
Coprophilous ascomycetes in Kenya: *Chaetomium* species from wildlife dung

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In our studies to document the diversity and distribution of coprophilous ascomycetes in Kenya, we collected several species in *Chaetomium*. This genus, comprises a large group of saprobic ascomycetes growing on dung and other cellulose-rich substrates. In the present study we collected wild animal dung from different ecosystems in Kenya. The dung substrate was laboratory cultured using a moist chamber method. Five taxa, *Chaetomium convolutum*, *C. globosum*, *C. muelleri*, *C. seminis-citrulli* a new record and *Chaetomium* sp., probably a novel species, are examined, described and illustrated. *Chaetomium convolutum* and *C. globosum* are the most common taxa in the dung studied. *Chaetomium* seems to have a preference of growing on browser animal dung.

Key words – basal fascicles – biodiversity – Chaetomiaceae – saprobic – taxonomy – wild animals

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Introduction

Chaetomium Kunze belongs to the family Chaetomiaceae G. Winter (www.indefungorum.org/Names/Names.asp October 2012). Species of this genus are very homogenous making intra-species differentiation very difficult. *Chaetomium* species grow on a variety of substrates such as plant remains, decomposing textiles, seeds, dried spices and sugar cane, with many species preferring materials with high cellulose content (von Arx et al. 1986, Doveri 2004, 2008, Bell 2005, Abdullah & Saleh 2010).

The genus is characterized by superficial perithecioid, rarely cleistothecioid, ostiolate dark ascomata, usually adorning

flexuous, spirally coiled or uncinata, rigid, straight or slightly curved setae and warted or verruculose, rarely smooth, wavy branched hairs over the entire ascoma and connected to the substrate by rhizoidal hyphae. Species of this genus have a relatively wide ostiolar pole whose apex is lined with periphyses and completely covered by terminal hairs making it almost obscure (von Arx et al. 1986, Doveri 2004, 2008, Bell 2005).

The relatively ephemeral asci develop in basal fascicles and are stalked, clavate, fusiform, obovate or narrow with a somewhat thin unitunicate evanescent wall. The ascospores are single-celled, pigmented, pale when young, brown or grey olivaceous at

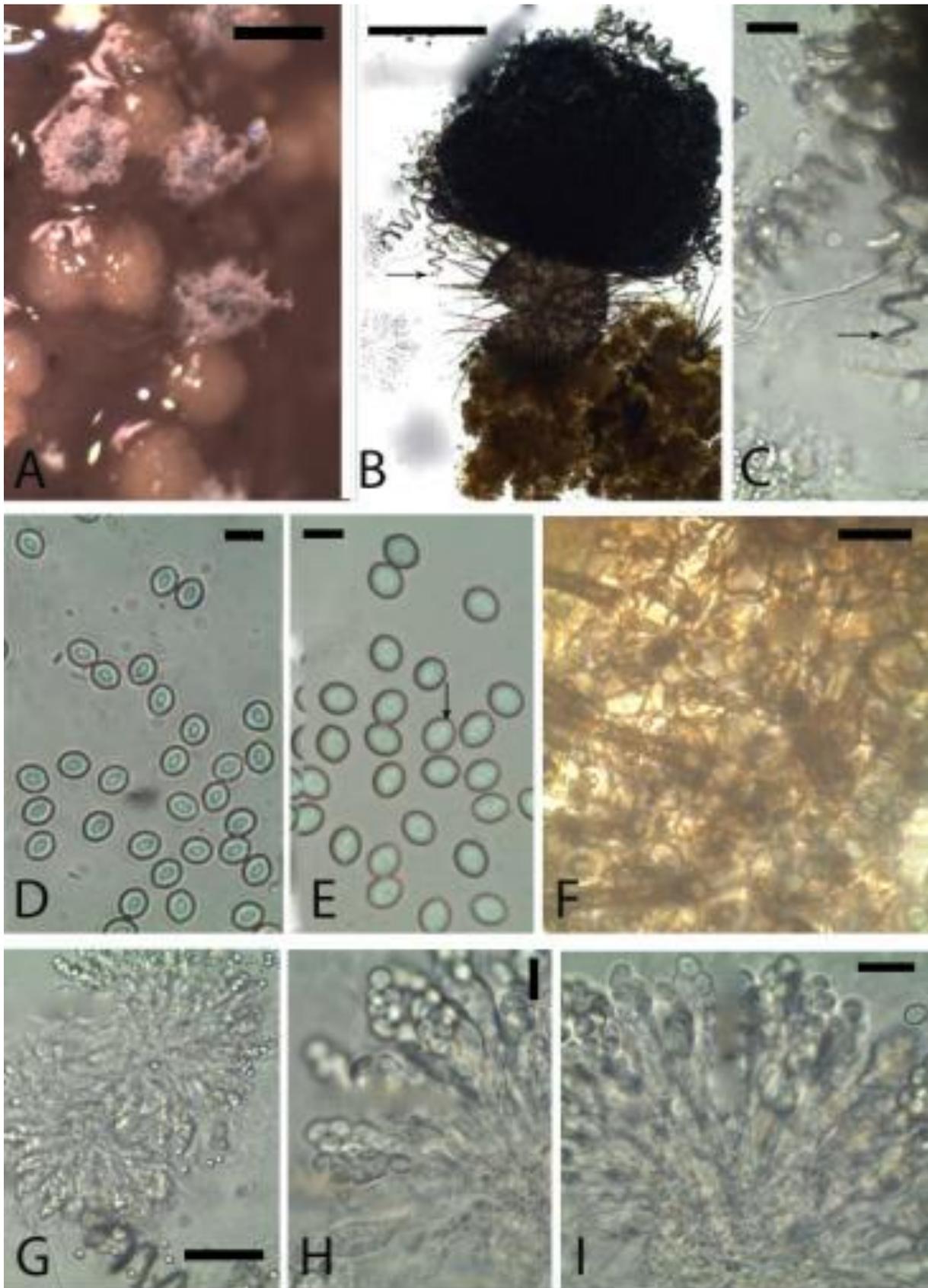


Fig. 1 – *Chaetomium convolutum* (KWSTE005B-2008). **A** Ascomata on dung. **B** Squashed ascoma, note uneven spiralling (arrow). **C** Terminal hairs, note uneven spiralling (arrow). **D-E** Mature ascospores, note apical germ pore (arrow). **F** Ascumatal wall, note the petalloid structure (arrow). **G-I** Asci at various stages of development. **Scale bars:** **A** = 500 μ m, **B** = 200 μ m, **C G** = 50 μ m, **D-F** = 20 μ m, **H-I** = 20 μ m.

maturity and have one or two distinct non-protuberant germ pores. Ascospores of most species are bilaterally flattened and are released from asci in a dark sticky cirrhous from whence ascomatal wall, ascospore and cultural attributes are important diagnostic features for this genus.

The genus is known to produce important secondary metabolites such as chaetomin, chaetoglobosins, cochliodinol sterigmatocystin, O-methylsterigmatocystin, chaetochromin, chaetocin and mollicellin G which have a wide range of bioactivity including antibacterial, mutagenesis, toxicity and as natural dyes (Piecková 2003).

