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Fungi fimicola Aegyptiaci: I. Recent investigations and conservation in arid South Sinai

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Abstract

Sixty one species of coprophilous fungi distributed in 39 genera were recorded from dung of goat, feral donkey and one-humped camel collected from the arid desert areas of the Saint Katherine Protectorate, South Sinai, Egypt. The samples were collected on a monthly basis from October 2012 to March 2013, dried, taken to the laboratory and incubated in moist chambers for 6 to 20 weeks. Morphological features of sporulating ascomycetes were used to characterize and identify the species. Higher number of taxa was observed in feral donkey dung, followed by camel and goat dung. On the generic level, *Chaetomium* came first, accommodating the highest number of species (7), followed by Fusarium, *Pilobolus* and *Thielavia*. *Coprinopsis stercorea* is apparently a new record for Egypt. Collections are described and the occurrence and distribution of species is discussed, supplemented with a dichotomous key to all reported taxa.

Key words – Ascomycota – basidiomycota – biogeography – coprophilous – protectorate – Saint Katherine

Introduction

The coprophilous mycobiota is a diverse group of morphologically and physiologically specialized fungi, very important in the decomposition and recycling of animal feces (Angel & Wicklow 1974). Dung inhabiting fungi are ideal organisms for both teaching and research in ecology and biodiversity and also provide useful systems for studies of community ecology (Wicklow 1981, 1992; Killer & Braun 1999; Richardson 2001a). Saccardo, in his *Sylloge* (1882-1931), enumerated 757 species belonging to 187 genera as coprophilous taxa, being most of them recorded from herbivore dung. This number has increased with the results of the researches from different parts of the world *viz*: Cain (1934), Brummelen (1967, 1981, 1998), Mirza & Cain (1969), Sutton (1980), Bell (1983, 2005), Seifert et al. (1983), Richardson & Watling (1997), Doveri et al. (2000), Doveri (2004), Richardson (2001a, b, 2004) and Jeamjitt (2007).

The mountainous region of southern Sinai contains a greater biodiversity than the rest of Egypt, and 4350 km^2 of the area was declared a Protectorate in 1996 (Zalat et al. 2008). Because of the recent political history of the Sinai, little is known about the ecology and distribution of the species. The potential fungal resources of Egypt are globally important and there are vast areas that are still unexplored (Abdel-Azeem 2010). Despite their importance and suitability for mycological

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study, coprophilous fungi have received little attention in Egypt (Abdel-Azeem 2010). According to Krug et al. (2004), most published records of dung fungi comes from Europe and North America, rarely from Africa and South America. Previous contributions to the study of this group in Egypt were made by Lundqvist (1969, 1970, 1972, 1974), Binyamini (1973), Bagy & El-Sharouny (1985), Bagy et al. (1986), Moustafa & Abdel-Azeem (2005). These contributions, however, were only confined to taxonomical studies.

Considering the few studies of coprophilous fungi in Egypt, especially in South Sinai Region, the aims of this work were to study the relationships between coprophilous fungi and fecal substrates of 3 herbivores grazing on arid desert vegetation in the southern Sinai, for the first time, and to compare species composition and number of occurrence in these substrates.

Materials & Methods

Study area

The Saint Katherine area is situated in the southern part of Sinai between 33°57' to 34°00' South, 28° 33' North and 28°26' to 28°34' East (Danin, 1983). Generally, the area is composed of igneous and metamorphic rocks; chiefly granites are intensely dissected and rugged (Said 1990). The Protectorate of Saint Katherine covers about 4350 km^2 of Southern Sinai, and declared as protected area due to its immense biological and cultural interest. The climate of Saint Katherine is extremely arid (Zahran & Willis 2008) with long, hot and rainless summers and cool winters with annual precipitation mean of 45 mm up to 100 mm as rain and snow in high mountains. Temperatures vary from a lowest mean temperature in January of 1.4^{o}C to a highest mean temperature of 31.8^{o}C in August.

Sampling

One hundred and fifty dung samples were collected from ten Ring Dyke high-mountain wadis and rsh (=open areas) systems namely: Shyraj, Arbaein, Itlah, Abu Sayla, Tala', Ahmar, Farsh El-Luza, Farsh Eilia, Shaq Musa and Gebel Sefsafa in Saint Katherine protectorate (Fig. 1). Dung of goat (*Capra aegagrus hircus* L.), feral donkey (*Equus asinus* L.) and one-humped camel (*Camelus dromedarius* L.) were collected between 5 October 2012 and 24 March 2013 (Table 1). Samples were gently air dried, if not already dry when collected, and preserved in paper envelopes containing 1-4 dichlorobenzene. Localities (latitude and longitude) were determined with a Garmin Etrex Vista HCX satellite navigator.

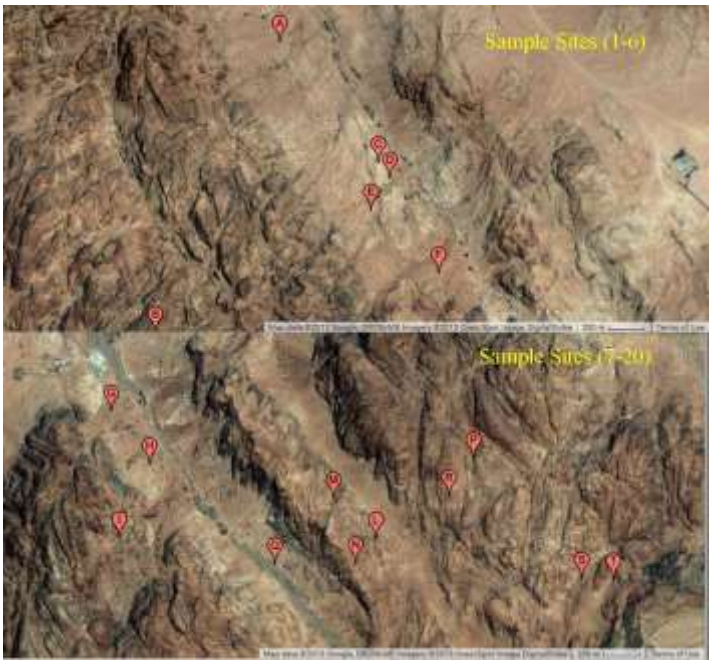

Fig. 1 – Sampling sites based on GPS readings.

Table 1 Details of South Sinai dung samples and collection localities

*Sample no**	*Locality*	*Elevation (m.a.s.l.)*	*Latitude N°*	*Longitude E°*	*Date*	*Substrate*
1/012	Abu Sayla	1300	28º 35' 15.9"	33º 55' 05.6"	5/10/2012	Goat, camel, donkey
2/012	Abu Sayla	1342	28º 35' 32.6"	33º 55' 11.9"	5/10/2012	Goat, camel, donkey
3/012	Itlah	1370	28º 34' 34.0"	33º 55' 34.5"	5/10/2012	Goat, camel, donkey
4/012	Tala'	1374	28º 34' 34.0"	33º 55' 34.5"	5/10/2012	Goat, camel, donkey
5/012	Tala'	1375	28º 34' 31.4"	33º 55' 34.9"	5/10/2012	Goat, camel, donkey
6/012	Itlah	1431	28º 34' 31.6"	33º 55' 34.4"	5/10/2012	Goat, camel, donkey
7/012	Arbaein	1498	28º 33' 04.0"	33º 56' 54.0"	20/11/2012	Goat, camel, donkey
8/012	Arbaein	1504	28º 32' 55.3"	33º 57' 01.2"	20/11/2012	Goat, camel, donkey
9/012	Arbaein	1594	28º 33' 04.8"	33º 56' 53.0"	21/11/2012	Goat, camel, donkey
10/012	Fara'	1612	28º 33' 20.7"	33º 57' 36.3"	21/11/2012	Goat, camel, donkey
1/013	Shyraj	1690	28º 32' 49.5"	33º 57' 36.1"	12/1/2013	Goat, camel
2/013	Shyraj	1691	28º 32' 42.9"	33º 57' 44.2"	12/1/2013	Goat, camel
3/013	Shyraj	1788	28º 32' 43.1"	33º 57' 43.4"	12/1/2013	Goat, camel
4/013	Sefsafa	1847	28º 31' 39.5"	33º 58' 42.8"	15/1/2013	Goat, camel
5/013	Sefsafa	1915	28º 32' 56.2"	33º 58' 02.7"	7/2/2013	Goat, camel
6/013	Ahmar	1928	28° 31' 72.6"	33° 56' 45.2"	20/3/2013	Goat, camel
7/013	Mousa	1931	28º 32' 38.7"	33º 578' 25.0"	24/3/2013	Goat, camel
8/013	Sefsafa	1933	28º 32' 49.9"	33º 57' 58.0"	24/3/2013	Goat, camel
9/013	Sefsafa	1937	28º 32'37.4"	33º 58' 25.7"	24/3/2013	Goat, camel
10/013	Farsh Elia	1970	28º 32' 36.1"	33º 58' 29.3"	24/3/2013	Goat, camel

* SCF sample no. and year

Incubation and Identification

Samples were incubated in non-axenic damp chambers, made with moist paper in plastic boxes with lightly fitting transparent lids, under ambient light and at room temperature (ca 25-28 oC), from 22 of April 2014, for 6 to 20 weeks. Samples were generally of similar size, with incubation chambers 10 × 7 cm, which would accommodate approx. 2-4 g dry wt (= 15 goat pellets), or 13 × 8 cm for donkey and camel (approx. 10 - 20 g dry wt) dung. The microscopic characteristics of species from damp chambers were studied using water, Congo red, Melzer's reagent, lactic cotton blue (or methyl blue), and Indian ink as mounting media. Voucher slides and dried samples were deposited in the Fungarium of Arab Society for Fungal Conservation (Botany Department, Suez Canal University, Ismailia, Egypt). The microscopic characteristics were observed with a Carl Zeiss-amplival microscope and microscopic photos were taken with a Canon Power Shot G10 digital camera.

