Tanzanian Myxomycetes: second survey

TARJA UKKOLA, MARJA HÄRKÖNEN AND TIINA SAARIMÄKI


This work compiles the results obtained by moist chamber cultures of bark material collected in 1988–1989 and field collections made in 1990 and 1991. The collections represent 59 species, 30 of which are new to Tanzania, including Licea tanzanica Ukkola, Härk. & Gilert which is new to science. The following five are new to Africa: Ceratiomyxa sphaerosperma Boedijn, Cribraria minutissima Schw., Leptoderma iridescens G.Lister, Licea bulbosa Nann.-Brem. & Y.Yamam. and Physarum perfectum M.E.Peck. Altogether 91 species of Myxomycetes are now reported from Tanzania, the majority of them collected in montane forest belt. Decayed wood, litter, bark of living trees and living herbaceous plants served as substrata. The members of the orders Stemonitales and Physarales were most undemanding in their selection of substrata, and Physarales was the only order that preferred litter to other substratum.

Key words: Africa, Myxomycetes, Tanzania

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Introduction

The Myxomycetes of Tanzania were first studied by Eichelbaum (1906), who reported 16 species from the East Usambara Mountains. On the basis of three excursions in Tanzania in 1988–1989, Härkönen and Saarimäki (1991) reported 53 species (collections made in the field), 45 of them new to Tanzania and seven new to Africa. Between 1988 and 1991, altogether six excursions were made to Tanzania each lasting approximately four weeks. This paper reports the results of the three excursions made in 1990–1991 and the results of the moist chamber cultures of bark collections made in 1988–1989. The conclusions about the ecology of the Tanzanian Myxomycetes, and the discussion, are based on the whole material collected in Tanzania between 1988 and 1991.
Material and methods

The material was collected by Marja Häkkönen and Tiina Saarimäki and identified by Tarja Ukola. Collections were made during three trips to Tanzania during the rainy season: December 1990, April–May 1991 and November–December 1991. Several vegetation belts were visited, from rain forests to high mountains, miombo woodlands and semideserts. During the three earlier excursions to Tanzania, in 1988 and 1989 (see Häkkönen & Saarimäki 1991), bark from living trees was collected for moist chamber cultures and the results from the cultures are included in this paper. The moist chamber cultures were prepared in Finland by Tiina Saarimäki about five to six weeks after collection. Altogether 223 moist chamber cultures were established. For preparing the moist chamber cultures, see Gilbert & Martin (1933), Gray & Alexopoulos (1968), Häkkönen (1979) and Häkkönen & Uotila (1983).

The specimens are deposited in the Botanical Museum, University of Helsinki (H), Finland. Permanent slides of all cited specimens prepared in Hoyer’s medium (Martin & Alexopoulos 1969) are included.

Collecting localities

The collecting localities are described below and marked by numbers on the map in Fig. 1. Numbers 2–29 refer to places where Myxomycetes and Basidiomycetes were collected during the first three excursions to Tanzania in 1988–1989 (Häkkönen & Saarimäki 1991, Koponen et al. 1990). Only those collecting localities where Myxomycetes were found are listed. Many of these places were revisited in 1990–1991. New collecting sites for Myxomycetes, found in 1990–1991, are numbered 30–39. The capital letter and number, e.g. T2, refer to the geographical subdivision of Tanzania (Polhill 1988). MH refers to collections of Marja Häkkönen and TS to collections of Tiina Saarimäki, while mc indicates a collection obtained from a moist chamber culture.

2a. T2, Northern Province, Arusha District. Western foot of Mt. Meru, Olmotonyi, Training forest of the Sokone University of Agriculture; shady c. 20-year-old stand of Cupressus lusitanica on gently elevating SSW slope, 1830 m. MH 3594 mc

2e. T2, Northern Province, Arusha District. Western foot of Mt. Meru, Olmotonyi, Training forest of the Sokone University of Agriculture, c. 20-year-old stand of Eucalyptus saligna, 2010 m. MH 3595 mc, 3596A mc, 3596B mc

2h. T2, Northern Province, Arusha District. Western side of Mt. Meru above Laikinoi, ridge between the streams Engare Olmotonyi and Engare Narok, Juniperus procera forest, 2600 m. MH 3597 mc

2l. T2, Northern Province, Arusha District. Western side of Mt. Meru above Laikinoi, ridge between the Engare Olmotonyi and Engare Narok, upper limit of Hagenia abyssinica forest, with bushes of Stoebe kilimandscharia and Helichrysum spp., 2850–3200 m. MH 3598 mc

3f. T2, Northern Province, Arusha District. Arusha National Park, E slope of Mt. Meru, mossy forest along the path between the View Point and the Njeku campsite, 2600 m. MH 3587 mc, 3588 mc

3h. T2, Northern Province, Arusha District. Caldera of Mt. Meru; patch of open, temporarily flooded grassland near the Njeku campsite in eruaceous vegetation, 2560 m. MH 3600 mc

5a. T2, Northern Province, Moshi District. Moshi International school park, c. 800 m. MH 3575–3577 mc

5b. T2, Northern Province, Moshi District. Moshi. Lutheran hostel, in yard, c. 800 m. MH 3903–3909 mc, 3912–3915 mc

7. T2, Northern Province, Pare District. C. 40 km from Same along the main road to Mombo; dry deciduous bushland (semidesert), c. 800 m. MH 3601A mc, 3601B mc, 3602 mc, 3603 mc, 3604A mc, 3604B mc, 3605 mc

10c. T3, Tanga Province, Lushoto District, West Usambara Mts. Mombo, town centre, yard of the restaurant, c. 400 m. MH 3589A mc, 3589B mc, 3591–3593 mc


12f. T3, Tanga Province, Lushoto District, West Usambara Mts. Lushoto, town centre, yard of the Lawns Hotel. MH 3572 mc, 3573A mc, 3573B mc

18a. T3, Tanga Province, Lushoto District, East Usambara Mts. Amani Medical Research Centre, 850–950 m. MH 3567 mc

18b. T3, Tanga Province, Lushoto District, East Usambara Mts. Amani Forest Reserve, tropical submontane rain forest, c. 900 m. MH 3867

18g. T3, Tanga Province, Lushoto District, East Usambara Mts. Amani, near the Rest House, c. 900 m. MH 3860

19. T3, Tanga Province, Tanga District. Baobab Beach Hotel, 7 km South of Tanga near Mwambani village, 5 m. MH 3569 mc, 3570A mc, 3570B mc

26a. T6, Eastern Province, Morogoro District. Morogoro, Sokone University of Agriculture, the campus area plantations, c. 500 m. MH 3560–3561 mc, MH 3568AA mc, 3568B mc, MH 3586A mc, 3586B mc

26c. T6, Eastern Province, Morogoro District. Hillside of the Uluguru Mts. in vicinity of the town of Morogoro; thinned and partly cultivated miombo woodland with Brachystegia microphylla and B. boekhmi. MH 3562–3564 mc

27e. T6, Eastern Province, Morogoro District. E slope of N Uluguru Mts., Kimboza Forest Reserve, lowland rain forest, 200–440 m. TS 792, MH 3813–3818, 3822–3825

29a. T3, Tanga Province, Pare District, South Pare Mts., Mbagga Manka village, yard of the Lutheran Missionary House, alt. c. 1500 m. MH 3772, 3775A, 3775B, 3776

29b. T3, Tanga Province, Pare District, South Pare Mts., Mbagga Manka village, up from the Lutheran Missionary House, 1500 m. MH 3773