Chaetomium has been recorded in many places worldwide (von Arx et al. 1986, Bell 1983, 2005, Doveri 2004, 2008). *Chaetomium bostrychodes* Zopf, *C. murorum* Corda and *C. convolutum* Chivers, *C. apiculatum* Lodha, *C. aureum* Chivers, *C. caprinum* Bainier, *C. coarctatum* Serg., *C. cochliodes* Palliser, *C. cuniculorum* Fuck., *C. dolichotrichum* Ames, *C. funicola* Cke, *C. globosum* Kunze, *C. indicum* corda, *C. multispirale* Carter, *C. quadrangulatum* Chivers, *C. retardatum* Carter & Khan, *C. subspirale* Chivers and *C. succineum* Ames, *C. crispatum* (Fuckel), *C. murorum*, *C. olivaceum* Cke & Ellis and *C. mareoticum* Besada & Yusef, *C. fusiforme* Chivers and *C. undulatum* Bainer have been recorded in Kenya (Minoura 1969, Carter & Khan 1982, Gatumbi et al. 1994, Caretta et al. 1998). These studies depict high diversity of *Chaetomium* species in this country.

The primary objectives of this survey were to: i) to examine and classify *Chaetomium* species from wild herbivore dung, ii) document species diversity and distribution of *Chaetomium* associated with dung from different wild herbivores in Kenyan National Parks and iii) create awareness on role of fungi in conservation and management of biodiversity and the environment.

Materials and methods

Dung from wild animals including Kirk's dikdik (*Madoqua kirki* Günther), Jackson's hartebeest (*Alcelaphus buselaphus* Pallas) and impala (*Aepyceros melampus* Lichtenstein) which are rarely studied substrates, were collected from Tsavo East

they are dispersed in various ways including small animals and insects (von Arx et al. 1986, Bell 2005, Doveri 2008). Morphological characters of the terminal hairs, National Park, Nairobi National Park and from the Aberdare Country Club Game Sanctuary. These were incubated in a moist chamber and examined over about three months. Refer to our work on coprophilous *Ascobolus* and *Saccobolus* species from wildlife dung in Kenya for details on materials and methods (Mungai et al. 2012a, b).

Taxonomy

Chaetomium Kunze, in Kunze & Schmidt, Mykologische Hefte (Leipzig) 1: 15, 1817.

The genus *Chaetomium* belongs to the family Chaetomiaceae which was placed in the order Sordariales based on molecular studies (Lee & Hanlin 1999). *Chaetomium* is notably comprised of very similar species thereby making delimitation using morphological characters a difficult task (von Arx et al. 1986, Bell 2005, Doveri 2008).

Dreyfuss (1976) divided *Chaetomium* into ten basic groups but was only able to study four of these in detail, namely, the *C. murorum*, *C. globosum*, *C. bostrychodes* and *C. aureum* groups. These are based on the temperature and nutritional requirements, growth and fruiting body development rates, anamorph, compatibility, asci, ascospores shape and ontogeny.

The genera *Achaetomium*, *Subramaniula* and *Chaetomidium* resemble *Chaetomium*. However, *Achaetomium* can be differentiated from *Chaetomium* by having ascomata that are devoid of distinct hairs or seta-like ornamentation, dark chocolate brown ascospores and a thick-walled textura *intricata* ascomatal wall (Dreyfuss 1976, Cannon 1986, Rodriguez et al. 2004). *Subramaniula* also lacking seta-like ornamentation can be differentiated by its thin-walled ascomata of *textura epidermoidea* cells and a wide ostiole surrounded by a collar of thin-walled hyaline cells (Cannon 1986, von Arx et al. 1988), while *Chaetomidium* is differentiated by its non-ostiolate globose ascomata and being evenly hairy (von Arx et al. 1988, Doveri et al. 1998). According to Greif et al. (2009) a

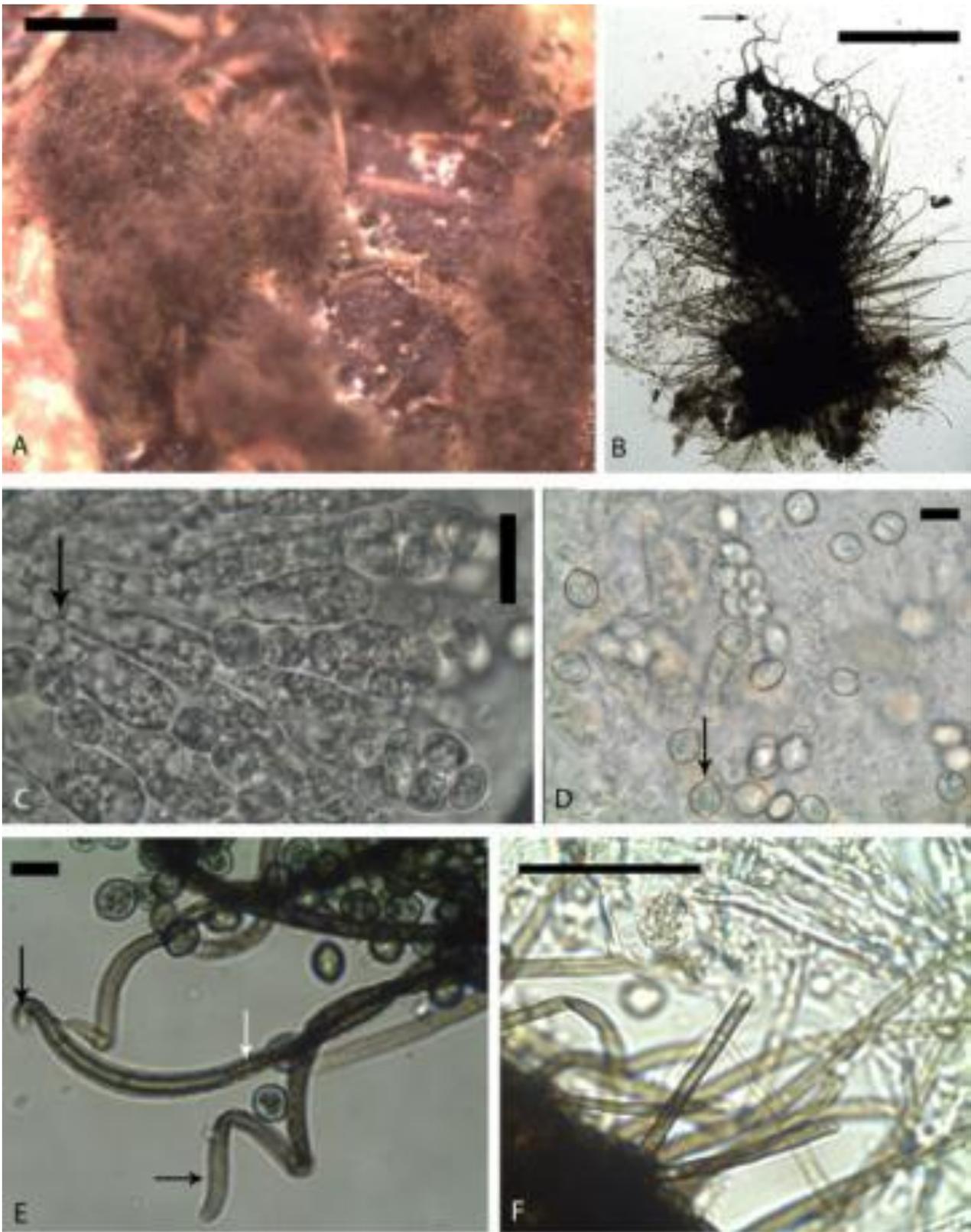


Fig. 2 – *Chaetomium globosum* (KWSNNP013-2009). **A** Ascomata on dung. **B** Squashed ascoma, note coiling of terminal hairs. **C** Mature asci, note stipe. **D** Free mature bi-apiculate ascospores, note germ pore (arrow). **E** Terminal hairs showing coiled tips and warty surfaces (arrows). **F** Lateral hairs. **Scale bars:** **A** = 500 μm , **B** = 200 μm , **C-F** = 20 μm .

cephalothecoid peridium used in the past by many authors as a diagnostic character does not seem to be homologous within *Chaetomidium* and therefore he argues that this cannot be used to correctly circumscribe the genus. This genus *Chaetomium* is treated in detail by Dreyfuss (1976), von Arx et al. (1984), von Arx et al. (1986), Bell (2005) and

Doveri (2008). Recent molecular phylogenetic studies (Lee & Hanlin 1999, Greif et al. 2009) have helped resolve the confusion in the systematics of Chaetomiaceae.

