# A TAXONOMIC SURVEY OF MACROFUNGI OF KARURA FOREST, WITH PARTICULAR REFERENCE TO THE GASTEROMYCETES

BY

ADUNGAH, JOHN ANGEGAS

(UNIVERSITY OF NAIROBI)



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# D E C L A R A T I O N

This thesis is my original work and has not been presented for a degree in any other University.

14/10/93

John Adunga Angegas

This thesis has been submitted for examination with my approval as University Supervisor.

14/10/93

Dr. Richard K. Mibey
Department of Botany
University of Nairobi

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# A B S T R A C T

Specimens of the macrofungi were collected at two forest types at Karura namely, mixed indigenous and exotic forests. The spores of the collected specimens were examined by SEM and their surface configurations described and used together with other characters for purposes of classification. Keys for the determination of orders, families, genera and species have been prepared. Scanning Electron Microscope has been used in the study of spore and capilitial surfaces, where possible, to eliminate the ambiguity, normally common when studying the structures with light microscope.

The present study reveals that of the 13 species recorded, 3, viz; Geastrum coronatus, Scleroderma geaster and Cyathus olla are records new to Kenya; 8, viz: Dictyophora duplicatus, Geastrum saccatum, G. velutinum, G. fimbriatum, G. triplex, Calvatia gardneri, Scleroderma flavidum and Cyathus poepigii, are records new to Karura forest, while only two, Lycoperdon fuligeneum and G. pectinatum had previously been recorded. Cyathus nigro-albus, previously reported from the same locality was not found during this study.

The results indicate that while all the 13 species recorded are represented in the indigenous forest type, only three are represented in the Cupresseus sp. forest type, and none is represented in both Eucalyptus sp. and the Araucaria sp. forest types. This may suggest that gasteromycete species population are threatened from existence, when indigenous forest types are replaced by exotic forests.

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# CHAPTER I

## 1. Introduction

Taxonomic information of an organism is a key component of any biological research work.. It is an important discipline in man's ever progressing exploration of, and adjustment to his surroundings (Singer, 1962). It makes it easier to substantiate or refute theories of evolution; or at least to achieve one of the two main objectives of systematic biology; (a) the assembling of related groups and forms into taxa, to which fungi are no exception and (b) accurate identification, which is needed by physiologists, foresters, biochemists, plant pathologists, medical mycologists, pharmacologists, ecologists, cytologists, geneticists, and those who eat Macrofungi

Macrofungi are a multitude of higher fungi with complex macroscopic fruiting bodies that one encounters and directly recognises in the field as fungi (Zoberi, 1972). They are confined to two classes, Ascomycetes and Basidiomycetes. The series Gasteromycetes belongs to the class Basidiomycetes.

### 1.1 TAXONOMIC ACCOUNT OF MACROFUNGI IN KENYA

As far as the taxonomic knowledge of the macrofungi in general is concerned, some work has been done in Kenya in particular and East Africa in general.

The first Systematicists in the area were more interested in the Agaricales. Otieno (1964, 1966, 1968) described nine species of Termitomyces Heim., five species of Favolaschia Heim., the genera Campanella Henn. and Dictyopoloca (Mont.) Heim. and the genus Favolus Fr.,Pegler and Rayner (1969), in their contribution to the agaric flora of Kenya recorded 44 species mainly from Central Province. Pegler (1977), worked on the Agaricales of East Africa, although his work based on a few chosen localities in East Africa is short of an exhaustive representation of the agaric flora of the region. Ryvarden and Johansen (1980), worked on the polypore flora of East Africa, excluding Uganda.

In the series Gasteromycetes, Otieno (1966, 1967), described six species of Geastrum Pers., six species of Cyathus Pers., one species of Sphaerobolus Tode ex Pers., six species of Lycoperdon Tourn. ,one species of the genus Calvatia Fr. mostly from Kenya. Dring and Rayner (1967), worked on some gasteromycetes of Eastern Africa. The area from where this work was reportedly done is too large for an intensive collection and as such, a lot of materials must have been left in the process.

From the review, much of the available descriptive work on Macrofungi from Kenya have been done by Otieno (loc. cit.), whose work was concentrated between 1964-1968.

His studies, however were patchy and have therefore left many gaps to be filled.

Mycologists from other parts of the world, have also shown interest in the systematics of macrofungi in East Africa, including Kenya (Dring and Rayner 1967, Pegler 1977, and Ryvarden and Johansen 1980). Such systematicists have had limited time and often came with already defined interests; to work on. Some of the descriptive works recorded have been by workers to whom the materials were sent by various collectors. A good example is Dring and Rayner's (1967) work on the gasteromycetes of Eastern Africa; to whom the materials were sent at Kew. A lot of macrofungi have therefore not been systematically collected for study. This has resulted in poor knowledge of the macrofungi in our area. Worse still, such workers leave with their collections to their countries; leaving nothing for reference and typification.

The forests are the best habitat for the macrofungi in general; and gasteromycetes species so far reported are from the forests or woodlands; and particularly the indigenous ones. The indigenous forests in Kenya are amongst the endangered habitats. They are being threatened by human activities namely: cultivation, human settlements and infrastructural developments, and replacement of indigenous tree species with exotic ones. These activities may have far-reaching effects

on the macrofungal flora of Kenya. Due to lack of systematic information on the forest macrofungi, the effect may go unnoticed, and may lead to the extinction of certain beneficial species.

## 1.2 Economic Importance of Gasteromycetes

Gasteromycetes like all other macrofungi are responsible for the decomposition of most of the organic materials, along-side other organisms, without which the forests would be an impenetrable tangle of fallen leaves, branches, and trunks. The residues of the organic materials form humus that contributes towards the improvement of soil texture, increase in nutrient content, and conservation of soil moisture. Mycorrhizal association is yet another important aspect of certain gasteromycetes to certain forest trees. Some trees have been known to die young when not in association with root-inhabiting mycobionts. Gasteromycetes species known to grow in association with roots of trees like Pinus sp. are Rhizopogon and Scleroderma sp. (Webster, 1980), and the most important one for afforestation of disturbed sites is Pisolithus tinctorius (Marx, 1977).

In the recent past, some workers have studied macrofungi to distinguish between the edible and poisonous species. Gasteromycetes as a group are without any species known to cause serious poisoning

and certainly indicates that it is one of the safest groups of fungi for any one to use for food (Smith, 1951). However, it is advisable that one uses the young ones whose sporocarps are white clear through. Over-mature Calvatia sp. and Lycoperdon sp. have been known to cause violent gastro-intestinal upsets upon consumption.

pharmacologically, Cyathus helenae has been found to contain an antibiotic complex , Cyathin (Allbut, et al., 1971). The genus Lycoperdon Pers.'has its mass of spores and capillitium used for stopping blood flowing from wounds (Findlay, 1967, Zoberi, 1972). The genus Calvatia Fries may contain a substance calvacin which might be anti-cancer (Zoberi, 1972).

## 1.3 Objectives

1. To collect and identify the gasteromycetes of the indigenous and exotic plantations of Karura forest.
2. To develop a key for identification of the gasteromycetes of Karura forest.

# Chapter II

## Literature Review

### 2.1 Introduction

The taxonomic knowledge of gasteromycetes has undergone developmental stages. Among the nine genera of fungi that Linnaeus (1753), listed, three were of the group Gasteromycetes, viz; Phallus, Clathrus and Lycoperdon, while Michellis' (1729), classification of gasteromycetes was based only on morphological features. For example, Phallus, Boletus, Morchella, and Polyporus were assigned to one taxon and Lycoperdon, Clathrus, and Tulostoma also in another group. Gledirchs put together the genera Phallus, Boletus, and Agaricus in one taxonomic group all on the account that they were capitate, while Clathrus, Lycoperdon, Mucor, and Stemonitis, in another group as being otherwise [In Ainsworth, 1976].

In 1801, Persoon classified the fungi into two broad groups. He separated the larger basidiomycetes into angiocarpic forms, which released their spores from closed fructification. This included the genera Sphaera, Pilobolus, Sphaerobolus and Lycoperdon, and gymnocarpic forms which bore their spores over exposed surfaces, for example the Clathrus, Phallus, Agaricus and Stereum [In Ainsworth, 1976].

Elias Magnus Fries, (1821) in his Systema Mycologicum applied for the first time, the terms Gasteromycetes to

the angiocarpic forms and Hymenomycetes to the gymnocarpic forms of fungi (Chester, 1968; Ainsworth, 1976).

Leveille (1846), classified the fungi according to the arrangements of spores on the fruiting bodies; putting Hymenomycetes, Gasteromycetes and Myxomycetes together as members of the class Basidiospores, that is spores on basidia (Ainsworth, 1976).

De Bary (1866), gave an evolutionary approach in a general classification of fungi which closely resembles the present classification system. He grouped the Hymenomycetes, Gasteromycetes and Tremellini under the class Basidiomycetes (Ainsworth, 1976).

## 2.2 Gasteromycetes

The term Gasteromycetes was coined by Elias Magnus Fries in 1821. He applied the term to all the angiocarpic forms of fructification, and Hymenomycetes to all the gymnocarpic forms (Chester 1968; Ainsworth, 1976). The term gasteromycetes means stomach fungi, [that is, Gastero - stomach, Mycetes - fungi]; due to the fact that basidia that produce the spores develop inside a closed fruit body (Smith, 1951; Findlay, 1967).

The difference between Hymenomycetes and Gasteromycetes is that in the former, the basidia are displayed on a well developed hymenial layer, throughout and the

individual spores are normally violently discharged, while in the latter series, the basidia, though well developed at immaturity as in Lycoperdales and Phallales are poorly defined, not exposed and individual spores are not violently discharged. The basidia break down at maturity and spores lie freely within the ripe sporophores (Ingold, 1965; Webster, 1980). The term does not therefore apply only to the higher basidiomycetes in which the spore-mass is enclosed in a sac-like peridium, typical of the puffball, but also those very much like the agarics and boletes (Dring and Rayner, 1967).

There are many differences of opinion on the taxonomic treatment of the Gasteromycetes; since it merges with the hymenomycetes (Ainsworth, 1976). Following the works of various systematicists, gasteromycetes are regarded as an unnatural assemblage of basidiomycetes that only share a common character in non-violent discharge of spores (Webster, 1980). They are treated as a group primarily as a matter of convenience; in as much as they are not monophyletic in origin (Alexopoulos, 1979).

Suggestive series linking Hymenomycetes genera with others amongst Gasteromycetes are known. A striking example is the species Secotium agaricoides, a Hymenogastrales, which in its early stages of development, agrees exactly with the genus Agaricus.

