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A HAND BOOK

to the

FUNGI ASSOCIATED WITH INSECTS OF SRI LANKA

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The absence of Handbooks and guides to most grou ps of plants and animals of Sri Lanka has limited the development of interest in our fl ora and fauna, and this has also been a very serious handicap to ecological studies in this island.

The UNESCO - MAB Committee set up jointly by the Ministries of Science and Education is sponsoring therefore, the Publication of Checklists of Species and Handbooks to the identification of Genera of various groups of plants and animals. The Committee welcomes any additions, corrections and suggestions for improvement of these publications.

B. A. Abeywickrama
Chairman, MAB Committee.

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PREFACE

The UNESCO-MAB (Man and the Biosphere) National Committee for Sri Lanka has in its programme the compilation of checklists and handbooks as essential guides to the identification of the flora and fauna of Sri Lanka. Already several have been published and the present work is concerned with the fungi associated with insects.

This handbook is concerned with two great worlds of life : insects and fungi, which come together in many and fascinating ways. The dynamics of the associations between insects and fungi is great in intensity and complexity. Even a partial grasp and knowledge of any type of association between the insects and fungi will thrill a mycologist. However in the recent years heavy emphasis has been laid upon the infectious diseases of insects which have two principal applications—use of parasitic fungi to manage insect pests; control of disease in beneficial and useful insects. A knowledge of the infectious diseases will contribute information to the fields of Microbiology, Entomology, Crop protection, Medicine, Veterinary Science and General Biology.

Sri Lankan records on the insect fungi are mainly contained in the work by Petch and Bisby (1950). Since then no serious studies have been undertaken in Sri Lanka. The present work is of preliminary nature and is an attempt to bring together all the existing data and compile a guide to facilitate future work. Although this handbook is devoted to the fungi associated with insects, those that are found on mites and other small invertebrates are also included. The author would welcome any information which have escaped her notice and any suggestions towards the improvement of this work.

The first part aims to outline the types of associations found between the fungi and insects. The second part deals with the taxonomical treatment of the fungi recorded in this country. The classification and arrangement of the genera is based on the schemes set forth by Ainsworth (1963) and Ainsworth et al (1973). In devising simple dichotomous keys to the sub-divisions, classes, orders, families and genera, already existing keys have been selected with appropriate modifications to fit the material covered. The genera are arranged in the order in which they appear in the keys. The numbers after the generic names in the keys refer to the serial number of the genera. For the taxonomic data of the genera, a brief description of the characters are given. After each generic description the local species are listed, host indicated and source of information cited. The letter P with figures after each specific name refer to the page in Petch and Bisby (1950). Elsewhere full references will be given. No attempt has been made to come down to devise keys at the species level. The author hopes to extend this work later on. In order to provide a better understanding of the structure of the fungi listed many of them have been illustrated. Many of the drawings have been adapted from standard works. For the convenience of the user a glossary of terms is given at the end of the text.

CONTENTS

LIST OF THE GENERA

PART 1

FUNGI AND INSECTS

1. INTRODUCTION

The relation between insects and fungi are very complex. Insects like other animals and plants are subjected to attack by fungi. From the time of Aristotle, the honey bee was known to suffer from disease. In 1835 Agostino Bassi the father of insect pathology was the first to experimentally demonstrate that a fungus can cause a disease in insects and he published his great works on the white muscardine disease by *Beauveria bassiana* of the silkworm common in France and Italy. Fungal parasites of insects are now known to be scattered in a number of taxa. However most of the infections are relatively minor and have little or no effect upon the host. Many are not truly pathogenic or are pathogenic only under certain conditions and only a few cause disablement and very few fatal. The importance of some of these fungi lies in the fact that they help to keep the population of certain insects in check and so are a factor in the biological balance.

Fungi have also formed different kinds of partnerships with animals. The nature of animals is such, that one would hardly expect many of them to form close partnerships with fungi. The fungi are relatively stationary while some animals are consistently on the move. Insects are unique among animals in having developed mutualistic relation with fungi totally dependent upon the other. Some of the partnerships appear to be fairly loose, each partner being able to survive as individuals. Some of these partnerships will be discussed in the following section 2.

There are a number of insects which make use of fungi in their alimentary systems eg. yeasts in the alimentary canal and breeding sites of *Drosophila.* The small size and ubiquitous presence of insects endows them with habits particularly suitable for disseminating fungi. These two relationships of fungi with insects will not be included in this treatment.

2. TYPES OF ASSOCIATIONS BETWEEN INSECTS AND FUNGI

2.1 Fungal parasites

2.1.1. *Mastigomycotina*

The class Chytridiomycetes include species which have motile reproductive units and so dependent at some stage of their life cycle on the presence of free water. The important members are *Coelomomyces* and *Myiophagus.* The Genus *Coelomomyces* is widely distributed all over the world. There is considerable interest in this Genus because there is the possibility of using this Genus as the agent for biological control of mosquitoes to supplement chemical control (Laird 1960). None of the members of this class have been recorded in Sri Lanka.

2.1.2 *Zygomycotina.*

2.1.2.1 *Zygomycetes.*—Most of the parasitic Zygomycetes belong to the order Entomophthorales. Occasionally members of Mucorales can cause infections. *Mucor hiemalis* is normally a harmless saprophyte but it has been recorded as a parasite on stressed or injured insects. *Entomophthora* (=*Empusa*) and *Massospora* are true entomogenous fungi that develop in the bodies of immature and/or adult stages of various insects. Vast majority of the known species belong to *Entomophthora.* Because of the potential economic importance of species of *Entomophthora* as insect pathogens many successful attempts have been made to establish them on artificial media (Macleod 1956, Sawyer 1929 ; Wolf 1951). The most extensive studies concerning the growth of these fungi are those of Sawyer (1929) who successfully cultivated them on over 40 different media including pork, swordfish and other media rich in protiens. Some species of *Entomophthora* appear to be rather specific in their host range and others are capable of attacking wide range of hosts. *E. muscae* infected flies are commonly found indoors attached to the walls windowpanes or ceilings of buildings. A close inspection of these reveals on the wall or window pane, a distinct halo of discharged 'conidia' encircling the insect. This phenomenon illustrates a very interesting characteristic of most Entomophthoraceae. This order has been reviewed comprehensively by Macleod (1963).

A remarkable characteristic of *Entomophthora* is their particularly effective means of survival and dissemination. They have a capacity to survive in a wide variety of adverse conditions. It seems a general characteristic that species of *Entomophthora* form resting spores toward the end of infectious phase, their function being to ensure survival over prolonged adverse periods until growth can be resumed. Thus these resting spores re-establish the disease in new insect populations.

Interest in the parasitic Entomophthorales have recently been aroused by the possibility of using them in biological control of insect pathogens (see section 3 of this chapter). 10 species of *Entomophthora* have been recorded in Sri Lanka (P. 15).