In the current study, we have examined morphological features such as the shape of terminal hairs, ornamentation, spiraling and arrangement, peridial wall structure, colour, size and shape of ascospores, presence of germ pore(s) and the characters of hair ends to describe the *Chaetomium* species presented in this paper (Dreyfuss 1976, von Arx et al. 1984, von Arx et al. 1986, Bell 2005, Doveri 2008).

Chaetomium convolutum Chivers. Proc. Amer. Acad. 48: 85, 1912 Figs.1.A–I
Synonyms

Chaetomium hydrabadense Salam & Nusrath, J. Indian Bot. Soc. 38:543, 1960.

Chaetomium biapiculatum Lodha, J. Indian bot. soc. 43:124, 1964.

Chaetomium concinnum Sorgel ex Seth. Nova Hedwigia 37:52, 1972.

Chaetomium montiblanchense Guarro et al. Nova Hedwigia 32:207, 1980.

(Synonyms based on von Arx 1986)

Ascomata perithecioid, superficial, with well-developed dark brown rhizoids, 300–600 µm high, 100–225 µm diam., gregarious, pale to metallic or grey when young, obovate, ovoid, turbinate or ampulliform, ostiolate, ostiolar region wall often darker. *Peridial wall* ochraceous or cinnamon-brown, elongate, thick-walled cells of *textura cephalothecoidea* arranged in a petalloid structure around a hair bearing cell. *Terminal hairs* not branched, arising from the apical collar, erect, unevenly spiraled, thick walled, brown, septate, verrucose, the tips circinate; *lateral hairs* simple, up to 6 µm in diam., straight, tapering, bristle-like, septate, brown, warty. *Paraphyses* and interascal tissue not observed. *Asci* 8-spored, 34.5–54.5 × 9–12.5, unitunicate, thin-walled, fasciculate, abundant, clavate, without

an apical apparatus; stipe long, evanescent. *Ascospores* irregularly multi-seriate, 7–9.5 × 6.5–7.5 × 5–6.5 µm, limoniform to almost spherical, laterally flattened, single-celled, smooth, hyaline and dextrinoid when young, pale grey-bluish when mature, darker near the ends, without gelatinous equipment, bi-apiculate, germ pore apical.

Material examined – four isolates on dung incubated for 18, 40 and 41 days – KENYA, Tsavo East National Park, Coast Province, GPS S03°02'29.7" E038°41'35.8", riverine habitat, altitude 354 m, dikdik, 27-8-09, P. Mungai, KWSTE005B-2008; GPS S03°21'666" E038°38'772", riverine, altitude 514 m, giraffe, 23-9-08, P. Mungai, KWSTE002A-2008; GPS S03°032'447" 038°37'828", riverine, altitude 514 m, dikdik, 23-9-08, P. Mungai, KWSTE006A-2008; GPS S01°20'50.1" E036°47'51.3", savannah grassland, altitude 1681 m, Jackson's hartebeest, 31-8-09, P. Mungai, KWSNNP013-2009.

Notes – *Chaetomium convolutum* belongs to *C. bostrychodes* Zopf group. It therefore closely resembles *C. bostrychodes* from which it is differentiated by the former's relatively larger ascospores with darkened ends and a darker *cephalothecoid* peridium (von Arx et al. 1986, Doveri 2004). Intermediate species between *C. convolutum* and *C. bostrychodes* are frequently observed (von Arx et al. 1986).

Chaetomium globosum Kunze:Fr Syst. Mycol. Soc. 44:46, 1961. Figs.2A–F, 3A–D
Synonyms

=*Chaetomium globosum* Kunze, Mykologische Hefte (Leipzig) 1: 16, 1817.

=*Chaetomium chartarum* Ehrenb. Sylv. Mycol. Berol. 15:27. 1818.

=*Chaetomium fieberi* Corda, Icones Fung. 1: 24. 1837.

=*Chaetomium lanosum* Peck, Rep. N.Y. state museum Nat. Hist. 28: 64. 1876.

=*Chaetomium orientale* Cooke, Grevillea 5: 103. 1877

=*Chaetomium kunzeanum* Zopf, Nova Acta Acad. Leop. Carol. 42: 278. 1881.

=*Chaetomium cymatotrichum* Cooke, Grevillea 12: 21. 18883

=*Chaetomium varium* Delacr., Bull. Soc. Mycol. Fr. 13: 114.1897.

