Four new genera of cleistothecial Ascomycetes with hyaline ascospores

DAVID MALLOCH AND R. F. CAIN
Department of Botany, University of Toronto, Toronto, Ontario
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Four new monotypic genera of cleistothecial coprophilous Ascomycetes are described: *Eremomyces bilateralis* gen. and sp. nov. found on dung in Ontario, California, and Kenya, has hyaline, one-celled ascospores and is accommodated in Eremomyctaceae, a new family of the Loculoascomycetes; *Myco- rhychinum saccatum* gen. and sp. nov. found in Kenya belongs to the Neuctriaceae and is similar to *Mycohyphomyces*; *Cleistothecobolus nigogenus* gen. and sp. nov. found on wolf dung in Ontario, and *Lateololdium spirale* gen. and sp. nov., represented by four collections on horse and cow dung from Nevada and Wyoming are members of the Eoterfeziaceae.

**Introduction**

The four genera treated here represent three unrelated families, one of them new. All of the species described have hyaline, smooth ascospores.

**Eremomyctaceae**

*Eremomyctaceae* Malloch & Cain, fam. nov.


Mycelium hyaline or brown. Asccorcarp initials pseudoparenchymatosis. Asccorcarps subglobose to globose, nonostiolate, glabrous to setose, dark brown to black, with a single cavity. Asci irregularly disposed, subglobose to clavate, evanescent. Ascospores one-celled, hyaline, without gern pores. No conidial stage known.

The Eremomyctaceae is erected to accommodate the single species *Eremomyces bilateralis*. It would include saprophytic Loculoascomycetes with solitary ascosporas and hyaline nonseptate ascospores. The irregularly disposed evanescent asci may not necessarily be of significance at the family level. Apparently, there are no closely related families.

The inclusion of this family with the Loculoascomycetes may seem questionable. Irregularly disposed asci which are not distinctly bitunicate are not usually considered to be characteristic of Loculoascomycetes, although present in some genera such as *Preussia Fockel and Phaeotrichum*.

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Figs. 1-6. *Eremomyces bilateralis*. Fig. 1. Ascocarp initials (× 1500). Fig. 2. Ascocarp (× 130). Fig. 3. Peridial "plate" (× 1500). Fig. 4. Asci (× 1500). Fig. 5. Ascospores (× 1300). Fig. 6. Germinating ascospores (× 1500). Figs. 7-10. *Mycorhynchidium saccatum*. Fig. 7. Ascocarp broken open to show mass of asci enclosed within the common sack-like membrane (× 130). Fig. 8. Peridium surface (× 650). Fig. 9. Asci (× 1500). Fig. 10. Ascospores (× 1500).
Ascocarp initials pseudoparenchymatous. Ascocarps subglobose to globose, black, setose or with long dark hairs, with a single cavity, produced as ascostroma. Asci irregularly disposed, subglobose to clavate, eight-spored, evanescent. Ascospores inequilaterally ellipsoid to reniform, hyaline, smooth, one-celled, without germ pores. Conidial stage unknown.

*Eremomyces* is an unusual Loculoascomycete in that it produces one-celled hyaline ascospores. As Nannfeldt (1932) pointed out, Loculoascomycetes tend to produce dark, septate ascospores and conidia. Superficially, *Eremomyces* resembles some of the tropical leaf parasites such as *Pilgeriella* P. Hennings and *Cleistosphaera* Sydow. It differs from these genera in having irregularly disposed ascii, a cephalotheceid peridium, and in its coprophilous habitat.

The origin of *Eremomyces* is a subject on which it is difficult to speculate. It may have arisen from a stromatic group such as the Dothiorales, through some leaf parasitic form that was regularly being ingested by animals along with its host. It may have originated from the Sporormiaceae, a family of coprophilous species which has given rise to the cleistothecial genus *Preussia* Fückel. All of the members of this family, however, have dark septate ascospores with germ slits. A third possibility is the Venturiaceae which has produced at least one coprophilous species, *Antennularia fimisisa* (Mout.) Barr. The members of the Venturiaceae produce yellowish two-celled ascospores. *Eremomyces* also resembles members of the Venturiaceae by producing setose ascosporas.