However, with time, the gills anastomose and the fruit body does not open to expose hymenial surface. At maturity, spores are set free passively within the sporophore and most of the gill tissue break down (Ingold, 1965). This behaviour, is a bridge between the two series.

2.2.1 Taxonomic status of Gasteromycetes

This group of fungi has been given different positions by various systematicists in their efforts to classify it among other Basidiomycetes.

Gwynne-Vanghan and Barnes (1927), classified the gasteromycetes as the order Gasteromycetes. Bessey (1950), classified it as a sub-class, Gasteromycetes. Alexopoulos (1962) recognised the group as a series Gasteromycetes, while Kressel (1969) gave it a class status; Gasteromycetes. Oring(1973), (In Alexopoulos, 1979) and Webster (1980), have given it the status of a series; although Alexopoulos in his conclusion puts it that Gasteromyscetes in the real sense has no taxonomic status. This is because it is comprised of heterogenous members; whose certain characters can be traced into members of other taxonomic units such as Agaricales [Alexopoulos,1979].

The series gasteromycetes fall under the sub-class Holobasidiomycetidae, characterised by single-celled

basidia; with four but frequently more basidiospores (Alexopoulos, 1979).

2.2.2. Fructification

The fruiting body of Gasteromycetes is a simple structure, more or less globular in shape. It is characterised by a distinct outer wall, the peridium. The peridium opens naturally in various ways after the spores are mature or may remain closed permanently, with the spores liberated by disintegration (Smith, 1951). The peridium encloses the inner fertile portion of the basidiocarp, the gleba. This simple type of structure has undergone modifications in the course of evolution (Smith, 1951). A good example of such a modification is the development of stem-like base, which in its final expression gives a true stipe as in the species Tulostoma fibrillosum. In Phallales, the stem-like structure is the receptaculum, while in sclerodermatales, it develops into a pseudostipe. In the Lycoperdales, there is no developed stipe, other than just a stem-like base as in the genera Calvatia Fries and Lycoperdon Pers. while in Nidulariales, some of the fructifications have stipe-like bases.

2.2.3. Spore Liberation

Most of the adaptations developed by the gasteromycetous group, have had a bearing on the

problem of spore dispersal. They are adapted to xerophytic conditions reaching their fullest development in warm dry parts of the world, with spore dispersal mechanisms not showing dependence on continued dampness of the surrounding air (Ingold, 1965). The following are five different mechanisms of spore dispersal amongst the group members; according to Smith (1951) and Ingold (1965).

(a) Wind and Water Droplets

Blowing wind and falling drops of water depress the glebal wall, with the spores escaping through the Ostiole or spores just blow out where there is no ostiole. This mechanism is exhibited by members of the orders Lycoperdales, Tulostomatales, and Sclerodermatales.

(b) Insects

This mechanism is exhibited mainly by the members of the Phallales. In these species, the exposed spore slime, which is sweet and emits strong unpleasant odour attracts insects. The gleba is sticky and as such the spores cling to the mouth parts and bodies of the insects with some being eaten and passed through the alimentary tract unaltered.

(c) Rodents

This mechanism is mainly by the hypogeal, forms, the false truffles; which include the members of the

orders Hymenogastrales and Melanogastrales. The sporophore on maturity emits a smell detectable by rodents that eat them. Spores are then deposited after passing through the alimentary canal.

(d) Splash Mechanism

During the heavy storms, rain drops eject the peridioles to a distance of over a meter and the peridioles then adhere to solid surfaces that they land on. This mechanism is common in the family Nidulariaceae of the order Nidulariales.

(e) Catapult Mechanism

This involves an increase in osmotic pressure, resulting into thrusting of the gleba upward with an explosive force, propelling it through the air. It is mainly exhibited by the family sphaerobolaceae of the order Nidulariales.

2.2.4. Habit and Habitat

Fructification of the gasteromycetes, normally coincide with the wet seasons, particularly with the onset of the rains. With exception of the members of the order Phallales, the fruiting bodies of most species of the gasteromycetes stay on for long and can be found during the dry seasons (Smith, 1951).

Most of the species are epigeal, that is they mature above the ground while some like members of the order

Hymenogastrales and Melanogastrales are hypogeal (Sub-terranean). They can be found growing gregariously, scattered or solitary. Gasteromycetes can be found in woodlands, pastures, burnt ground and sub-terranean soils. The coprophilous forms grow on animal droppings and dung heaps. In the forests, there are lignicolous and Mycorrhizal forms. The lignicolous forms are mainly found on fallen and worked timber stumps; and also on rotting leaves and tree branches. In fact the majority of the gasteromycetes are lignicolous. Just a few species like those of Cyathus Pers. and Crucibulum Tulasne are coprophilous, with the Mycorrhizal forms being members of the genera Rhizopogon Fries and Scleroderma Pers. (Webster, 1980).

# Chapter III

## MATERIALS AND METHODS

### 3.1 Locality: Karura Forest

Karura forest which was gazetted in the 1920s by the colonial administration, falls within the city of Nairobi. It covers 594 hectares of which, 410, hectares are under exotic trees and 184 hectares under indigenous trees. It stands at an altitude of 1,640m above the sea level. The area receives an average rainfall of about 900mm annually with March to June and October to December being long and short rain periods respectively.

A survey on the forest revealed that the exotic plantations are of pure stands except for species of Araucaria which are mixed. The species include Cupressus lustitanica Mill, Eucalyptus longifolia Link. Otto, E. tereticormis SM., Araucaria cockii R. Br. ex Lindl, Araucaria cunninghamii Bec. and Araucaria angustifolia O. Kuntze.

Eucalyptus sp. plantation floors are covered with seemingly decay resistant litter. At certain points, the leaf litter is up to 15cm thick. Such an accumulation of litter is also on the floor of the

Araucaria sp. plantations although the litter here is apparently not as decay resistant. The Cupressus sp. plantation floors are clean with only thin layers of scattered litter; which seem easily swept away by the rains or probably more easily decomposed, leaving some parts of the forest floor, bare with bryophytes growing.

The indigenous forest is composed of several species, which differ both in age and height. This has resulted in layering into canopies. The forest floor is rich in tree stumps, fallen logs, tree branches and leaves and is also well shaded against direct light rays.

The common tree species in the forest are: listed as follows:

| Family | Species |
|---|---|
| Anarcadiaceae | Tamarindus indica L. |
| Bignoniacea | Markhamia hilderbrandtii (Baker) Sprague. |
| | Spathodea nilotica Seem. |
| Cannelacea | Warbugia Ugandensis Sprague. |
| Caesalpiniaceae | Cassia didymobotrya Fres. |
| Compositae | Brachylaena hutchinsonii Hutch. |

| | |
|---|---|
| Mimosaceae | Albizia coriaria Welw. ex. Oliv. |
| Moraceae | Ficus thonningii Blume |
| | Ficus natalensis Hochst. |
| Papilionaceae | Erythrina abyssinica Lam. ex. Dc. |
| Podocarpaceae | Podocarpus gracilior Pilger |
| Rutaceae | Teclea trichocarpa Taylor |
| | Toddalia asiatica L |
| Rubiaceae | Pavetta albertina S. Moore |
| | Turraea mombassana DC. |
| Sterculiaceae | Dombeya burgessiae Gerrard |
| Verbenaceae | Lantana camara L |
| | Vitex keniensis Turrill. |

## 3.2 Field Collection

The study involved collection of specimens from all the blocks of Karura forest. Specimens from each type were kept differently. Visits to different forest types were done alternately with a view to collect as many specimens as possible. The collections were concentrated in the early hours of the day at a frequency of three to four times a week during the wet and dry seasons respectively. The exercise took twelve months covering both the short and long rainy seasons.

In the field, a knife or chisel was used for picking up the specimens at different ages. At collection, data on colour, size, habit, texture, date and collection number were recorded in the field note book. Photographs of some specimens in their natural habitats were taken. The collected specimens were put in polythene bags, envelopes, newspapers and cartons with their collection numbers indicated. All the materials collected were carried to the laboratory for further studies within 24 hours of collection.

## 3.3 Laboratory

### 3.3.1. Specimen Preservation

Most of the lesser soft materials collected were air-dried on benches. The few soft and fleshy members of the order Phallales capable of rotting easily were kept in alcohol-formalin in glass jars.

The dried specimens were put back in polythene bags or envelopes with labels, and moth balls added in for protection against insect attack.

### 3.3.2. Extraction of structures for mounting

Spores from the specimens with the exception of the order Phallales, were gently shaken onto the slides or

stubs. The sticky spores of the Phallales were picked by forceps. Where the capillitia were present, again the forceps were used in pulling them out, and shaken clean from the spores. These were mounted on the glass slides or the case of S.E.M., the metal stub.

3.3.3. Microscopy

Both light and scanning electron microscopes were used in studying the spores and capillitial structures of the spore and sizes were determined with the help of the ocular micrometer; from permanent mounted glass slides. Using camera lucidum some structures like spores of Cyathus sp. were drawn on sheets of paper, their photographs taken and photomicrographs made.

3.3.4 Identification

Using information from the field, and those from the microscopic studies, a full datum was made.

With the help of the already available taxonomic keys, the specimens were then identified to the species level. Because there were no already collected and correctly identified materials in our Herbaria, no comparisons were made. The identified specimens were put in duplicate for keeping in the E. A. Herbarium and the Nairobi University Herbarium for future reference.

The information from the scanning electron microscope, together with other morphological characters such as

the sporocarp shape, size and colour, the spore colour ornamentation and size, exo and endoperidium characters and development habits were used in making the key to the Gasteromycetes of Karura forest.

# CHAPTER IV RESULTS

## 4.1. GASTEROMYCETES OF KARURA FOREST

After field collection covering a period of over one year, 13 species of the series Gasteromycetes were recorded. Of these, 2 species are of the order Sclerodermatales, 8 species are of the order Lycoperdales, 2 species are of the order Nidulariales and 1 species of the order Phallales. (Coker and Couch 1928, Dring and Rayner, 1967, Otieno, 1966, 1967, 1968). Below is the key to different orders of Gasteromycetes of Karura forest; designed using the S.E.M. spore surface characters, capillitial characters, general morphological characters, spore sizes and shapes and the surface colours, observed and based on previous literature (Otieno 1967, Dring & Rayner 1967, Couch & Cooker 1928, Dube 1981, Dring 1973)

### 4.1.1. Key to the orders of the Gasteromycetes

1. Gleba, a powdery or pulpy mass of spores at maturity.....2
   Gleba, not as above.....3

2. Gleba, dark, hard with no distinct hymenium and capillitia in early stages.....

2. .....Sclerodermatales

Gleba light, capillitia present, with distinct hymenium in early stage.....Lycoperdales

3. Gleba slimy, odoriferous, exposed by extension of spongy receptacle.....Phallales

Gleba, with cavities isolated from other as periodioles, the fructification reminiscent of the nest with eggs .....Nidulariales.