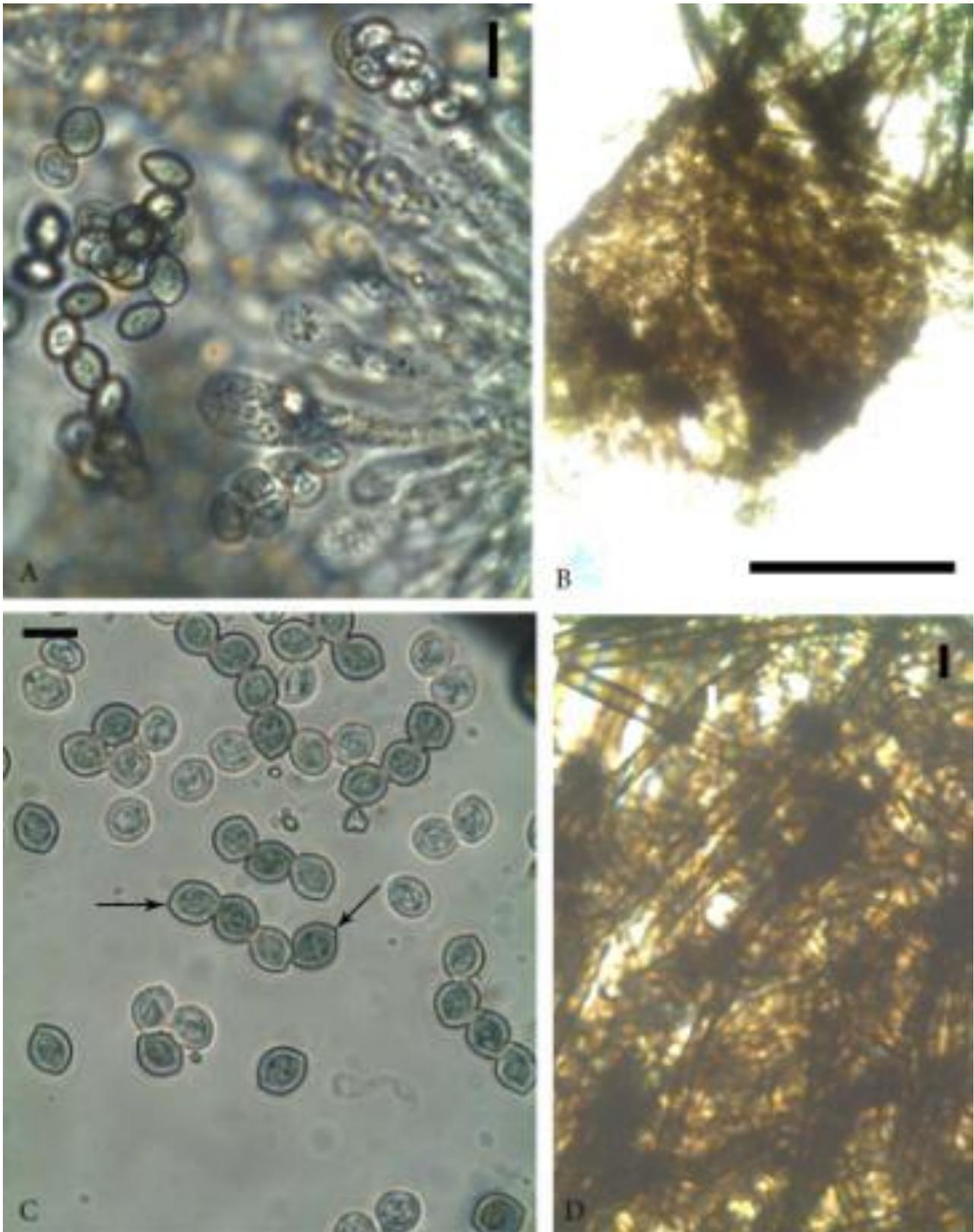


Fig. 3 – *Chaetomium globosum* (KWSNNP013-2009). **A** Mature and immature asci and ascospores. **B** Squashed ascoma. **C** Free mature ascospores, note germ pores (arrows). **D** Terminal hairs. **Scale bars:** **A C D** = 20 μ m, **B** = 50.

- =*Chaetomium elasticae* Koorders, Verh. K. Akad. Wet. Amsterd. 134: 185. 1907.
- =*Chaetomium cochliodes* Palliser, North Amer. Flora 3: 61. 1910.
- =*Chaetomium flexuosum* Palliser, North Amer. Flora 3: 61. 1910.
- =*Chaetomium setosum* Bainier, Bull. Soc. Mycol. Fr. 25: 209. 1910.
- =*Chaetomium angustum* Chivers, Mem. Torrey bot. Club 14: 206. 1915.
- =*Chaetomium subterraneam* Swift & Povah, Mycologia 21: 210. 1929.
- =*Chaetomium kauffumaniunum* Povah, Pap. Mich. Acad. Sci. 13:193. 1931.
- =*Chaetomium ochraceum* Tschudy, Am. J. Bot. 24: 475. 1937.
- =*Chaetomium deustum* Batista & Pontual, Bol. Agr. Pernambuco 15: 72. 1948.
- =*Chaetomium fibripilium* Ames, Mycologia 42: 642. 1950.
- =*Chaetomium lustanicum* Gomes, Dir. Ger. Serv. Flor. Portugal 18: 3. 1953.
- =*Chaetomium angustipirale* Sergejeva, Not. Syst. Sect. Crypt. Inst. Bot. Acad. Sci. USSR 11: 115. 1956.
- =*Chaetomium subglobosum* Sergejeva, Not. Syst. Sect. Crypt. Inst. Bot. Acad. Sci. USSR 13: 172. 1960.
- =*Chaetomium rectum* Sergejeva, Not. Syst. Sect. Crypt. Inst. Bot. Acad. Sci. USSR 14: 143. 1961.
- =*Chaetomium coarctatum* Sergejeva Not. Syst. Sect. Crypt. Inst. Bot. Acad. Sci. USSR 14: 146. 1961.
- =*Chaetomium spiculipilium* Ames, Monograph Chaetomiaceae p. 37. 1963.
- =*Chaetomium aurangabadense* Tilak & Reddy, Mycopath. Mycol. Appl. 24: 329. 1964.
- =*Chaetomium coprophilum* Narendra & Rao, Nova Hedwigia 27: 632. 1974.
- =*Chaetomium cinnamomeum* Subrahm. Gopalk., Kavaka 7: 22. 1980.

(Based on Doveri 2008)

Ascomata perithecioid, superficial, with brown rhizoids, 150–250 µm diam., 400–700 µm high (including terminal hairs), olivaceous to grayish-green, fully covered by a vestiture, with yellowish exudate, gregarious, spherical to ovoid or obovate, ostiolate. *Peridial wall* brown of *textura intricata* of cells 2–3.5 µm broad. *Terminal hairs* numerous, simple, stiff lower parts, flexuous, undulate or irregularly

coiled, tapering, septate, greenish-brown, strongly verrucose, those covering upper part of ascoma 4.5–6.5 µm in diam. at the base. *Lateral hairs* septate, tapering, warty, 3.5 × 84 µm in diam, hardly differentiated from the apical hairs. *Paraphyses* highly evanescent at an early stage, exceeding the asci and mixed with them, filiform, septate. *Asci* ephemeral, 8-spored, 51–77 × 11.5–15.5 µm, clavate or slightly fusiform, evanescent at an early stage, thin unitunicate wall, lacking an apical apparatus; stipe up to 28 µm long. *Ascospores* 9.5–11 × 7 – 9.5 × 6 – 8 µm, irregularly biseriate, limoniform, usually weakly bi-apiculate, bilaterally flattened, fairly thick walled, smooth, brownish when mature, spotting numerous guttules, lacking a gelatinous sheath; single small apical germ pore.

Material examined – three isolates from dung incubated for 8, 11 and 13 days – KENYA, Nairobi National Park, Nairobi Province, GPS S01°20'50.1" E036°47'51.3", savannah grassland, altitude, 1681 m, Jackson's hartebeest, 31-8-09, P. Mungai, KWSNNP008-2009; GPS S01°21'15.1" E036°46'54.1", 1768 m, impala, 31-8-09, P. Mungai, KWSNNP013-2009; GPS S01°20'50.1" E036°47'51.3", savannah grassland, altitude, 1681 m, Jackson's hartebeest, 31-8-09, P. Mungai, KWSNNP009-2009.

Notes – *Chaetomium globosum* is a very common and variable species. Strains of *Chaetomium globosum* possessing spiraled terminal hairs are historically identified as *C. cochliodes* and large-spored variants treated as *C. olivaceum*. Strains sometimes considered as close relatives are heterothallic, often expressing in culture as immature ascomata with retarded growth and development (Dreyfuss 1976, von Arx et al. 1986). *Chaetomium globosum* is usually isolated from soil, rotting vegetation, cellulosic products including paper and is also commonly encountered in indoor environment fungi surveys (Dreyfuss 1976). *Chaetomium globosum* strains are diagnosed through the variability in colony pigmentation and colour of ascomatal hair in reflected light (von Arx et al. 1986, Doveri 2004). The differences in pigment and colour which ranges between pale