Whatever its origin, *Eremomyces* is distinct from all other genera. It is included in its own monotypic family, Eremomyctaceae, because of its apparent lack of close connection with any group.

*Eremomyces bilateralis* Malloch & Cain, sp. nov. Fig. 1-6

Coloniae in agar V8 secundum diametrum acetate 42 dierum 2 cm, coactae, lobatae, griseo-brunneae, zonatae; mycelium ad hyalimum fusco-brunneum; hyphae 1.0-4.5 μ crassae, septatae; ascocarpeae 120-320 μ crassae, subglobosae vel globosae, nigrae, setosae vel crinitae; peridium ascocarpi cephalafoideum; ascii 7.0-15 × 3.5-5.5 μ, ab ovoideis clavati, stipitati, octospori, evanescentes; ascosporae laeves, 3.5-5.5 × 2.0-3.5 μ, ab inaequalilateraliter ellipsoides reniformae, hyalinae; conidia nulla.


**ETYMOLOGY:** Latin, *bilateralis*, referring to the symmetry of the ascospores.

*Colonies* on V8 juice medium (Miller 1955) attaining a diameter of 2 cm in 6 weeks at room temperature, feltly, lobed, grey to brown, indistinctly zonate; reverse dark olive green to brown; hyphae 1.0-4.5 μ in diameter, hyaline to dark brown, remotely to abundantly septate, branch- ed, becoming darkest and most highly septate when submerged or in the vicinity of ascocarps; *ascocarp initials* consisting of an intercalary cell which continuously divides in several planes to form a large pseudoparenchymatous mass which eventually becomes the ascocarp; *ascocarps* 120-320 μ in diameter, subglobose to globose, opaque, black by reflected light, covered with numerous dark flexuous hyphal attachments, setose in age on the natural substrate; *ascocarp peridium* cephalafoideum, consisting of plates of radiating cells which separate at maturity along well-defined lines of dehiscence, dark brown, of one cell type; peridial cells 2-11 μ in diameter, irregular to elongate in surface view, nearly isodiametric in cross section, thick-walled, dark brown; *asci* 7.0-15 × 3.5-5.5 μ, irregularly disposed, ovoid to clavate, short-stipitate, eight-spored, evanescent; ascospores 3.5-5.5 × 2.0-3.5 μ, inequilaterally ellipsoid to reniform, hyaline by transmitted light, white to cream in mass, smooth, nonseptate, without germ pores; conidial stage lacking.


Cultures derived from TRTC 45344 and 45710 have been deposited with the American Type
Culture Collection (ATCC), the Centraalbureau voor Schimmelcultures (CBS), and the Commonwealth Mycological Institute (CMI).

_E. bilateralis_ grows very slowly and somewhat atypically on agar media. Ascocarps tend to split open while still immature; those which reach maturity usually lack the characteristic cephalothecoid peridium. Pure cultures on sterilized dung, however, grow well and produce typical ascocarps. On the natural substrate the ascocarps, although minute, are fairly prominent because of their completely superficial growth habit. On the natural substrate, too, the ascocarps produce short setae rather than the long hairs seen in agar culture.

**Hypocreaceae**

*Mycorrhynchium* Malloch & Cain, gen. nov.


**Typus Generis:** *Mycorrhynchium saccatum* Malloch & Cain.

**Etymology:** The genus _Mycorrhynchus_ and the Latin diminutive suffix, _-idum_, referring to the similarity of _Mycorrhynchus_.

Ascocarps subglobose to globose, orange, glabrous to sparingly hairy, nonostiolate, nonstromatic. Ascii irregularly disposed, clavate, enclosed together within a common sack-like membrane. Ascospore unequally two-celled, clavate, hyaline, without germ pores. Conidial stage unknown.