30a. T3, Tanga Province, Pare District, South Pare Mts., Mpepera village, in Acacia and Eucalyptus forest, c. 1600 m. MH 3777, 3778A, 3778B, 3781A, 3781B, 3781C, 3783, 3786–3787
Fig. 1. Tanzania. Collecting sites of Myxomycetes. The numbers are explained in the list of collecting localities, page 4. Map compiled from Polhill (1988), Härkönen et al. (1993) and two road maps.
30b. T3, Tanga Province, Pare District, South Pare Mt's. Mpepe village, natural montane forest, c. 1600 m. MH 3784-3785
31. T3, Tanga Province, Pare District, E slope of South Pare Mt's. Gonja. Mjema village, in coffee and banana plantation, c. 1400 m. MH 3862
32. T3, Tanga Province, Pare District, E slope of South Pare Mt's. Gonja, Bombo village, near Gonja Lutheran hospital, c. 1350 m. MH 3863-3866
33. T4, Western Province, Kahama District, c. 40 km SW of Kahama, Mpuze Forest Reserve, in woodland (Brachystegia, Terminalia, Combretum, Rothmannia, Hyphaene), c. 1150 m. MH 3867, 3868
34. T4, Western Province, Tabora District, c. 20 km W of Tabora, Lulanguru village, in woodland (Brachystegia, Terminalia, Combretum, Dichrostachys, Annona, Vitis, Markhamia), c. 1100 m. MH 3869
36. T7, Southern Highlands Province, Iringa District, Mufindi, Kibao. Acacia mearnsii and Eucalyptus plantations near Sailing Club, c. 1900 m. TS 643–645, MH 3804–3808, 3819
37. T7, Southern Highlands Province, Iringa District, Mufindi, Fishing Club by Kilima Tea Estate, degenerated mist forest (Eucalyptus and Acacia), c. 1900 m. MH 3810–3817
38. T7, Southern Highlands Province, Rungwe District, Mwakaleli, Training Centre, Old Missionary House, in yard, c. 1750 m. MH 3820–3821
39. T8, Southern Province, Songea District, 45 km W of Songea, Lipokela, in degraded miombo woodland dominated by Uapaca, 1100 m. TS 673

In addition to the above localities, two specimens were collected in Malawi:
40. Malawi, Zomba District, Zomba, near Government Hostel, 850 m. MH 3823
41. Malawi, Zomba District, c. 20 km North of Zomba, Makawara village, Uapaca-Brachystegia woodland, 850 m. MH 3829

Tanzanian species of Myxomycetes

The species of Myxomycetes collected in Tanzania in 1988–1989 have been briefly described by Härkönen and Saarimäki (1991). The present paper lists all the specimens found in Tanzania after that study. Species that are new to Tanzania are described on the basis of the Tanzanian material. The collecting localities are not listed in the descriptions, but indicated by numbers, or numbers and letters, in boldface, as explained above and shown in Fig. 1. In total 162 specimens were studied. Of these, 111 were collected in the field in 1990–1991 and 51 were harvested from moist chamber cultures prepared from the bark collections made in 1988–1989. The collections comprised 59 species, one of them being new to science and five new to Africa. The field collections included 38 species, and 25 species were obtained from the moist chamber cultures (four species the same as in the field). All specimens are deposited at the Botanical Museum of the University of Helsinki (H).


Order Ceratiomyxales

A total of 37 species of the order Ceratiomyxales were collected from Tanzania. The following specimens are new species for Tanzania and additions to the already reported ones (see Härkönen & Saarimäki 1991).

Ceratiomyxa fruticulosa (O.F.Müll.) Macbr.
Seven specimens from montane forest, one from submontane rain forest and four from lowland rain forest; eleven specimens on decaying wood, one on plant litter. Cosmopolitan.

Three specimens \( MH \ 3851, \ 3852, \ TS \ 917 \) represent var. \textit{porioides} \citep{Lister1925}. Fructifications are honeycomb-like. \citet{Emoto1977} considered this a distinct species, but we consider it a variety of \textit{C. fructiculosa} following \citet{Neubert1993}.

\textbf{Ceratiomyxa sphaerosperma} \citet{Boedijn1928}

One specimen from montane forest; on decayed wood. Relatively common in the tropics and subtropics. No earlier reports from Africa.

Fructifications, 1–2 mm in total height, scattered or loosely gregarious, composed of a fairly short, brownish stalk, darker at the base, bearing a cluster of thin, branched or unbranched arms. Spores hyaline by transmitted light, globose or ellipsoid, nearly smooth, by oil-immersion some scattered warts, with granular contents, 9–9.9–11 µm or 13.5–13.8–16 x 6.5–7.6–8 µm.

In most references the spores are described as subspherical or spherical. In this specimen there were also elliptical spores. The species is fairly common in the tropics and subtropics \citep{Martin1969, Neubert1993, Stephenson1994}.

\textbf{Order Liceales}

We collected 54 specimens of the order \textit{Liceales} in Tanzania in 1988–1991. These specimens belong to the genera \textit{Licea} (18), \textit{Tubifera} (3), \textit{Lycogala} (14), \textit{Dictydiaethalium} (1) and \textit{Cribraria} (18). New specimens, representing species new to Tanzania, are described below.

\textbf{Licea biforis} Morgan

\textit{MH}. One specimen from the Lushoto town centre, alt. c. 850 m; on \textit{Juniperus procera}. Widely distributed in the world. In Africa reported from northern and western parts and from the Canary Islands; no earlier reports from eastern Africa.

One specimen (MH 3568A) grew mixed with *Calomyxa metallica* and one specimen (MH 3586A) with *Arcyria pomiformis*.

The species has recently been described (Nannenga-Bremekamp & Yamamoto 1987) on the basis of a single specimen developed in a moist chamber on the bark of a living tree from Japan. We have examined a slide of the type specimen, kindly sent by late Mrs. Nannenga-Bremekamp, and our material matches it perfectly; even the peridium which was described as smooth seems to be weakly...
warted in some places. The Tanzanian material, which comprises six specimens, shows the sizes of the sporangia and the spores to vary more widely than announced in the description of the species. According to Nannenga-Bremekamp and Yamamoto (1987), the sporangia are 150–200 μm in total height and the spores 10–11 μm in diameter.

*Licea parasitica* (Zukal) Martin

7:3602 *MH mc, 12f:3573A MH mc*. One specimen from the town centre (Lushoto, submontane belt), on *Juniperus proceras;* the other from semidesert *Commiphora* bush (alt. c. 850 m), on *Delonix elata*. Common all over the world. Earlier reports from Africa from Tunisia (Mitchell & Kylin 1984) and the Canary Islands (Champion & Beltrán Tejera 1980).

Sporangia scattered or in groups, sessile, subglobose, sometimes somewhat prolate, dark brown to black, occasionally shiny, 50–300 μm in diameter; opening by a lid, when this is lacking by apical, irregular dehiscence. Stalk one half to two thirds of the total height, thick, dark brown to black, furrowed, filled with refuse matter. Spores brown in mass, olivaceous brown by transmitted light, globose to subglobose, thick-walled with a wider paler area, smooth, 8–9.2–10 μm in diameter.

This scanty specimen approaches *L. pedicellata,* but the spores are smaller and totally smooth.

*Licea tanzanica* Ukkola, Härk. & Gilert sp. nov. – Figs. 5–10

5a:3576 *MH mc, 5b:3905 MH mc, 3915 *MH mc, 10c:3589B MH mc, 3591* *MH mc, 3592* *MH mc, 3593* *MH mc, 18a:3567 MH mc*. Four specimens from lowland on *Araucaria cunninghamii* or *Azadirachta indica*; four specimens from submontane belt on *Jacaranda mimosaflora, A. cunninghamii* or *Mangifera indica*.


Holotype: Tanzania. Tanga Prov.: Lushoto Distr., on *Juniperus procera*. Four specimens from lowland on *Araucaria cunninghamii* or *Azadirachta indica*; four specimens from submontane belt on *Jacaranda mimosaflora, A. cunninghamii* or *Mangifera indica*.

Sporangia scattered or loosely gregarious, stipitate, sometimes nearly sessile with a restricted base, globose or subglobose to slightly clavate or angular, somewhat shiny, brown to dark brown, erect; total height 150–400 μm, 90–150(−200) μm in diameter. Peridium thin, pale, slightly olivaceous by transmitted light, warted, warts sometimes joined into short ridges; covered with granular matter; dehiscence circumscissile or irregular. Stalk one half to nearly two thirds of the total height, thick, erect, furrowed, occasionally tapering upwards, sometimes very short and wider at the base, concolourous with the sporangium or darker.

With inclusions (yellowish oliv brown by transmitted light); peridial layer thin, smooth. Stalk thick, dark brown to black, furrowed, filled with refuse matter. Spores brown in mass, olivaceous brown by transmitted light, globose to subglobose, thick-walled with a wider paler area, smooth, 8–9.2–10 μm in diameter.

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Spores palish brown in mass, pale brownish with olivaceous tint by transmitted light, globose, smooth in light microscope even in high magnification, punctate in SEM, not very thick-walled, with a wide, paler area, often with pale inclusions, 12–13.0–15 μm in diameter.

The distinguishing characteristics of *Licea tanzanica* are the brown stipitate, erect, globose or subglobose sporangia dehiscing in circumscissile fashion or irregularly (Figs. 5–6, 8–9) and the relatively large spores with not very thick walls (Figs. 7, 10).