2.1.2.2 *Trichomycetes.*—This class includes parasites or commensals of living arthropods. Most inhabit the hindgut of the associated arthropod. A most significant development in recent years has been the axenic culturing of *Trichomycetes* (Clark et al 1963 ; Licht wardt, 1964; Whisler, 1962). Species

in this class have not had any application in the biological control of insects. Members have not been reported from Sri Lanka.

2.1.3. *Ascomycotina*

This is a large class in which insect parasites are represented in diverse genera. This includes the ectoparasitic Laboulbeniomycetes and the endoparasitic forms distributed in Pyrenomycetes and Loculoascomycetes.

2.1.3.1 *Laboulbeniomycetes (exo—parasites)*.—These fungi and the insects they parasitise are of no apparent importance to mankind whether for good or for ill. Yet these parasites are interesting enough themselves. They are not closely related to other classes of Ascomycotina. They are uniquely specialised, obligate superficial parasites, causing no apparent injury to their hosts. In the course of their evolution these fungi have adapted to insects inhabiting an almost endless variety of habitats, damp places, vegetable debris, grass cuttings haystack refuse, damp decaying wood, debris on the sides of streams and ponds, aquatic insects etc. Their hosts are true insects except for a few mites and myriopods. They are relatively minute and inconspicuous and appear as bristles or bushy hairs projecting from the chitinous integument (Thaxter 1896).

They develop externally upon the host except for a dark coloured haustorium or foot. They penetrate into a very thin layer of chitinous armour with which the host is covered but does not ramify deeper into the interior of the host where it might find a rich source of food. From the stand-point of the host generally the fungus causes no discomfort, no loss of function, no impairment of any metabolic activities. In general they seem to use the host for little more than support.

15 Genera are recorded in Sri Lanka (P. 18).

2.1.3.2 *Pyrenomycetes and Loculoascomycetes (endoparasites)*.—The endoparasitic ascomycetes show close resemblances in their modes of parasitism to the Fungi Imperfecti. They commonly spread within the insects body by means of free cell stages in the hemolymph. After the host's death they exploit the cadaver saprophytically by vigorous filamentous growth and eventually sporulate or fructify generally on its surface. The vegetative phase of the fungus is contained within the insect's body.

The largest single genus of such endoparasite is *Cordyceps* (Fries) Link,. This has been reviewed comprehensively by McEwen (1963). Over 250 species of *Cordyceps* are known

on several orders of insects including Diptera, Hymenoptera, Coleoptera, Lepidoptera, Homoptera, Isoptera and Orthoptera and on Spiders. Most species are host specific confined to single species or minor grouping of insects. A number of species of *Cordyceps* have their conidial stages in the Fungi Imperfecti. Among the genera are *Isaria, Hirsutella, Hymenostilbe Stilbum, Akanthomyces, Spicaria, Sporotrichum* and *Cephalosporium* (Mains, 1958; Mathieson, 1949.) Many species invade principally the larvae, hyphal bodies appear in the hemocoel, they reproduce by budding and fill the entire body cavity replacing or digesting the softer host compounds in the process. At this point death of the host occurs. Fungus penetrates gut integument and other tissues of the host, entire mass becomes hardened and converts the host into a mummy consisting largely of dense mycelium. From this stromata will arise later (Mathieson 1949). Stromata vary greatly in size, colour and form between species. At the end of the stroma is the fertile portion the head, which contains the perithecium. The mummified insect may convert into a sclerotium which consist of a compact mass of mycelial hyphae contained within the body wall of the parasitised host. With the onset of favourable conditions the stromata are produced from the sclerotium.

Little is known of the role *Cordyceps* play in natural control. Most of the species so far encountered, attack insects that are injurious to our crops and so are to be encouraged. However, whether or not infection by *Cordyceps* is a significant factor in the natural control of any insect population remains to be determined. Attempts to increase such beneficial fungi artificially or to introduce them into new areas as a form of biological warfare have not met with much success.

Rather little information has appeared in receent years on other endoparasitic ascomycetes. Most of these entomogenous fungi have in addition to the perfect form an inperfect form. Unfortunately for many of these sexual forms the corresponding asexual forms have not been recog nized and conversely the sexual forms if they exist are not known for most of the entomogenous fungi.

The true pathogenicity of some of these species has been questioned and in some cases it does appear that the fungi are secondary invaders or grow only on weakened insects or those dead or dying of other causes. Some however are true pathogens. Among the more important species are *Sphaerostilbe, Nectria, Podonectria, Litsea, Hypocrella, Myriangium.*

Sphaerostilbe species are commonly called the red-headed scale fungi and has been noted as an important natural control agent on *Lepidosaphes beckii* in Citrus in Mozambique (Annecke 1963). *Myriangium thwatesii* has assumed importance in New Zealand where it is a major enemy of *Eriococcus orariensis* (Hoy 1961).

12 Genera are recorded in Sri Lanka (P. 17; P. 32)

2.1.4. *Basidiomycotina*

Those basidiomycetes which parasitise insects are closely interrelated forms which show a relationship with the insect that is distinctive morphologically and biologically. Insect parasitising habit is represented among the Basidiomycetes in only the Genera *Septobasidium* and *Uredinella*. The Genus *Septobasidium* was monographed by Couch (1938) who described a part-parasitic and part - symbiotic realtionhip that exist between these fungi and their associated scale insects.

The basidiospores germinate on the scale insect and send their hyphae into their body. As the insect attaches itself to a plant host the fungus grows and forms a hyphal mat over the insect. The young scale insect is hidden by a thin mantle of mold mycelium. The fungus derives all its food from the scale insect. As the fungus spreads out over the surface of the bark in a patch it forms 2 or 3 storied structures with chambers. The chambers have openings toward the outside of the patch. The insects live in tunnels in these chambers. In some species definite pillars support the successive layers of the fungus. The *Septobasidium* colony may be few m.m. in diameter to 20-30 c.m. or more. It resembles a lichen and colour varies from very light grey to dark brown, purple or even almost black. Other young scale insects of the same brood wander into these chambers. Some of the members of this community will have been infected and these will not reproduce. The noninfected ones will reproduce and perpetuate the colony. The hyphal covering has a trap door over each chamber through which mating takes place. The young ones born go out through a narrow tunnel from each maternal chamber to the outside, the tunnel formed by the fungus alone, insect playing no role at all.

In this kind of a relationship, for the majority of the insects, fungus provides a home and shelter where they feed upon the woody host plant and produce their young. Some of the insects however are parasitised and they continue to feed upon the host plant but give up their food to the fungus which penetrate their bodies with numerous curled or knotted haustoria. They may outlive the non-parasitic ones but they are sterile.

Although theoretically individual scales, not protected and housed by the fungus, should be able to survive on their own, they actually never do so. In the relationship between *Septobasidium pinicola* and the scale insect *Matsucoccus macrocicatrica* neither the fungus nor the insect occured without the other. (Watson et al 1960).

Uredinella is also parasitic upon the scale insect. However it forms a crust over individual scales and not over whole colonies. Fungus is an annual and not a perennial. The top layer is a hymenium of ovoid to club-shaped brown basidial primordia (called teleutospores by couch 1937). In addition to the teleutospores it also forms another binucleate spore (called uredospore by Couch 1937) probably representing a link between *Septobasidium* and the rusts.