For identification, relevant references were consulted, such as van Brummelen (1967), Mirza & Cain (1969), Korf (1972), Lundqvist (1972), Arx et al. (1986), Richardson & Watling (1997), Bell (1983, 2005) and Doveri (2013). The names of authors of fungal taxa are abbreviated according to Kirk and Ansell (1992). The systematic arrangement in the present list follows the most recent system of classification appearing in the 10th edition of Ainsworth and Bisby's Dictionary of the Fungi (Kirk et al. 2008). Name corrections, authorities, and taxonomic assignments of all taxa reported in this work were checked against the Index Fungorum database (www. indexfungorum.org).

Data Analysis

Morisita-Horn index of similarity/dissimilarity were calculated according to Chao et al. (2008) and implemented in the program SPADE by Chao & Shen (2010), while species diversity was calculated using Simpson's diversity index (Lande 1996).

Results

Table 2 presents the list of identified species, their occurrence and distribution. The table shows a total of 61 species belonging to 39 genera. The genera are taxonomically distributed as

follows: Sordariomycetes (15 genera, 28 species; 45.9% of the species); Pezizomycetes (4 genera, 7 species; 11.4% of the species); Dothideomycetes (4 genera, 5 species; 8.1 % of the species); Eurotiomycetes (2 genera, 2 species; 3.2% of the species); Zygomycota (12 genera, 17 species; 27.8% of the species), and Agaricomycetes (1 genus, 1 species, 1.6% of the species). Species of Sordariomycetes and Pezizomycetes were the most common (36.06%).

The results show that fungi called formerly as Zygomycota, was represented by 17 species (27.8% of the total species number), teleomorphic Ascomycota by 30 species (48.18%), anamorphic Ascomycota by 13 species (21.13%) and Basidiomycota by 1 species (1.63%). The dominant genera were *Chaetomium* (7 species, 11.4% of the total taxa), *Fusarium*, *Pilobolus* and *Thielavia* (3 species each, 4.9%). The remaining taxa were represented only by 2 or 1 species each. The most abundant species were: *Saccobolus glaber* (8.5% of the total isolate number), *Lasiobolidium egyptiacum* (6.06%) and *Rhizopus stolonifer* (5.4%).

Taxonomically, reported species were assigned to 3 phyla with 5 classes, 10 orders, and 21 families (Table 3). Taxa with uncertain position were distributed among classes, orders and families. Chaetomiaceae had the highest contribution (12 species out of 61) followed by Microascaeae (6 species), Mucoraceae (5 species), being the remaining families represented each by only 1 to 4 species. The species/genus ratio (S/G) per family, however, shows that family Chaetomioaceae, Necteriaceae and Pilobolaceae were the most diverse taxonomical rank by recording a ratio of 3.

40 fungal species were rare in their frequency (< 12%) on dung samples examined (Table 1). *Lasiobolidium egyptiacum*, *Saccobolus glaber* and *Ascobolous immersus* were recorded as common taxa, with 86 %, 66%, 54% on camel, goat and donkey dung respectively. Other species accommodating the moderate class of frequency by recording range between 14% to 44% of the samples were *Pilaira moreaui* (on donkey dung) and *Pilobolus crystallinus* (on donkey dung), *Thamnostylum piriforme* (on donkey dung), *S. glaber* (on camel dung) and *Coprinopsis stercorea* (on goat dung).

Table 2 Taxa isolated from the three herbivore dung, % frequency of occurrence and % frequency of species

Taxa	% Frequency on dung of			Species F%
	Camel	***Donkey***	***Goat***	
Zygomycota				
Actinomucor elegans (Eidam) C.R. Benj. & Hesselt.	0	0	12	0.71
Circinella muscae (Sorokīn) Berl. & De Toni	16	4	10	1.78
C. umbellata Tiegh. & G. Le Monn.	12	0	0	0.71
Lichtheimia corymbifera (Cohn) Vuill.	12	26	16	3.21
Mucor hiemalis Wehmer	6	26	14	2.73
M. racemosus Fresen.	0	14	0	0.83
Mycotypha microspora Fenner	0	8	0	0.48
Pilaira nigrescens Tiegh.	0	6	0	0.36
P. moreaui Y. Ling	10	26	16	3.09
Pilobolus crystallinus (F.H. Wigg.) Tode	10	36	10	3.33
P. kleinii (Tiegh.) Kuntze	0	16	0	0.95
P. lentiger Corda	6	14	4	1.43
Piptocephalis arrhiza Tiegh. & Monn	0	16	4	1.19
Rhizopus stolonifer (Ehrenb.) Vuill.	28	38	26	5.47
Rhopalomyces elegans Corda	12	0	8	1.19
Syncephalastrum racemosum Cohn ex J. Schröt.	10	14	18	2.5
Thamnostylum piriforme (Bainier) Arx & Upadhyay	14	26	22	3.69
Thamnostylum piriforme (Bainier) Arx & Upadhyay	14	26	22	3.69

Taxa	% Frequency on dung of			Species F%
	Camel	*Donkey*	*Goat*	
Teleomorphic Ascomycota				
Arachniotus ruber (Tiegh.) J. Schröt.,	12	0	8	1.19
Ascobolus cervinus Berk. & Broome	0	22	0	1.31
A. immersus Pers.	0	54	10	3.8
Chaetomium atrobrunneum Ames	4	12	0	0.95
Ch. bostrychodes Zopf	6	14	12	1.9
Ch. globosum Kunze	14	6	6	1.55
Ch. gracile Udagawa	0	0	12	0.71
Ch. nigricolor Ames	8	4	4	0.95
Ch. piluliferum Daniels	8	12	8	1.66
Ch. subspirilliferum Sergeeva	0	0	4	0.24
Gymnascella dankaliensis (Castell.) Currah	18	36	6	3.57
Kernia nitida (Sacc.) Nieuwl.	14	18	6	2.26
Lasiobolidium egyptiacum Mustafa & Ezz-El-din	86	14	2	6.06
Lophotrichus plumbescens Morinaga	12	14	2	1.66
Microascus albonigrescens (Sopp) Curzi	4	2	0	0.36
M. trigonosporus Emmons & Dodge	4	14	2	1.19
Myceliophthora sepedonium (C.W. Emmons) van den Brink & Samson	14	0	0	0.83
Myxotrichum chartarum Kunze	6	0	0	0.36
Podospora comata Milovtz.	2	14	0	0.95
P. communis (Speg.) Niessl	0	16	0	0.95
Saccobolus citrinus Boud. & Torrend	0	10	2	0.71
S. glaber (Pers.) Lambotte	44	34	66	8.56
Sordaria fimicola (Roberge ex Desm.) Ces. & De Not.	14	28	0	2.5
S. superba De Not.	0	6	0	0.36
Sporormiella minima (Auersw.) S.I. Ahmed & Cain	2	8	0	0.59
Thielavia microspora Mouch.	4	0	0	0.24
T. subthermophila Mouch.	6	0	0	0.36
T. terricola (Gilman & Abbott) Emmons	8	0	0	0.48
Zopfiella erostrata (Griffiths) Udagawa & Furuya	8	20	0	1.66
Zygopleurage zygospora (Speg.) Boedijn	0	8	0	0.48
Anamorphic Ascomycota				
Beauveria felina (DC.) J.W. Carmich.	10	0	4	0.83
Botryotrichum piluliferum Sacc. & Marchal	0	8	12	1.19
Cephaliophora irregularis Thaxt.	14	4	10	1.66
C. tropica Thaxt.	10	6	2	1.07
Cephalotrichum nanum (Ehrenb.) S. Hughes	0	0	2	0.12
Fusarium equiseti (Corda) Sacc.	6	8	8	1.31
F. lateritium Nees	4	6	14	1.43
F. moniliforme J. Sheld.	38	14	22	4.4
Lasiodiplodia theobromae (Pat.) Griffon & Maubl.	4	0	2	0.36
Mycosylva clarkii M.C. Tulloch	6	0	0	0.36
Parascedosporium putredinis (Corda) Lackner & de Hoog	0	18	0	1.07
Phoma humicola J.C. Gilman & E.V. Abbott	0	0	2	0.12
Ph. leveillei Boerema & G.J. Bollen	4	0	0	0.24
Basidiomycota				
Coprinopsis stercorea (Fr.) Redhead, Vilgalys & Moncalvo	8	22	34	3.8

*Occurrence- C= Common (recorded 50% or more); M= moderate (recorded 24-49%); L = low (recorded 12-23% times); and R = rare (recorded less than 12%).