*Licea bulbosa* differs from *L. tanzanica* in always exhibiting circumscissile dehiscence, leaving a cup and a lid, and also in having smaller, paler, thinner-walled spores. *L. capitata* is ochraceous in colour, opens by a vertical split and the spores are smaller, very pale yellow by transmitted light (Ing 1982). *L. capitatoides* is smaller, dark grey in colour and has small (7–9 μm), brown spores (Nannenga-Bremekamp & Yamamoto 1990). *L. tanzanica* differs from *L. pedicellata* in its thinner walled and paler spores, which look totally smooth under the light microscope. *L. rugosa* has spores, which are thick-walled and dark brown by transmitted light (Nannenga-Bremekamp & Yamamoto 1987). *L. sopphoides* has circumscissile dehiscence and minutely roughened spores (Keller & Brooks 1977).

Dr. Elisabeth Gilert (Gothenburg) examined specimens of *L. tanzanica* (and *L. bulbosa*) and took SEM micrographs, which revealed that the spores are not totally smooth but minutely punctate. We have studied slides of type specimens of *Licea bulbosa* and *L. rugosa* kindly sent by late Mrs. Nannenga-Bremekamp, and Dr. Keller has seen some of our material and compared it with *L. sopphoides*. We have also examined the type specimen of *Licea pedicellata*, sent by NFC.

All our specimens of *Licea tanzanica* emerged on bark collected from trees growing in town areas in lowland or submontane belt (alt. under 1000 m). No specimens of the genus *Licea* emerged on the numerous bark collections from high elevation (alt. above 2000 m).

One specimen (3589A) grew mixed with *Badhamiopsis ainoae*.

Additional material examined. Tanzania. Northern Prov.: Moshi Dist., Moshi International school park (03 37 AD), in moist chamber culture on *Jacaranda mimosaefolia*, 800 m, 23.V.1988 Härkön 3576. Lutheran hostel, in moist chamber culture on *Mangifera indica*, 800 m, XII.1989 Härkön 3905. In moist chamber culture on *Araucaria cunninghamii*, 800 m, XII.1989 Härkönen 3915. Tanga Prov.: Lushoto Distr., E Usambara Mts., Amami Medical Research Centre (05 38 BA), in moist chamber culture on *Araucaria cunninghamii*, 850–950 m, 08.XII.1988 Härkönen 3567. W Usambara Mts., Mombo, town centre (04 38 CD), in moist chamber culture on *Azadirachta indica*, 400 m, 12.XII.1988 Härkönen 3591, 3592. In moist chamber culture on *Araucaria cunninghamii*, 400 m, 12.XII.1988 Härkönen 3589B.

*Lycogala epidendrum* (L.) Fr.

27e:3825 MH, 36:3806 MH, 643 TS. Two specimens from montane forest, one from lowland rain forest; on decaying wood. Cosmopolitan.

*Dictydiaethalium plumbeum* (Schum.) Rostaf.

11n:3830 MH. One specimen from lower montane forest; on decaying *Parinari*. Cosmopolitan. Reported from many parts of Africa.

Pseudoaethalium depressed, composed of numerous closely connected sporangia, about 13 x 30 mm in diameter and 0.5–1.0 mm thick, light brown. Cortex of polyhedral plates, composed of the thickened caps of the sporangia. Hypothallus white, protruding outside the aethalium. Pseudocapillitium composed of thickened strands, 4–5 μm in diameter, which are remains of the vertical sporangial walls, running from the corners of the platelets to the base. One side of the strands is often thickened and roughened, bearing thin, fringy threads. Spores brown-yellow in mass, almost colourless in transmitted light, globose, distinctly spinulose, 8.5–9.1–10 μm in diameter.

*Cribraria minutissima* Schw.

2e:3595 MH. One specimen from montane forest, on bark of *Eucalyptus saligna*. Reported from North and South America, West-Indies, Europe and Asia. New to Africa.

Sporangia loosely gregarious, stipitate, erect or suberect, subglobose to oblong, orange-
brown to brownish-red; 0.1–0.3 mm in diameter, 0.35–1(-1.2) mm tall. Peridium persisting as a deep, distinct cup, about one third to one half of the sporangia bearing pale granules; clearly delimited from the peridial net; the rim of the cup smooth. Peridial net forming angular meshes, threads flattened, lacking dictyidine granules, slightly expanded at the nodes; nodes not thickened. Stipe slender, long, red-brown, darker at the base (refuse matter), tapering upwards. Spores orange-brown in mass, pale yellow in transmitted light, globose, covered with fine warts, 8–8.2–9 μm in diameter.

According to many investigators the sporangia of *Cribraria minutissima* may or may not possess a peridial cup. According to Nannenga-Bremekamp & Yamamoto (1983), *C. minutissima* should be restricted to the specimens with a distinct cup. The cupless form was described as *C. confusa* Nann.-Bremek. & Y. Yamam.. In ultrastructural studies Keller et al. (1988) have shown that two species exist even if they sometimes grow mixed. *C. confusa* differs from

*C. minutissima* not only in the lack of calyculus but in the peridial net and the colour and ornamentation of the spores. Härkönen (1981) recorded from Gambia seven specimens with the name *C. minutissima*. All of them are without any kind of cup, and belong to the separate species *C. confusa*. Thus the present specimen is the first record of *C. minutissima* in Africa.

According to Keller et al. (1988), many species of *Cribraria* occur on ground sites, e.g. on decaying logs, and only *C. minutissima*, *C. confusa* and *C. violacea* have been found with regularity on the bark of living trees.

**Order Echinosteliales**

The two specimens listed below are the only representatives of the order *Echinosteliales* collected in Tanzania in 1988–1991.

*Echinostelium minutum* de Bary

2e:3596B MH mc, 26a:3561 MH mc. One specimen from montane forest on bark of *Eucalyptus saligna*, one from lowland rain forest on bark of *Tectona grandis*. Cosmopolitan. Reported from North and West Africa and from the Canary Islands, no previous records from eastern Africa.

Sporangia gregarious or scattered, stipitate, 40–70 μm in diameter, 300–500 μm tall, globose, white to beige. Peridium fugacious, leaving a small collar at the base. Stipe long, several times longer than the head of the sporangium, hair-like, tapering upwards, containing granular particles. Columella short, cylindrical. Capillitium scanty, composed of a few colourless dichotomously branched threads with horn-like endings, sometimes forming a few meshes. Spores white in mass, colourless in transmitted light, globose, smooth, 7–7.5–8(-9) μm in diameter.

One specimen grew mixed with *Trichia botrytis*.

**Order Trichiales**

A total of 133 specimens of order *Trichiales* were collected in Tanzania in 1988–1991. These specimens belong to the following genera: *Calomyxa* (1), *Perichaena* (8), *Arcyria* (83), *Trichia* (2), *Hemitrichia* (35) and *Metatrichia* (4).

*Calomyxa metallica* (Berk.) Nieuwl.

26a:3568B MH mc. One specimen from lowland; on bark of *Jacaranda mimosafoia*. Reported from many parts of the world. Earlier reports from Africa are from the northern and central parts and from the Canary Islands.

Sporangium sessile, subglobose, umbilicate; iridescent yellow; 0.7 mm in diameter. Peridium membranous, translucent, shiny, partially with fine warts. Capillitium threads tangle with loops, elastic, yellow-brown, single or scarcely branched; threads yellow in transmitted light, marked with spirally arranged fine warts, 1–1.5 μm in diameter. Spores ochraceous in mass, pale yellow in transmitted light, globose, distinctly spinulose, 9.5–10.3–11 μm in diameter.

There was only one sporangium of *Calomyxa metallica* in this specimen and it grew mixed with *Licea bulbosa*.

*Calomyxa metallica* is not rare in moist chamber cultures, it has been reported for example, from southern Finland (Härkönen 1979) and the Hawaiian Islands (Eliasson 1991).
Perichaena chrysosperma (Currey) A.Lister  
5b:3908 MH mc. One specimen from submontane rain forest; on Juniperus procera. Cosmopolitan. Reported from many parts of Africa.

Sporangia gregarious, sessile, subglobose, ring-shaped or elongated to short plasmodiocarps; 0.2–0.5 mm wide and up to 1 mm long, brown, dark-brown or reddish brown. Peridium double, the outer layer with granules, inner thin, translucent; dehiscence irregular. Capillitial threads yellow, elastic, scarcely branched, filled with granules, 2–3(–3.5) µm in diameter; ornamentation long spines, up to 6 µm; ends clavate. Spores bright yellow in mass, yellow in transmitted light, globose to slightly subglobose, covered with regular fine spines, 9–9.5–11 µm in diameter.