*Mycorrhynchium* is a nonostiolate counterpart of _Mycorrhynchus_ Saccardo, a genus of Hypocreaceae according to Petrak and Sydow (1935) and Rogerson (1970). _Mycorrhynchium_, with only one known species, _M. saccatum_, has three-spored ascus, a condition known in at least one species of _Mycorrhynchus_. It differs from _Mycorrhynchus_ in having nonostiolate ascocarps and asci entirely enclosed in mass, in a membranous envelope. This type of membranous envelope also occurs in species of _Monascus_ van Tieghem and _Triptrerospora longicaudata_ Cain and apparently develops as a result of the breakdown of the inner peridial layers.

The genus _Mycorrhynchus_, although monographed and illustrated by Breton and Faurel (1967), is still not well known. It has not been studied in pure culture, although for a few months, we had a culture in our laboratory. This culture was contaminated with several other fungi and bacteria and produced numerous ascocarps. All attempts to subculture it were unsuccessful. _Mycorrhynchidium_ is very similar to _Mycorrhynchus_ and might be expected to show the same range of characteristics.

**Mycorrhynchidium saccatum** Malloch & Cain, sp. nov.

Figs. 7-10

Ascocarps 230–310 μ crassae, globoseae, aurantiaceae, translucidae, laeves, glabrae vel puberulae, nonostiolatae; asci 30–44 × 7–14 μ, irregulariter dispositi, clavati, evanescentes, trispores, nonostipitati, in membrana saccata circumclausea; ascosporae 28–32 × 5.0–6.0 μ, clavatae, subbasaliter uniseptatae, hyalinae, sine porae, cum tunica gelatinosa circumclausae. Conidia ignota.

**Holotypus:** In fimo _Panthera pardus_, Aberdare National Park, Kenya, 4 Sept. 1966, _Cain, Griffin & Krug_, TRTC 66.1542a. In Cryptogamic Herbarium, University of Toronto.

**Etymology:** Latin, _saccus_ = bag, referring to the sack-like membrane surrounding the ascus.

Ascocarps 230–310 μ in diameter, scattered within and upon the surface of the substrate, globose, orange, transparent, smooth, somewhat hairy as a result of adhering hyaline mycelium, nonostiolate; _ascocarp peridium_ 7–11 μ thick, orange, consisting of one type of cells; peridial cells pseudoparenchymatous in surface view, flattened in cross section; _asci_ 30–44 × 7–14 μ, irregularly disposed, clavate, thin-walled, evanescent, three-spored, nonostipitate, held together in a large sack-like membrane; _ascospores_ 28–32 × 5.0–6.0 μ, clavate, with a single basal septum, hyaline, thin-walled, without germ pores, entirely enclosed in a broad hyaline gelatinous sheath 2–7 μ thick, arranged side by side in the ascus; upper ascospore cell 22–26 × 5.0–6.0 μ; lower ascospore cell 3.5–6.0 × 3.0–3.5 μ; conidial stage unknown.

**Specimen Examined:** KENYA: Aberdare National Park, on leopard dung, 4 Sept. 1966, _Cain, Griffin & Krug_, holotype TRTC 66.1452a.
We have been unable to obtain cultures from the rather sparse type collection. There are no other collections known.

**Eoterfeziaceae**

*Cleistothelebolus* Malloch & Cain, gen. nov.


**TYPUS GENERIS:** *Cleistothelebolus nipigonensis* Malloch & Cain.

**ETYMOLOGY:** Greek, *kleistos* = closed and the genus *Thelebolus*, referring to the ascosporae.

Asccopari ini coiled. Ascosporae subglobose to irregular in shape, pale brown, nonostiolate, nonstramatic. Asci irregularly disposed, ovoid, evanescent. Ascospores one-celled, hyaline, without germ pores, without "de Bary bubbles." Conidia produced as blastosporae, hyaline, one-celled, often budding.