Table 3 Taxonomic assignment of isolated taxa of South Sinai coprophilous fungi

Phylum	Classes	Orders	Families	Genera	Species
Ascomycota	Dothideomycetes	Botryosphaeriales	Botryosphaeriaceae	1	1
		Incertae sedis	Myxotrichaceae	1	1
		Pleosporales	Sporormiaceae	1	1
			Incertae sedis	1	2
	Eurotiomycetes	Onygenales	Gymnoascaceae	2	2
	Incertae sedis	Incertae sedis	Incertae sedis	1	1
	Pezizomycetes	Pezizales	Ascobolaceae	2	4
			Incertae sedis	1	2
			Pyronemataceae	1	1
	Sordariomycetes	Hypocreales	Cordycipitaceae	1	1
			Nectriaceae	1	3
		Microascales	Microascaceae	5	6
		Sordariales	Chaetomiaceae	4	12
			Lasiosphaeriaceae	3	4
			Sordariaceae	1	2
Basidiomycota	Agaricomycetes	Agaricales	Psathyrellaceae	1	1
Zygomycota	Incertae sedis	Mucorales	Lichtheimiaceae	1	1
			Mucoraceae	3	5
			Mycotyphaceae	1	1
			Pilobolaceae	1	3
			Rhizopodaceae	1	1
			Syncephalastraceae	3	4
		Zoopagales	Piptocephalidaceae	1	1
			Helicocephalidaceae	1	1
3	**5**	**10**	**21**	**39**	**61**

Distribution of coprophilous fungi among the dung

Data analysis showed that donkey dung recorded 722 individuals, followed by camel dung (538) and goat dung (422). Figure 2 shows the distribution of the fungal species among the dung types. 44 species (28 genera) were found on donkey dung; 43 species (31 genera) were found on camel dung and 38 species (28 genera) were found on goat dung. Species of Sordariomycetes (28 species) were the most common in this study. Among these, 21 species were found on camel and donkey dung and 16 on goat dung.

31 species were recorded both on camel and donkey dung, while camel and goat and donkey and goat were shared as common substrate by the same number 29 species each. 25 species were shared among the 3 types of dung.

Similarity index of Morisita-Horn among the 3 dung communities based on species composition using all shared data is 0.386. The index revealed moderate similarities between the donkey and goat dung mycobiota (0.654) in comparison with other dung types.

Species diversity was high based on Simpson's index of diversity results, with a value of 0.969 in donkey dung, followed by 0.949 and 0.947 for camel and goat dung, respectively.

Records

Notes on species and the sample numbers on which they were recorded are given below. Dried material (D) and/or slides (S) have been deposited in the Fungarium of the Arab Society for Fungal Conservation (Botany Department, Faculty of Science, University of Suez Canal in Ismailia, Egypt).

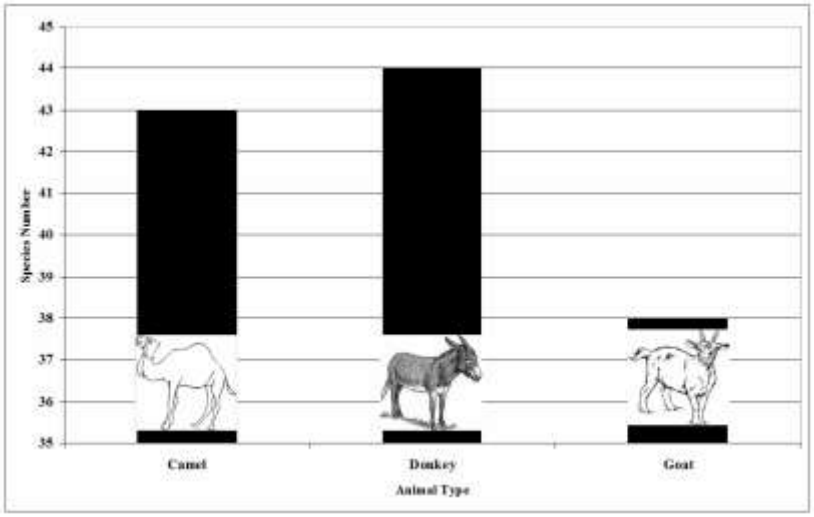

Fig. 2 – Distribution of species among the 3 dung types.

Taxonomy

Zygomycota

Actinomucor elegans (Eidam) C.R. Benj. & Hesselt., Mycologia 49: 241 (1957)
SCF 1, 6/012-S

Circinella muscae (Sorokīn) Berl. & De Toni, in Berlese, De Toni & Fischer, Syll. fung. (Abellini) 7: 216 (1888)
SCF 7, 10/012-S (Fig. 3 a)

Circinella umbellata Tiegh. & G. Le Monn, , Annls Sci. Nat., Bot., sér. 5 17: 300 (1873)
SCF 4, 6/013-S

Lichtheimia corymbifera (Cohn) Vuill., Bull. Soc. mycol. Fr. 19: 126 (1903)
SCF 8/012, 3,4/013-S

Mucor hiemalis Wehmer, Annls mycol. 1(1): 39 (1903)
SCF 1,4,7/012, 7,10/013-S

Mucor racemosus Fresen**.**, Beitr. Mykol. 1: 12 (1850)
SCF 1,2,3,4/012-S

Mycotypha microspora Fenner, Mycologia 24(2): 196 (1932)
SCF 5,6/012-S

Pilaira nigrescens Tiegh., Annls Sci. Nat., Bot., sér. 6 1: 60 (1875)
SCF 1,8,10/012-S

Pilaira moreaui Y. Ling, Mem. Ac. Sc. Clermont-Ferrand: 2 (1926)
SCF 1,5,9/012, 4,6/2013-S

Pilobolus crystallinus (F.H. Wigg.) Tode, Schr. naturf. Fr. Berlin 5: 96 (1784)
SCF 2,4,10/012, 1,2/2013-S

Pilobolus kleinii (Tiegh.) Kuntze, Annls Sci. Nat., Bot., sér. 6 4(4): 337 (1878) [1876]
SCF 1,2, 3, 5, 9/012-S

Pilobolus lentiger Corda, Icon. fung. (Prague) 1: 22 (1837)
SCF 3,4,7/012, 1,2,5/2013-S

Piptocephalis arrhiza Tiegh. & G. Le Monn., Annls Sci. Nat., Bot., sér. 5 17: 366 (1873)
SCF 1,4,7/012, 5,10/013-S

Rhizopus stolonifer (Ehrenb.) Vuill., Revue mycol., Toulouse 24: 54 (1902)
SCF 1,2, 3, 4, 6, 7/012, 1, 2, 6, 7,10/013-S

Rhopalomyces elegans Corda, Prachtflora: 3 (1839)
SCF 5, 6, 7, 10/013-S

Syncephalastrum racemosum Cohn ex J. Schröt., in Cohn, *Krypt.-Fl. Schlesien* (Breslau) 3.1(9–16): 217 (1886) [1889]
SCF 1,2, 3, 4, 6, 7, 9, 10/012-S

Thamnostylum piriforme (Bainier) Arx & H.P. Upadhyay, in Arx, Gen. Fungi Sporul. Cult. (Lehr): 247 (1970)
SCF 1,2, 3, 4, 6, 7/012, 3, 4, 6, 9/013-S

Teleomorphic Ascomycota
Eurotiomycetes
Onygenales

Arachniotus ruber (Tiegh.) J. Schröt., in Cohn, Krypt.-Fl. Schlesien (Breslau) 3.2(1–2): 210 (1893) [1908]
SCF 4, 6, 7/012, 2, 9/013-S

Ascomata. Gymnothecial, initials consisting of 2 equal coiled gametangia. Peridial hyphae present or absent. Asci scattered in orange to red patches throughout the aerial mycelium. Ascospores yellow to orange, oblate with 2 equatorial rims separated by a furrow, smooth-walled, 5.5-7.0 × 4.0-5.0 μm in front view. The pigmentation and equatorial rims of the ascospores distinguish this species from others of its genus.