Fructifications vary widely in shape. The specimen grew mixed with Perichaena depressa and Physarum diderma.

Perichaena corticalis (Batsch) Rostaf. var. liceoides (Rostaf.) A.Lister  
3h:3600 MH mc, 3f:3587 MH mc, 3588 MH mc. Three specimens from Ericaceous belt; on bark of deciduous trees. An earlier report from Africa is from Morocco (Malençon & Bertault 1967).

Sporangia sessile, subglobose or short plasmodiocarps, tiny, 0.3–0.4 mm in diameter, light brown to yellowish brown, sometimes shiny. Peridium fragile, covered with a layer with inclusions; dehiscence irregular. Hypothallus thin, membranous, inconspicuous. Capillitium undeveloped. Spores yellowish brown in mass, yellow in transmitted light, globose to slightly angular, spiny, sometimes with groups of more distinct spines, 12.5–14.3–15.5 µm in diameter.

The variety was described as a species, Perichaena liceoides, by Rostaf ski, whose description was based on material collected by Cienkowski (Gilert 1990). Lister (1925) and Hagelstein (1944) considered P. liceoides to be a variety of P. corticalis. Gilert (1990) studied the type collection and considered it to be a minute form of P. corticalis. No capillitial threads were found in the material collected in Tanzania.

The spore size is larger than given in Rostaf ski’s description (9.2–10 µm). Whereas Rostaf ski described the spores as smooth, our material is comparable to Gilert’s (1990) in being covered with prominent spines. The Tanzanian specimens were corticolous, but the type collection of P. liceoides grew on leaves (Gilert 1990). Two collections cited by Lister as P. corticalis var. liceoides were found on the dung of fallow deer and on hedge clippings (Lister 1925).

Perichaena depressa Libert  
5b:3906 MH mc, 3909 MH mc. Two specimens from submontane rain forest. On it usually grows on bark of dead trees. From moist chambers it has been obtained for example, from Turkey (Härkönen & Uotila 1983) and Hawaii (Eliasson 1991); Mitchell (1980) also mentions it from bark of living trees. According to Neubert et al. (1993), P. corticalis usually grows on deciduous trees.
**Juniperus procera.** Cosmopolitan. Reported from almost every part of Africa.

Sporangia crowded, depressed, discoid, polyhedral due to mutual contact, red-brown to dark-brown, 0.1–1.5 mm in diameter. Peridium thick, double, outer layer with granules closely appressed to the thin inner layer. Dehiscence by a lid formed from the upper part of the peridium, the basal part a shallow cup. Capillitium of thin, yellow, scarcely branched threads, covered with warts and spines, 1.5–2 \( \mu m \) in diameter. Spores bright yellow in mass, yellow in transmitted light, globose, regularly minutely warted, (8–)9.5–10.5 \( \mu m \) in diameter.

**Perichaena depressa** is easy to recognize by the flat polyhedral sporangia; upon dehiscence upper part forms a distinct lid, lower part a shallow cup.

Specimen MH 3909 grew mixed with *Perichaena chrysosperma* and *Physarum diderma*.

According to Neubert et al. (1993), *Perichaena depressa* usually grows on deciduous trees.

**Arcyria cinerea** (Bull.) Pers.


Three collections in the field from montane forest, one from submontane rain forest; on decaying wood. One specimen from moist chamber culture from submontane belt; on *Plumeria*, mixed with *Diderma hemisphaericum*.

**Arcyria denudata** (L.) Wettst.

11n:3831A MH, 3850 MH, 11o:3836 MH, 27e:3813 MH, 3816 MH, 3823 MH, 35:3797 MH, 41:3829 MH. Four specimens from montane forest, one from miombo woodland (in Malawi) and three from lowland rain forest; on decaying wood.

**Arcyria minuta** Buchet

39:673 TS. One specimen from miombo woodland; on litter.

Reported from many parts of the world. Described from Madagascar (Patouillard 1928), reported from many parts of Africa.

Sporangia in small clusters, 1–1.5 mm tall, bright rose to salmon-pink, cylindrical, tapering upwards. Peridium evanescent; calyculus shallow, shining rosly, smooth or delicately papillate inside, the papillae sometimes connected by low ridges. Stipe short, concolorous with the sporangia or brownish red, filled with spore-like cells. Hypothallus thin, rosy to brownish red, shining, sometimes extending under the entire cluster. Capillitium firmly attached to the peridial cup, not very elastic; tubes 2–5 \( \mu m \) in diameter, ornamented with large spines and warts and some half-rings, smoother in the basal part of the sporangium. Spores pink to salmon-pink in mass, colourless in transmitted light, globose, nearly smooth, by oil-immersion very minutely warded, 8–9.5–10 \( \mu m \) in diameter.

The spore diameter given in the literature varies: Neubert et al. (1993) 6–8(-10) \( \mu m \), Martin & Alexopoulos (1969) 8–10 \( \mu m \) and Nannenga-Bremekamp (1991) (6–)8–10\(-12) \( \mu m \). Neubert and Nannenga-Bremekamp (1979) revised *A. minuta* and stated that *A. gulielmae* Nann.-Bremek is a synonym of *A. minuta*. The name *A. gulielmae* was created to replace the name *A. carnea* (G.Lister) G.Lister (Nannenga-Bremekamp 1971). The information on the distribution of *A. minuta* in the present paper is according to the species concept of Neubert & Nannenga-Bremekamp (1979).

**Arcyria minuta** can be distinguished from the other similar looking species of *Arcyria* as follows: *A. insignis* Kalchbr.& Cooke has smaller spores and the capillitial threads are ornamented with transverse bands and spines arranged in a loose spiral. The capillitium of *A. incarnata* (Pers.) Pers. is not firmly attached to the calyculus. *A. cinerea* (Bull.) Pers. is never salmon coloured. *A. corymbosa* Farr & Martin stands in clusters of 2–20 on fused (but individual) stalks; the capillitial ornamentation is blunt papillae or cogs and sometimes weak spirals, and the spores are marked with scattered or loosely grouped prominent warts and faint lines.

**Arcyria obvelata** (Oeder) Onsberg

11o:3837 MH. One specimen from montane forest, on decaying wood.
Arcyria pomiformis (Leers) Rostaf.

26a:3586B MH mc, 26c:3564 MH mc. One specimen from lowland, on Jacaranda, one from miombo on Pterocarpus angolensis. Reported from many parts of the world and of Africa. No earlier records from East Africa.

Sporangia scattered, stipitate, globose or somewhat prolate, ochraceous to pale ochraceous, up to 1.2 mm tall, expanding at maturity. Peridium fugacious except the shallow, plate-like calyculus, the inside of which is covered with papillae. The papillae are sometimes connected with short ridges forming a reticulum. Stalk erect, yellowish to pale brown, one-third to one-half (sometimes little longer) the total height, filled with spore-like cells. Hypothallus scanty. Capillitium ochraceous, firmly attached to the cup, net rather wide meshed, elastic; the tubules (2-)3-7 μm in diameter, marked with half-rings, spines and warts, which are sometimes locally connected by ridges into a reticulum. Spores brownish yellow in mass, pale yellow by transmitted light, spherical, nearly smooth with some scattered warts, 6.5-7.5-8 μm in diameter.

The stipe is relatively tall in both specimens. In one specimen (MH 3564A) the capillitial tubules are thinner (2-)3-4 μm and the ornamentation is somewhat taller and not so dense. According to Nannenga-Bremekamp (1991), some small sporangia of Arcyria pomiformis have a very wide-meshed capillitial net, with wide tubes densely covered with warts. This description fits the other specimen (MH 3586B), which grew mixed with Licea bulbosa.

Arcyria pomiformis is common in moist chamber cultures, reported for example, on material collected from southern Finland (Härbön 1979) and Turkey (Härbön & Uotila 1983).

Hemitrichia calyculata (Speg.) M.L.Farr


According to Alexopoulos & Saenz (1975), Hemitrichia calyculata is common and abundant in the tropics. Lister (1925) and Hagelstein (1944) believe H. calyculata to be an environmentally induced variant of H. clavata developed under warm temperature. Yamamoto et al. (1993) also consider H. calyculata to be a variant of H. clavata. According to them, var. clavata differs from var. calyculata in the gradually expanding stalk, in the deep, vase-like cup and in the easily detached capillitium. The capillitium of H. clavata is usually rougher than that of H. calyculata (Martin & Alexopoulos 1969, Stephenson & Stempen 1994). H. clavata is found only in the temperate zones. We have in total 35 specimens of H. calyculata from Tanzania, one from lowland forest but most from montane forest. To determine the range of the two taxa, spore to spore cultivate should be made.