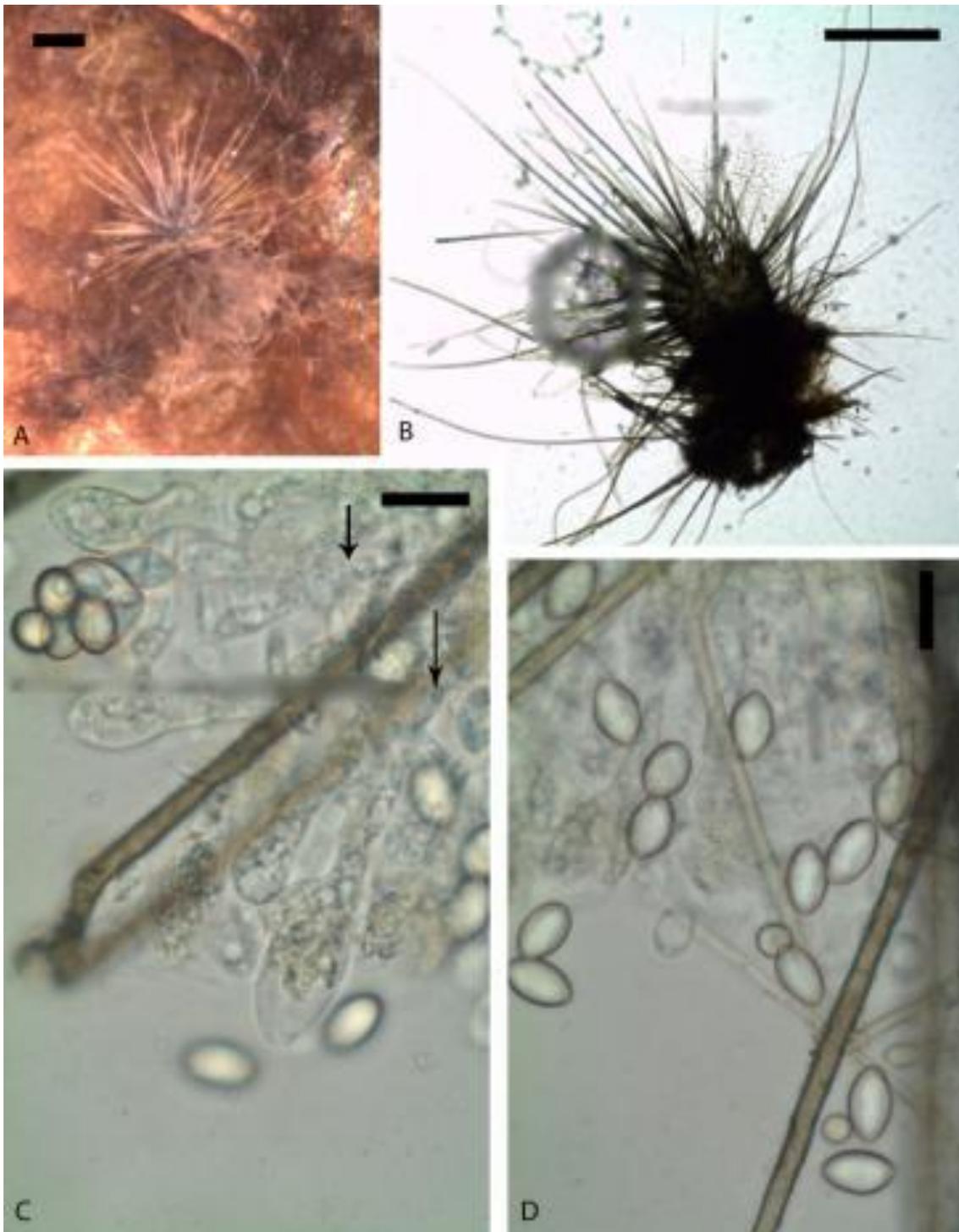


Fig. 4 – *Chaetomium muelleri* (KWSACC004-2009). **A** Ascomata on dung. **B** Squashed ascoma, showing long straight terminal hairs. **C** Asci showing long stipes (arrows). **D** Free mature ascospores. **Scale bars:** **A** = 500 μ m, **B** = 200 μ m, **C-D** = 20 μ m.

green to ochraceous with some even being dark olivaceous are used to circumscribe the strains (von Arx et al. 1986, Doveri 2004). *Chaetomium globosum* is similar to: *C. elatum* Kunze but can be differentiated by an ascomata that develops slowly plus dichotomously (regularly) branched terminal

hairs; *C. subaffine* Serg. differentiated by its larger ascospores and flexuous, straight and longer ascomatal hairs; *C. coarctatum* differentiated by its slower ascomata development and *C. spirochaete* which has dark regularly coiled terminal hairs (von Arx et al. 1986, Doveri 2004).

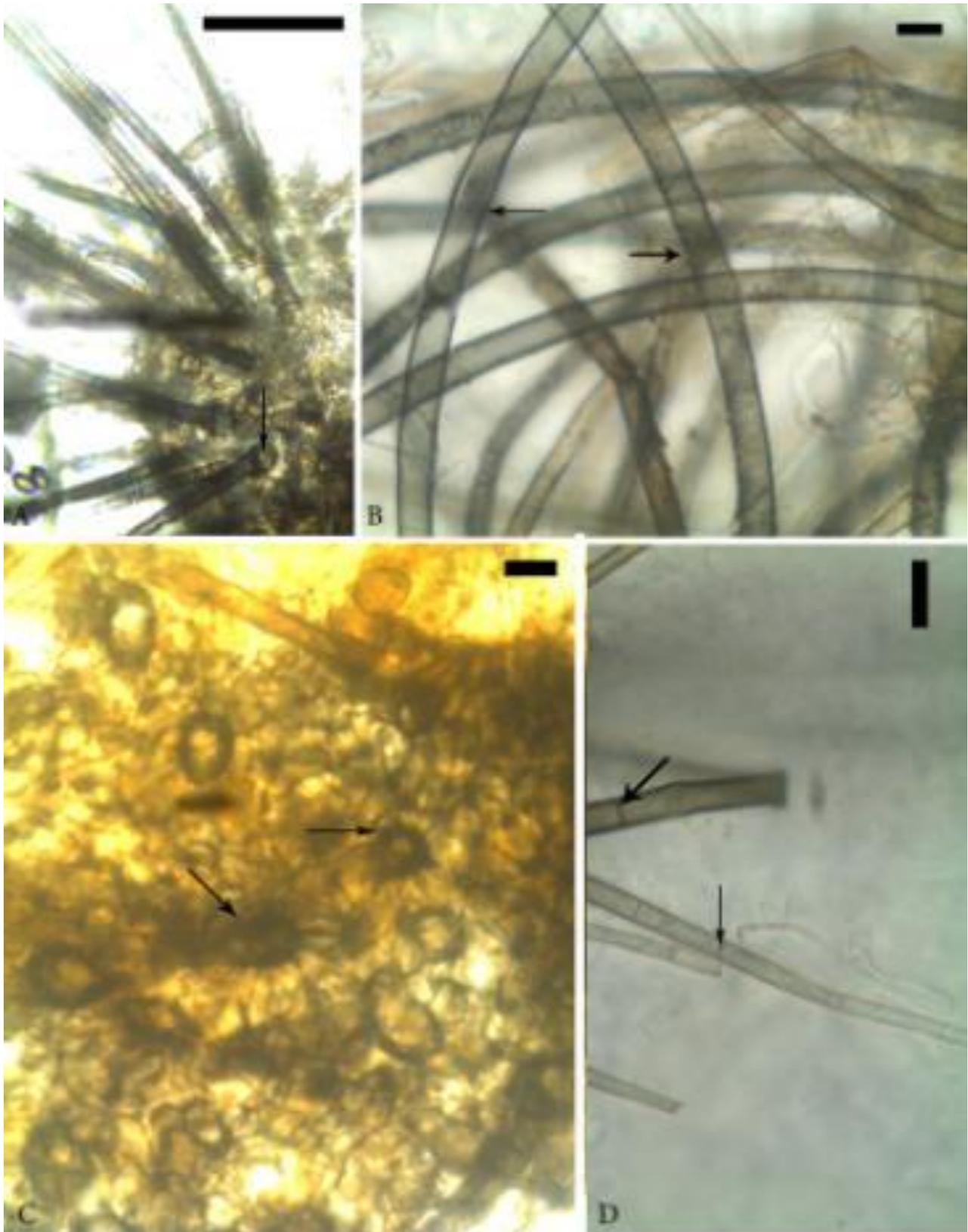


Fig. 5 – *Chaetomium muelleri* (KWSACC004-2009). **A** Lateral hairs, note bulbous base (arrow). **B** Terminal hairs note arcuate and warty nature (arrows). **C** Ascomatal wall note petaloid structure (arrows). **D** Lateral hairs showing septa (arrows). **Scale bars:** **F** = 50 μ m, **G-I** = 20 μ m.