4.1.2. Taxonomic description of the Orders, Families, Genera and Species of the Gasteromycetes

Order: Sclerodermatales

Fructification, globose, thick with typically hard peridium, and a dark gleba with no well organised hymenium in the early stages of development. The peridium is 1-4 layered, dehiscing by an apical stoma, or irregular fissuring, with the gleba being pulvurulent at maturity, with or without capillitium. The order in this case is represented by a single family Sclerodermataceae.

Sclerodermataceae Fischer, Nat. Pflanz. fam.1. (1990) 334. G.H. Cunningham, Gast. (1944) 115.

2. .....Sclerodermatales

Gleba light, capillitia present, with distinct hymenium in early stage.....Lycoperdales

3. Gleba slimy, odoriferous, exposed by extension of spongy receptacle.....Phallales

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Sclerodermataceae Fischer, Nat. Pflanz. fam.1. (1990) 334. G.H. Cunningham, Gast. (1944) 115.

Fructification more or less globose, sessile or stipitate, usually epigeal. The peridium consists of single layer, being thick or thin, tough or fragile at maturity continuous with tramal plates. The fruiting body has virtually no distinct hymenium. Mature spores are relatively large and strongly ornamented with prominent spines or deep reticulum. The family is represented by a single genus, Scleroderma Pers. in this case.

Scleroderma Pers. Synop. Method. Fung. (1801) 159. Pro parte ended Fries. Syst. Mycologicum 3 (1829) 44. Fischer, Nat. Pflanza. 7a (1933); Verwood, Ann. Univ. Stell 3(1925) G.H. Cunningham, Gast. (1944) 114.

Tramal plates breaking down at maturity resulting in Pulvurulent gleba consisting of spores plus large quantities of debris derived from the trama, placentae etc. often obscuring ornamentation of the epispore. The peridium just before drying out is always fairly thick (1mm - 1cm), brittle or tough when dry.

Dehiscence is by more or less regular stellate cracking of the peridium and recurving of the resulting lobes or by irregular flaking away of the apex.

Key to Species of the Scleroderma

1. Fructification more or less smooth when young, opening stellately, spores globose, strongly echinate, with conic spines.....S. flavidum.

   Fructification coarse and roughened opening as in Geastrum, spore globose, and reticulate.....S. geaster.

Scleroderma flavidum Ellis and Everhart, (Plate 1). Journ. Mycol. 1 (1885), Coker and Couch, Gastero (1928) 162; Verwoerd, Ann. Univ. Stell. 3(1925); G.H. Cunningham, Gastero (1944) 120; Bottomsley, A. M. (1948) Gast. of S. Africa. Bothalia Vol. 4; Dring and Rayner (1967), some gastero.of east africa Journ.E.A. N. H. Vol. 26(144).

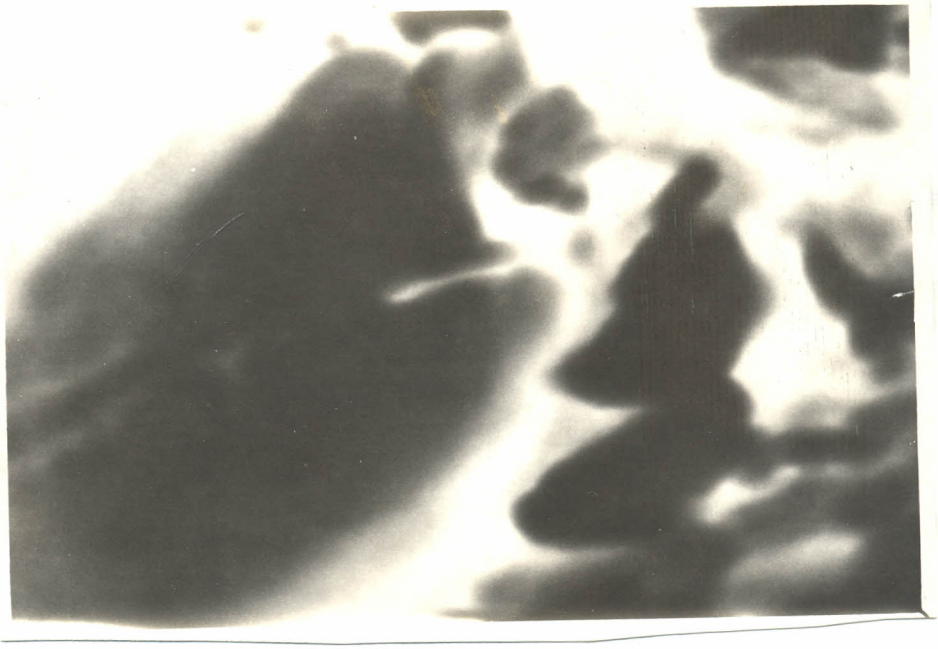
Fruit bodies depressed globose, to pyriform to 6cm. diameter, dehiscing stellataely apically with a well developed stem-like base. Peridium buff up to 5mm. thick when fresh, when dry smooth to areolate. Gleba, dark purple when young, while at maturity, powdery, often falling away completely leaving the empty star-shaped peridium. Spores dark brown, globose 10-12u diamieter strongly echinate with conic spines (Plate 1b).

Habit and Habitat

Solitary, scattered to gregarious; almost buried in the soil at first. Found growing in the open less humus rich soils, in both *Cupressus* sp. plantation and indigenous forest; during the long rains.

PLATE 1

A. Sporocarp (Full & L.S.) Scleroderma flavidum (A 609, x 0.75)



B. An S.E.M. micrograph, showin basidiospore with spines (s) of Scleroderma flavidum.

(A 609, x 15,000

Scleroderma geaster Fries. (Plate 2) Engler Prantt. Lloyd. Myc. Notes No. 9: (1902). (1905) Massee, Journ. Myc. 6. Murill. Mycologia 2: fig. 9. 1910. Vittadini. Monog. Lycoperd. Cocker and Couch. 1928.

Syn. Sclerangium polyrhizon (Gmel.) Lev.

Stella americana Mass. Journ. mycol. 1.

Hard. Mushrooms. pl. 65.

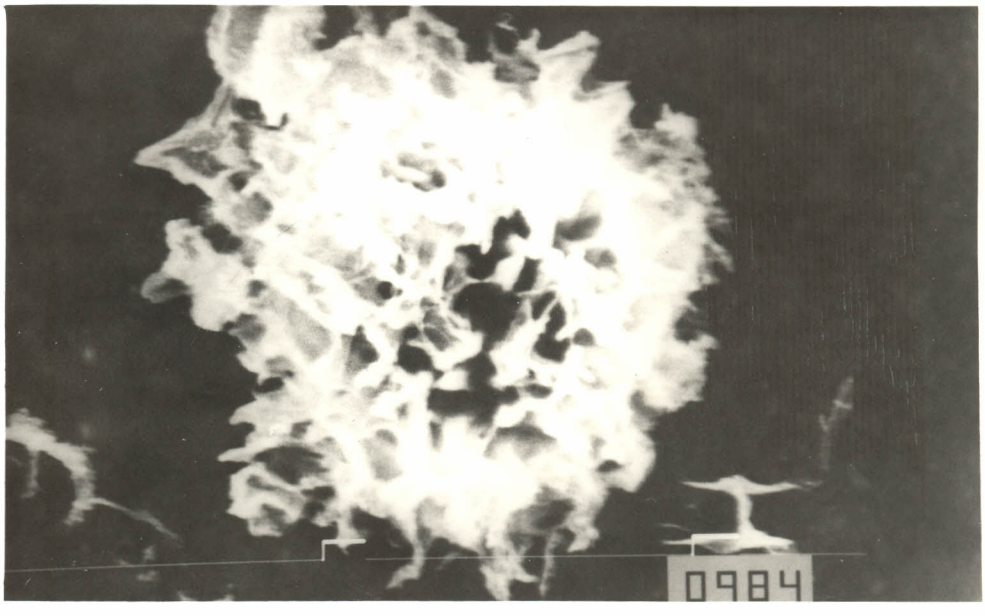
Fructification 3.5 - 1.2cm. broad, opening up to 15cm, globose to subglobose, depressed and often sessile and entirely embedded until near maturity, connected beneath with diffused plates and strands of mycelium. Peridium hard rigid to 5mm thick when fresh, about 1 - 2cm. thick when dry, yellow or dull yellowish clay, rough and more or less cracked into areolations and scales, splitting up at maturity into a varying number of lobes that curl back as in the genus Geastrum on drying, exposing the dark spore mass which is deep brown. Spores 6.5 - 10cm in diameter globose and reticulate. (Plate 2b).

Habit and Habitat

Found growing solitary on poor roadside, soil heaps, cutting through the indigenous forest, under a tree shade.

PLATE 2

A. Sporocarp of Scleroderma geaster, showing the rays and pseudostem. (A 823, x 0.5)




B. Spores of Scleroderma geaster under S.E.M., showing its reticulate surface pattern.
(A. 823, x 15,000).

Order: Lycoperdales

Fructification mostly epigeous, Sessile, single or in groups on a stromatic layer, rarely substipitate, globose, pyriform; peridium 2-4 layered, dehiscing by an apical pore, by several pores, by irregular or stellate cleavages, or by flaking. Gleba wholly fertile or sterile below, consisting of powdery spore mass and well developed capillitia. The combination of the spore mass and capillitium to form the gleba is typically characteristic of the order.

Key to the families of Lycoperdales

1. Exoperidium, 2-3 layered, opening stellately at maturity, endoperidium apically opened by single or several pores.....Geastraceae.
2. Exoperidium, single layered, thin, endoperidium flakes off or opens by an apical pore.....Lycoperdaceae.

Family Geastraceae

Fruiting body at first hypogeous, or epigeous, rounded or stalked below, peridium duplex, exoperidium 2-3 layered, opening stellately at maturity; endoperidium papery thin, loosening from the

exoperidium, and dehiscing by a pore or many pores; gleba with loose spore mass and well developed capillitia. The family in our case is repressented by a single genus, Geastrum Pers.

Geastrum Micheli ex Pers. in synospis methodica fungorum (1801) 131.