Trichia botrytis (J.F.Gmel.) Pers.

2e:3596A MH mc. One specimen from montane belt; on bark of Eucalyptus saligna. Widely distributed in temperate regions, in Africa earlier reported from northern and southern parts and from the Canary Islands.

Sporangia crowded, sessile, subglobose to clavate, brown with darker areas, 0.4–0.8 mm in diameter. Peridium rather thin, brown with darker thickened areas with granular matter. Capillitium composed of ochraceous brown elaters ornamented with spirals, about 5-7 μm in diameter at the centre, tapering gradually to the long, slender tips. Spores ochraceous brown in mass, pale yellow by transmitted light, globose, minutely warted, 8–9.3–10 μm in diameter.

The peridium, capillitium and spores are like those of Trichia botrytis although the species is usually stipitate.

The specimen grew mixed with Echinostelium minutum.

Only two Trichia species have been found earlier in Tanzania: one of them, T. decipiens, was found by Eichelbaum (1906) in the East Usambara Mountains and the other, T. favoginea, by Härbön & Saarimäki (1991), also in montane conditions. The genus Trichia is commonly considered rarer in warm than in cooler climates (Eliasson 1991, Farquharson & G. Lister 1916, Farr 1969, Gottsberger 1968, Ing & McHugh 1968).

Order Stemonitales

Forty-eight specimens of the order Stemonitales were collected in Tanzania in 1988–1991.
These specimens belong to the following genera: *Diachea* (1), *Leptoderma* (1), *Lamproderma* (4), *Comatricha* (3), *Stemonitis* (32) and *Stemoni-topsis* (7).

*Diachea leucopodia* (Bull.) Rostaf.

30a:3783 MH. One specimen from montane forest; on litter.

Cosmopolitan. Reported from almost every part of Africa.

Sporangia in large groups, stipitate, cylindrical, blunt at the tip and base, iridescent bronze and blue; often the bronze zone is at the base and the blue zone in the middle of the sporangia; total height 1–2 mm. Peridium thin, partially persistent, iridescent. Stipe white, erect, limy, having an expanded base, about one-half the total height. Hypothallus thin, white, calcareous. Columella thick, white, containing lime, nearly reaching the top of the sporangium. Capillitium rising from the whole length of the columella, composed of thin, branching and anastomosing brown threads which become paler at the periphery. Spores blackish brown in mass, relatively pale brown in transmitted light, globose, minutely warted, 8–8.9–10 μm in diameter.

*Leptoderma iridescens* G.Lister

5b:3914 MH mc. One specimen from submontane belt; on bark of *Plumeria*. Reported from Europe and U.S.A. New to Africa.

Fructifications sporangiate, loosely gregarious, pulvinate, sessile on a restricted base, sometimes short stipitate, greyish brown, 0.5–0.7 mm in diameter. Peridium membranous, greyish brown, somewhat iridescent, wrinkled, enclosing lime granules. Stipe, if present, very short and thick, concolorous with the sporangia. Columella absent. Capillitium of stout, simple or scarcely branching threads, dark brown in the middle, hyaline and tapering at the tips, having colourless or dark expansions and some fusiform swellings enclosing granular material; threads c. 1.5–2 μm thick. Spores dark brown in mass, darkish brown in transmitted light, globose, coarsely and irregularly spiny, spines partially in rows, 10–10.6–13 μm in diameter.

*Stemoni-topsis* (7).

*Lamproderma arcyronema* Rostaf.

19:3570A MH mc. One specimen from lowland rain forest on bark of *Cocos nucifera*.

*Lamproderma scintillans* (Berk. & Br.) Morgan

30a:3781B MH. One specimen from montane forest. On litter. Mixed with *Physarum mutabile* and *Didymium nigripes*.

*Comatricha nigra* (Pers.) Schroet.

37:3811 MH. One specimen from montane forest. On decaying wood.

*Stemonitis axifera* (Bull.) Macbr.

35:3792 MH. One specimen from montane forest. On decaying wood.

*Stemonitis fusca* Roth

36:3808 MH. One specimen from montane forest. On decaying wood.

*Stemonitis splendens* Rostaf.

40:3828 MH. One specimen from miombo (in Malawi), on a decaying stump.

Order Physarales


*Badhamiopsis ainoae* (Yamash.) Brooks & Keller syn. *Badhamia ainoae* Yamash.

10c:3589A MH mc. One specimen from lowland; on *Araucaria cunninghamii*. Reported from North America, Hawaiian Islands and Japan. The only earlier African record is from the Canary Islands (Bañares Baudet & Beltrán Tejera 1987).

Sporangia scattered, sessile, subglobose to pulvinate, flattened, greyish brown; 0.3–0.8
mm in diameter. Peridium one-layered, membranous, translucent, shiny, grey brown. Columella absent. Capillitium composed of tubular, calcareous columns, simple or scarcely branched, extending from the upper part of the peridium to the base. Spores dark brown in mass, brown in transmitted light, globose, evenly spiny, 9–11 μm in diameter.

Keller & Brooks (1976) described a new genus for this species, which earlier was known as Badhamia ainoae. Badhamiopsis differs from Badhamia in having flat, effused plasmodiocarps and especially in having tubular columns of capillitium. Keller and Brooks (1976) remark that there is considerable variation in the shape and colour of fructifications. Peridial lime may be absent and then the fructifications are dark brown. This was the case in the collection from Tanzania.

Eliasson (1991) reported this species from Hawaii from moist chamber on bark from the base of a living coconut palm.

The specimen grew mixed with Licea tanzanica.

**Fuligo cf. cinerea** (Schw.) Morgan
32:3864 MH. One specimen from montane forest. On dead banana leaves. Cosmopolitan, from Africa reported from northern, western and southern parts.

Fructifications crowded, heaped, irregular in shape, pale grey to greyish white. Hypothallus cream-white, strand-like, branching. Cortex not observed, peridium fragile, covered with white lime nodes or scales, translucent after spores are gone. Capillitium nearly badhamoid, composed of tubules forming a net with a few thin, hyaline threads, lime nodes angular or irregular in shape. Spores black in mass, darkish brown in transmitted light, subglobular to ellipsoidal 16–18 x 12–13 μm, warted to spinulose.

Except for missing cortex, the specimen resembles *Fuligo cinerea*. It looks similar to that described in Listr’s monograph (1925). According to Listr (1925) and Nannenga-Bremekamp (1991), the cortex may sometimes be absent. Also the spores agree with those of *F. cinerea*. In some respects the specimen resembles *Physarum dideroides* (Pers.) Rostaf., which however has a double peridium and the spores are often angular or irregular in shape. *Badhamia cinerasens* Martin has spherical or nearly spherical spores (Martin & Alexopoulos 1969).

**Fuligo septica** (L.) Wiggers
27e:3814 MH, 35:3795 MH, 36:3804 MH, 3805 MH, 3807 MH, 644 TS, 645 TS, 646 TS. Seven specimens from montane forest, one from lowland rain forest. Two on decaying wood, six on litter.

**Craterium aureum** (Schum.) Rostaf.
11n:3842 MH, 3844 MH, 930B TS, 938A TS, 939A TS, 940 TS, 35:3794. All collections from lower montane forest. One specimen on twigs, all others on fallen leaves. Cosmopolitan. No earlier records from eastern Africa.

Sporangia gregarious, stalked, subglobose or obovoid, yellow to greenish yellow, 0.7–1.5 mm tall. Peridium thin with yellow lime granules or scales; at maturity breaking up irregularly with a circumscissile crack leaving the lower portion as a cup with an uneven rim. Stipe erect, grooved, about one third or a little less than half the total height, cream-coloured to yellowish, sometimes darker at the base; in transmitted light pale yellow, filled with lime or sometimes empty. Hypothallus thin, small. Capillitium composed of thin threads connected by relatively large, irregular, yellowish or white lime nodes which in some sporangia form a roundish pseudocolumella in the centre of the sporangium. Spores blackish brown to black in mass, brown in transmitted light, globose, minutely to very minutely warted, 7–8.5–10.5 μm in diameter.