Species of both *Septobasidium* and *Uredinella* are present in Sri Lanka (P. 44).

2.1.5. *Deuteromycotina*

Insect parasitism among Fungi Imperfecti is shown by many species in a variety of unrelated genera. Most species belong to the Order Moniliales of the Class Hyphomycetes. This group has been comprehensively reviewed by Madelin (1963). The so-called muscardine diseases and mycoses are all caused by Hyphomycetes. Numerous Hyphomycetes have been reported on insects (Charles, 1941 ;Petch, 1948 ; 1957). Some of them are conidial states of Ascomycetes such as *Cordyceps*, *Torrubiella* and other genera. For many of them it has to be proved whether they are parasitic or saprophytic or are hyperparasitic on the entomogenous fungi. There is only a small number of species which are very common, widespread and important in nature as biotic factor in controlling the size of the insect population. Those most widely found are *Beauveria, Metarhizium, Isaria, Spicaria* and to a lesser extent *Aspergillus, Cephalosporium Aegerita Hirsutella* and *Acrostalagmus* (Madelin 1963). Some species have a wide host range while others a single host species. *Beauveria bassiana* is known on 30 species of insects.

As the insect develops there are changes in its form physiology and habits so that a particular fungal pathogen tends to be restricted in nature to a certain span in host's life cycle. The later stages in development are commonly the more susceptible. However there are exceptions. Eggs of insects are generally resistant to fungi which can attack other stages. There are nevertheless a number which are not parasites of other stages yet attack eggs. They include *Oospora ovarum*, sp of *Aspergillus, Fusarium, Macrosporium* and *Penicillium.*

As a group they are facultative parasites. Virtually all grow readily in artificial media. Evidence also suggest that a number of pathogenic hyphomycetes grow saprophytically in nature and for some species of *Aspergillus* saprophytic existence may be the dominant life habit.

The infective unit of the parasitic hyphomycetes is usually the conidium. In the majority of instances fungal pathogens infect their insect hosts not so much through ingestion as by penetration of the body cavity through their integument. Once within the body cavity the fungus proliferates, invades the tissues and kills the body of the insect. After the death of the insect fungus proceeds to live as a saprophyte on the dead tissues. In most cases the infected insect usually assumes a dried mummy like appearance, with compact often hard mass of mycelium within a more or less intact integument. This is often termed a sclerotium. The most important resting stage in the natural life cycle of insect pathogen is the sclerotium within the mummified insect. The behaviour of this sclerotium depends on the prevailing atmospheric conditions. If unfavourable sclerotium remains dormant for a long time. If adequate moisture and humidity prevails, generally in 1-4 days after the death of the insect, conidiophores emerge through weaker parts of the integument and sporulate abundantly on the surface. The reproductive structures of the pathogen itself may become associated with or attacked by secondary fungi (Morril and Back 1912). Petch (1931) has warned that it cannot be concluded that all the fungi found on an insect at the sametime are stages of the same fungus nor that the most obvious fungus on an insect is the one that killed it. When a insect is killed by a fungal pathogen theoretically it can be attacked by unspecialised saprophytic fungi and bacteria (Boyce and Fawcett 1947). In nature this is rare. Antibiosis may be one reason. A number of *Aspergillus* spp. for which pathogenic strains have been recorded produce antibiotics (Brain 1951). Cunningham et al (1951) reported that residual tissues of insects killed by *Cordyceps militaris* were resistant to decay because of the antibiotic Cordycepsin produced by the fungus.

Although most hyphomycetes that attack insects are internal pathogens, few for eg. *Fusarium acridorum* are superficial parasites. This fungus forms white powdery masses or a greyish down on the surface of some parts of the insect. The fungus is entirely superficial on the cuticle which it darkens.

2.2 Cultivation of fungi by insects

2.2.1. *Ambrosia beetles*

The term ambrosia is used here to designate those beetles that are symbiotically associated with fungi throughout their life cycle, cultivating and using the fungi concerned as a source of food for larvae and adults. Certain species of bark beetles and timber beetles which attack hard woods and soft woods and belonging to the families Scolytidae and Platypodidae are known to be ambrosia beetles. They rarely attack healthy trees or dry timber. The ambrosia beetles form galleries and tunnels. The tunnels of ambrosia beetles can be easily distinguished from those of other wood borers. A tunnel shows a dark

discoloration around the circular hole which is only slightly larger than the insect's body. When beetles are active there is usually fresh fine wood powder outside the entrance. Occasionally this powder along with dark brownish minute pellets of larval frass is extruded in the form of compact cylinder of .25 - .3 c.m. long and tightly fitting the entrance.

The ambrosia beetles have on their heads structures like miniature baskets called mycangia which always contain a supply of viable fungus spores which they carry from an old home to a new one. When the ambrosia beetles tunnel into new wood the spores are dislodged from the mycangia and soon a mass of velvety fungi lines the interior of the tunnel.

Most ambrosia fungi belong either to the Ascomycotina or the Fungi Imperfecti. Ambrosia fungi are usually species specific in relation to the insect symbiont. Some egs. of the associations are *Ascoidea hylecoti* associated with *Hylecotus dermestoidea*; *Monilia ferruginea* with *Trypodendron domesticum*; *Endomycopsis fasciculata* with *Gnathortrichus materiarum.* The ambrosia fungi have thus far been isolated only from the beetles or from their tunnels in wood. The characteristic ambrosia mass is variously colored, are pleomorphic and can readily change from a fluffy mold-like form to a dense yeast like form. During the optimal period of insect activity ambrosial mass consists of palisade of catenulate hyphal bodies that may or may not bear monilioid chains of conidia. Sometimes this palisade consists of distinct conidiophores bearing conidia terminally or laterally.

None of the ambrosia beetles eat anything other than the spores of the fungus they cultivate. On the walls of the chambers, fungus form multitude of spores. The insects get all the nourishment they need from the cultivated mold. The fungus is also difficult to cultivate in the laboratory even on wood with holes bored in it to simulate the tunnels made by the insects. Apparently the fungus is also dependent on the beetles as the beetle is on its fungus partner.

Although the tunnel is open to the air at one end and the spores of air-borne fungi can enter the tunnel and contaminate, it has been found that so long as, the gallery or tunnel system is occupied by actively feeding beetles only their food fungus thrives and no other fungi compete with it at one time or another.

A number of beetles related to ambrosia beetles also carry fungi around with them, and eat these fungi to some extent. These beetles mostly depend on fungi to kill the trees for them and this give them places in which to raise their broods. A number of bark beetles common on coniferous or evergreen trees bore through the bark of living trees, inoculate the wood with molds which stain the wood blue and kills the trees and so provide homes for more bark beetles.

2.2.2. *Ants and termites*

These are insects with complex social structure that have a symbiotic relation with the fungi they cultivate.