Chaetomium muelleri Arx, in von Arx, Guarro & Figueras, Beih. Nova Hedwigia 84: 6, 1986. Figs 4A–D, 5F–I

Ascomata perithecioid, superficial, 100–320 µm high, 80–185 µm diam., scattered, olivaceous, ovate, ostiolate, exudate not prominent, with white or grayish to pale aerial mycelium, hairs not spirally coiled. *Ascomatal wall* composed of *textura angularis/petaloid* brown or pale cells. *Terminal hairs*, arcuate or flexuous, dark brown, verrucose, over 900 µm long, 3–7 µm broad, sparingly septate: tips pale or hyaline, straight. *Lateral hairs* seta-like up to 13 µm diam. at base, verrucose, septate. *Paraphyses* not observed. *Asci* 8-spored, 38.5–65.5 × 14.5–16.5 µm, clavate, unitunicate, thin non-persistent wall, long stipitate. *Ascospores* 10.5–13.5 × 7–8 µm, irregularly multiseriate, ellipsoid-fusiform, with rounded ends, smooth, grayish-brown at maturity, lacking gelatinous appendages or sheath; germ pore protuberant, slightly sub-apical.

Material examined – single isolate on dung incubated for 47 days – KENYA, Aberdare Country Club Game Sanctuary, Central Province, GPS S00°19'25.4" E036°55'50.7", highland woodland, altitude 2025 m, 30-8-09, dikdik, P. Mungai, KWSACC004-2009.

Notes – *C. muelleri* is close to *C. carinthiacum* Sorger, however the latter has smaller ascospores and paler thinner ascomatal hairs (von Arx et al. 1986). The ascospores of *C. muelleri* are similar in size to those of *C. raii* Malhotra & Mukerji. However, the latter is differentiated by the ascomatal shape and flexuous spirally coiled hairs (Doveri 2008). This is a new record for Kenya.

Chaetomium seminis-citrulli Sergejeva, Not. Syst. Sect. Crypt. Inst. Bot. Acad. Sci. U.R.S.S. 11: 113, 1956. (Figs.6A–I)

Chaetomium semen-citrulli, Notul. Syst. Sect. Cryptog. Inst. Bot. Acad. Sci. U.S.S.R. 11: 113. 1956.

Ascomata perithecioid, superficial, 800–1000 µm high (including hairs), 150–290 µm diam., gregarious, dark-gray in reflected light, ostiolate, globose, fully covered by hairs, with white aerial mycelium. *Peridial wall* very thin, dark brownish. *Ascomatal hairs* numerous, wavy, thick-walled, over 900 µm

long, unbranched, straight and bulbous at the base, apically circinate, indistinctly septate, grey, dark brown, almost smooth to verruculose, 4–8 µm broad in middle parts. *Paraphyses* moniliform, hyaline, few, 6–8 µm broad, very evanescent, septate. *Asci* 8-spored, 63.5–84.5 × 16–21 µm, unitunicate, thin walled, evanescent, claviform, long stipitate. *Ascospores* 12.5–14 × 7.5–8.5 µm, irregularly biseriolate, bilaterally flattened, broadly ellipsoidal, somewhat thick-walled, with rounded ends, rather symmetrical, smooth, olivaceous or pale grayish at maturity, with an indistinct apiculus on one end and a distinct germ pore at the attenuated end.

Material examined – one isolate on dung incubated for 34 days – KENYA, Aberdare Country Club Game Sanctuary, Central Province, GPS S00°19'25.4" E036°55'50.7", highland woodland, altitude 2025 m, 30-8-09, dikdik, P. Mungai, KWSACC004-2009.

Notes – *Chaetomium seminis-citrulli* ascospore size and shape resemble those of *C. elatum* and *C. gangligerum* Ames but the size of asci is notably different (von Arx et al. 1986). It is related to *C. crispatum* which has smaller asci and ascospores (von Arx et al. 1986). *Chaetomium seminis-citrulli* is also close to *C. vitellinum* Carter from which it is differentiated by having smaller bilaterally flattened ascospores (Doveri 2004). The spore size range and asci width of *C. seminis-citrulli* falls within the limits of *C. succineum*, the only difference being the asci length (von Arx et al. 1986). According to Doveri (2004, 2008) this species is rare and has only been observed in USSR, Israel and Italy previously. This is a new record for Kenya.

***Chaetomium* sp.** from dikdik dung, herbarium number KWSACC004-2009 (Figs.7A–E, 8F–I)

Ascomata perithecioid, superficial, 400–620 µm high, 100–270 µm diam., solitary or gregarious, spherical or ovate, with light greenish exudate, with white aerial mycelium. *Peridial wall* pale brown, composed of *textura angularis* thick-walled cells. *Terminal hairs* numerous, 3–5.5 µm broad, flexuous, with even spirals, variable length, septate, verrucose, white to pale green. *Lateral hairs* fewer, 5–6 µm broad at base, up to 90 µm long,

