MORPHOLOGY AND TERMINOLOGY

The use of some terms to designate various structures involved is very essential in a systematic work. An account of various terms which have been commonly applied in this group of fungi, has been given by workers like Cunningham (194), Perdeck (1950), Kreisel (1962, 1967) and Brodie (1968, 1975a, 1977a). In this work, the accepted prevalent terms have been used. A brief account of the various structures important in the taxonomy of gasteromycetous fungi and the terms used to denote them is given below:

**Fructification:** This term is applied here for the fruit-body having basidiospores bearing organs. Though many names such as 'sporophore', 'fructification', 'basidiocarp', and 'cups' (for Nidulariaceae) have been used to denote fruit-body of these fungi, I have used the term 'fructification' in this work.

Fructifications in these fungi are angiocarpic i.e. gleba is enclosed within the peridium at maturity. These vary greatly in shape, size and colour.

**Peridium:** This term pertains to the wall of fructification which encloses gleba. It usually opens through an apical pore as in Lycoperdon, Geastrum and Tuleostoma etc., or rarely basal pore as in Disciseda. In some members, whole of the peridium breaks away irregularly at maturity exposing the
Global mass, e.g. as in Calvatia and Lycoperdopsis. Peridium is generally composed of two layers - exoperidium and endoperidium - as in the members of Lycoperdales or it may be single layered as in Scleroderma, Hysterangium and Melanosaster etc. However, in the genus Crathus, the peridium comprises three layers - outer, middle and inner.

**Exoperidium:** It is a prominent and well-developed layer in the young specimens but wears out partly or wholly in the aged specimens, or sometimes splits open into several stellate rays in the genera, viz. Gymastrum, Myriostoma, Astraeus. The texture of exoperidium varies greatly in different genera and species.

**Endoperidium:** It is usually a membranous or papery layer, which is present below the exoperidium. It may be smooth, rough or tomentose. This layer becomes visible only when exoperidium has fallen off or has split open at maturity.

**Anatomical Details:** Various tissues observed in different layers of peridium and peridiole have been named and described here after Starback's (1895) terminology, as modified by Korf (1958). The original key of these tissue types (Plate I) after Korf is given below:

I. Short-called tissue; the separate hyphae not distinguishable.

A. Cells round to polyhedral, almost isodiametric.

1. Cells rounding up, with intercellular spaces. ....... textura globulosa
2. Cells polyhedral by mutual pressure, no intercellular spaces.  
   textura angularis

B. Cells more or less rectangular, in section not isodiametric. ...
   textura prismatica

II. Long-celled tissue; the separate hyphae easily distinguishable.

C. Hyphae running in all directions, not parallel.
   textura intricata

3. Hyphae with their walls not united, usually with distinct interhyphal spaces.
   textura epidermoidea

4. Hyphae with their walls united, without interhyphal spaces, usually forming a membranous tissue.

D. Hyphae running in one direction, more or less parallel.

5. Hyphae with narrow lumina and strongly thickened walls, not cohering.
   textura oblita

6. Hyphae with wide lumina and non-thickened walls, not cohering.
   textura porrecta

Stipe: It functions to elevate the gleba before the spore dispersal in Gasteromycetes. It is very well-developed in Tulostomatales, Phallales and Podaxales. The length of stipe is variable, ranging from few millimeters as in some species of Tulostoma to 35 cm long as in Battarrea stevenii.

Pseudostipe: It is stipe-like structure but differs from true stipe in structure and origin. It chiefly serves the purpose of anchorage and is usually well-developed in the members of Scleroderma.

Stoma: This is a circular orifice formed in the peridium,
through which spores are discharged. It is naked in the members of Lycoperdaceae and in few species of Tulostoma and Geastrum etc. In the former, it projects out and becomes tubular or subtubular whereas in the latter it is enclosed within a modified part of the endoperidium known as peristome which may be fibrilllose, sulcate or pseudo-sulcate etc.

**Subgleba:** This term is commonly applied to the sterile part present below the gleba in the members of Lycoperdaceae. It is usually well-developed in the subglobose, turbinate or pyriform fructifications, whereas it is mostly lacking or greatly reduced in globose specimens. It may be minutely or distinctly chambered as in the species of Lycom perforatum or may be lacking or compact as in the genus Boletus. In majority of the members of Lycoperdaceae subgleba usually merges in gleba, however, in the genus Vascularum it is sharply separated from the gleba by a prominent diaphragm. The subglebal features are very important in the taxonomy of Lycoperdaceae.

**Gleba:** This tissue is enclosed within the peridium and is composed of trama1 plates lined with hymenium. Trama1 plates often break down to form pulverulent mass, as in the members of Lycoperdales, Tulostomatales and Solerodermatales etc., or remain persistent and fleshy as in most of the hypogaeous species. In the members of Phallales, gleba is mucilaginous, foetid and deliquescent. However, in Nidulariales it is organised into distinct disseminating bodies called peridioles which represent the glebal chambers.
Colour of the pulverulent gleba usually varies from light brown to dark brown or olivaceous brown.