Syn. Plecostoma Desv. Journ. de bot. 2 (1809) 97
Diploderma Link, mag. Ges. Nat. Freunde 7 (1816)
Geaster Micheli ex. Fries. syst. Myc. 3 (1829)
Cycloderma Klotzch. linnaea 8 (1832)
Astraeus Morgan, Journ. Cincinnati Soc. Nat. Hist. 12 (1889).
Myceliostroma P. Henn; Hedwigia 43 (1904)

Exoperidium of 3 layers well developed, dehiscing radially from the apex, resulting into lobes bending back to give a stellate appearance, to mature fruit-body. The endoperidium, thin and papery, opens by an apical pore called the peristome; whose characters are important in distinguishing species.

Key to the species of Geastrum as given by Otieno, (1966) and modified by the writer by incorporation of S.E.M. spore characters.

1. Endoperidium pedicillate.....2
   Endoperidium not as above.....3
2. Mouth sulcate, beaked to 2.5mm. spores spherical, 3.5 - 5.5u diameter regulate (S.E.M.) .....G. pectinatum.
   Mouth fibrilose, spore sac with glistening particles, spores spherical 3.5 - 5u in diameter rectulate, (S.E.M.).....G. coronatum.
3. Fleshy layer separating and forming a bowl on which the spore sac rests. Spores spherical bacculate, (S.E.M.) 3.5 - 5u diam.....G. triplex.
   Not as above.....4
4. Exoperidium, splitting into rays which recurve back against the bowl-shaped basin, non-hygroscopic.....G. fimbriatum.
   Not as above.....5
5. Exoperidium saccate
   Expanded plant, large to 2 - 3.5cm. peristome broadly conical, depressed round the edge, paler than the rest of the gleba.....G. velutinum.
   Expanded plant, smaller 0.8 - 1.5cm., peristome darker than the gleba.....G. saccatum.

G. pectinatum Persoon (Plate 3a, b) synopsis methodica fungorum (1801).Lloyd, Geastrae in myc. writ. 1(1902) G. H. Gunn., Gastero (1944). Bottomsley, Gaster. of S.S. Africa (1948), Bothalia. 4.
Dring and Rayner, Gast. of E. Africa (1967). Journ. E.A.N.H. Society Vol. 26.

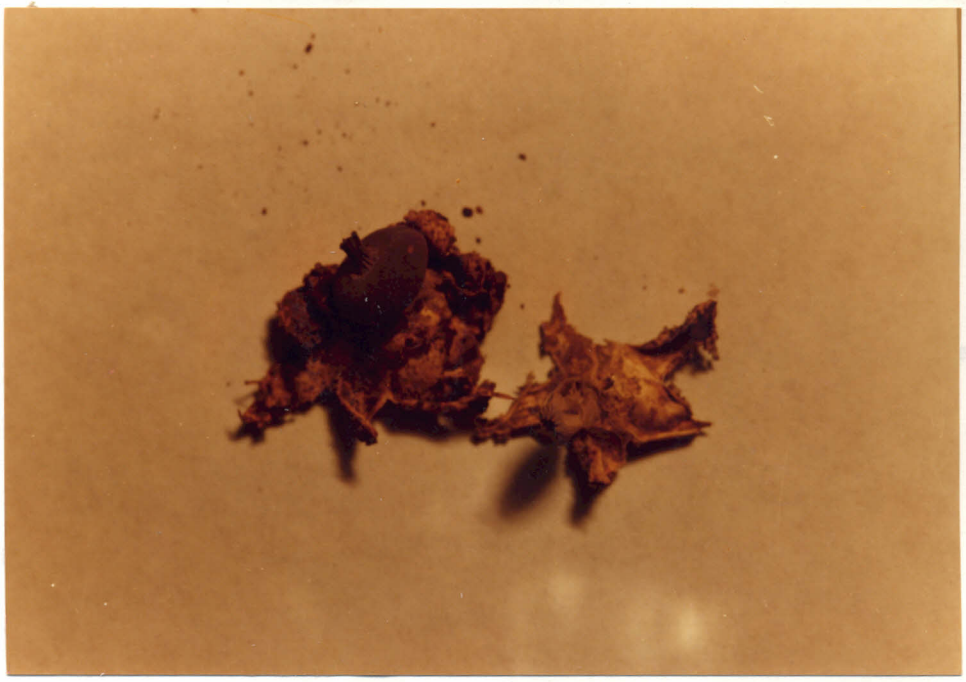
syn. Geaster platicus Berk. Ann. Nat. 3(1848).
G. schimidellii mass. mon. Brit. Gast. in Annals Bot. 4(1889).

Sporophore spherical, to subspherical, exoperidium revolute, rays splits into 5 (in our collection) non-hygroscopic fornicate with the inner surface becoming concave and outer surface covered with trash.

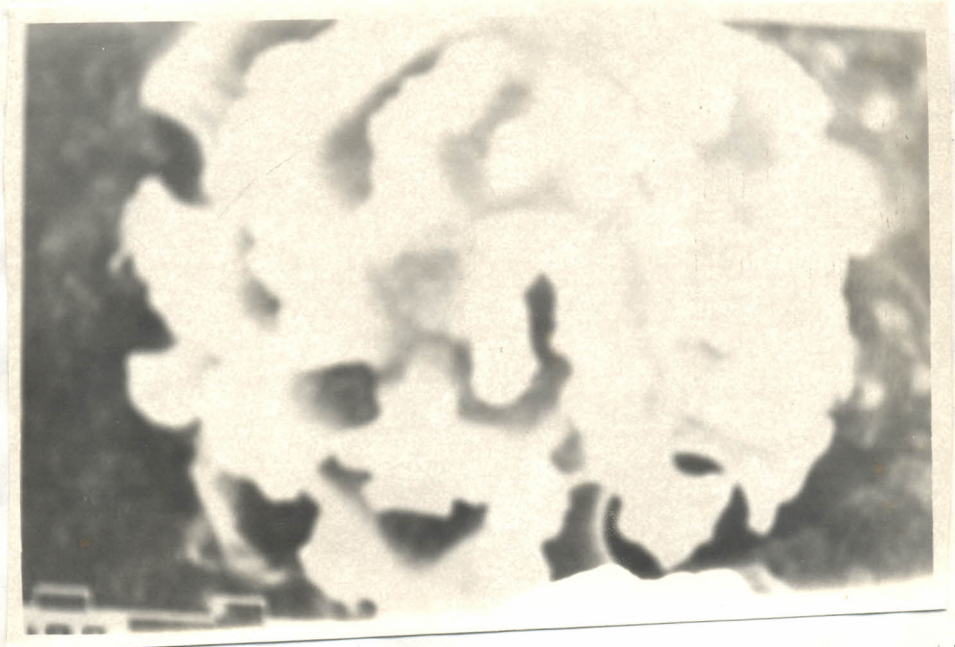
Gleba 10 - 20mm in diameter, sub-spherical ending in a sulcate peristome 2.5mm high, and resting on a pedicel; with a collar, merging into the pedicel below it, with basal striations.

Spores spherical, rugulate (as seen in S.E.M.) 3.5-5u. in diameter. Capillitial threads 4-5u in diameter, sparsely branched.

PLATE 3



A. Sporocarps of Geastrum pectinatum (A 360, x 0.75)



B. An S.E.M. photomicrograph of a single spore with characteristic regulate ornamentation of Geastrum pectinatum (From A 360, x 15,000).

Habit and Habitat

Growing solitary on the ground mixed with decaying plant debris. Three specimens were collected, all growing solitarily in indigenous forest. No any other materials other than my own collections were observed.

G. coronatum Persoon, (Pl. 4a, ♂. Trans. N. Z. Inst. 1883 pg. 362).

Smith, A. H. (1951), puffballs and their allies in Michigan, pg. 85.

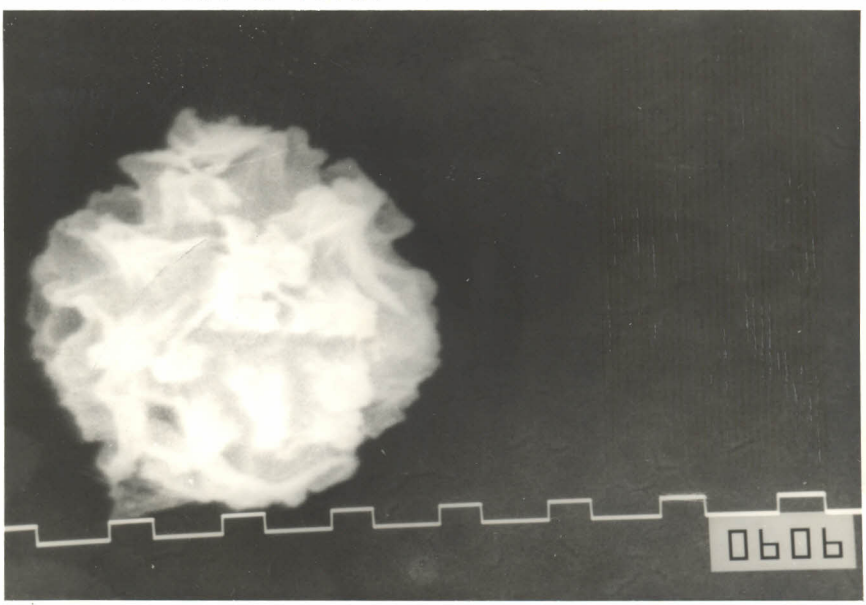
Sporophore, spherical to subspherical, covered by a dense coating of white mycelium intermingled with debris, 0.5 2cm. in diameter. Exoperidium splitting into 8 strongly recurved non-hygroscopic rays that touch the ground by their tips.

Gleba, dark purplish brown with a fibrillose peristome, outlined by a narrow groove, with the surface distinctively roughened with minute glistening particles; raised by 1 - 2mm long pedicel.

PLATE 4

A. Sporocarps of Geastrum coronatus

(A 706, x 0.75)




B. [illegible] photomicrograph, of a spore from Geastrum coronatus, illustrating the reticulate surface ornamentation

(From: A 706, x 20,000)

Spores dark brown, spherical, more or less reticulate (S.E.M.) 3.5 - 5u diameter.

Habit and Habitat

Growing solitary, on the soil among plant debris under big trees. Rare, so far only three specimens were collected, and both from the indigenous forest block; long after the rains.

G. triplex Jun. (Pl. 5a, b). Tijd-Schrif Voor Natuurlich Gesch. en physiologie 7(1840). Hollos, Gastero. ung. (1940).

N.J.G. Smith, Rec. Albany Mus. 4(1935).