Gymnascella dankaliensis (Castell.) Currah, Mycotaxon 24: 77 (1985)
SCF 4, 5, 6/012-S

Ascomata. Gymnothecial, orange-yellow to brownish orange clumps of ascospores surrounded by ± differentiated peridial hyphae, 80-600 μm diam. Peridial hyphae either undifferentiated from somatic hyphae or occasionally thick-walled, somewhat gnarled, roughened, irregular. Asci. 8.2-12 μm diam. Ascospores. Yellow to orange or red-brown, oblate, with equatorial and polar thickenings, surface irregular, (3-) 4.3-5.3 × 6-8 μm in front view.

Dothideomycetes
Pleosporales
Sporormiaceae

Sporormiella minima (Auersw.) S.I. Ahmed & Cain, in Ahmed & Asad, Pakist. J. scient. ind. Res. **12**(3): 241 (1970)
SCF 2, 4, 9/012, 1/013-S, D

Ascomata. Perithecia scattered or loosely aggregated, immersed when young, becoming nearly superficial when old, subglobose to nearly pyriform, 100-200 × 90-120 µm, smooth, bare, dark brown to nearly black; neck small, papilliform, smooth, bare, black; peridium thin, membranaceous. Asci. Short and broad, more or less cylindrical, (80-) 90-100 × 13-18 µm, broadly rounded above, broadest part below the middle, abruptly contracted below into a very short stipe, 8-spored, with spores obliquely arranged in 2 or 3 rows. Ascospores. Cylindrical, 28-32 (-34) × 5-6 µm, broadly rounded at the ends, straight or curved, ranging from colourless when young through yellowish brown to dark brown and opaque, transversely 3-septate; markedly narrower at each septum; segments readily separable; cells nearly equal in size; terminal cells very slightly narrower toward the ends; germ slit nearly parallel with a kink near the middle; gelatinous sheath colourless, narrow. Paraphyses. Scanty, filiform, septate, equaling the asci and mixed with them (Fig. 3b).

Incertae sedis
Myxotrichaceae

Myxotrichum chartarum Kunze, in Kunze & Schmidt, Mykologische Hefte (Leipzig) 2: 110 (1823)
SCF 6, 9/012-S

Ascomata. Gymnothecial, greyish-green to blackish-brown, up to 1mm diam. Peridial hyphae of thick-walled, dark brown hyphae with radiating spine-like branches, appendages dark brown, smooth, uncinate and thickened at their tips. Asci. Oval, 8-spored. Ascospores. Hyaline at first, becoming pale orange-brown, ovoid, 4-5 × 2-3 µm, wall finely striate.

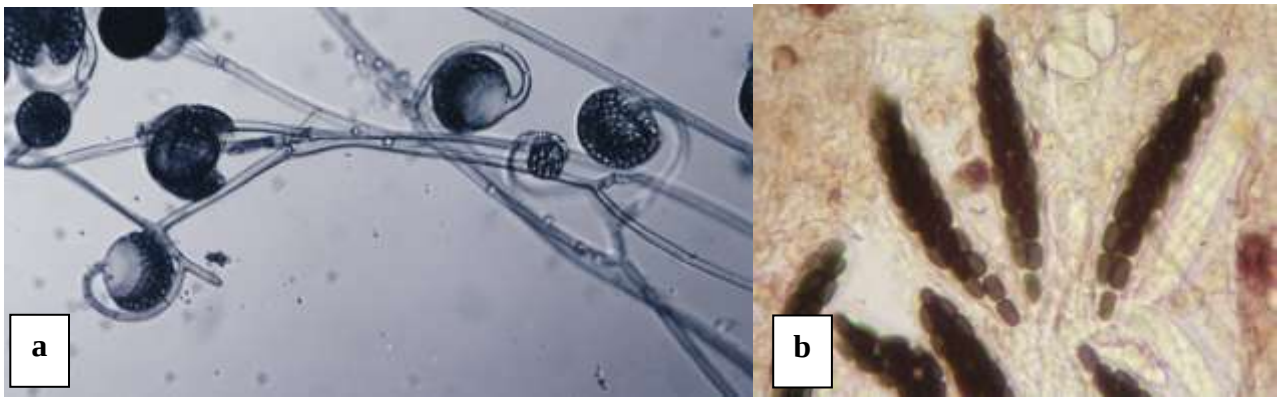

Fig. 3 – a *Circinella muscae*, sporangia and straight spine developing on the same branch. b *Sporormiella minima*, bitunicate asci and ascospores.

Pezizomycetes
Ascobolaceae

Ascobolus cervinus Berk. & Broome, J. Linn. Soc., Bot. 15(1): 85 (1876) [1877]
SCF 4, 7, 6, 9, 10/012-D

Ascomata. Apothecial, gregarious or crowded, superficial, sessile on a broad base, 1-5 mm wide, 0.5 mm high, receptacle olive-green, with a prominent margin. Asci 8-spored; cylindrical, wall not turning blue in Melzer's reagent. Ascospores uniseriate to biseriate, ellipsoid, pigmented, 14.5-16 × 8-9 µm, ornamented with longitudinal striation. Paraphyses branched, septate, filiform, 2.5 µm wide, often irregularly curved, terminating in a thin filament or a small knob, 2-4 µm, thick at the tip, hyaline, embedded in coloured mucus (Fig. 4 a).

Ascobolus immersus Pers., Neues Mag. Bot. 1: 115 (1794)
SCF 2, 4, 5, 8/012-D

Ascomata. Apothecial, gregarious or scattered, globular or turbinate, 0.3-0.5 mm wide, 0.3-0.5 mm high, receptacle yellowish brown, without margin, disc pale yellow. Ectal excipulum of *textura angularis*, cells 8-20 × 10-40 µm, thick-walled, yellowish brown, layer 25-50 µm thick. Medullary excipulum of *textura globulosa*, cells 4-8 × 6-12 µm, layer 40-50 µm thick. Asci 8-spored, clavate to broadly clavate (Fig. 4 b), with a short stalk, 312-550 × 42-114 µm, walls turning blue in Melzer's reagent. Ascospores oblong ellipsoid, purple-brown, 37-60 × 17-34 µm, smooth or with a few lines (Fig. 4 c), each with a thick gelatinous sheath. Paraphyses simple, filiform, 2-4 µm wide, rarely uncinate at the tips, embedded in yellowish mucus.

Saccobolus citrinus Boud. & Torrend, Bull. Soc. mycol. Fr. 27(2): 131 (1911)
SCF 2, 4, 5, 8/012, 3/013-D

Ascomata. Apothecial, scattered or gregarious, yellow, 200-450 µm wide, smooth, margin not differentiated. Excipulum composed of globose cells. Asci broadly clavate, 87-112 × 20-30 µm, walls turning blue in Melzer's reagent. Spore clusters arranged as pattern I , 35-40 × 12.5-15 µm, with thick gelatinous sheath. Ascospores ellipsoid-fusoid with blunt ends, violet to brownish purple, verrucose, 14-20 × 7-8 µm. Paraphyses tips filled with yellow pigments, 2-4 µm wide.

Saccobolus glaber (Pers.) Lambotte, Mém. Soc. roy. Sci. Liège, Série 2 14: 284 (prepr.) (1887) [1888] SCF 1, 2, 4, 5, 8, 10/012, 2, 3, 7, 8, 10/013- D

Ascomata. Apothecial, scattered or gregarious, yellow, 100-500 µm wide, smooth, margin not differentiated. Excipulum composed of globose cells, 6-15 µm diam. Asci broadly clavate, 102-150 × 18-33 µm, walls turning blue in Melzer's reagent. Spore clusters arranged as pattern I, 45-51 × 16-19 µm, with thick gelatinous sheath. Ascospores ellipsoid, violet to brownish purple, finely granulate and sometimes with cracks, 18-22 × 8-13 µm. Paraphyses tips filled with yellow pigments, 3-6 µm wide.

Fig. 4 – a *Ascobolus cervinus,* immature uniseriate ascus. b *A. immersus*, broadly clavate ascus before dehiscence. c Ascospore of *A. immersus* showing longitudinal fissure.