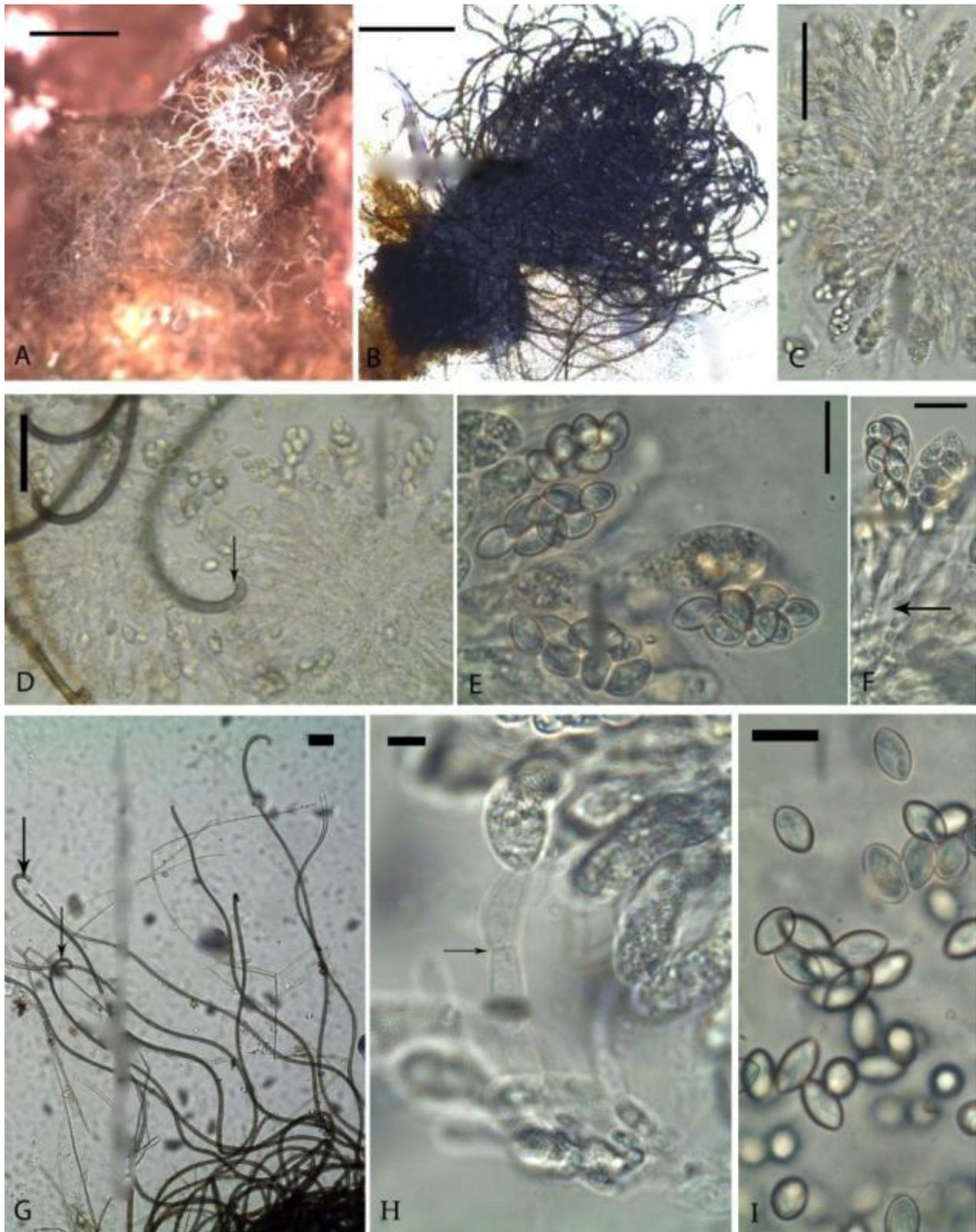


Fig. 6 – *Chaetomium seminis-citrulli* (KWSACC004-2009). **A** Ascomata on dung. **B** Squashed ascoma. **C** Asci. **D** Terminal hairs and asci, note curved apices (arrow). **E- F** Mature asci and ascospores, note stipe (arrow). **G** Terminal hairs showing curved apices (arrows). **H**. Paraphyses, note septation (arrow). **I** Free mature ascospores. **Scale bars:** **A** = 1000 μm , **B** = 200 μm , **C-E** = 50 μm , **F-J** = 20 μm .

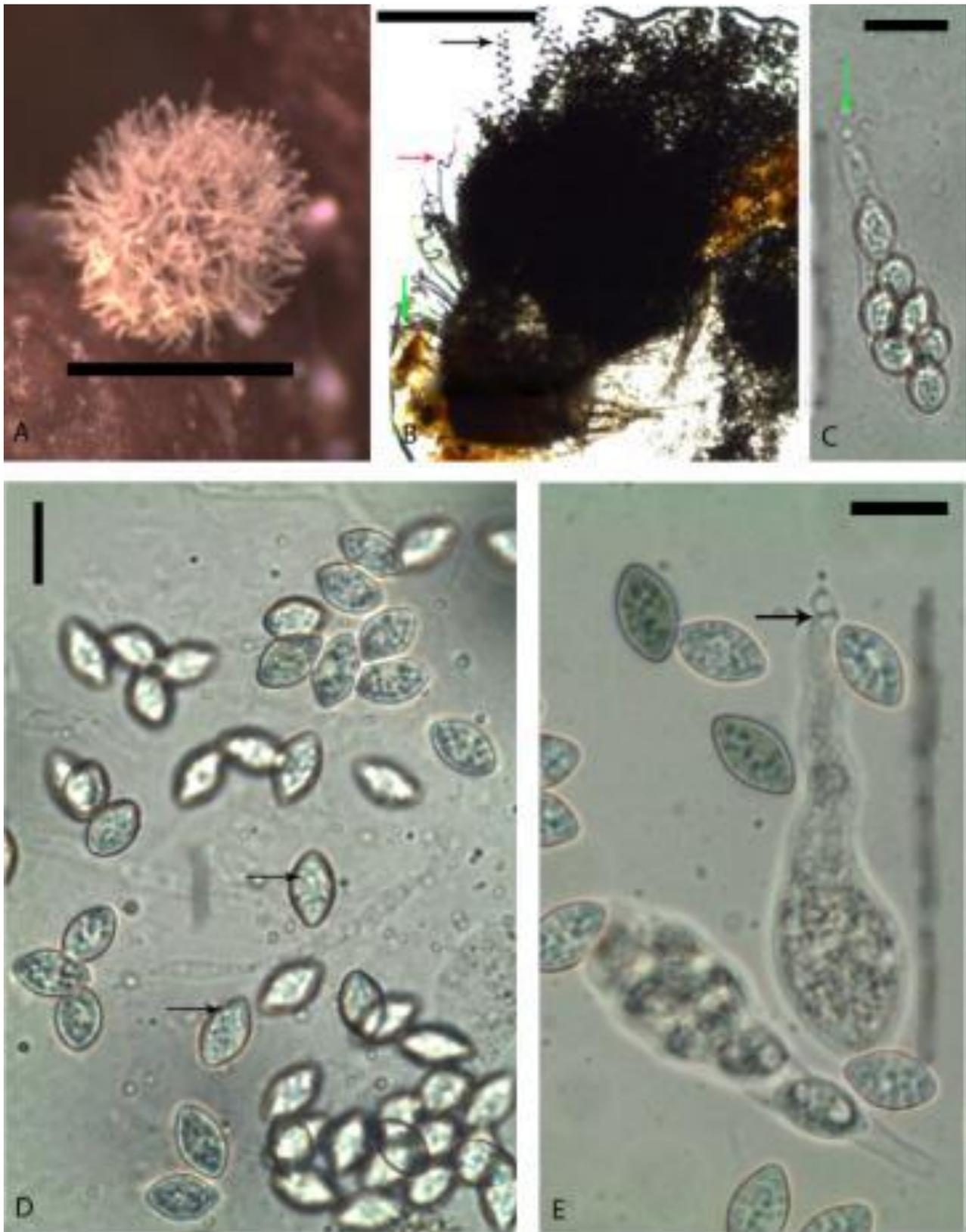


Fig. 7 – *Chaetomium* sp (KWSACC004-2009). **A** Ascoma on dung. **B** Squashed ascoma, note even spiraled terminal hairs (black arrow), lateral hairs tips (red and green arrow). **C** Ascus, note ascospore arrangement and stipe (arrow). **D** Free mature ascospores amongst paraphyses. **E** Immature asci amongst free ascospores, note long stipe (arrow). **Scale bars:** **A** = 500 μ m, **B** = 200 μ m, **C-D** = 20 μ m, **E** = 20 μ m.