2.2.2.1 *Ants.*—Most of the fungus growing ants are tropical. Several of the fungus growing ants have been studied in detail (Weber 1955, 1956 a, 1956 b). Many species of ants of this type are leaf-cutters-eg *Atta Acromyhrmex*—and considered as major agricultural pests particularly of tropics and subtropics. The ants are highly species specific, each ant species cultivating a particular species of fungus and the different species of ants are highly specific and intolerant of one another in maintaining their fungus gardens. The fungus itself has not been recog nised outside the ant's nests. The ant's nests are generally recognisable from the low volcanic crater-type of structure surrounding the entrance.

On the bits of leaves brought by leaf cutting ants for compost into the nest, there is a heavy population of micro-organisms. Yet by their licking and peculiar habits of defecating ants evidently release antibiotic substances against foreign contaminants and stimulate the growth of symbiotic fungus only. The ants seem to be able to keep pure cultures of fungi growing in their gardens for years or for decades.

The fungus gardens vary greatly in size. Some make chambers from 1/2" to 10" in diameter from the roofs of which they suspend hanging fungus gardens like draped curtains. The soil of these gardens is made up mostly of caterpillar excrement and small bits of leaves picked up on the ground. Some of them make a series of such hanging gardens in chambers one below the other in the soil. In the tropics some of the ant gardens are larger than many of our homes 300 cubic yards in volume. On such a colony a million ants live, all of them nourished solely by the fungus. A special caste of the ants tend these gardens.

2.2.2.2 *Termites.*—The most conspicuous and most destructive of the fungus growing insects are the termites native to tropics of Asia and Africa. The termites make tremendous nests. Within the nest certain rooms are devoted to growing of fungi and a special caste of workers will care for these gardens just as in the case of ants. Other kind of termites build above ground nests of clay that are shaped almost exactly like giant mushroom. Usually the fungi is fed to the young of all castes but after the young have reached a certain stage they get no more of this food. The royalty or the reproductive caste are

fed upon it continuously. It has recently been found that a fungus cultivated by one kind of termites contain special growth promoting vitamins.

Several genera of unrelated fungi grow in the fungus gardens of termites, the most abundant are the species of the agaric *Termitomyces*.. The various species are found only in the nest of fungus growing termites. Sometimes the fruit bodies are not allowed to grow from fungus gardens while they are being actively tended by termites. If the termites die or are removed mushrooms are produced. The architecture of the fungus gardens built by these was found to be characteristic of the genera.

3. ENTOMOGENOUS FUNGI AS POTENTIAL MICROBIAL PESTICIDES

The principal applications of insect pathology are found in Agriculture, Medicine and General Biology. As far as the agricultural practices and crop protection are concerned applications include the suppression of disease in beneficial insect parasites and predators, silk worm, honey bee, and harmful insects. However the most significant application of insect pathology currently gaining most attention by workers throughout the world is the use of microorganisms to control insect pests, an application commonly designated as microbial control which is a form of biological control. Most attention has recently been given to biological control because of the increasing awareness of the dangers of pesticides, particularly the use of broad spectrum chemical insecticides, to the consumer, environment, wildlife and non target species. However this type of control was in fact used before insecticides became generally available and is as old as any presently known and used control measures. LeConte in 1873 presented the first clearcut recommendation advocating the use of diseases as a means of insect control to appear in the English language. Shortly thereafter the number of advocates for microbial control increased rapidly. In 1879 Metchnikolf conducted tests with *Metarhizium anisopliae* and infected the scale beetle *Anisoplia autriaca* and in 1888 spores of the fungus was mass produced and applied in field tests against insect pests.

Although some of the early attempts with fungi have resulted in failure; 52 partially successful and successful attempts were reported by Baird in 1958. Much of the current interest is directed toward bacteria because of the ease with which they can be cultivated and processed into usable preparations. Only a few field studies have been attempted with entomogenous fungi. Successful utilisation of species of *Entomophthora* against larvae of brown tail moth, green apple bug and spotted alfalfa aphid have been reported (peare and Co ley 1912; Dustan 1924; Hall and Dunn. 1958). Following successful introduction of the fungus by Hall and Dunn (1958) those fungi spread gradually from the point of establishment depending upon the availability of host insects in successive generation or on the condition of the microenvironment. Possible role of *Coelomomyces* fungi in the biological control of mosquitoes has been reported by Laird (1959). Getzin (1961) reported on the studies of spores of *Spicaria* causing moderate mortality of cabbage loopers. A number of successes have also been obtained with the white muscardine fungus *Beauveria*

bassiana on larvae of artichoke plum moth (Tanada and Riener 1960) European Corn borer (York 1958) and Colorado potate beetle and green muscardine fungus *Metarhizium anisopliae* (Mcleod 1963).

These entomogenous fungi enter their hosts through the integument and do not have to be ingested to cause infection (Hall 1961). Therefore they have been considered similar to the contact chemical 'insecticides'. However the utilisation of entomogenous fungi to suppress insect pests may be dependent to a considerable degree on the host specificity of the fungi and physical factors such as temperature and humidity of the microenvironment.

PART II

KEY TO THE SUB-DIVISIONS OF THE FUNGI ASSOCIATED WITH INSECTS

1.	Perfect state present	— 2	
	Perfect state absent	— DEUTEROMYCOTINA	(P: 46)
2.	Perfect state with zygospores	— ZYGOMYCOTINA	(P : 12)
	Perfect state with no zygospores	— 3	
3.	Perfect state producing ascospores	— ASCOMYCOTINA	(P : 17)
	Perfect state producing basidiospores	— BASIDIOMYCOTINA	(P : 43)

SUB-DIVISION ZYGOMYCOTINA

Mycelium coenocytic, well developed, richly branched. Cell wall contains chitin. Most species have a creeping vegetative mycelium on which the sporangiophores arise Asexual spores are always non-motile, in the form of sporangiospores or conidia. Sexual reproduction is by means of gametangial copulation resulting in the formation of zygospores which is the chief characteristic of members of the subdivision.

A single class treated

CLASS ZYGOMYCETES

Some members are ubiquitous in soil and dung as saprophytes, few are parasitic on plants, other fungi, insects and animals. Most of the common species are readily recognized as belonging to this group, by their rapid rate of growth and their characteristic appearance, the colonies usually being floccose and of a grey or brown-grey in colour. A sexual reproduction is by spores contained in pear shaped or rounded sporangia. Some species also possess few-spored sporangia termed 'sporangioles', dispersed as a unit. In the conidial types unicellular propagules are dispersed. The gametangia may be similar in size or markedly dissimilar. Zygospore is usually thick walled, and dark colored. In several genera the zygospores have never been observed.

Insect parasitising Zygomycetes, are located principally in the Order Entomophthorales, but occasionally members of the Mucorales cause infections.

Single order treated.