Pyronemataceae

Lasiobolidium egyptiacum Moustafa & Ezz-El-din [as '*aegyptiacum*'], *Mycol. Res.* 92(3): 377 (1989)
SCF 1, 2, 4, 5, 8, 9/012, 3, 4, 6, 7, 10/013-S, D

Ascomata. Cleithothecial, subglobose to globose, 450-650 µm, vinaceous purple, appearing granular due to the projecting peridial elements, non-ostiolate, covered with long appendages; ascocarp peridium indefinite in thickness, of two tissue types, outer layer of large swollen cells, 16-48 × 10-12 µm forming irregular tissue, radiating outwards as clavate or ellipsoidal to subglobose projections, inner layer of smaller cells, 3.6-4.8 µm diam, colourless, thin-walled, prosenchymatous; ascocarp appendages 2-3 mm in length, arising from the outer peridial layer,

colourless, 4-6 µm wide, sparsely or non-septate, thick-walled, mostly unbranched, smooth, wavy to loosely coiled, swollen at base, round at the tips. Asci. Cylindrical, 60-70 × 14-16 µm (Fig. 5 a), short to non-stiptate, 8-spored, with spores arranged in a single row, evanescent. Ascospores. Broadly ellipsoidal, colourless, smooth, aseptate, 11-12 × 8-9 µm, without germ pores. Paraphyses. Not observed.

Sordariomycetes
Microascales
Microascaceae

Microascus albonigrescens (Sopp) Curzi, Boll. Staz. Pat. Veg. Roma 11: 60 (1931)
SCF 4/012, 5/013-S

Ascomata. Perithecial, black and brittle, spherical to pyriform, papillate to short necked, 200-500 µm diam., with scattered setae; setae mostly short, up to 40 µm long, dark, smooth. Asci. Subglobose to ovoid, 8-12 × 6-10 µm, 8-spored, evanescent. Ascospores. Lunate with rounded ends, 3.5-5 × 2-3.5 µm, guttulate, red-brown in mass, extruded at maturity in the form of a gelatinous ball at the mouth of the perithecium or as a long cirrhus. Paraphyses. Not observed.

Microascus trigonosporus C.W. Emmons & B.O. Dodge, Mycologia 23(5): 317 (1931)
SCF 4,7,8/012, 1,3, 5/013-S

Ascomata. Perithecial, black, brittle, glabrous or with scattered hairs, flask shaped, with spherical base, 125-250 µm, diam.; neck up to 250 µm long, cylindric, or tapering, sometimes swollen at the trumpet-like tip, smooth or with well-marked protuberances, giving a rough outline; ascomatal wall 10-13 µm thick, composed of several layers of brown, flattened cells, forming a textura angularis in surface view. Asci. Subglobose to ovoid, 8-spored, evanescent, 6-9 × 9-12 µm sessile. Ascospores. Triangulate in planar view, concave on all 3 sides, 2.5-3.5 × 3.5-5.5 µm, broadly rounded at the ends, red-brown in mass, with an indistinct germ pore. Paraphyses. Not observed.

Lophotrichus plumbescens Morinaga, Minoura & Udagawa, Trans. Mycol. Soc. Japan 19(2): 140 (1978)
SCF 1, 5, 4, 7/012, 7/013-D

Ascomata. Perithecial, superficial, scattered or somewhat aggregated, black, globose, 270-300 µm diam., covered on the exposed part with clusters of terminal and lateral hairs; neck usually 1, occasionally 2 on a single ascoma, black, cylindrical, 145-225 µm long 40-50 µm wide at the base, sometimes curved, terminated on an ostiole fringe of numerous, colourless to pale olive brown, unbranched, remotely septate, more or less flexuous, smooth-walled hairs 80-200 × 4.5-5 µm; peridium thin, dark brown, opaque, membranaceous, with outer layer consisting of dark, angular, thick walled cells 5-8 µm diam.; terminal hairs arising from the upper surface of the ascoma including the neck region surrounded the ostiole; of 2 kinds: (a) sparse, up to 16 or more in number, slender, straight or slightly flexuous below, flexuous above, rather rigid, septate, smooth, thick-walled, dark olivaceous brown, up to 1-1.3 mm long, 3-4 µm wide near the base, tapering gradually to a colourless or pale coloured, incurved or circinate tip; (b) numerous, mixed with type (a) hairs and similar to them but shorter, up to 500 µm long, ending in a pointed tip; lateral hairs straight, short. Asci. 8-spored, ovoid to broadly clavate, 19-26 × 11-14 µm, short-stipitate, irregularly disposed, evanescent. Ascospores. Dextrinoid when young, straw-coloured, broadly ellipsoidal, 6-7.5 × 5-6 µm, smooth-walled, rounded but later slightly acuminate at both ends, extruded as a reddish brown cirrhous; germ pores 1 at each end of the spore. Paraphyses. Not observed.

Kernia nitida (Sacc.) Nieuwl., Am. Midl. Nat. 4: 379 (1916)
SCF 1, 5, 8, 11/012, 7, 8, 9/013-D

Ascomata. Cleistothecial, superficial, surrounded by delicate hyphae, rarely spherical, usually triangular, elliptical or ovate in surface view, black, at the attenuated ends usually with a single or a small brush of long appendages, non-ostiolate, 100-350 µm diam.; ascomatal wall thick, composed of several layers of slightly flattened, brown, 3-9 µm sized cells, *textura angularis* in surface view; ascomatal appendages seta-like, thick-walled, smooth, septate, often undulate and circinate at the tip, up to 1.5 mm long, 4-7 µm broad near the base. Asci. Irregularly disposed, obovate or nearly spherical, thin-walled, evanescent, 8-spored, 10-15 × 8-12 µm. Ascospores. Ellipsoidal, colourless and dextrinoid when young, pale brownish or yellowish when mature, smooth 4.5-7 × 3.5-4.5 µm, with a single, apical germ pore. Paraphyses. Not observed.

Chaetomiaceae

Chaetomium atrobrunneum L.M. Ames, Mycologia 41(6): 641 (1950) [1949]
SCF 1, 8, 11/012, 9, 10/013-S

Ascomata. Perithecial, olivaceous or pale green in reflected light, superficial, 70-150 µm, with a thin wall of dark, angular, 5-10 µm cells; ascomatal hairs arising around the ostiolar pore and lateral, long, tapering, occasionally branched, 3-4 µm broad at base, smooth or covered with some exudates, brown, indistinctly septate. Asci. Clavate, stalked, 8-spored, evanescent. Ascospores. Fusiform or elongate pyriform, grey-brown when mature, 9-11 × 4.5-6 µm, with a distinct, often slightly subapical germ pore. Paraphyses. Not observed.

Chaetomium bostrychodes Zopf, Abh. Botan. Ver. Prov. Brandenburg 19: 173 (1877)
SCF 1, 2, 5, 6, 8, 9, 10/012-S

Ascomata. Perithecial, superficial pale metallic or steel grey in reflected light, dark grey to black when old, ovate, obovate, turbinate, ampulliform or cylindrical, 140-250 µm, usually 200-400 µm high, apically flattened and often darkened around the 25-35 µm wide ostiolar pore; ascomatal wall brown or ochraceous, composed of angular, rather thick walled, 5-12 µm cells; ascomatal hairs arising mainly from the apical disc, erect, usually spirally coiled in the upper part, brown, septate, thick walled, verrucose or warty, 4.5-6.5 µm thick, occasionally with coiled branches; lateral hairs seta- or whip-like, tapering, septate. Asci. Numerous, fasciculate, clavate, with a long, evanescent , 8 spored, 11-14 µm broad, often surrounded by paraphyses-like, broad, evanescent filaments. Ascospores. Limoniform or nearly spherical, often slightly apiculate at the ends, bilaterally flattened, colourless and dextrinoid when young, pale bluish grey or olivaceous when mature, 5.5-7.5 × 5-6.5 × 4-5.5 µm, with an apical germ pore. Paraphyses. Not observed.

Chaetomium globosum Kunze, in Kunze & Schmidt, Mykologische Hefte (Leipzig) 1: 16 (1817)
SCF 1, 2, 5, 6, 8, 9, 10/012-S

Ascomata. Perithecial, olivaceous, grey-green or brown in reflected light, superficial, spherical, ovate or obovate, 175-280 µm; ascomatal wall brown, of *textura intricata*, cells 2-3.5 µm broad; ascomatal hairs numerous, usually unbranched, flexuous, undulate or coiled, often tapering, septate, brownish, 3-4.5 µm broad at the base, up to 500 µm long. Asci. Clavate or slightly fusiform, stalked, 30-40 × 11-16 µm, 8-spored, evanescent. Ascospores. Limoniform, usually biapiculate, bilaterally flattened, brownish when mature, rather thick-walled, containing numerous droplets, 9-12 × 8-10 × 6-8 µm, with an apical germ pore. Paraphyses. Not observed.