**Columella**: This is a persistent central sterile body enclosed by the tissues of the gleba and often extends basally as a stem. It is known as axile – when penetrates the gleba as an axis in *Podaxis*; dendroid – when having several lateral branches as in *Gymnoglossum*; percurrent – extending to the apex of the gleba and merging with the peridium and called simple when it is unbranched as in *Secotium*. In *Geastrum*, this structure is denoted as pseudocolumella, which may be clavate, cylindric or globose and stands free from the rest of the glebal tissue.

**Capillitium**: It represents sterile thread-like structures intermixed with spores in the pulverulent gleba. These are usually stout but sometimes fragile as in *Calvatia*, coloured, branched, septate or aseptate, with or without clamps, thick or thin-walled. The wall of capillitial threads may be with or without pores, whose presence or absence is an important taxonomic character for distinguishing various taxa of genera like *Lycoperdon*, *Calvatia*, *Bovista* etc. In the genus *Geastrum*, these are usually simple and highly thick-walled threads. In the genera *Kacsoellum* and *Morganella*, capillitial threads are replaced by thin-walled, hyaline, branched or unbranched, septate threads and are called as paracapillitial threads.

Kreisel (1962, 1967) recognised four types of capillitial
threads in Lycoperdaceae. These are as follow:

(a) **Lycoperdon-type**: These threads lack distinct main stem and form interconnected network. These are connected with the subgleba and endoperidium.

(b) **Intermediate-type**: These threads are very similar to 'Lycoperdon'-type but have a distinct main stem, at least in the centre of the gleba.

(c) **Bovista-type**: The capillitium is composed of discrete units which have distinct main stem with lateral branches throughout the gleba.

(d) **Mycenastrum-type**: The capillitium consists of a single unit, usually S-shaped and elastic, main stem remains almost unbranched and instead it is covered with numerous, short, thorn-like processes as in *Mycenastrum*.

**Peridioles**: These are small, hard spores-containing bodies present in the members of Nidulariales and are of various shapes, i.e. globular, lenticular or orbicular etc. In *Sphaerobolus stellatus*, peridiole is single while in other genera like *Nidularia, Nidula, Crucibulum* and *Cyathus*, these are numerous in number. Peridioles lie freely in the genera *Nidularia* and *Nidula* while these are attached to the peridial wall by simple (*Crucibulum*) or complex (*Cyathus*) funiculi.

Anatomical studies of the peridiole in transverse section reveals the following layers in the genera *Nidularia, Nidula* and *Cyathus*. 
(a) Tunica: This is an outermost layer of the peridiole in the members of Nidulariaceae. It is thin, paler, delicate membrane, which is usually evanescent on sectioning.

(b) Cortex: This is a dark and hard layer present beneath the tunica and is composed of highly thick-walled, dark, indurated hyphae. Cortex may be single or double in the different species of Cyathus. When cortex is double, the outer is called as exocortex and inner as endocortex. Presence or absence of tunica and whether cortex is single or double, are the important taxonomic features for distinguishing the different species of Cyathus and Nidula.

(c) Antler hyphae: This term has recently been used by Brodie (1980) for the characteristic, brown or dark brown, thick-walled, branched hyphae of the peridiole wall in the genus Nidula.

(d) Subcortex: This layer represents the very wide, hyaline or subhyaline, gelatinous tissue present below the cortex. It is a very thick layer and occupies major part of the peridiole.

(e) Hymenium: It pertains to the innermost layer of the peridiole. Hymenium is conspicuous in the species of Nidula and comprises basidia and paraphyses etc. arranged in palisade manner. However, in the genus Cyathus term hymenium is applied here to the innermost (central) tissue of peridiole comprising mainly spore mass. The hymenium is also well represented in most of the hypogaeous genera.

Basidia: These are spore producing organs in Basidiomycetes.
These are usually clavate, cylindrical or short cylindrical in shape and are mostly arranged in a palisade manner. Basidia have 1-15 (commonly 4), long or short sterigmata.

**Basidiospores:** These show a great variations in shape, size, colour and ornamentation. The spores are usually globose or subglobose, ovoid, ellipsoid, bacillloid; varying in size (2-42 μm); hyaline to dark brown, smooth, rough, verruculose, verrucose, echinulate, reticulate or subreticulate. These may be guttulate or aguttulate, pedicellate or apedicellate.

**Ancillary structures:**

(a) **Paraphyses:** These are sterile structures, present in the hymenium along with basidia. They are clavate, hyaline or subhyaline, thin or thick-walled.

(b) **Cystidia:** These structures are common in Hymenomycetes and are of much taxonomic value there. However, in Gasteromycetes, I could observe these structures only in the hymenium of *Hydnangium nigricans*.

(c) **Setae:** These are usually irregular in shape, usually cylindric, highly thick-walled with narrow lumen and sharply or bluntly pointed apices. Setae were observed only in the outer zone of exoperidium of *Lycoperdon setiferum*.

**Epiphraea:** It is a thin, usually whitish membrane covering the mouth of young fructifications in the members of Nidulariaceae. Epiphraea ruptures at maturity in slit-like manner and exposes the peridioles lying inside the
fructifications.

*Basal emplacement*: It is a solid round mass of hyphae at the lower and narrow end of the fructifications of *Cyathus*. It may be small and inconspicuous or may be well-developed and as wide as the mouth of fructification itself, e.g. *Cyathus helena*. 