G.H. Gunn.; Gastero. (1944). Smith, A .H. Bottomsley (1948).

Gast. S. Africa, Bothalia 4. Puffballs and their allies of Michigan 1951.

Syn. Geaster lageniformis vitt. monog. LYc. (1842).

G. capensis Thum. in Mycott. Univ. 815. Sacc. syll. Fung. & (1888).

G. morgani Lloyd in myc. in myc. Writ. 1 Myc. Notes 8(1901).

Sporophore large, 25-30mm. diameter, in unexpanded specimens, with the apex forming a pointed beak, sessile,

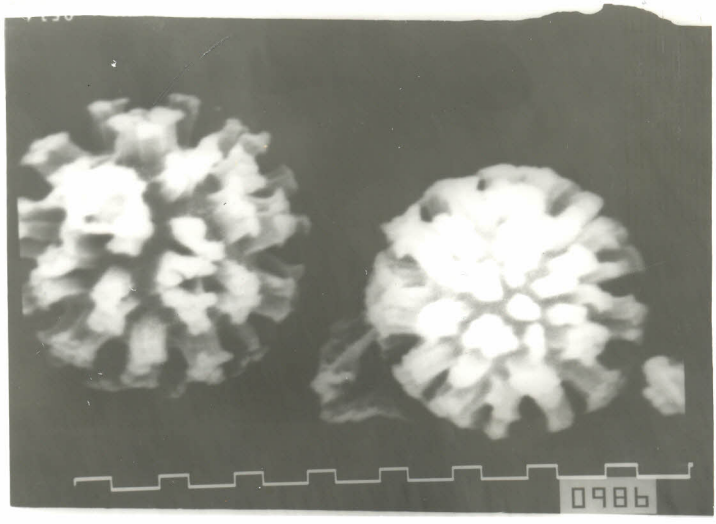
dirty white with scales but free from trash on the external surface. Exoperidium splits into 5-8 recurved non-hygroscopic rays, mycelial layer papery to leathery, rough without dirt, the base with definite scar at the point of attachment. Fleshy layer dresden brown, forming a continuous bowl on which the spsore sac rests; with part of it adhering to the rays unevenly cracked and peels off in places.

Gleba Sudan brown, sessile, 22-28mm in diameter ending in a broadly conical, radially fibrillose peristome; spores, spherical bacculate 3.8-5u diam. (S.E.M.) Capillitial threads thick ruled, rarely branched.

PLATE 5

A. Geastrum triplex: Sporocarps

(A 361, x 0.5)




B. Geastrum triplex: S.E.M. photomicrograph, spores and their surface ornamentation

(From A 361, x 15,000)

## Habit and Habitat

Growing gregariously, amidst plant debris, on the forest floors of the indigenous forests.

G. fimbriatum Pers. (Pl. 6a, b), Synopsis methodica fungorum (1801). Otieno (1966), the genus Geastrum Pers. Pg. 67, Pl. 2.

Syn. Geaster novo-hollandicus Mull. sec. Berk.

G. velutinus Morgan Journ. Cinch. Soc. Nat. Hist. 18 (1895).

G. velutinus Var. Caespitosus Lloyd, Geastrae in Myc. Writ. 1(1902).

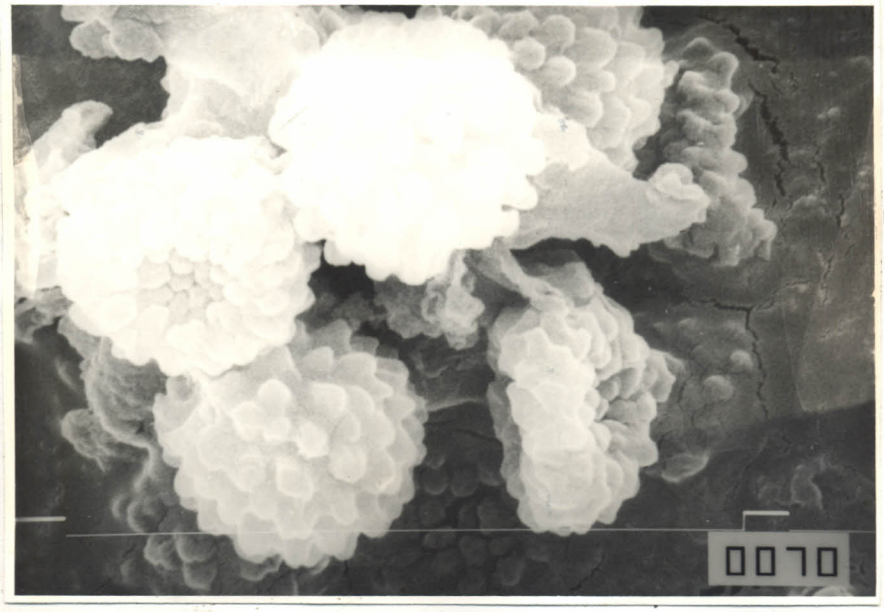
Lycoperdon australia Berk. in Hok. Flor. Tasm. II.

Sporophore sub-spherical, depressed, 15-18mm diameter and 11mm high before opening. Exoperidium splits into non-hygroscopic 8-12 rays with acute tips that recurve, to touching the exterior, forming a bowl in which the sessile gleba rests. Fibrous layer smooth, thin and pale when exposed mycelial layer, light brown, smooth when dry and lines the inside of the recurved rays.

PLATE 6

A. Geastrum fimbriatum: Sporocarp

(A 707, x 0.75)




B. Geastrum fimbriatum: Spores photomicrograph

(From A 707, x 20,000

Gleba, sessile, spherical, purplish brown terminating in a conic peristome, paler than the rest of the spore sac. Spores echinulate, 2.8-7.7u in diameter, capillitial threads hyaline, thick walled, unbranished 3.8-5u diameter.

Habit and Habitat

Grows gregariously among decaying plant debris, during the rainy seasons.

Geastrum velutinum Morg. (Plate 7a, b) Journ. Cincinnati. Soc. Nat. Hist. xviii. 1895. Lloyd, Geastrae in Myc. Writ. 1(1902), Bottomsley in Bothalia 4(1948).

Dring and Rayner 1967, Journ. E.A.N.H. Vol. 26.

Syn. Gycloderma ohiensis Cooke et Morgan, Grevillea - 2 (1883).

Geaster lloydii Bres. ex. Lloyd, Myc. Writ. Notes 6(1901).

Sporophore globose, or ovoid, top rounded rarely slightly umbonate. Exoperidium saccate, splitting into 5-8, thick hygroscopic rays; fleshy layer coloured, becoming amber to dark amber when dry usually cracking across the base of the rays to reveal the buff fibrous layer.

Mycelial layer thick, typically very finely felted-tomentose to more coarsely-felted tomentose, amber, free from debris, adnate or tends to bend away from the fibrous layer especially at the points of the rays.

Endoperidium smooth, sessile, globose to depressed globose 2cm. diameter enclosed by the saccate base of the exoperidium. Peristome broadly conical, fibrillose, depressed around the edge, concolorous or paler. Spores, globose, bacculate, (S.E.M.) 2.5-4.5u in diameter.

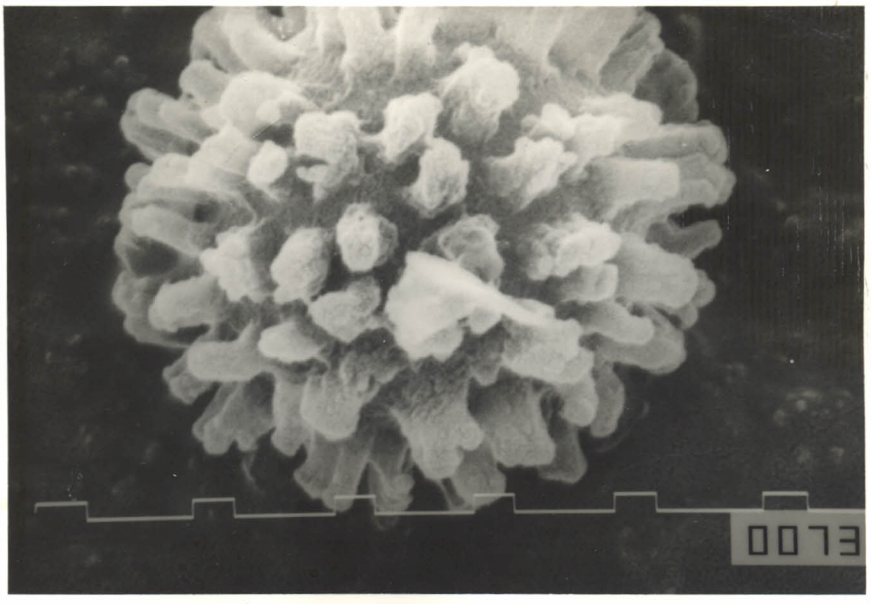
Habit and Habitat

Gregariously, on the ground amidst, rotting debris growing mostly during the onset of the rains; in the indigenous forest.

G. saccatum Fr. (Pl. 8a, b) Syst. Myc. iii. Fischer. Nat. Pflanz. 7a (1933); G.H. Cunningham Gastero. (1944), Lloyd, Geastreae in Myc. writ. 1(1902) Verwoerd, Ann. Univ. Stell. 3(1925). Bottomsley in

PLATE 7

A. Geastrum velutinum: Sporocarp, both open and unopened (A 363, x 0.5)




B. Geastrum velutinum: S.E.M. photomicrograph, illustrating a spore with the bacculate ornamentation (A. 363, x 20,000)

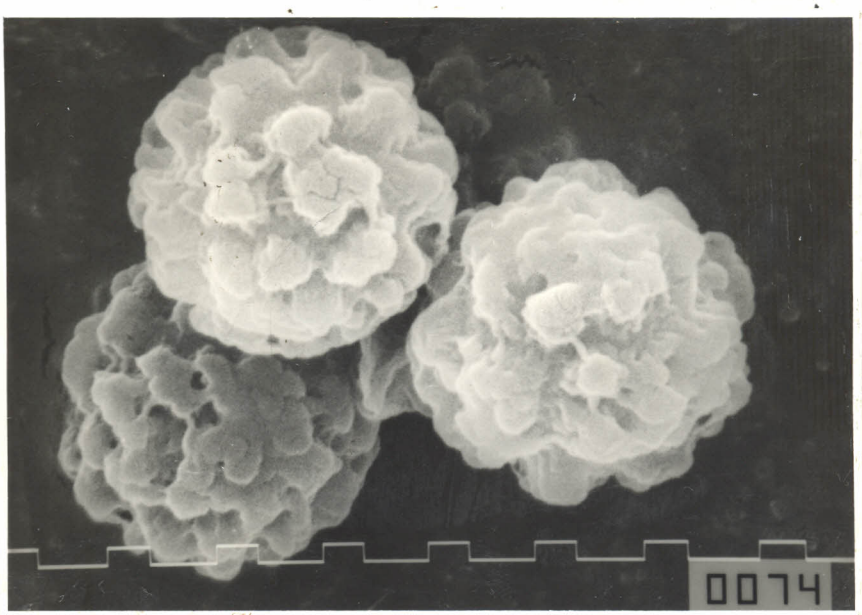
Bothalia 4(1948), Smith, (1951) Puffballs and their allies in Michigan. Dring and Rayner, Journ. of E.A.N. H.S. 26(1967) Otieno, Nytt. magasin for Botanikk 13(1966).