ORDER ENTOMOPHTHORALES

This order includes fungi which are chieflly parasitic on insects. Mycelium is often much reduced, and generally show signs of loose organization. In many genera the mycelium has a definite tendency to form septa. In a few genera the septate mycelium fragments into portions called 'hyphal bodies' averaging 13μm or up to 30μm or more in diameter. The walls of hyphal bodies are rather thick, mainly composed of chitin which is colourless or tinted brown, Hyphal bodies multiply by fission or budding or they may become chlamydospores. A sexual reproduction is by means of reduced sporangia (probably 'sporangioles') functioning as conidia. The shapes of these 'conidia' are varied and they usually have a basal papilla. 'Conidia' are formed singly at the apex of simple or branched somewhat club shaped, hyaline or colored sporophores. In many species the 'conidium' may produce another sporophore and shoot off a secondary 'conidium' and this may produce a tertiary conidium and so on. Sexual reproduction is by the union of gemetangia which gives rise usually by lateral budding, to a thick walled zygospore. Similar azygospores may be formed without fusion.

PLATE I Figs. 1—3

Fig. 1—*Entomophthora muscae* : (*a*) unbranched conidiophores as seen in a section through the housefly (enlarged) ; (*b*) hyphal bodies (enlarged) ; (*c*) conidium immediately after discharge (enlarged) ; (*d-f*) germination of a conidium (enlarged).

Fig. 2—a-e *Myriangium duriaei* : (*a*) stroma showing apothecium (x10) ; (*b*) apothecium (x20) ; (*c*) broken ascus showing ascospores x500; (*d*) ascospores (x600) ; (*e*) broken ascus showing hyaline plasma extruded(x600) ; (f-g) *M. montagnei*: (f) stroma showing apothecia (x10) ; (*g*) ascospores (x600); (*h-k*) *M. thwaitesii* ; (*h*) stroma showing apothecia (x10) ; (*j*) asci (x600) ; (*k*) ascospores (x600).

Fig. 3—Receptacle variations : (*a*) receptacle with lower foot cell, a subbasal cell bearing one or more perithecia or secondary sterile or fertile outgtowths and an upper cell subtending an appendage; (*b*) receptacle consisting of number of cells super-posed in a single series of cells ; (*c*) receptacle superposed in tiers of cells variously disposed ; (*d*) a simple primary receptacle.

Appendage variations: (*a*) determinate series of few to many superposed cells ; (*e, h*) arising from products of division of the original upper spore segment ; (*c*) formed by cells comprising the receptacle ; (*f*) secondary appendage extensively branched.

Male sex organs : (*f, g*) rod-like branchlets arising on appendages and referred to as spermatia ; (*h*) simple antheridium with a neck and spermatium found in flask shaped cell ; (*a*) simple antheridium terminating a simple primary appendage ; (*j*) simple antheridium terminating an appendage of a male individual ; (*k*) compound antheridium.

(l) Perithecium (enlarged).

(*m*) ascospore (enlarged).

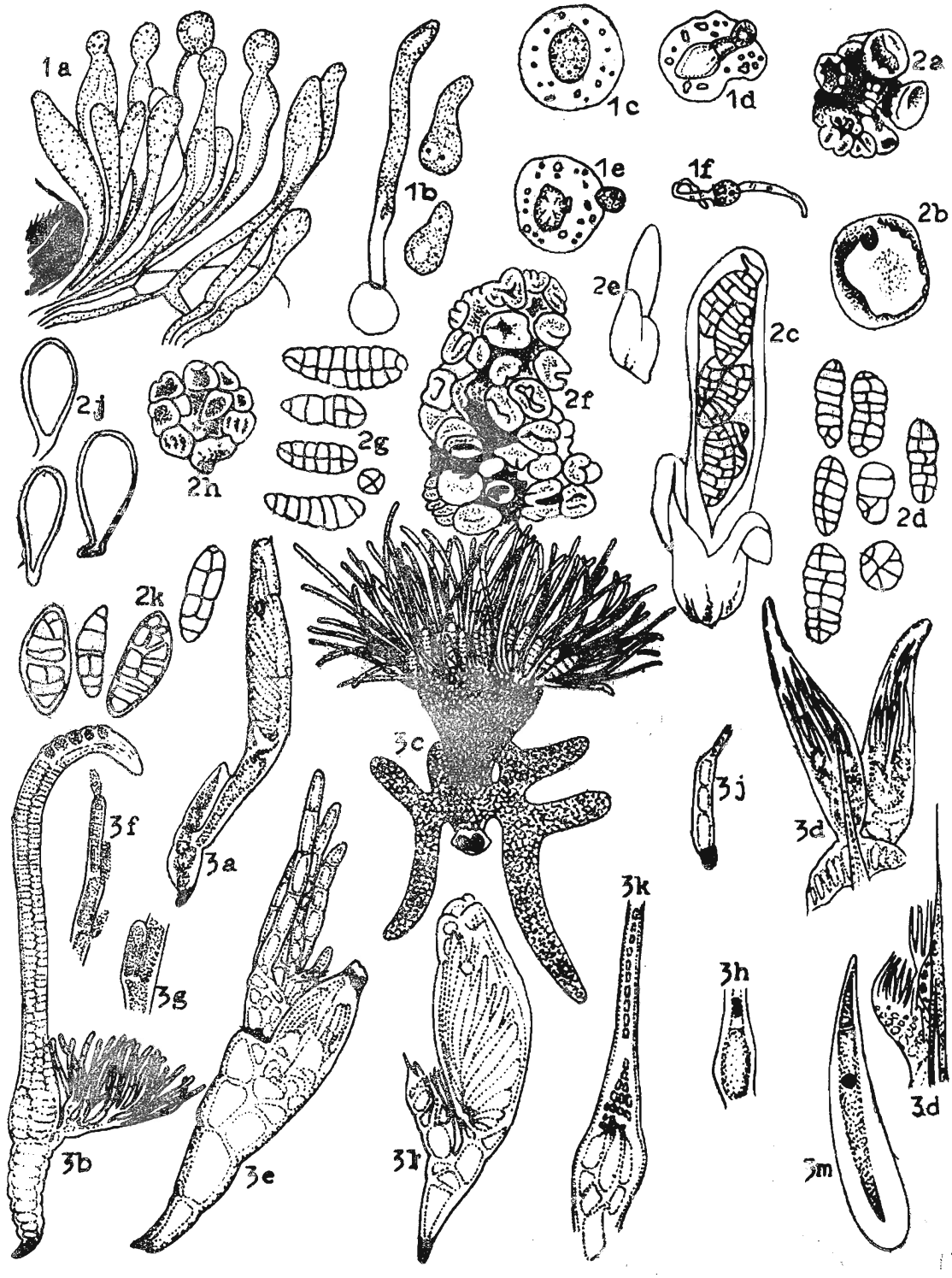

PLATE 1 Figs. 1—3

A single genus treated.

1. **Entomophthora.** Fres. (Plate I; Fig. 1)
=*Empusa* Cohn

The largest and the most well known genus containing about 40 species, all parasitic within insect. Mycelium may be quite extensive and filamentous or feebly developed. In many species mycelium break up in to 'hyphal bodies'. Conidiophores arise from the 'hyphal body' or chlamydospores, simple and packed together in a palisade layer or they may be branched at the base. Conidium l-celled, large, sometimes with an adhesive pad. Both zygospores and azygospores are known.