*Cleistothelebolus*, as its name implies, is in many ways similar to the genus *Thelebolus* Tode ex Fr. and has probably evolved from a member of the Thelebolaceae. According to Eckblad (1968), Rifai (1969), and Kimbrough (1970) the Thelebolaceae would include ocreulare Discocystae that are greatly reduced in size and complexity, have nonamylaid asci, and occur mainly on dung. In addition to *Cleistothelebolus*, certain other cleistocarpous genera with evanescent asci, such as *Eoterfezia* Atkinson, *Lasibolidium* sp. nov., *Microeuridium* Ghatak, *Orbicula* Cooke, and *Xeromyces* Fraser, appear to be related to the Thelebolaceae. The oldest family name available for this group is the Eoterfeziaceae (Atkinson 1902). The Eoterfeziaceae are characterized by hyaline to reddish-brown ascosporae, oblong to cylindrical asci, hyaline, thin-walled, obolate to ellipsoid ascosporae, and imperfect states other than phialides. The Monascaceae is a similar family that we prefer to maintain separately to accommodate the unique genera *Ascorhiza* Lechtova-Trnka and *Monascus* van Tieghem.

The similarities between *Cleistothelebolus* and *Thelebolus* are several. The ascospores of *Cleistothelebolus* are identical to those of *Thelebolus* and the ascocarps are of a similar pale brown color.

In both genera the ascogenous system is greatly reduced and no longer produces asci from croziers. The two genera also differ in several respects. Unlike *Thelebolus*, *Cleistothelebolus* produces irregularly disposed evanescent asci. Wicklow and Malloch (1970) reported that species of *Thelebolus* all had an unusal tolerance to low temperatures, but this is not the case with *Cleistothelebolus*. Although *Cleistothelebolus* is capable of producing ascospores at 15–20°C it has an optimum around 25°C, a temperature unfavorable to all species of *Thelebolus* studied.

While species of *Thelebolus* were found to produce ascospores throughout nearly their whole temperature tolerance range, *Cleistothelebolus* has a very narrow fruiting range. The original and only isolate of this genus, was made from dung containing at least three species of *Thelebolus*.

The conidial stage of *Cleistothelebolus* is especially interesting. The conidia are produced as blastospores on short peg-like conidiophores. In broth culture these conidia bud vigorously and produce typical yeast cells. We have not been able to demonstrate any fermentative ability on any of several carbohydrates although growth is abundant.

Some of the eight-spored species of *Thelebolus* have been observed to produce arthrospores but none of these produce blastospores. Nonbudding arthrospores may also be produced in older colonies of *Cleistothelebolus*.

*Cleistothelebolus* is not likely to be confused with other Eoterfeziaceae except *Microeuridium*. That genus, however, is not reported to produce conidia and has a very poorly developed peridium. *Cleistothelebolus* might, more likely, be confused with some of the Pseudocystaceae such as *Pseudoeonium* van Beyma or *Nigrospalum* Malloch. Its lighter colored peridium, less complex ascogenous system, and lack of phialides would separate it from that group.

*Cleistothelebolus nipigonensis* Malloch & Cain, sp. nov.

Figs. 11–17

Coloniae in agar “Yps” secundum diametrem acetate 24 diurnum 7.5 cm, appressae, ceraee, roseae vel pallide brunnea; hyphae hyalinae, 1.5–3.5 μ crassae, septatae, frequenter

*Malloch & Cain, sp. nov.*

Figs. 7–10

Ascosporae, globosa, aurata, glabrae vel puberulis, 44–7–14 μ, irregularmente dispuestas, trísporadas, evanescentes. Ascosporae unicellulares, hyalinae, sine porae, sine "de Bary bubbles." Conidia modo blastosporae producta, hyalina, unicellaria, frequentem gemmifera.

