313–357.

MOREAU, C. (1953). Les genres *Sordaria* et *Pleurage*. *Encyclopédie Mycologique* **25**, 1–330.

PETCH, T. (1943). British Nectrioideae and allied genera. *Transactions of the British Mycological Society* **26**, 53–70.

REHM, H. (1896). *Rabenhorst's Kryptogamen-Flora. Die Pilze. III. Abteilung: Ascomyceten: Hysteriaceen und Discomyceten.* Leipzig.

RICHARDSON, M. J. & WATLING, R. (1968). Keys to fungi on dung. *Bulletin of the British Mycological Society* **2**, 18–43.

SOUTHWOOD, T. R. E. (1966). *Ecological methods.* London: Methuen.

VAN BRUMMELEN, J. (1967). A world monograph of the genera *Ascobolus* and *Saccobolus* (Ascomycetes), Pezizales. *Persoonia*, Supplement 1, 1–260.

WALKEY, D. G. A. & HARVEY, R. (1965). British Records, 74. *Transactions of the British Mycological Society* **48**, 145.

WEBSTER, J. (1970). Presidential Address. Coprophilous fungi. *Transactions of the British Mycological Society* **54**, 161–180.

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