4 species described.

(1) *E. americana* Thaxt. On flies .. P : 18
(2) *E. dipterigene* Thaxt. On flies .. P : 18
(3) *E. echinospora* Thaxt. On insects .. P : 18
(4) *E. pyralidarum* Petch. On Pyralidae .. P : 18

6 more species described as *Empusa*

(5) *E. apiculata* Thaxt. On a fly and a wasp. Vavuniya .. P : 18
(6) *E. apiculata* var *major* Thaxt. On a beetle Nuwara Eliya .. P : 18
(7) *E. aulicae* (Reich.) Thaxt. On larvae ..
(8) *E. freseni* Nowak. On *Lecanium* and other insects. =*E. lecanii* Zimm .. P : 18
(9) *E. jassi* Cohn On insects .. P : 18
(10) *E. papillata* Thaxt. On flies .. P : 18

PLATE II

a— Perithecium ; (1) centrum ; (2) hymenium ; 3)paraphyses ; (4) periphyses ; (5) neck ; ostiole ; (7) pseudoparenchymatous wall. (all enlarged).

b — Perithecium seated on a subiculum ; (1) wall of perithec ium ; (2) subiculum (all enlarged)

c^1—c^2 Stromata containing perithecia; c^1—entire stroma; c^2—cross section through a stroma showing perithecia arranged peripherally, 1—perithecia ; 2—hyphal tissues of stroma (all enlarged).

d — Loculoascostroma ; (1) asci arranged in locule ; (2) stroma (all enlarged).

e^1—e^2 Apothecium ; e) diagrammatic vertical section through an apothecium ; (1) hymenium (2) hypothecium (3) medullary excipulum (4) ectal excipulum ; e_2) enlarged drawing of a section ; 1) mature ascus, (2) young ascus ; (3) paraphyses ; (4) hypothecium ; (5) excipulum ; (all enlarged).

f^1—f^2— Ascus enlarged ; f^1—u nitunicate ascus ; f^2 bitunicate ascus ; (all enlarged).

g^1—g^3— Basidiocarp ; g — entire basidiocarp of mushroom ; (1) volva ; (2) stipe ; (3) pileus ;

g_1 — vertical section through a basidiocarp ; (1) volva ; (2) stipe ; (3) pileus ; (4) lamellae or gills on the underside of the pileus.

g^2— section through a gill (x400). (1) trama (2) hymenium containing basidia and paraphyses; (3) basidiospores (4) cystidia. (all enlarged).

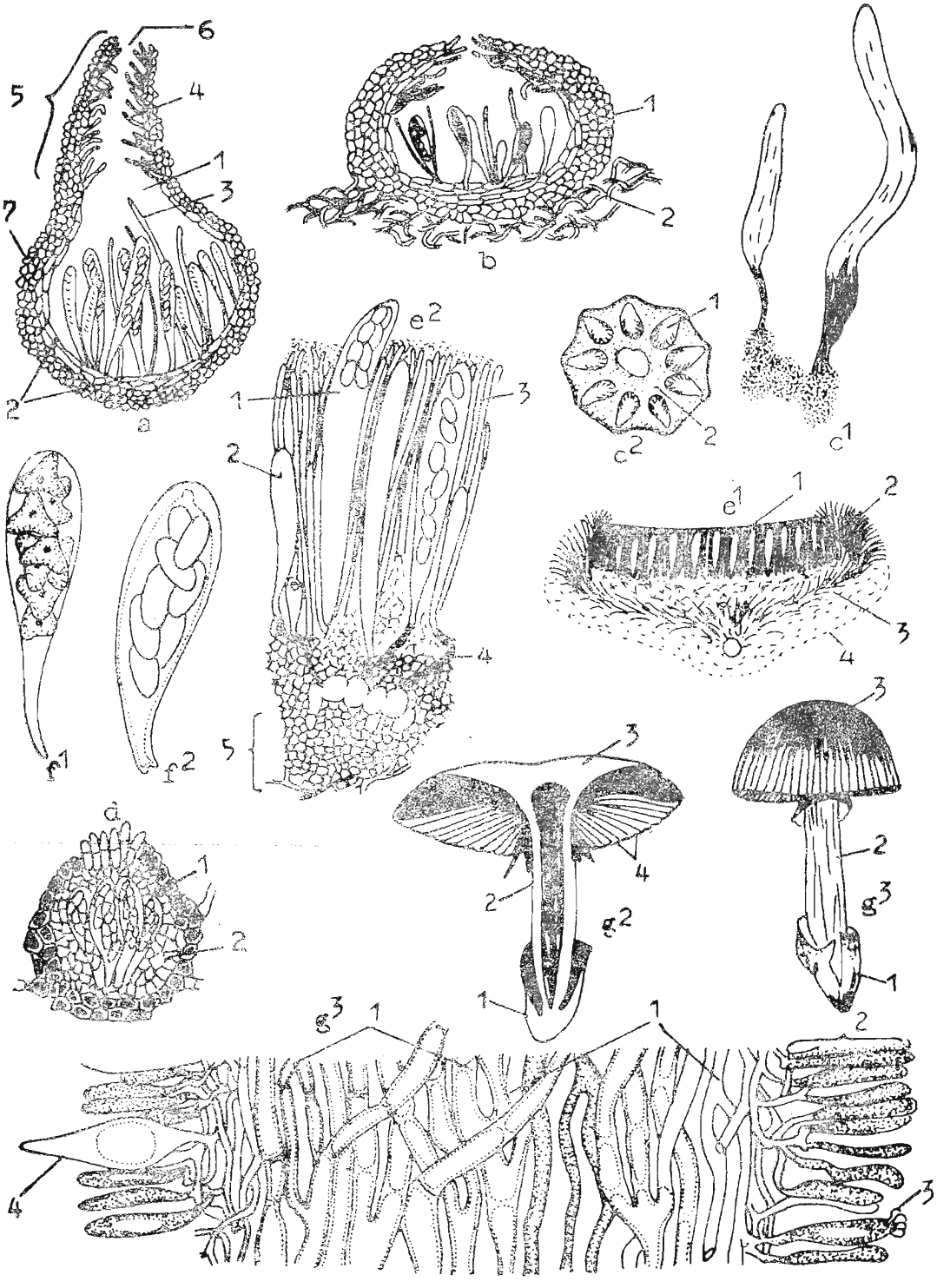

PLATE II

SUBDIVISION ASCOMYCOTINA

(Ascomycetes)