Chaetomium gracile Udgawa, J. gen. appl. Microbiol., Tokyo 6: 235 (1960)
SCF 2, 5, 6/012, 7, 8/013-S

Ascomata. Perithecial, olivaceous grey in reflected light, superficial, spherical or ovate, ostiolate, 110-l80 µm; producing asci and ascospores within 10 days; ascomatal wall composed of rather thick-walled, brown, angular or irregular, 6-10 µm sized cells; ascomatal hairs surrounding mainly the apical opening, arcuate, partly undulate, septate, thick-walled, verrucose, punctulate or nearly smooth, 110-200 × 3-5 µm, with a distinctly swollen basal cell. Asci. Clavate, stalked, 8-spored, evanescent, 36-50 × 10-14 µm. Ascospores. Ellipsoidal or broadly fusiform, attenuate at

both ends, bluish grey when young, later brown, 11-15 × 6-8.5 µm, with an apical germ pore, occasionally with 2 germ pores. Paraphyses. Not observed.

Chaetomium nigricolor L.M. Ames, Mycologia 42(5): 645 (1950)
SCF 1, 2, 5/012-S

Ascomata. Perithecial, superficial or immersed in the aerial mycelium, black in reflected light, spherical or ovate, 120-230 µm, with an apical pore and a brown wall of *textura intricata* or *epidermoidea*, composed of incrusted, often indistinct hyphal cells; ascomatal hairs long, unbranched, undulate to spirally coiled, dark, verrucose or warty, 2.5-4 µm. Asci. Fasciculate, clavate, stalked, 8-spored, evanescent, 28-36 × 7-12 µm. Ascospores. Ovate, greyish olivaceous or brown and rather thick-walled when mature, 6-8 × 4-6 µm, with a germ pore at the attenuated end. Paraphyses. Not observed.

Chaetomium piluliferum J. Daniels, Trans. Br. mycol. Soc. 44(1): 84 (1961)
SCF 7, 8/012, 6/2013-S

Anamorph. Brownish due to pigmented hyphae and erect, verrucose hairs; "aleurioconidia" numerous, often in clusters, spherical or nearly so, thick-walled, colourless, 13-18 µm, formed on short hyphal branches; phialoconidia obovate, colourless, 3-4 × 2-2.5 µm, formed basipetally on clustered ampulliform cells, aggregated in droplets. Ascomata. Perithecial, spherical or obovate, dark grey in reflected light, 150-240 µm, with a brown or reddish brown wall of *textura epidermoidea*; ascomatal hairs long, flexuous or apically circinate, thick-walled, brown, septate, usually smooth, 4-5.5 µm broad, with a swollen, 6.5-8 µm broad and 10-14 µm long basal cell; thinner verrucose hairs also present. Asci. Obovate or broadly clavate, with a rather short stalk, 8-spored, evanescent, 48-60 × 17-22 µm. Ascospores. Ellipsoidal, with attenuated ends, brown when mature, 13-17 × 8-10 µm, with an apical germ pore. Paraphyses. Not observed.

Chaetomium subspirilliferum Sergeeva, Notul. syst. Sect. cryptog. Inst. bot. Acad. Sci. U.S.S.R. 13: 174 (1960)
SCF 4, 10/013-S

Ascomata. Perithecial, yellow green or olivaceous in reflected light, superficial, spherical or ovate, 80-140 µm, with a distinct, 20-25 µm wide ostiolar pore; ascomatal wall pale brown, composed of flattened, thin-walled, angular, often elongate, 6-12 µm cells, often covered by 2-3 µm broad, brown hyphae; ascomatal hairs flexuous, undulate or spirally coiled, pale brown, finely verrucose, indistinctly septate, 2-3 µm broad. Asci. Obovate or nearly spherical, with short stalks, 8-spored, evanescent, 25-40 × 14-24 µm. Ascospores. Ellipsoidal-fusiform, often inequilateral, at both ends attenuated and rounded, laterally not or only slightly flattened, pale grey olivaceous when young, olivaceous brown when mature, 13-16 × 7-8 µm, with a distinct, apical or occasionally slightly subapical germ pore. Paraphyses. Not observed.

Myceliophthora sepedonium (C.W. Emmons) van den Brink & Samson, in Brink, Samson, Hagen, Boekhout & Vries, Fungal Diversity 52(1): 206 (2012)
SCF 6, 8, 9/012, 4, 9/2013-S

Ascomata. Cleistothecial,superficial, embedded in the aerial mycelium, spherical or nearly so, dark brown, 50-110 µm, with a peridium composed of a layer of irregular, flattened cells, up to 20 µm long and 4-8 µm broad, each with a thickened, ridged and pigmented outer cell wall. Asci. Obovate or nearly spherical, 30-40 × 20-30 µm, 8-spored, with a delicate and evanescent wall. Ascospores. Ellipsoidal or broadly fusiform, brown when mature, 12-19 × 8-11 µm, with a distinct germ pore at both ends, occasionally with a single or with 3-4 germ pores. Paraphyses. Not observed.

Thielavia microspora Mouch., Bull. trimest. Soc. mycol. Fr. 89: 300 (1973)
SCF 6, 8/012-D

Ascomata. Cleistothecial, spherical, 50-200 (-350) μm diam., with a 3-6 μm thick wall, forming a *textura epidermoidea*, composed of brown, flattened, 2-5 μm wide hyphal cells, surrounded by a weft of brown, septate, branched, often appendage-like, 1.5-3 μm wide hyphae. Asci. Obovate or ellipsoidal, evanescent, 8-spored, 15-25 × 10-15 μm. Ascospores. Broadly fusiform or ellipsoidal, at one end with a rather distinct germ pore, at the other end often slightly apiculate, brown when mature, with a rather thick wall, 8-10 × 5.5-6.5 μm. Paraphyses. Not observed.

Thielavia subthermophila Mouch., Bull. trimest. Soc. mycol. Fr. 89(3-4): 309 (1973)
SCF 8/012, 4, 5/013-D
Ascomata. Cleistothecial, developing in the mycelial mat, spherical, black, 90-200 μm diam.; ascomatal wall thin, dark, composed of *textura epidermoidea* or flattened cells, 5-8 μm, irregular in outline and often covered with dark hyphae. Asci. Evanescent, not observed. Ascospores. Fusiform or ellipsoidal, aseptate, brown, 14-19 × 8-10 μm, with a distinct, subapical germ pore. Paraphyses. Not observed.
Thielavia terricola (J.C. Gilman & E.V. Abbott) C.W. Emmons, Bull. Torrey bot. Club 57: 124 (1930)
SCF 3/012, 7, 8/013-S

Ascomata. Cleistothecial, superficial, often covered by the aerial mycelium, spherical, 70-200 μm diam., with a thin wall composed of pale brown, 3-5 μm broad hyphal cells, forming a *textura epidermoidea* in surface view. Asci. Obovate or broadly clavate, often fasciculate, 8-spored, with an evanescent wall, 26-40 × 15-18 μm. Ascospores. Ellipsoidal or broadly fusiform, brown when mature, smooth, 11-16 × 6-9 μm, with an distinct apical germ spore. Paraphyses. Not observed.

Lasiosphaeriaceae

Podospora comata Milovtz, Trav. Inst. Bot. Charkov 2: 20 (1937)
SCF 8, 9, 10/012, 1, 2, 5/013-S, D

Ascomata. Perithecial, scattered, semi-immersed or almost superficial, 280-640 × 190-250 μm, pyriform, dark brown to almost black, with straight, sparingly septate, brown hairs measuring 100-600 × 2-4 μm, sometimes forming a few tufts at base of neck; neck papilliform or conical, blackened with papillae; peridium thin, membranaceous, brown, consisting of indistinct cells. Asci. Rounded at the apex, cylindrical to clavate, 160-200 × 16-27 μm, stipe 50-70 μm, with a small apical ring, 4-spored, with spores arranged in 1 row. Ascospores. Ellipsoid, 26-32 (-35) × 15-17.5 (-19) μm, dark brown and opaque, narrowly rounded at the apex, truncate at the base; exospore thin; primary appendage basal, cylindrical 11-24 × 4.5-6 μm; secondary appendages lash-like, the upper eccentrically attached near the apex of the spore, longer than spore and 4.5-5 μm wide at base, the lower similar, attached to distal end of primary appendage; occasionally 2 very small, fugaceous secondary appendages attached to the primary appendage near the middle; germ pore apical, 1.5-2.5 μm diam. Paraphyses. Abundant, filiform, septate, longer than the asci.

Podospora communis (Speg.) Niessl, Hedwigia 22: 156 (1883)
SCF 1, 3, 4, 5, 9/012-D

Ascomata. Perithecial 650-1000 × 300-500 μm, covered up to the neck with long, flexuous, olivaceous or brown, septate hairs or almost bare; neck conical to cylindrical, blackened- with papillae; peridium thin, membranaceous, almost black, and opaque near the neck, olivaceous and semi-transparent below. Asci. Clavate, 180-210 × 26-32 μm, swelling considerably in water, apical ring distinct, 8-spored with spores arranged in 2 rows. Ascospores. Ellipsoid, 28-36 × 17-21 μm, primary appendage cylindrical, 25-35 × 5-6 μm; 4 short secondary appendages near apex of spores; 4 similar appendages at the distal end of the primary appendage. Germ pore apical, about 2 μm diam.