According to Nannenga-Bremekamp (1991) it would be logical to place this species in the genus *Physarum*, close to *Physarum flavidum*, which has a distinctly double peridium and somewhat darker and larger spores than *Craterium aureum*.

In two specimens *Craterium aureum* grew mixed with *C. leucocephalum* and in two other mixed with *Physarum melleum*. 
Craterium leucocephalum (Pers.) Ditmar


Eight specimens, seven from montane forest, one from miombo woodland. On dead leaves.

Physarum auriscalpium Cooke

19:3570B MH mc. One specimen from lowland rain forest on coconut palm. Reported from many parts of the world. Earlier records from Africa are from northern and southern parts of the continent.

Sporangium globose, very short stalked, lemon-yellow. Peridium thin, fragile, with yellow lime scales, limeless at the base. Stipe very short, dark. Capillitium with yellow, angular or roundish lime nodes connected with short, thin hyaline threads, sometimes difficult to see. Spores black-brown in mass, brown in transmitted light, globose, warted, 12-12.4-13 μm in diameter.

The species frequently occurs on the bark of living trees in culture (Martin & Alexopoulos 1969, Farr 1976). It has been reported from moist chamber cultures, e.g. from Dominica (Farr 1969) and from Turkey (Härkönen & Uotila 1983, Härkönen 1987).

The specimen grew mixed with Lamproderma arcryionema.

Physarum bitectum G.Lister

7:3603 MH mc. One specimen from semidesert Commiphora bush. On a fruitbody of Sarcosoma. Reported from many parts of the world. In Africa earlier from North, West and South Africa and from the Canary Islands.

Sporangia in groups, sessile, subglobose, 0.6-0.8 mm wide, cream-white. Peridium double, the outer layer a cream-white lime shell, the inner membranous, pale. Columella absent. Capillitium of thin, colourless threads with relatively large roundish, angular or branched white lime nodes. Spores black in mass, rather dark brown in transmitted light, globose, spiny, 10-10.8-11 μm in diameter.

This species usually grows on dead leaves, twigs, compost heaps etc. From moist chamber cultures of bark of living trees it has been reported from Turkey, for example (Härkönen & Uotila 1983).

Physarum compressum Alb. & Schw.


Physarum crateriforme Petch

7:3601A MH mc, 3604A MH mc, 26a:3560 MH mc. Two specimens from semidesert, one on Delonix elata, the other on Commiphora. One specimen from lowland rain forest on Tectona grandis. Reported from U.S.A, the Caribbean, Europe, India, Sri Lanka and Japan. In Africa earlier reported from northern and western parts and from the Canary Islands.

Sporangia gregarious, stipitate or occasionally nearly sessile, globose, subglobose, or clavate, often depressed at the centre of the sporangia, being crateriform, sometimes also depressed beneath; 0.3-0.5 mm in diameter, 0.5-1 mm tall; pale-brown to greyish light-brown. Peridium thin, fragile, pale brown to greyish brown, yellowish brown inside; covered with pale brown lime granules. Stipe thick, dark-brown to black, about one half the total height of the sporangium or shorter, occasionally common for two sporangia; red brown in transmitted light, filled with refuse matter. Hypothallus concolorous with the stipe, small. Columella variable, often conspicuous, cylindric, extending to the apex of the sporangium, or shorter, conic; usually concolorous with the stipe; rarely lacking. Capillitium lime nodes rod-like, reaching horizontality from the peridium to the columella. Spores dark-brown in mass, brown in transmitted light, globose to subglobose, closely spiny, 10-12.1-14.5 μm in diameter.

There were some extra large spores (up to 20 μm) in one specimen (MH 3604A). The spore diameter is generally slightly larger than announced in the references (10-13 μm), probably because the sporangia are somewhat immature. One specimen grew mixed with Physarum ovisporum, one with Diderma hemisphaericum.
Physarum diderma Rostaf.

5b: 3903 MH mc, 3907 MH mc. Two specimens from submontane rain forest. On Juniperus procera. Reported from U.S.A., Europe, Israel and India. An earlier report from Africa is from Morocco (Malencolon & Bertault 1967).

Sporangia clustered, subglobose or somewhat prolate, sessile, with a constricted base, white or dingy ochraceous white, 0.5–1 mm in diameter. Hypothallus white. Peridium of two layers, outer layer of fragile, rather thick white to dingy white lime, inner layer membranous, pale, shiny. Capillitium of numerous, large, roundish, white lime nodes connected with thin, hyaline threads, lime in some sporangia massed in centre to form a roundish pseudocolumella. Spores black in mass, dark brown in transmitted light, globose, densely spinulose, sometimes with clusters of darker spines, some spores with a pale smooth band, 11–13.1–14.5 μm in diameter.

One specimen (MH 3903) grew mixed with Perichaena corticalis var. corticalis.

Physarum javanicum Racib.

11n: 3839 MH, 3840 MH. Two specimens from montane forest. On decaying wood.

Physarum melleum (Berk. & Br.) Massee

11n: 9338B TS, 939B TS, 941 TS, 30a: 3777 MH. Four specimens from montane forest. On dead leaves. Two specimens grew mixed with Craterium aureum.

Physarum mutabile (Rostaf.) G.Lister

11o: 3835 MH, 29a: 3776 MH, 30a: 3778A MH, 3781A MH, 32: 3863 MH, 33: 3868 MH. Five specimens from montane forest, one from miombo woodland. Four on dead leaves, one on plant debris, one on living plant.

One specimen (MH 3781A) was somewhat immature and the peridial lime was exceptionally thick. In this specimen P. mutabile grew mixed with Lamproderma scintillans and Diadymium nigripes. Another specimen grew mixed with Physarum perfectum.

Physarum nucleatum Rex

27e: 3815 MH. One specimen from lowland rain forest. On decaying wood.

Physarum ovisporum G.Lister


Sporangia or short plasmodiocarps, sessile, white, 0.5 mm in diameter. Peridium thin, fragile, covered with white lime granules, less limy at the base. Capillitium with white, rounded and elongate lime nodes connected with thin, hyaline threads. Spores blackish brown in mass, brown by transmitted light, slightly oval to subglobose, densely spiny, with a pale band of dehiscence, 10–11.4–12 μm in diameter.

Physarum ovisporum is distinguished from the other similar looking species by the often oval spores with a pale line and the dark base of the peridium.

Harkonen (1979) has studied the probable type specimen of Physarum ovisporum and published a photo of the spores (specimen G.Lister 3097). The spores are similar in form to those of the Tanzanian specimen but somewhat larger. According to Hagelstein (1944), P. ovisporum is closest to P. vernum. Martin & Alexopoulos (1969) doubted the validity of P. ovisporum. According to Farr (1976), P. ovisporum is a synonym to P. vernum. P. ovisporum, P. vernum and P. cinereum form a group of species, the differences of which need to be examined in detail. This specimen grew mixed with Physarum crateriforme.

Physarum perfectum M.E.Peck

11n: 857B TS, 30a: 3778B MH. Two specimens from lower montane forest. On litter. Reported from temperate regions. New to Africa.

Sporangia gregarious, stipitate to nearly sessile, globose, pale grey to grey. Peridium thin, shiny, translucent after the spores are gone; sparsely covered with lime granules, which sometimes are connected with short ridges. Stalk white, short, rather thick, slightly tapering upwards, limy. Hypothallus rather small,
thin, colourless. Columella distinct, white, conic, about one-third the height of the sporangium. Capillitium composed of thin, translucent threads, with numerous angular to branched or rounded white lime nodes, some of which are occasionally massed to a small central body. Spores blackish brown in mass, pale brown in transmitted light, globose, covered with fine warts, 8–8.8–10 μm in diameter. Close to Physarum melleum, the sporangia of which range widely in colour and sometimes are almost totally grey, approaching P. perfectum. Well-developed columella and slightly larger spores distinguish P. perfectum.

One specimen grew mixed with Physarum mutabile, one with P. pusillum.

Physarum pusillum (Berk. & Curt.) G. List

11n:857A TS, 35:3798 MH, 3799A MH. Three specimens from montane forest. On dead leaves and twigs. One specimen grew mixed with Physarum perfectum, one with Didymium clavus.