**TYPI GENERIS:** *Cleistothelebolus nipigonensis* Malloch & Cain.

**ETYMOLOGY:** Greek, *kleistos* = closed and the genus *Thelebolus*, referring to the ascosporae.

Asccopari ini coiled. Ascosporae subglobose to irregular in shape, pale brown, nonostiolate, nonstramatic. Asci irregularly disposed, ovoid, evanescent. Ascospores one-celled, hyaline, without germ pores, without "de Bary bubbles." Conidia produced as blastosporae, hyaline, one-celled, often budding.
in segmentis arthrosporoidis fragmentae; asco-
carpae 15–75 μ crassae (si compositae, majores),
subglobosae vel globosae, frequenter confluentes
et lobatae, brunneae, glabrae, nonostiolatae;
asci 9.0–14 × 8.0–10.5 μ, irregulariter dispositi,
ovoidei, frequenter breviter stipitati, evanes-
centes, octospori, sive crozieri; ascosporeae 5.5–7.0
× 3.5–4.2 μ, ellipsoidae, hyalinae, laeves, sine
pora; conidia 3.5–7.0–(12) × 1.5–3.5 μ, in
modo blastosporeae producata, ab ellipsoidis
cylindraceae, brevi pediculata, hyalina, uni-
cellulare, laeves, frequenter gemmifera.

**HOLOTYPUS:** In fimo *Canis lupus,* Circle Lake,
Nipigon Lake region, Thunder Bay Dist.,
Ontario, Canada, 29 July 1965, *Cain,* TRTC
45645. In Cryptogamic Herbarium, University
of Toronto.

**ETYMOLOGY:** from the locality Nipigon.

**Colonies** on “YpSs” medium (Emerson 1958)
attaining a diameter of 7.5 cm in 24 days at 25°C,
appressed, waxy in appearance, characterized by
a brown field of ascocarps covered by a mass of
pink conidia; reverse showing the same blend of
brown and pink; *hyphae* 1.5–3.5 μ in diameter,
yaline, thin-walled, abundantly septate, branch-
ed, often separating into arthrospore-like units
in older parts of the colony; *ascocarp initials*
consisting of short septate coils with filaments
about 2.0–2.5 μ in diameter, soon becoming
surrounded by numerous *hyphae* which arise
from the cells below the coil; *ascocarps* 15–75 μ
in diameter (often much larger when compound),
subglobose to globose, often becoming confluent
and forming large lobed structures, light to dark
brown by transmitted light, dark brown in mass,
smooth, glabrous, nonostiolate, superficial or
immersed in the natural substrate, immersed in
agar culture; *ascocarp peridium* consisting of one
tissue type, at first two or three cells thick in
cross section but becoming one cell deep at
maturity; peridial cells 2.5–10 × 1.5–2.0 μ,
pseudoparenchymatous in surface view, strongly
flattened in cross section; *asci* 9.0–14 × 8.0–10.5
μ, irregularly disposed, borne directly on the
reduced ascogenous system, without croziers,
ovo, often short-stipitate, thin-walled, evan-
escent, eight-spored; *ascospores* 5.5–7.0 × 3.5–
4.2 μ, ellipsoidal, hyaline, smooth, one-celled,
without germ pores, without “de Bary bubbles”;
*conidia* 3.5–7.0–(12) × 1.5–3.5 μ, produced as
blastospores at hyphal tips and at the ends of
short swellings, ellipsoidal to cylindrical, usually
with a very short truncate pedicel, hyaline, one-
celled, smooth, usually yeast-like and budding
in liquid culture.

**SPECIMEN EXAMINED:** CANADA: Ontario: Thun-
der Bay Dist., Nipigon Lake region, Circle Lake,
on wolf dung, 29 July 1965, *Cain,* HOLOTYPE
TRTC 45645.

Cultures derived from the type have been
deposited with ATCC, CBS, and IMI.

**Lasiobolium** Malloch & Cain, gen. nov.

Ascogonia convoluta. Ascocarpeae subglobosae
vel globosae, luteo-brunneae, appendiculatae,
onostiolatae. Ascii irregulariter dispositi, cum
agoli, octospori, evanescentes, nonstipitati vel
brevi stipitati, nonamyloidei. Ascosporeae ellip-
soideae, unicellulare, hyalinae, laeves, sine pora.
Conidia ignota.

**TYPUS GENERIS:** *Lasiobolium spirale* Malloch
& Cain.

**ETYMOLOGY:** The genus *Lasiobolus* and the
Latin diminutive suffix, -*idum,* referring to the
similarity of *Lasiobolus*.