Syn. Lycoperdon coronatum Plumier. in Fougeres de l'Amerique. Tab. 167 f. 9. G. lloydii Bres. et. Pat. in Lloyd Myc. Writ. 1 Notes No. 6(1901).
G. velutinus Morgan Journ. Cinch. Soc. Nat. Hist. 18(1895).
G. velutinus Var. Caespitesus Lloyd, Geastrae in Myc. Writ. 1(1902).

Unexpanded sporocarp ovoid, umbonate, half buried attached by a bunch of hyphal strands which leave a prominent scar at sporocarp base. Exoperidium splitting to about middle into 5-7 pliable thin, subequal acute rays, which may become revolute or remain at an angle of 45 to the vertical;and frequently rimose, mycelial layer straw coloured to ochracious or rust colour, smooth.

PLATE 8

A. Geastrum saccatus: Sporocarps (A 364, x 1)




B. Geastrum saccatus: S.E.M. photomicrograph of spores (A 364, x 20,000)

Endoperidium sessile 10-15mm diameter subglobose, glabrous, greyish brown, usually partly enclosed by the saccate base of the exoperidium, peristome fibrillose, almost plane, concolorous with or darker than gleba; which is umber. Spores globose 4-6u in diameter usually strongly Verrucose. (S.E.M.).

Habit and Habitat

Found growing on soil, amidst the plant debris in the indigenous forest in damp places, along side G. velutinum Morg.

Family: Lycoperdaceae

Sporocarps more or less spherical, sessile, or carried on pseudostem.

Exoperidium single layered, thin, smooth to ornamented on the surface with minute spines, warts or granules, which weathers to expose an intact thin membranous endoperidium. The endoperidium, breaks into flakes and falls away or is provided with a small central apical opening through which the spores are released.

As in the family Geastraceae, the gleba is pulverulent at

maturity, consisting of globose or ellipsoid, usually ornamented spores and of well developed capillitia.

Key to the genera of the family Lycoperdaceae

1. Peridium consisting of membranous endoperidium which is aid bare at maturity by sloughing off exoperidium. Endoperidium breaking up and falling away, leaving a sterile base covered by a definite membrane....
.....Calvatia.

Endoperidium opening by an apical pore.....
.....Lycoperdon.

Genus Calvatia Fr.

Sporocarp medium to large, with a strongly rooting sterile base. Exoperidium usually thin, occasionally of two layers; endoperidium thin, the apical part flaking off to expose gleba. Gleba, copious capillitia present, subgleba small and dense to massive with large chambers, often poorly differentiated from the gleba, even when the latter is mature at the top.
Spores spherical and ornamented. Only a single species of the genus is represented in the locality.

Calvatia gardneri (Berk) Lloyd (Plate 9a, b) Syn. Lycoperdon gauttieroides B.

Dring and Rayner, 1967, Journ. E.A.N.H. Vol. 26 No. 2.

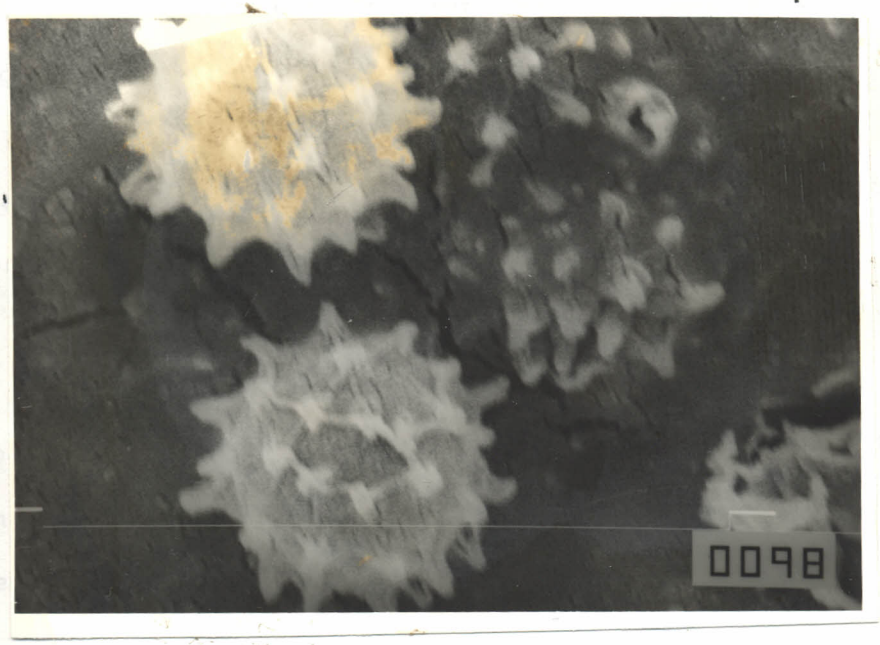
Sporocarp turbinate, to 10 by 10cm, half the height being occupied by the sterile base. Exoperidium Chestnut, minutely velvety below, tufted above, sometimes breaking into small scales. Endoperidium ochraceous, becoming rust colour above, pale below, brittle. Gleba ochraceous, fragile, capillitium of branched, septate, fairly straight to 7mm in diameter with occasional large pits in the walls. Spores globose 3.5-5u in diameter; subgleba at first ochraeous, becoming brown, minutely and obscurely chambered.

Habit and Habitat

Grows solitary to gregarious, on the forest floor of the Cupressus sp. and indigenous trees; also found growing on open ground, along a path cutting through the indigenous forest.

PLATE 9

A. Calvatia gardneri: Sporocarps (A.285, x 0.75)




B. Calvatia gardneri: S.E.M. photomicrograph of spores (A. 285, x 15,000).

Genus Lycoperdon Journ. ex. Pers. Synopsis methodica Fungorum (1801). Bottomsley (1941) = Gastero. S. Afr. Bothalia 4.

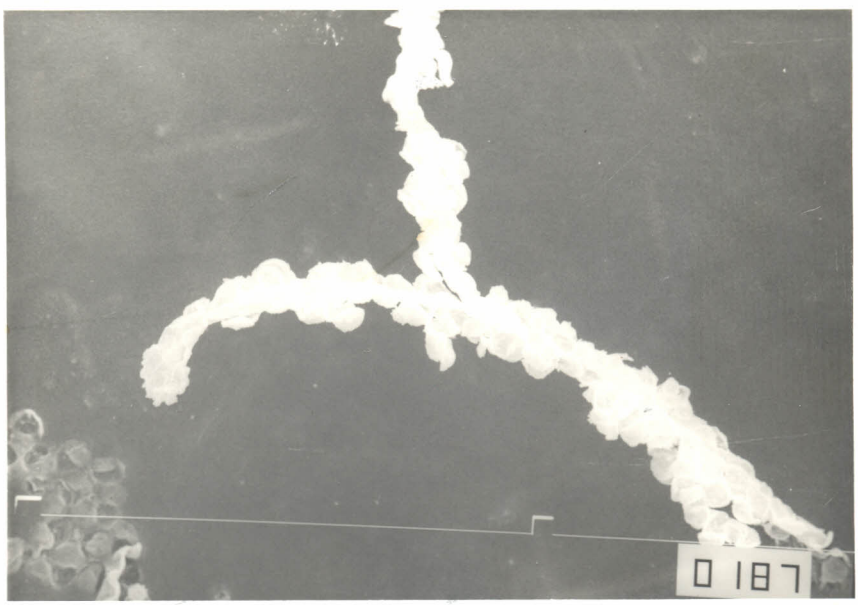
Plants globose, subglobose or pyriform, attached to the substratum by means of basal, root like threads. Peridium of two layers, a usually fugacious roughened exoperidium which dehisces by means of an apical aperture. A sterile base with or without a diaphragm. Gleba pulverulent at maturity, consisting of capillitia and spores. Capillitial threads, long, simple or branched, septate or otherwise, coloured or hyaline. Spores coloured, globose or oval, smooth, verrucose or echinulate, pedicellate or not.
A single species is recorded in this work.

Lycoperdon fuligeneum Sensu Dring (1964). Dring and Rayner (1967), some Gast. of E. Africa. Journ E. A. N. H. S. Vol. 26, No. 2(144).

Sporocarp depressed globose to turbinate, occasionally umbonate, to 2.5mm in diameter solitary to crowded on rotten wood.

PLATE 10

A. Lycoperdon fuligeneum Sporocarps (A 372, x 1)




B. Lycoperdon fuligeneum: Capillitial elements, S .E. M. Photomicrograph illustrating spores in membranes (A 372, x 15,000).

Dring and Rayner (1967). Gast. of E. Africa. Journ. E.A.N.H.S. Vol. 26, No. 2(114).

The family is recognized by their delicate ephemeral spongy receptacles, which develop inside a globose "egg" bursting from it naturally, exposing the foetid, mucilaginous gleba to the attentions of insects. Mature fruit body consists of the volva, or ruptured remains of the peridium, from which springs a hollow, chambered, spongy stipe holding aloft the gleba; on the surface. Members of this family are rare to come by in the forest, given their nature of decay, and immediate attack by the insects. A species of the genus Dictyophora Desv. was collected.

Dictyophora Desv. Journ. de Botanique 2(1809).
Bottomsley (1948) Gast. E. Africa. Bothalia: 4. Dring and Rayner (1967). Journ. E.A.N.H.S. 26.
Syn. Hymenophallus Nees. syst. Pilze un. sch. (1867).
Phallus Fr. myc. 2(1822).
Sophronia Pers. Gaud. Voyage Aut Monde (1826)
Retigerus Raddi. mem. soc. Hal. Moden 20(1820).
Clautirivia Pat. Lloyd. myc. Writ. 3(1909).