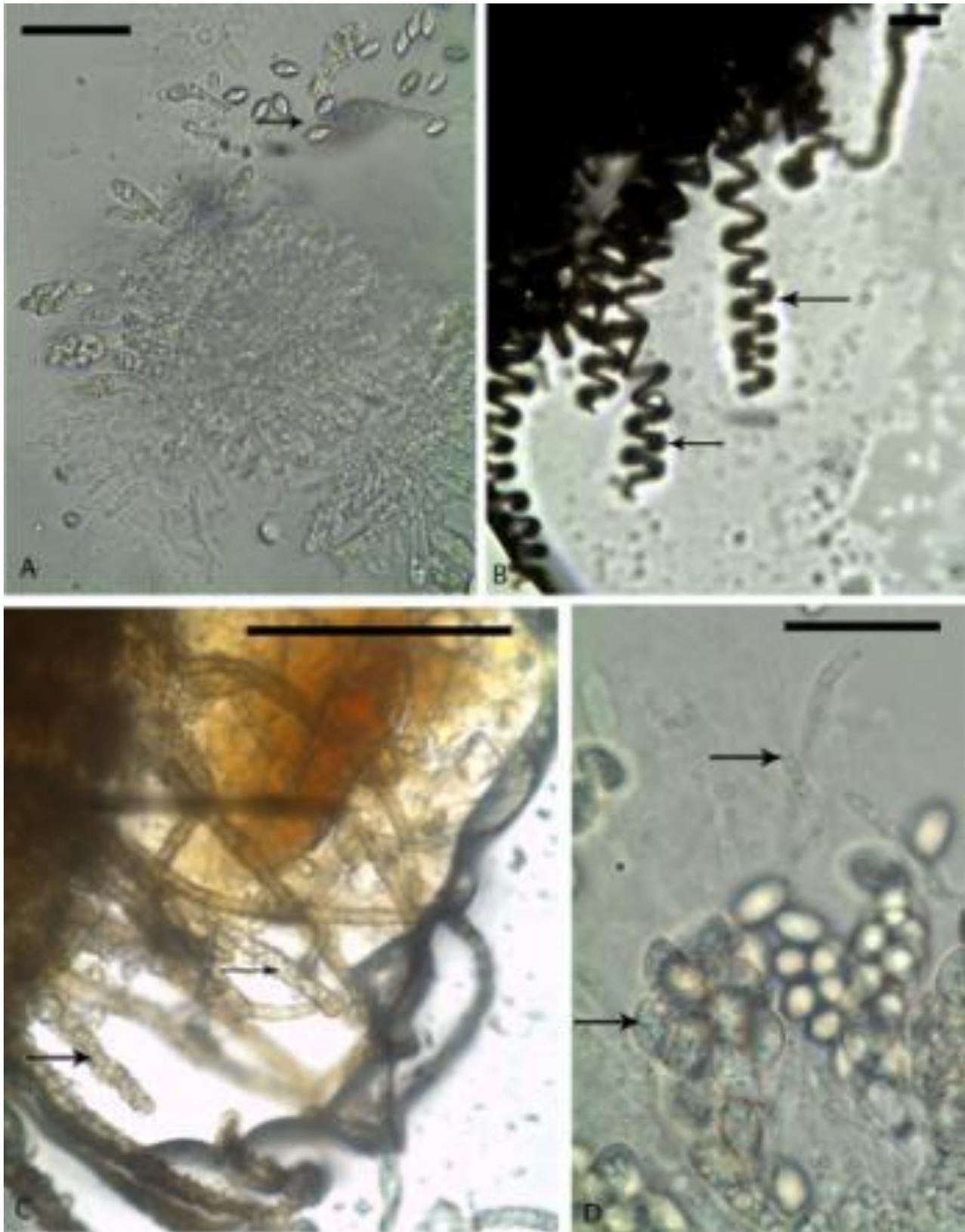


Fig. 8 – *Chaetomium* sp (KWSACC004-2009). **A** Asci with spores at various stages of maturity, note stipe (arrow). **B** Terminal hairs note even spirals (arrows). **C** Lateral hairs, note warty surface (arrows). **D** Asci and paraphyses (arrows). **Scale bars:** A-B = 50 μ m, C-D = 20 μ m.

brown, septate, verrucose; tips coiled or straight. *Paraphyses* scanty, moniliform, 3.5–7.5 μm broad, septate hyaline, with numerous vacuoles. *Asci* 8-spored, 58–61.5 \times 15.5–18 μm , broadly clavate to obovate, evanescent, with slender stipes 10–17 μm long. *Ascospores* 10.5–14 \times 6.5–8 μm , irregularly biserial, ellipsoidal–fusiform, symmetrical, attenuated and umbonate at both ends, brown when mature, with many oil droplets, bi-apiculate

Material examined – a single isolate on dung incubated for 47 days – KENYA, Aberdare Country Club Game Sanctuary, Central Province, GPS S00°19'25.4" E036°55'50.7", highland woodland, altitude 2025 m, dikdik, 30-8-09, P. Mungai, KWSACC004-2009 holotype.

Notes – *Chaetomium* sp. appears to be close to *C. gracile* and *C. gangligerum*; the ascospore size is within the range for *C. gracile* and *C. gangligerum*; the width of the asci of our collection is also similar to that of *C. gracile* and *C. gangligerum*; however, the length is markedly different (von Arx et al. 1986, Doveri 2008). Another notable difference is the evenly spiraled terminal hairs in our specimen. This collection is also similar to *Chaetomium raii* (von Arx et al. 1986, Doveri 2008), but has slightly smaller ascospores and wavy terminal hairs (von Arx et al. 1986). The description of this specimen does not fully fit into any of the currently known species and therefore we treat it as an unknown species pending further examination to determine conclusively if it is a novel species or not.

Discussion

Morphology and species cultural attributes were used to characterize the Kenyan *Chaetomium* specimens in this study. Most of the specimens had ascomata growing superficially on dung, adorning either flexuous, spirally coiled or uncinat hairs and connected to the substrate by rhizoidal hyphae. The ascomata had relatively wide ostioles lined at the apex by periphyses and surrounded by terminal hairs (von Arx et al. 1986, Bell 2005, Doveri 2008). The terminal hairs typically fully covered the ostiolar orifice thereby making it almost invisible.

The asci developed in basal fascicles and were relatively ephemeral, stalked, clavate, fusiform, obovate or narrow and had a relatively thin unitunicate evanescent wall. Ascospores were single-celled, pigmented, pale when young, brown or grey olivaceous at maturity and had one or two distinct germ pores. Most of our specimens had ascospores that were bilaterally flattened (Bell 2005) and usually were released from asci in a dark sticky mass (von Arx et al. 1986, Bell 2005).

Chaetomium seminis-citrulli, a new record only recorded previously in USSR, Italy and Israel from fox and an unidentified dung type is a very rare species while *Chaetomium* sp isolated from dikdik dung is probably a novel species (Carter & Khan 1982, von Arx et al. 1986, Doveri 2004).

Chaetomium is not considered as truly coprophilous ascomycetes as species of this genus usually grow on a variety of other substrates such as plant remains, decaying textiles, seeds and dried spices, many of them showing a preference to material with high cellulose content (von Arx et al. 1986, Doveri 2004, 2008, Bell 2005). Carter and Khan (1982) isolated 16 species from various dung types from Kenya, a majority of which were browsers. The results of the current and a previous study (Mungai et al. 2011) seem to indicate that species of this genus indeed have a preference to grow on dung of browsing wild herbivores. *Chaetomium convolutum* and *Chaetomium globosum* are very frequent species on wildlife dung in Kenya.

Chaetomium species are thus an important component of dung mycobiota which help in biomass recycling and has potential in biotechnological applications.

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