Ascocarps initials coiled. Ascocarps subglobose
to globose or irregular in shape, yellow-brown,
nonostiolate, nonstromate, with distinct append-
eges. Asci irregularly disposed, arising from
croziers, evanescent, nonstipitate to short-stipi-
tate, nonamyloid. Ascospores ellipsoidal, one-
celled, hyaline, smooth, without germ pores.
Conidia unknown.

**Lasiobolium, like* Cleistothelebolus,* appears
to be a member of the Euterfeziaceae. The
peridium is differentiated into what appears to
be fairly characteristic etal and medullary ex-
cipulum. The ascocarp appendages, which char-
acterize the genus, are similar to those in *Lasio-
bolus* except that they are long and helically coiled.
The ascospores are typical of the family in being
hyaline, thin-walled, and ellipsoidal.

**Lasiobolium spirale** Malloch & Cain, sp. nov.

Figs. 18–23

Coloniae in agaro “corn meal” secundum
diametram aetate 40 dierum 5 cm, ad impressas
arachnoideae, hyalineae, azonatae; *hyphae* 2.0–
5.0 μ crassae, hyalinae et laeves vel luteo-
brunneae et crustatae, irregulariter inflatae;
ascogonia 10–17 μ crassa, septata, convoluta;
ascocarpeae 170–750 μ crassae, subglobosae vel
globosae vel irregularae, luteo-brunneae, appen-
diculatae, granulosae, nonostiolatae; peridium
ascocarporum bipartitum; appendices ascocarporum 5.0–10.5 μ crassae, in peridio sequaliter dispositae, aurantio-luteae, crassitunicatae, non-septatae, helicoideae; asci 35–62 × 12–21 μ, irregulariter dispositi, clavati, octosporei, evanescentes, nonstipitati vel brevi stipitati, nonamyloidei; ascospores 12–17 × 9.0–12 μ, ellipsoidae, hyalinae, laeves, sine porae; conidia nulla.


ETYMOLOGY: Latin, spiralis = with spirals, referring to the coiled ascocarp appendages.

Colonies on cornmeal agar (Grosklegas and Swift 1957) attaining a diameter of 5 cm in 40 days at room temperature, appressed to arachnoid, colorless, brownish where fruting, azonate; reverse colorless; hyphae 2.0–5.0 μ in diameter, hyaline and smooth, occasionally yellow-brown and encrusted, thin-walled, remotely septate, with frequent irregular swellings; ascocarp initials consisting of multiseptate filaments 10–17 μ in diameter which become more or less coiled, soon becoming surrounded by a mass of smaller diameter filaments arising from the base; ascocarps 170–750 μ in diameter, subglobose to globose or irregular in shape (especially in agar culture), light brown by reflected light, yellowbrown by transmitted light, roughened or granular due to projecting peridial elements, nonostiolate, with long helical appendages; ascocarp peridium indefinite in thickness, of two tissue types; peridial cells of the outer layer about 11–33 × 5.5–12 μ, yellow-brown, forming a somewhat irregular globose to angular tissue, radiating outward as ellipsoidal to subglobose projections; peridial cells of the inner layer 3.0–5.0 μ in diameter, hyaline, thin-walled, prosenchymatous; ascocarp appendages arising from the outer peridial layer, evenly distributed over the surface of the ascocarp, yellow to yellow-orange by reflected light, pale yellow by transmitted light, thick-walled, nonseptate, helically coiled, several millimeters in length when fully extended, 5.0–10.5 μ wide; asci 35–62 × 12–21 μ, irregularly disposed, borne on croziers, clavate, eight-spored, evanescent, nonstipitate to short-stipitate, nonamyloid; ascospores 12–17 × 9.0–12 μ, broadly ellipsoidal, hyaline, smooth, one-celled, without germ pores; conidia lacking.


Cultures derived from TRTC 43808 have been deposited with ATCC, CBS, and IMI.

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