Zopfiella erostrata (Griffiths) Udagawa & Furuya, Trans. Mycol. Soc. Japan 15(3): 208 (1974)
SCF 4,5, 6, 8, 10/012, 1,3, 4/013-D

Ascomata. Cleistothecial, scattered, superficial, 240-385 μm diam., covered with very long, flexuous, sometimes geniculate, simple, septate, brown, thick-walled hairs, 4.5-5 μm wide, with straight, obtuse tips and often curved and dilated at the base; peridium semitransparent to somewhat opaque, olivaceous brown with angular, slightly thick-walled, outer cells, 5-10 μm diam. Asci. 50-70 × 12-15 μm, clavate, with a short stipe and a tapering rounded apex, 8-spored, with spores arranged in 2 rows; apical ring hardly visible; subapical chamber rounded, ca 1.2 μm broad. Ascospores. Clavate to obovoid-fusiform when young, filled with large oil drops, becoming transversely 1-septate; upper cell ranging through olivaceous to light brown, 9.5-12 × 6.5-8.5 μm, broadly ellipsoidal, somewhat truncate below and umbonate at the apex, with an apical germ pore; pedicle cylindrical, 3.5-8.5 × 2.5- 3μm; gelatinous equipment lacking or possibly in the form of an evanescent cauda at each of end of the spore. Paraphyses. Short, up to 12 μm broad, composed of swollen cells, evanescent.

Zygopleurage zygospora (Speg.) Boedijn, Persoonia 2(3): 316 (1962)
SCF 2, 5, 8/012-D

Ascomata. Perithecial, 900-1100 × 600-700 μm, tomentose on the upper third (except the neck); neck very dark-pigmented, 450-550 × 180-200 μm;. Asci. Broadly-clavate, 230-250 × 35-50 μm, mostly 8-spored (sometimes 4- or 6-spored), with round apices but without apical structures. Ascospores. 2-septate, 2 apical dark broad-fusiform cells (25-35 × 15-22 μm) and a colourless, non-septate connecting long hypha (150-200 μm); connecting hyphae non-septate and usually colourless (sometimes pigmented and septate, Fig. 5 b), strongly coiled around each other, without gelatinous sheath; apical dark cells very often showing 4 gelatinous caudae on the distal surface and 4 others at the junction with connecting hyphae.

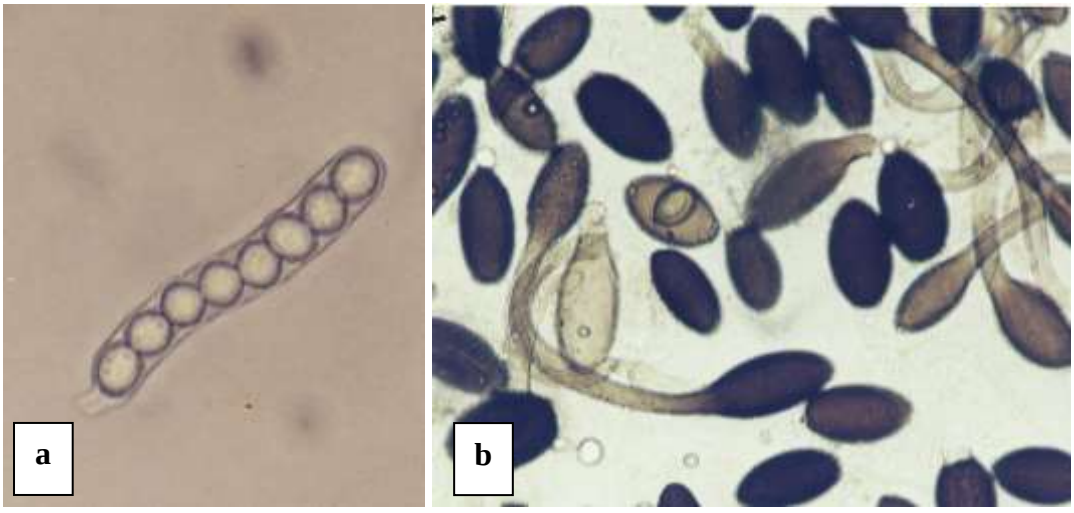

Fig. 5 – a *Lasiobolidium egyptiacum*. a uniseriate ascus b *Zygopleurage zygospora*, mature ascospores and some still connected in pairs.

Sordariaceae

Sordaria fimicola (Roberge ex Desm.) Ces. & De Not., Comm. Soc. crittog. Ital. 1(4): 226 (1863)
SCF 5, 6,7, 8, 9/012, 1, 5, 8, 9/013-S

Sordaria superba De Not., Comm. Soc. crittog. Ital. 2(3): 479 (1867)
SCF 5, 6,7, 8, 9/012, 1, 5, 8, 9/013-D

Colonies. Homothallic. Ascomata. Perithecial, mostly aggregated, semi-immersed, broadly obpyriform, 530-670 × 385-480 µm, sparsely soft-haired; peridium membranaceous, almost opaque, dark brown below, blackish in the short, papillose neck, with angular to rounded, thick-walled, 8-23 µm diam. outer cells. Asci. 8-spored, with spores arranged in a single row, 240-300 × 20-24 µm, cylindrical, with a truncate, 10-12 µm broad apex; apical ring 6-7 µm in diam., ca 2.5 µm high; subapical chamber 7-10 µm wide. Ascospores. Aseptate, binucleate, at maturity brown-black, (21-) 23-29 × (-30) × 14.5-17 (-18) µm, broadly ellipsoidal, often slightly inequilateral, rounded above, apiculate below with a basal germ pore; gelatinous sheath surrounding the spore except for a basal invagination, swelling in water, persistent, with a distinct outline, without visible inner microstructure, blackening in Indian ink. Paraphyses. Not observed.

Anamorphic ascomycota

Beauveria felina (DC.) J.W. Carmich., in Carmichael, Kendrick, Conners & Sigler, Genera of Hyphomycetes (Edmonton): 48 (1980)
SCF 1, 3,4,5, 6/012-S

Botryotrichum piluliferum Sacc. & Marchal, in Marchal, Bull. Soc. R. Bot. Belg. 24(1): 66 (1885)
SCF 1, 5, 6, 9/012-S

Cephaliophora irregularis Thaxt., Bot. Gaz. 35: 158 (1903)
SCF 4, 6, 8, 9/012, 4, 7/013-S

Cephaliophora tropica Thaxt., Bot. Gaz. 35: 157 (1903)
SCF 5, 7, 9, 10/012, 3, 5, 7/013-S

Cephalotrichum nanum (Ehrenb.) S. Hughes, Can. J. Bot. 36: 744 (1958)
SCF 2/012-S

Parascedosporium putredinis (Corda) Lackner & de Hoog, IMA Fungus 2(1): 44 (2011)
SCF 1, 3,4,5,6, 9/012-S

Fusarium equiseti (Corda) Sacc., Syll. fung. (Abellini) 4: 707 (1886)
SCF 1, 3, 4 /012-S

Fusarium lateritium Nees, Syst. Pilze (Würzburg): 31 (1816) [1816-17]
SCF 5, 6, 10/012- S

Fusarium moniliforme J. Sheld., Nebraska Agric. Exp. Stat. Rep. 17: 23 (1904)
SCF 1, 2, 3, 5, 9/012, 1, 2, 4, 7/013-S

Lasiodiplodia theobromae (Pat.) Griffon & Maubl., Bull. Soc. mycol. Fr. 25: 57 (1909)
SCF 1, 3/012-S

Mycosylva clarkii M.C. Tulloch, Trans. Br. mycol. Soc. 60(1): 155 (1973)
SCF 1, 3, 4 /013-D

Phoma humicola J.C. Gilman & E.V. Abbott, Journal of Iowa State College, Sci. 1(3): 266 (1927)
SCF 10/013-S

Phoma leveillei Boerema & G.J. Bollen, Persoonia 8(2): 115 (1975)
SCF 1, 3/013-S

Basidiomycota

Coprinopsis stercorea (Fr.) Redhead, Vilgalys & Moncalvo, in Redhead, Vilgalys, Moncalvo, Johnson & Hopple, *Taxon* 50(1): 231 (2001)
SCF 1, 2, 5, 6, 9/012, 1, 3, 6, 7, 8, 10/2013-S, D

Cap 2-6 mm (Fig. 6), broad at maturity, at first ellipsoid to ovoid, then obtuse-conic, expanding to plane, the margin becoming recurved and torn; surface white to pale-grey, striate-plicate to near the disc, mealy-granulose, hairy toward the margin, in age the hairs inconspicuous; context thin, membranous, weakly deliquescent; odor unpleasant. Gills adnexed, subdistant, narrow, pallid in youth, eventually blackish; lamellulae in up to 2 series. Stipe 1.0-3.5 cm long, 0.5-1.0 mm thick, more or less equal, hollow, fragile; surface watery-white to pale-grey, when young covered with whitish hairs, soon sparse, except at the base; partial veil absent. Basidiospores elliptical in face view, smooth, dark reddish-brown, 7.5-9.2 × 4.2-5 µm. Basidia clavate, 12-19 × 6-7.5 µm, 4-spored.