Receptacle, a hollow stipe, with a volva at the base and a campanulate, glebiferous cap at the apex. The wall of the stipe consists of a spongy mass or more or less clearly defined double layer of chambers, or a single

layer of large chambers. The tissue of stipe may be white, or some hue of red or orange. The cap surface is ornamented rugulose, papillate, or tuberculate, or consists of a bold network of folds or ridges in which case it is called reticulate. The cap and stipe are perforated at their apex, and surrounded by a ring of solid tissue, the collar. Typically a perforated indusium hangs down from near the apex of the stipe, under the pileate cap. It is the indusium that distinguishes Dictyophora Desv. from closely related genus Phallus Pers.

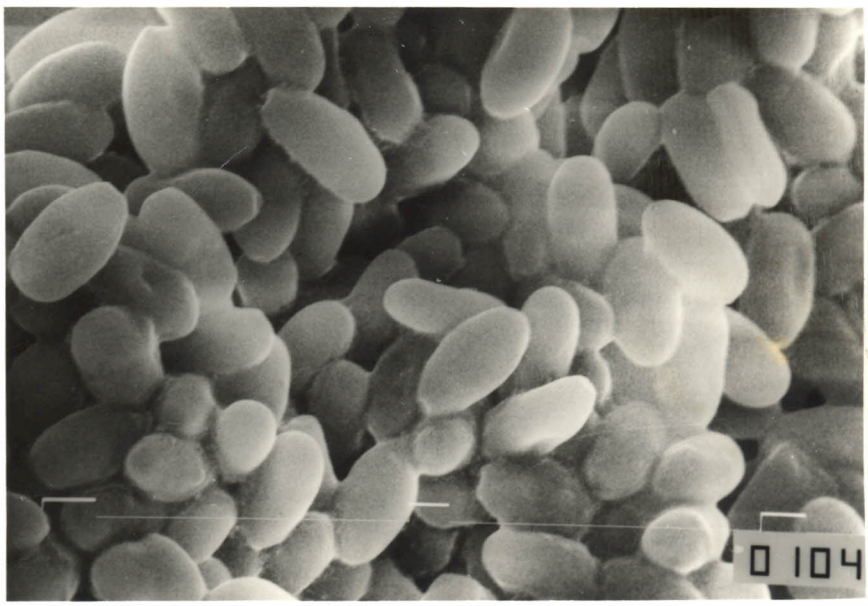
Dictyophora duplicatus (Bosch) Fisher, Saccardo, syll. Fung. 7(1888).

Syn. Phallus duplicatus (Bosch) Fischer, Saccardo, naturf Freunde zu Berlin 5(1811).
Lloyd, myc. writings 3(1909).
Dring and Rayner, Gast. E. Africa, Journ. E.A.N.H.S. Vol. 26(1967).
Hymenophallus duplicatus (Bosch). Nees syst.Pilze und schw. (1817).
Hymenophallus togatus Kalchbr. Gast. novi. v. minus cogniti (1884).

Egg subglobose, to about 45cm diameter, dirty white to brownish, strongly rooting, interconnected by mycelial

A. Dictyophora duplicatus: Opened sporocarps

(A 510, x 1)




B. Dictyophora duplicatus: Spores: S.E.M.

Photomicrograph (A 510, x 20,000)

Order Nidulariales

Fruiting bodies small, sessile, cupulate, campanulate, or depressed globose, peridium 1-4 layers, dehiscing by rapture of an epiphragm, or where this is absent, by irregular fissuring of the wall, gleba enclosed in one or many globose or lens-shaped peridioles; peridioles attached to the inner wall of peridium by a mucilaginous secretion or by thread-like funiculi, escaping singly or they may be forcibly ejected from the exoperidium; capillitia none. These fungi are popularly known as the "bird's nest fungi". Only one family Nidulariaceae is represented here.

NIDULARIACEAE Fries. System mycologicum 2(1822).

Sporophores of members of this family are small, bell or cup-shaped bodies growing either in the soil, with decaying organic matter, or from decaying wood. The peridium is composed of one to four layers, and is covered by a membranous epiphragm when young which weathers away at maturity. The gleba is composed of lenticular bodies, the peridioles; which are either attached to the peridium by the thread-like structures- the funiculi or embedded in mucilage. Basidia with basidiospores occur in the peridioles. The spores are

smooth, hyaline, globose or ovoid. Only one genus Cyathus Hall. ex. Pers. is represented here.

Cyathus Hall. ex Pers. Sys. Meth. Fungi (1801). Syn.: Fungoides Vaillent. Bot. Paris Leidae et Amsterdam (1727).
Cyathoides Mich. Nova plant. genera (1729).
Cyathia Browne, cir. and Nat. Hist. Jamaica (1756).
Cyathus Hall ex Pers. Syn. Fungi, pl. 236, 1801.
Haller, Historia stipium Helvetiae 3(1768).

Sporophore ovoid or bell shaped at maturity peridium 3-layered and covered by a thin epiphragm when young. At maturity the epiphragm ruptures irregularly and exposes numerous lenticular dark peridioles which are attached by funiculi to the wall of the peridium.
Spores inside the peridioles ovoid, thick walled and smooth.

Key to the Cyathus species.

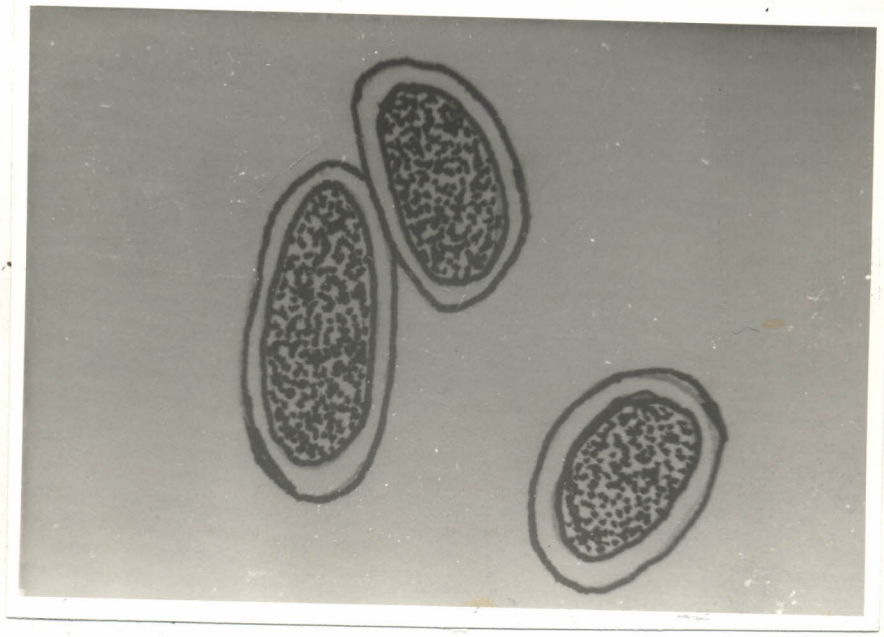
1. Both surfaces of the fructification striated
   .....C. poepigii
   Neither surface is as above.....C. olla.

Cyathus poepigii Tul. Monograph Nidulariales in Ann. sci. nat. 3 ser. 1(1844), sacc. syll. fung. 7, Coker and

PLATE 12

A. Cyathus poepigii: Sporocarps on wood

(A 312, x 0.5)



B. Cyathus poepigii: Photomicrograph of spores

(A 312, x 1,000)

obscurely zoned, inner surface smooth, silvery brown to lead colour, peridioles large, disc-shaped, 2.3mm wide and 0.5-1mm thick in centre, dull brownish attached to cup by a strong whitish funiculos; spores 6.5-10.5 x 6-11.5u thick walled hyaline, ovoid to ellipsoid.

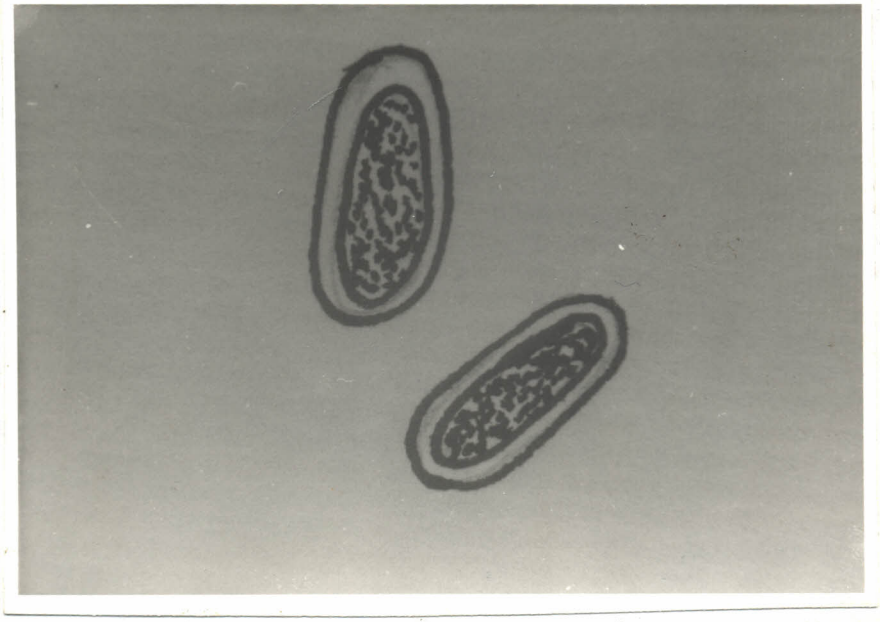
## Habit and Habitat

Gregarious on soil in contact with wood during the rainy period. This is the first report of the species from Kenya.

PLATE 13

A. Cyathus olla: Sporocoarps

(A 715, x 0.75)



B. Cyathus olla: Spores micromicrograph

(A 715, x 1,000)

# Chapter V

## Discussion and Conclusion

The Gasteromycetes in Kenya have not been studied, apart from patchy works on different genera of the group by Otieno (1966, 1967). Like other particular localities in Kenya, very little work on the group has been carried out from Karura forest prior to this study. This has resulted into lack of literature and herbarium material that may provide items of information about the local group members. It must be noted that due to the unavailability of type specimens in any of our herbaria in Kenya, no comparison has been made in identifying the materials collected. The identification carried out in this work therefore, has purely been based on literature, [Zoberi 1972, Dring and Rayner 1967, Otieno 1967, 1968; Smith 1951, Bottomsley 1948, Coker and Couch 1928 and Lloyds (1905 - 1912)], whose descriptions were found matching the characters of the materials collected. The botanical names provided in this work are thus provisional and must be treated as such.