Physarum stellatum (Massee) Martin

35:3788 MH, 3793 MH. Two specimens from lower montane forest. On decaying wood. Common in the tropics. Earlier records from Africa are from Liberia (Farr 1959) and Nigeria (Ing & McHugh 1968). Sporangia gregarious, stipitate, globose or somewhat depressed, erect or nodding, sometimes umbilicate below, white to greyish white. Peridium thin, shiny translucent, with white lime granules on the surface; at maturity dehiscing in floriform fashion. Stalk rather long and slender, tapering upward, calcareous, light brown or yellowish, dark at the base, at the tip sometimes almost white; groovy. Hypothallus inconspicuous. Capillitium delicate, almost colourless with a few small, oval or subfusiform nodes, most nodes massed in the centre forming a white, round pseudocolumella. Spores brown in mass, pale brown by transmitted light, globose, delicately warted, 8–8.8–9.5 μm in diameter. Physarum stellatum resembles P. globuliferum and P. nutans, but clearly differs from both in the central lime ball, which after dehiscence easily falls out. From P. nucleatum it differs in the more delicate capillitium with few subfusiform lime nodes and in the calcareous stalk.

Physarum vernum Somm.

21:3598 MH mc, 30a:3786 MH. One specimen from montane forest. On litter. One specimen from moist chamber, on Diospyros abyssinica from Ericaceous belt; the specimen grew on the side of the petri dish. Reported from many parts of the world. No earlier records from eastern Africa.

Sporangia crowded, sometimes heaped, sessile, globose to subglobose varying to short plasmodiocarps, white to greyish white. Peridium single, fragile, usually rather densely covered with white lime granules. Hypothallus inconspicuous. Capillitium a net of thin, hyaline tubules with many white, oblong and rounded lime nodes, nodes occasionally massed to the centre forming a roundish pseudocolumella. Spores blackish brown in mass, rather pale brown to dark purple brown in microscope, minutely or sometimes distinctly warted, warts occasionally connected with ridges, 9.5–10.4–12 μm in diameter.

This species is very close to Physarum cinereum. The main differences are the usually more plasmodiocarpous sporocarps, more limy peridium and the darker and slightly larger spores of P. vernum (Martin & Alexopoulos 1969). Martin & Alexopoulos (1969) mention that the capillitial lime nodes sometimes mass in the centre forming a pseudocolumella, but Nannenga-Bremekamp (1991) disagrees. The specimen collected in the field is assigned with some hesitation to P. vernum. The fructifications are sporangiate to very short plasmodiocarps, and in spite of the dark spore mass the spores are relatively pale brown by transmitted light. On the other hand, there is a pseudo­columella, and the peridium is relatively calcareous. Evidently this is an intermediate form.

Physarum cf. virescens Ditmar

36:3819 MH. One collection from montane forest, alt. 1900 m. On a fallen leaf. Mostly reported from temperate regions. In Africa earlier reported from northern parts and from the Canary Islands.
Sporangia crowded or heaped in small clusters, partially nearly plasmodiocarpous, sessile or with weak, strand-like stalk, subglobose, ovoid or prolate, or partially merged at the base and then branched. Peridium membranous, fragile, covered with greenish yellow lime granules. Hypothallus colourless. Columella none. Capillitium composed of delicate, hyaline threads with yellow, angular and branched lime nodes.

Spores dark brown in mass, pale brown by transmitted light, covered with small warts, 6.5–6.9–7.5 μm in diameter.

In appearance this specimen resembles Physarum virescens, but the spores are smaller and paler, and like the spores of Fuligo septica. The spore size of P. virescens is 8–10 μm for Martin & Alexopoulos (1969) and Farr (1976), 7–10 μm for Nannenga-Bremekamp (1991) and Emoto (1977). According to Emoto the spores are covered with spines, but the other three describe them as minutely punctate or warted. In the specimen examined here the spores were minutely warted. P. obscurum is close to P. virescens with spores 6–8 μm in diameter. The sporangia are scattered rather than heaped however, olivaceous rather than greenish-yellow and larger, and the capillitium contains non-limy threads producing a more rigid network (Ing 1982).

Didymium anellus Morgan


Sporangia or short plasmodiocarps, sessile on a constricted base, pulvinate to flat-pulvinate, occasionally umbilicate above. Peridium covered with dirty white lime nodes, membranous, translucent. Columella absent or represented by a deposit at the base of sporangium. Capillitium composed of slender, more or less dark threads, simple or branching. Spores dark brown in mass, brown by transmitted light, evenly minutely spinulose, 7.5–7.9–8.5 μm in diameter.

Didymium bahiense Gottsb.

38:3821 MH. One specimen from montane forest. On fallen leaves.

Didymium clavus (Alb. & Schw.) Rab.

35:3799B MH. One specimen from lower montane forest. On decaying twigs. Widely distributed in the world. Earlier records from Africa from northern, western and central parts and from the Canary Islands.

Sporangia gregarious, stipitate, discoid, umbilicate at the base, sometimes also above, white to greyish white, up to 1 mm tall. Peridium thin, dark, shiny, covered with white stellate lime crystals. Stipe rather thick, short, erect, tapering upwards, black; red-brown in transmitted light, filled with refuse matter. Hypothallus thin, discoid, brown, rather wide. Columella none. Capillitium composed of thin, brown, sparsely dichotomously branched threads, covered irregularly with nodules. Spores dark brown in mass, pale greyish brown by transmitted light, globose, very delicately warted (oil-immersion), some spores with small groups of warts; 6–6.5–7 μm in diameter.

Didymium clavus is usually easily recognized by the discoid shape and by the thickened, black base of the peridium. In this specimen the dark basal plate is absent. All other features (discoid shape, black stipe and small, pale, very minutely warted spores), however, refer to this species.
Didymium clavus grew mixed with Physarum pusillum.

Didymium minus (A.Lister) Morgan
11n:929 TS, 30a:3787 MH, 34:3869 MH. Two specimens from montane forest, one from miombo woodland. On dead leaves.

Didymium nigripes (Link) Fr.
30a:3781C MH. One scanty specimen from montane forest on litter. Mixed with Physarum mutabile and Lamproderma scintillans.

Didymium squamulosum (Alb. & Schw.) Fr.
Five specimens from montane forest. Four on dead leaves, one on twigs. One specimen grew mixed with Diderma hemisphaericum.

Didymium sp.
27e:3818 MH. One specimen from lowland rain forest. On dead leaves of Pandanus.

Sporangia gregarious, stipitate, subglobose, white, erect to slightly nodding. Peridium fragile, thin, translucent, covered with white stellate lime crystals; dehiscing into lobes. Stalk erect, tapering, furrowed, pale to nearly white, filled with rhomboid lime. Hypothallus minute, discoid, white. No columella. Capillitium composed of thin, hyaline, scarcely branching threads. Spores black in mass, darkish brown in transmitted light, globose, densely spiny with groups of darker spines, 8–8.5–9 μm in diameter.

The white, limy stalk with rhomboid lime granules (peridial lime is stellate) is an unusual feature in the genus Didymium. D. intermedium has rhomboid lime, but the spores are totally different, larger and spiny with irregular reticulation. The present specimen somewhat resembles D. squamulosum, which is more robust and has a columella.

Distribution and habitats of the Tanzanian Myxomycetes

About one third of the Myxomycetes are more or less cosmopolitan. Some of them, however, prefer a certain kind of climate (Gray & Alexopoulos 1968). One group of species is more abundant in the tropics or subtropics and in warm temperate regions. Among these species at least Badhamia gigantospora, Ceratiomyxa spaeosperma, Hemitrichia calyculata, Physarum bogoriense, P. melleum, P. nucleatum, P. pezizoidesum, P. stellatum and P. superbum have been found in Tanzania (see also Härkönen & Saarimäki 1991, Ukkola & Häkkinen 1996). According to Gray & Alexopoulos (1968), also strictly tropical species exist. Of these species, Physarum javanicum and Tubifera bombarda occur in Tanzania.

Of the specimens collected in the field in Tanzania in 1990–1991, eleven originated from lowland (mainly rain forest, under 800 m). Only three specimens were from submontane rain forest (800–1000 m), and none was from the Ericaceous belt (above 2400 m).