Fig. 6 – *Coprinopsis stercorea* on goat dung pellets.

Key to reported South Sinai' coprophilous genera

1. Non septated mycelium, asexually reproducing by sporangiospores (Zygomycota) 2
1. Septated mycelium with fruit bodies (teleomorph) 13
1. Septated myceiulm without sexual phase (anamorphs) 28
2. Mycoparasite on mucoralean hosts 3
2. Saprobic 4
3. Merosporangia unispored, unbranched sporangiophore ..... *Rhopalomyces*
3. Merosporangia few-spored, regularly dichotomously branched sporangiospores ..... *Piptocephalis*
4. Columella present 5
4. Columella absent or, if present, accompanied by sporangioles, merosporangia or conidia 11
5. Sporangial wall persistent. Sporangia violently discharged 6
5. Sporangial wall thin and fragile. Sporangiospores passively liberated by breaking of sporangial wal1 7
6. Trophocysts and subsporangial vesicles present, discharging sporangia violently ..... *Pilobolus*
6. Trophocysts and subsporangial vesicles absent, not discharging sporangia violently ..... *Pilaria*
7. Apophysis absent 8

7. Apophysis below the sporangium present 10
8. Stolons and rhizoids absent 9
8. Stolons and rhizoids present ..... *Actinomucor*
9. Side branches highly coiled to circinate ..... *Circinella*
9. Side branches usually straight, rarely coiled ..... *Mucor*
10. Sporangiophores mostly arising in groups from rhizoids, pigmented ..... *Rhizopus*
10. Sporangiophores mostly arising from stolons, hyaline, at least in the lower par ..... *Lichtheimia*
11. Columellate sporangia never present and spore develop singly (sporangioles) or in rows (merosporangia) over round or elongated vesicles 12
11. Columellate sporangia present and always accompanied by sporangioles borne on the same sporangiophore ..... *Thamnostylum*
12. Spores produced in merosporangia on branched sporangiophore over round vesicles …….. ..... *Syncephalastrum*
12. Spores produced single as conidium on unbranched sporangiophore over elongated vesicles …… ..... *Mycotypha*
13. Ascomata apothecial 14
13. Ascomata without ostiole (cleistothecia or gymnothecia) 16
13. Ascomata with ostiole (perithecia or pseudothecia) 23
14. Mature ascospores pigmented and/or ornamented 15
14. Mature ascospores hyaline and smooth ..... *Lasiobolidium*
15. Ascospores clustered in bundles ..... *Saccobolus*
15. Ascospores not clustered in bundles ..... *Ascobolus*
16. Ascomata walls consisting of interwoven hyphae 17
17. Ascomata walls consisting of pseudoparenchymatous layers 19
17. Peridial appendages absent. If present,as short projections and similar to vegetative hyphae …….. ..... *Arachniotus*
17. Peridial appendages well-defined, present as spines or long hairs distinctive from somatic hyphae ……..……18
18. Appendages dark-pigmented ..... *Myxotrichum*
18. Appendages subhyaline ..... *Gymnascella*
19. Ascomata covered with distinct peridial appendages 20
19. Ascomata not covered with distinct peridial appendages 22
20. Appendages aggregated in tufts (fascicles) 21
20. Appendages scattered over ascoma surface ..... *Zopfiella*
21. Ascomata polygonal, appendages in several fascicles ..... *Kernia*
21. Ascomata round, appendages in 1 fascicle ..... *Lophotrichus*
22. Ascospores showing 1 germ pore, chlamydospores very often present ..... *Thielavia*
22. *Ascospores showing 2 germ-pores, anamorph Sepedonium-like* ..... *Myceliophthora*
23. Ascospores more than 2 celled ..... *Sporomiella*
23. Ascospores with 1 or 2 celled 24
24. Ascospores showing gelatinous sheath and/or caudae 25
24. Above characters not combined 27
25. Ascospores showing only gelatinous sheath ..... *Sordaria*
25. Ascospores showing gelatinous sheath and/or caudae 26
26. Ascospores connected in pairs ..... *Zygopleurage*
26. Ascospores not connected in pairs and showing primary and/or secondary caudae ..... *Podospora*
27. Ascomata glabrous (smooth) ..... *Microascus*
27. Ascomata covered with characteristic peridial appendages ..... *Chaetomium*
28. Conidigeous cells enclosed in pycnidia 29
28. Conidigeous cells not enclosed in pycnidia 30
29. Pycnidia aggregated in botryose clusters, conidia dark brown at maturity, ellipsoidal, 1-septate, with longtuidinal stariation ..... *Lasiodiplodia*

29. Pycnidia mostly separate, comidia hyaline, 1-septate and relrly 2-septate ..... *Phoma*
30. Conidia solitary..... *Botryotrichum*
30. Conidia not solitary..... 31
31. Conidia formed in acropetal succession 32
31. Conidia formed in basipetal succession..... 33
32. Conidia formed on some distance apart on a sympodially elongating sympodial shaped rachis … ..... *Baeuvaria*
32. Conidiaformed on short, swollen conidgenous cells ..... *Cephaliophora*
33. Conidigenous cells annellides increasing in length; synematous, conidia brown or hyaline 34
33. Conidiogenous cells progressively shorting; not synematous, conidia hyaline, fusiform to falcate with a differentiate foot cell ..... *Fusarium*
34. Conidia produced in slime or synnemata gelatinous ..... *Parascedosporium*
34. Conidia dry, synnemata not gelatinous..... 35
35. T Conidia in chains..... *Cephalotrichum*
35. Conidia single ..... *Mycosylvia*

Discussion

The distribution pattern of coprophilous mycobiota on different types of dung based on the presence/absence showed that recorded taxa could be tentatively classified into 3 groups. Group 1 comprises taxa of occurrence restricted to a single type of dung (22 species) e.g., *Sordaria superba*, *Myxotrichum chartarum*, *Myceliophthora sepedonium*, *Chaetomium gracile*. *Thielavia* showed occurrence restricted to camel dung and *Lasiobolidium* showed greater occurrence on camel than any other type of dung. Group 2 consists of species occurring in 2 types of dung (14 species, 22.95% of the total species number) e.g., *Piptocephalis arrhiza*, *Rhopalomyces elegans*, *Ascobolus immersus*. Group 3 comprises taxa occurring in all types of dung (25 species) e.g., *Lichtheimia corymbifera*, *Chaetomium globosum*, *Lasibolidium aegyptiacum* and *Kernia nitida*.

Based on the value of frequency of occurrence, the distribution pattern of ascosporic species among different types of dung indicated that while some species were of restricted occurrence on certain types of dung (e.g., *Thielavia* on camel dung), some others were of common occurrence in almost all types of dung (e.g., *Chaetomium globosum*, *Saccobolus glaber*). Such observations on the species-substrate relationship have also been reported among coprophilous fungi by Lundqvist (1972), Angel & Wicklow (1975), Parker (1979), Richardson (2001a) and Abdel-Azeem (2003, 2009). They advocated that the physical and chemical properties of dung differ from 1 animal to another and so the dung from a particular animal would favour colonization by certain fungi.

Chaetomium was the most frequent genus; it was represented by 7 species. *Lasiobolidium egyptiacum* is the most widespread taxon recorded. To our knowledge up till now *Coprinopsis stercorea* is apparently a new record for Egypt. In a previous study, on camel dung, by Bagy et al. (1986), 70 species were registered, some of which were apothecial or perithecial while some others were not exclusively coprophilous (e.g. *Emericella nidulans*).

Values of relative species richness of coprophilous fungi in this study in Egypt compared to values of the same groups worldwide, show that our knowledge of Egyptian coprophilous fungi is fragmentary and need more intensive studies (Abdel-Azeem 2010). The species diversity of coprophilous fungi from herbivore dung in Saint Katherine protectorate is very high. Most of the isolates and species were obtained from feral donkey. The correlation observed between the type of dung on one hand and coprophilous fungi on the other hand need further elucidation. We hope that this study will create awareness and generate interest to carry out more surveys and highlight the importance of mycology to biodiversity conservation.

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