Using the characters from the materials collected, (see appendix) keys to orders, families, genera and species of gasteromycetes of Karura forest have been made;

with modifications of the previous ones. For the first time in the country, a group key of different gasteromycetes species in Kenya has been made available; although it remains to be tested in the field.

It is interesting to note that of the 13 gasteromycetes species collected and identified only two had previously been collected from the locality, viz; Lycoperdon fuligeneum and Geastrum pectinatum. Cyathus nigro-albus, previously recorded (Otieno, 1967), was not collected during this study. Three species, Scleroderma geaster, Geastrum coronatum, and Cyathus olla, collected from this locality, are new records to Kenya. Eight species, Dictyophora duplicatus, Geastrum saccatum, Geastrum velutinum, Geastrum fimbriatum, Geastrum triplex, Calvatia gardneri, Scleroderma flavidum and Cyathus poepigii, previously recorded from other parts of Kenya are new records to Karura forest. This observation is a clear testimony to the patchy and unsystematic nature of the previous works done in Kenya. It is therefore quite likely that more species await collection.

Results, from the study of the spore surfaces and the capillitial structures by the scanning Electron Microscope (SEM) are thrilling. Striking observations

have been made on the spore surfaces of the species of the genus Geastrum. G. pectinatum Pers. was described as having spores with flat-topped spines (Otieno 1966, Smith 1951), and as Verrucose (Bottomsley, 1948). On observation under the S.E.M., and using Moore and Webb's (1978) work, the spore surface is rugulate.

G. triplex, jungh. whose spore surface has been described as strongly verrucose (Bottomsley, 1948), moderately to strongly warted (Smith, 1951; Dring and Rayner, 1967), echinulate (Otieno, 1967) is bacculate, that is with height of projecting elements greater than width and bases not constricted. Spore surfaces of G. velutinum was observed to be bacculate as opposed to earlier descriptions as verrucose (Bottomsley, 1948; Dring and Rayner, 1967). The spore surfaces of the species Calvatia gardneri, Lycoperdon fuligineum and Scleroderma flavidum, have all been confirmed as echinate, while that of Scleroderma geaster as reticulate. Confirmed too, is the spore surface of Dictyophora duplicatus as psilate.

Taxonomically, the detailed spore surface features from the S.E.M. results are important. Geastrum pectinatum and G. coronatum, at first sight look alike. Results based on the features on spore surfaces from the S.E.M., confirms the difference as regulate in the former and reticulate in the latter; and are therefore

distinctively two different species, when other characters are also taken into account. G. fimbriatum, and G. triplex, in the majority of the morphological characters are similar apart from the fimbriate rays of the former and the existence of the bowl in the latter. Their spore surfaces have been reported as echinulate/echinate (Otieno 1967, Smith 1951, Bottomsley 1948). In this study, the spore surface of the G. fimbriatum has been confirmed as echinate while that of G. triplex, bacculate as such they remain two different species.

Palynologically, G. velutinum and G. triplex are closely related, with reference to the S.E.M. results; as having bacculate spore. However, taking into account all other taxonomic characters, the two are different species of the genus.

In the observation of the capillitial elements, those of the species Lycoperdon fuligineum were found to be accompanied by membranes. Although all other characters of the specimen collected matched the descriptions of the genus Lycoperdon Pers., the membranes observed lack in the genus as is given by various authors. The species L. fuligineum once collected at the same locality, may not belong to the genus. It may belong to the genus Morganella.

mentioned in Smith's (1951) key to the genera of Lycoperdaceae in Michigan, which resembles the Lycoperdon Pers. in all features except for the presence of membranes in the former. This may be as well as a new genus in our region, and not Lycoperdon Pers., as previously proposed (Dring and Rayner 1967).

Of the 13 species recorded from the locality, only 3 which represents approximately 23% of the total number were found represented in the exotic plantations, particularly the Cupressus lusitanica. All the 13, species were found represented in the indigenous forest type, with none virtually represented in both Eucalyptus sp. and the Araucaria sp. types. However, other macrofungal species were found, although at very low frequencies. For example, agaricales, which are well represented in the indigenous forest, are however sporadic in their growth pattern in the exotic plantations. This trend is a threat to the macrofungi in general and tend to suggest that with continued replacement of the indigenous types with exotic species, a likelihood of continuous depletion of macrofungal population and their subsequent extinction exists. Parameters that could be responsible for these distinctive differences, have not been understood, and calls for a total ecological study to establish.

However, from the study observation, it may be suggested that:

Indigenous and exotic forests represent two different ecological habitats and some of the differences are:

(a) litter composition and chemistry
(b) soil chemistry e.g. PH, K, P, Ca, N, etc. especially within the rhizophere.
(c) light, temperature and moistrue conditions
(d) microflora and fauna.

These parameters are very important on fungal growth. It is also suspected that some of these differences such as the availability of local hardwood debris on the indigenous forest floor seem to support most gasteromycetes species than exotic forest floors which lack the same type of debris.

In conclusion, the following measures, may be suggested towards a better knowledge of our gasteromycetes; and other groups:

(a) Intensive studies, carried out in particular localities, all over the country on different macrofungal flora are inevitable. Such studies would provide collective information and fill

the knowledge gaps, in different groups, that now exist.

(b) Apart from the macrofungal materials provided from this work, and which are going to be used to set up or improve fungal Herbaria, more collections are necessary from all over the country; for future references by gasteromycetes student enthusiast and other researchers.

(c) Exhaustive work has to be done when working on the macrofungal groups, with the aid of any best study instruments such as SEM, so as to provide the best of the characters in order to enrich our taxonomic knowledge.

(d) More of an ecological study needs to be carried out on the relationship between the macrofungal flora, and the forest types, to establish facts behind the poor representation of macrofungi in exotic forest types as opposed to indigenous.

It is hoped that this work, and the results herein, will stimulate more workers with various mycological interests, into doing more than ever.

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APPENDIX 2

COLLECTED SPECIMEN CHARACTERS OBSERVED

| NO. | SPOROCARP | PEDICIL | ENDOPERIDIUM OPENING | RAYS | SPORES | CAPILLITIA | ORDER | GENUS | SPECIES |
|---|---|---|---|---|---|---|---|---|---|
| A 360 | Soft globose, opening stellately at maturity | + | Apically, by sulcate beak-pedicillate | Non-hygroscopic fornicate with trash | Globose 3.5-5.5 dia. regulate (SEM) | + | Lycoperdales | Geastrum | G. Pectinatum |
| A 361 | Soft, globose, beaked, opening stellately at maturity | - | Apically by fibrillose peristome | Non-hygroscopic not fornicate dirty white, no trash | Globose 3.8-5 bacculate (SEM) | + | " | " | G. triple |
| A 363 | " | - | " | Hygroscopic saccate outer surface felty | Globose, 2.5-4.5 bacculate (SEM) | + | " | " | G. velutinum |
| A 364 | " | - | " | Hygroscopic saccate | Globose, 4-6 dia. vercose (SEM) | + | " | " | G. Saccatus |


KARURA FOREST SHEET SCALE :- 1:10,0

| NO. | SPOROCARP | PEDICIL | ENDOPERIDIUM OPENING | RAYS | SPORES | CAPILLITIA | ORDER | GENUS | SPECIES |
|---|---|---|---|---|---|---|---|---|---|
| A 706 | Soft globose, opening stellately at maturity | + | Apically, by fibrillose peristome pedicillate surface with WHITE particles | Non-hygroscopic forming a fornicate resting base | Globose, 3.5-5 dia. reticulate (SEM) | + | Lycoperdales | Geastrum | G. coronat |
| A 707 | Soft, globose, beaked, opening stellately at maturity | - | Apically by fibrillose peristome | Non-hygro scopic fibriate | Globose 2.8-4.45 echinulate | + | " | " | G. fibriat |
| A 510 | Obovoid before opening, 4-6x2-3 cm. white with rods | Spongy receptacle 15x3 cm. | Apically, through slits | - | Oblong, 3x5x2.5 dia. psilate | - | Phallales | Dictyophorn | D. duplica |
| A 372 | Globose, black-grey on rotting wood | - | Apical pore | - | Globose | + | Lycoperdales | Lycoperdon | L. fuligen |
| A 285 | Dark-brown globose, on pseudo stem | - | Flaking off of particles | - | Globose, 3.5-5 dia. echinate | + | " | Calvatia | G. gardner |

| NO. | SPOROCARP | PEDICIL | ENDOPERIDIUM OPENING | RAYS | SPORES | CAPILLITIA | ORDER | GENUS | SPECIES |
|---|---|---|---|---|---|---|---|---|---|
| A 609 | Globose,brown with scales, endoperidium purplish,hard | Spongy recep tacle 15x3 cm. | Apically stella-tely | Not observed | Globose echi-nate with conic spines 10-12 dia. | - | Sclero-derma-tales | Screloro-derma | S. flavic |
| A 823 | Globose, hard at first, purple, maturity softens into powdery mass | ±short; fibri-llose | Opening stellately into rays | Bowl shaped | Globose reti-culate 6.5-10 dia. | - | Sclero-derma tales | Scleroerma | S. geaste |
| A 312 | Cupulate peri-dioles inside, striated both sides hairy out-side on wood | - | - | - | Elliptic smooth 10-12x19-39 dia. | - | Nidula- | Cythus | C. poepig |
| A 715 | Cupulate,silvery peridiles present, striations lacking on either sides on the ground | - | - | - | Oblong smooth | - | " | " | C. olla |

KEY: + Present
- Not observed

APPENDIX 3

Table 1: Showing the presence of Gasteromycetes Species in different forest - types

| Forest - types<br>Gasteromycetes sp. | Cupressus sp. | Eucalyptus sp. | Araucaria sp. | Indigenous type |
|---|---|---|---|---|
| Geastrum Pectinatum | - | - | - | + |
| G. Saccatum | - | - | - | + |
| G. Fimbriatum | - | - | - | + |
| G. Velutinum | ± | - | - | + |
| G. Triplex | - | - | - | + |
| G. Coronatus | - | - | - | + |
| Lycoperdon fuligineum | - | - | - | + |
| Calvatia gardneri | + | - | - | + |
| D. duplicatus | - | - | - | + |
| S. flavidum | + | - | - | + |
| S. geaster | - | - | - | + |
| Cyathus poepigii | - | - | - | + |
| Cyathus Olla | - | - | - | + |

KEY: + Present
- Absent