This is the largest class of fungi containing some 15,000 species. Mycelium is well developed (except in some Hemiascomycetes), usually richly branched and septate. The sexually produced spores (sometimes called the perfect spores) are borne in a sac or *ascus*, typically containing 8 spores. Asci may be formed on the vegetative mycelium, but typically, formed from ascogenous hyphae surrounded by sterile hyphae to form an *ascocarp*. The form of the ascocarp is very varied. When globose evanescent asci are borne at all levels from ascogenous hyphae ramifying irregularly throughout the central tissue of a closed ascocarp, they are termed **cliestothecia**; flask shaped or globose, closed or ostiolate fruit bodies with asci arranged in a basal or peripheral layer, are termed **perithecia** (plate II *a, b* & *c*); when asci are arranged in a layer on open saucer shaped ascocarps, they are termed **apothecia**. (plate II *e*). When the asci are individually and irregularly distributed in the stromatal tissue or grouped in locules, ascocarps are termed **ascostroma** (plate II *d*). In many, ascocarps are seated on, or in a mass of tissue termed a **stroma**. Wall of a mature ascus is either single layered (unitunicate) (plate II f), or two-layered (bitunicate) (plate II f^2). Whilst some members of Ascomycotina reproduce by means of ascospores only, many have one or more conidial states. The conidial state, is also referred to as the 'imperfect' state. Different authorities hold widely different views about the classification of Ascomycetes. For the purpose of this key, the system propsoed by Ainsworth (1973) will be followed.

KEY TO THE CLASSES OF THE SUB-DIVISION ASCOMYCOTINA

1.	Asci unitunicate ; ascocarps of various types	—	— 2
	Asci bitunicate ; ascocarp an ascostroma	LOCULOASCOMYCETES	(P : 17)
2.	Exoparasites of arthropods ; thallus reduced	— LABOULBENIOMYCETES	(P : 18)
	Not exoparasites of arthropods		— 3
3.	Ascocarp typically a perithecium	— PYRENOMYCETES	(P : 32)
	Ascocarp typically an apothecium	— DISCOMYCETES	(P : 41)

CLASS LOCULOASCOMYCETES

The asci are bitunicate. Ascocarp is an ascostroma with the asci individually and irregularly distributed in the stromal tissue or grouped in locules ; the ascostroma then becomes a perithecioid or less commonly an apothecioid pseudothecium. The pseudothecia are separate, grouped on a common basal stroma in which they are more or less immersed, or else they are completely immersed and appear as unwalled locules in a multilocular stroma. Ascocarps may be entirely superficial, erumpent or immersed in the substratum. The centrum is composed of asci interspersed with persistent pseudoparaphyses or of fasicles of aparaphysate asci in disintegrating centrum tissue. Perithecioid forms have ostioles. Apothecioid forms open by splitting. Usually the ascospores are septate. Loculoascomycetes appear as superficial parasites, epiphytes or hyperparasites of superficial fungi and insects.

A single order treated.

ORDER MYRIANGALES

Ascocarps intra—or sub-epidermal and are only partially erumpent. They occur in the form of extensive crusts on large to small, pulvinate, subglobose or discoid ascostromata. Asci are globose, individually distributed in the parenchymatous tissue of the ascostroma. Ascospores are phragmosporous (spores with transverse septa).

A single genus reported.

2. Myriangium Mont. & Berk. (Plate I; Fig. 2)

A perennial stroma is formed over the insect and fertile stromata arise from this stroma later. The fertile stromata are discoid and resemble apothecia ; stroma superficial, parenchymatous or sclerotioid, usually black, simple, pulvinate or compound and consisting of a basal disc bearing pulvinate, turbinate or nail-shaped process. Asci embedded singly on the parenchyma, the process when present irregularly distributed or in more or less definite regions. Asci are globose to saccate and scattered throughout the fertile stroma in individual locules. Spores muriform, hyaline.

2 species recorded.

1. *M. duriaei* Mont. and Berk.
   On *Aspidiotus* and *Chionaspis* (P : 33)

2. *M. thwaitesi* Petch.
   On a scale insect (P : 33)

CLASS LABOULBENIOMYCETES

This constitutes a well defined natural taxon. This group is not closely related to other ascomycetes. This is a large group of minute specialised external parasites of insects, arachnids and millipeds. They seldom penetrate beyond the exoskeleton and appear to do little injury to their hosts, inducing at most a slight irritation but never causing death. These fungi have adapted to insects inhabiting an almost endless variety of habitats—water, soil, decomposing plant and animal matter. They have a high degree of host specificity. Many species exhibit a narrow host range and many occur only on very restricted areas of the host's body.

Vegetative part consists of a receptacle attached to the integument of the host by a sucker-like dark organ called the **foot**. The receptacle varies greatly in size and, complexity and its structure (Fig. 3 *a-d*) constitutes a criterion of primary importance for distinguishing genera within the class. From the receptacle grows out, filamentous **appendages** (Fig. 3 *a-f*) on or among which the male organs are produced. With a few exceptions the

receptacle of the same individual also give rise to a female organ from which a **perithecium** develops. Appendage characteristics often are important taxonomic criteria. The male organs are of 3 types. In the simplest examples they are produced externally on the tips of more or less specialised branches. They are walled and correspond to the spermatia of the other fungi (Fig. 3 *f,g*). The most commonly encountered male organ is a simple antheridium, in which spermatia are formed endogenously in a flask shaped cell (Fig. 3 *h*). In some genera few to many of the simple antheridia are united into a compound structure so that their spermatia are discharged into a common chamber before escaping to the outside through a single opening (Fig. 3, *k*).

When mature the female organ consists of 3 superposed cells. First two cells become surrounded by the developing perithecium whereas the trichogyne is partly or entirely external and may consist of a series of superposed cells forming a simple or branched receptive organ. Asci are formed in the perithecial cavity (Fig. 3, *l*). Ascospores are hyaline, fusiform or acicular and almost always 2-celled (Fig. 3, *m*). There is a gelatinous sheath around the spore.

Asexual reproduction is not known to occur.

A single order treated.

ORDER — LABOULBENIALES

Characteristics are as for the class.

KEY TO THE GENERA OF THE ORDER LABOULBENIALES

1. Antheridium present 2
   Antheridium absent 14

2. Antheridium compound 3
   Antheridium simple 6

3. Dioecious .. .. *Dimeromyces* (3)
   Monoecious 4

4. Antheridia arising on an appendage .. .. .. *Monoicomyces* (4)
   Antheridia arising on the receptacle 5

5. Receptacle of a single row of several to superposed cells .. .. *Enarthromyces* (5)
   Receptacle of 1 or 2 superposed cells followed by 2 or 3 oblique or transverse rows .. .. *Dichomyces* (6)

6. Dioecious .. .. *Herpomyces* (7)
   Monoecious 7

7. Antheridia on definite series on the appendage 8
   Antheridia not in definite series on the appendage 10

8. Antheridia in a single or double vertical series 9
   Antheridia more or less distinctly whorled .. .. *Arthrorhynchus*(8)

9. Receptacle consisting of 2 superposed cells, upper giving rise to the single perithecium on one side and to the single appendage on the other .. *Stigmatomyces* (9)
   Not as above .. .. *Carpophoromyces*(10)