Most of the Myxomycetes were found in montane forest. This was also the case in earlier field work (Härkönen & Saarimäki 1991). About 60% of Tanzania is covered by wooded savannas, miombo woodlands (Niemela 1988). The miombo trees shed their leaves during the dry season, and in the rainy season tall grass covers the ground. Most miombo trees form mycorrhiza with fungi of Basidiomycetes and at the beginning of the rainy season a rich variety of fungal fruit bodies appear. In spite of an eager search, only six specimens of Myxomycetes were found in miombo woodland in the field. Two of these were found in Malawi. Fire may be the major reason for the rarity. In addition to natural fires, the local people have a tradition of setting fire to the dead grass of the previous growing season. Thus there is very little litter or dead wood available. Similarly in Nigeria, slime mould specimens in savanna and dry grassland have been few (Ing 1964, Ing & McHugh 1968). Maimoni-Rodella & Gottsberger (1980) have studied Myxomycetes in Botucatu, Brazil. Slime moulds were investigated during a one-year study (1976–1977) in an evergreen forest and in a savanna-like cerrado. Twenty-three species of Myxomycetes were found in the cerr-
do and twenty in the forest. The cerrado area
had not been burned for at least eight years.
Bark samples for moist chamber cultures
were collected from localities where no
fruitbodies of Myxomycetes were found. There­
fore only 13% of the bark samples originated
from montane forests. Most of the samples
were collected in the Ericaceous belt and in
lowland and submontane belt, a few from the
semidesert (Commiphora) bushland and three
from miombo. The Ericaceous belt is a barren
and cool habitat for slime moulds; from the 95
moist chamber cultures prepared from bark
samples collected from the belt, we harvested
only five specimens. Possibly also the high UV­
radiation in this vegetation belt contributes to
the rarity of the Myxomycetes. Seven speci­
mens were found from the twelve moist cham­
ber cultures prepared of bark samples collected
from semidesert. Although semidesert is an
arid habitat it is warm, and during the onset of
rains the dormant spores of slime molds prob­
ably germinate very quickly. All three bark
samples collected in miombo produced Myxo­
mycetes (two species).
Fig. 11 shows all the specimens collected in
Tanzania in 1988–1991 distributed by vegeta­tion belt. The column for montane forest is by
far the highest.

Substrata
For the whole life-cycle of slime moulds to
appear requires proper moisture and the
availability of decaying plant material (Martin
& Alexopoulos 1969). According to Gray &
Alexopoulos (1968), the quality of the subst­
ratum is less important. Some species never­
theless, occur more frequently on certain sub­
strata. Of the 162 specimens examined in this
study (collections in 1990–1991), 67 grew on
litter and 44 on decayed wood. Specimens on
bark of living trees numbered 51, all of them
harvested from moist chamber cultures. Fif­
teen of these grew on coniferous bark and 31

Fig. 11. Myxomycete specimens collected in Tanzania (including two specimens in Malawi) in 1988–1991, distributed
by vegetation belt. Lowland = under 800 m (mainly rain forest); submontane = submontane rain forest, 800–1000 m;
semidesert, mainly of Commiphora bushland; miombo = miombo woodland, 850–1150 (-1600) m; montane = montane
forest, alt. 1000–2400 (-3000) m; Ericaceous = Ericaceous belt, alt. above 2400 m.
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<th>incubation time in days</th>
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Fig. 12. Myxomycete species harvested from bark of living Tanzanian trees in moist chamber cultures. * In one Perichaena corticalis collection the tree species is not mentioned.
Fig. 13. Number of Myxomycete specimens collected on different substrata in Tanzania and (two specimens) Malawi 1988–1991. Living herb. plant = living herbaceous plant.

Fig. 14. Number of specimens in the six orders of Myxomycetes on different substrata. The diagram includes all (cited) collections in Tanzania, and two in Malawi, in 1988–1991. 
Living herb. plant = on living, herbaceous plant.
on deciduous bark, three grew on a palm tree (Cocos nucifera) and one on Euphorbia heterochroma. In this case the result does not reveal a preference for deciduous trees as substrata because the majority of our bark collections were from deciduous trees. Champion & Mitchell (1980) have noticed that in the Canary Islands specimens of bark from deciduous trees yield relatively better results than those collected from trees of evergreen forests.

The pH values of substrata of the moist chamber cultures with bark of living Tanzanian trees can be seen in Fig. 12. In the most acid substrata (pH 4.3–4.7), Echinostelium minutum, Trichia botrytis and Arcyria pomiformis were found, and in almost neutral conditions (pH 7.2–7.4) Licea cf. pedicellata, Physarum diderma and Didymium anellus. These results agree fairly well with those of Harkonen & Uotila (1983) for Turkey and of Stephenson (1989) for temperate forests in southwestern Virginia. In Stephenson’s study the members of Liceales appeared to have a relatively wide pH tolerance, and the members of the Echinosteliales and the Stemonitales generally developed under more acid conditions than did members of the Trichiales and the Physarales. In this study, however, the widest pH tolerance is found in the Trichiales.

Fig. 13 shows the specimens collected in Tanzania in 1988–1991 distributed by substratum. The majority of the specimens grew on decayed wood.

Fig. 14 shows the number of specimens in the six orders of Myxomycetes on different substrata. The diagram includes all collections made in Tanzania in 1988–1991. Most of the orders show some preference for certain substrata. In general, for example, members of the orders Ceratiomyxales, Liceales, Trichiales and Stemonitales prefer decayed wood or the bark of living trees. In the case of Stemonitales there were even some specimens growing on living herbaceous plants. The members of the order Physarales grew on several kinds of substrata, most commonly on litter.

Discussion

Altogether 455 specimens of Myxomycetes were collected in Tanzania in 1988–1991. Two additional specimens were collected in neigh-bouring Malawi. The specimens represent 88 species, 12 of which are new to Africa, and one of twelve, Licea tanzanica, is new to science. The most abundant species in Tanzania was Ceratiomyxa fruticulosa. The most abundant genus was Physarum (91 specimens) and the most abundant order the Physarales (179 specimens). Including Eichelbaum’s collections in 1903, a total of 91 species have been found in Tanzania.

According to Alexopoulos (1970), there are fewer Myxomycetes in tropical rain forests than in temperate deciduous forests. Most Myxomycete specimens collected in the field in Tanzania during 1988–1991 were found in montane forests. The climate of this vegetation belt during the rainy season is not unlike the climate of the temperate or boreal zone during the growing season. The turnover of the litter and decaying wood is not so rapid as it is in the lowland rain forests, so there are substrata available for slime moulds. Although the quality of the substrata is usually not considered important, the Tanzanian material provides confirmation that certain species prefer certain substrata. The preference is even seen at the order level.

The ratio of the number of Myxomycete specimens harvested from moist chambers (51) to the number of moist chambers established (223) is not high. Comparable studies in West Africa in Gambia (Harkonen 1981) have given a figure of 71% and in Turkey (Harkonen & Uotila 1983) as much as 116%. The Gambian material was from lowland and comprised not only bark from living trees but several kinds of plant litter. Results for boreal bark material (Finland and Norway) gave a value of 45% (Harkonen 1979). Alexopoulos’ (1953) studies in Florida gave rather similar results to ours in Tanzania: 23.8%. The low ratio in the present study probably has to do with the vegetation belts from which the bark collections were made. Most of the collections were from the Ericaceous belt (above 2400 m), which clearly is too exposed and cool an environment for abundant occurrence of Myxomycetes. Stephenson (1989) has studied Myxomycetes occurring on the bark of living trees in temperate forests in southwestern Virginia. The percentage, 90%, of cultures yielding some stage of Myxomycetes is high compared to the corresponding presentage in this study, 36% (in-
including plasmodia that failed to produce mature fruiting bodies).

The identification of the material raised a number of problems as to the delimitation of some species, e.g. the group Physarum cinereum, P. vernum and P. ovisporum. The group Didymium nigripes, D. iridis and D. bahiense also needed a through revision. Härkönen and Saarimäki (1991) assigned six Tanzanian specimens to D. nigripes mainly on the basis of dark columelle and black stipes filled with refuse material at the base. Parts of some specimens were later sent to Prof. Jim Clark (University of Kentucky, U.S.A.) who is specialized in this Didymium group. Prof. Clark succeeded in cultivating one specimen of Didymium nigripes (Härkönen 3638) from spore to spore, and according to him, it produced descendants looking like typical D. iridis (Clark in litt. 1994). He believes that the differences between the two species are totally influenced by the environment and have no systematic value.

Acknowledgements. We wish to thank Dr. Harold Keller for studying the undescribed Licea species and late Mrs. N.E. Nannenga-Bremekamp for sending us the slides of the types of Licea bulbosa and L. rugosa. Herbarium specimens were obtained on loan from the herbarium NFC (Beltsville, MD). We thank Lic. Phil. Heino Vänski for the Latin translations. The collecting trips were financed by the Finnish International Development Agency (FINNIDA) and the University of Helsinki.

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Received on 6 November 1995