10.	Receptacle of seriate regularly superposed cells	*Chaetomyces* (11)
	Receptacle more or less parenchymalike at most only parts of the cells superposed in series	11
11.	Appendages all on one side	12
	Not as above	13
12.	Receptacle consisting typically of 7 cells	*Laboulbenia* (12)
	Receptacle indeterminate consisting of numerous cells	*Misgomyces* (13)
13.	Appendage completely surrounding perithecia	*Teratomyces* (14)
	Not as above	*Rickia* (15)
14.	Receptacle consisting of 3 vertical series of cells above a normal basal cell	*Diaphoromyces* (16)
	Not as above	*Euphoriomyces* (17)

3. **Dimeromyces** Thaxt. (Plate III, Fig. 4)

Dioecious. Male individual consisting of a series of superposed cells from which are produced, laterally sterile appendages and antheridia in a single series. The antheridium compound, consisting of a stalk cell followed by 4 basal cells, above which are 6 antheridial cells arranged symmetrically in the same plane, and discharging the antherozoids into a common cavity whence they make their escape through a terminal orifice, at the tip of a long slender tubular, terminal prolongation. Female individual is like the male, the antheridia being replaced by perithecia. The latter stalked, the cavity of the stalk cell, basal cells and perithecium eventually continuous, through the absorption of all the septa.

3 species recorded.

(1) *D. appressus* Thaxt.
On *Labia pilicornis* .. p : 35

(2) *D. brachiatus* Thaxt.
On *Heterophaga* sp. .. p : 35

(3) *D. petchi* Thaxt.
On a carabid allied to *Tachys* .. p : 35

PLATE III Fig. 4—6

Fig. 4—*Dimeromyces africanus* ; (*a-b*) mature female with mature perithecia (enlarged) ; (*c*) young female showing the origin of perithecia and appendage (enlarged) ; (*d*) male with antheridia (enlarged) ; (*e*) optical section of antheridium showing mature antherozoids (enlarged); (*f*) young perithecium showing remnants of trichogyne (enlarged).

Fig. 5—*Monoicomyces nigrescens* : (*a-b*) posterior view of mature individuals (x100) ; (*c*) anterior view of mature individuals (x600) ; (*d*) antheridium (enlarged greatly).

Fig 6—*Enarthromyces indicus* : (*a*) mature individual showing perithecium (enlarged); (*b*) spore (enlarged) (*c*) tip of young perithecium (enlarged); (*d*) process from lip cells of mature perithecium, (enlarged).

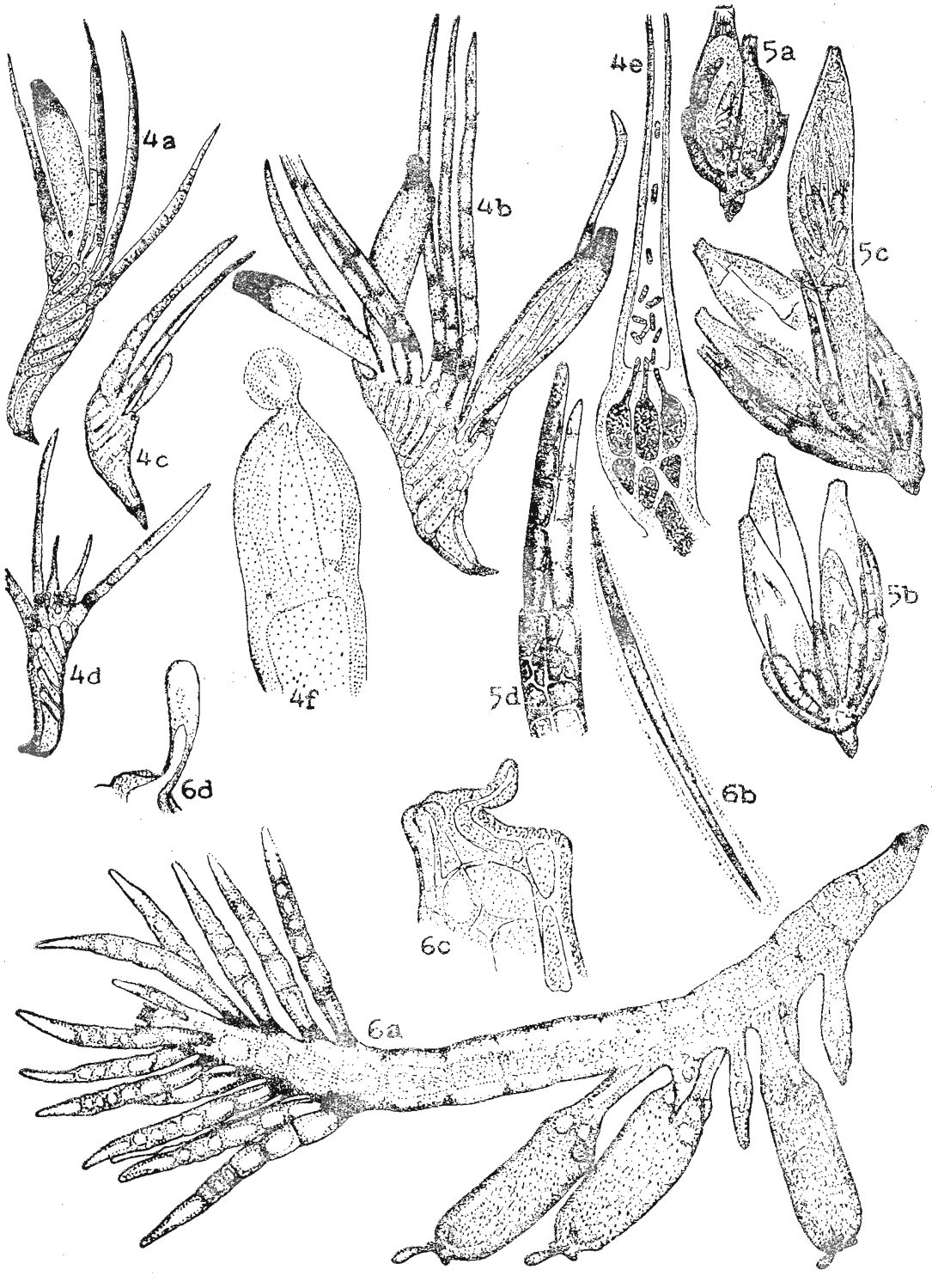

PLATE III Fig. 4—6

4. Monoicomyces Thaxt. (Plate III, Fig. 5)

Receptacle consisting primarily of two superposed cells, terminated by a sterile appendage which is variable in character and simple or branched ; the sub-basal cell producing one, typically two or in some species several, branches or secondary receptacle which may consist of one to many superposed cells and may be simple or branched, giving rise to antheridia and perithecia which may or may not be also associated with sterile appendages. The antheridium consisting of 4 tiers of paired cells, the lower pair forming the stalk, the cells of the two middle pairs producing each, a pair of antheridia from their upper inner angle ; those of the distal pair cutting off paired sterile cells which correspond to the paired antheridia below, and one or all of which give rise to variously developed, simple, cellular, terminal sterile appendages, the four pairs of antheridia opening into a common central cavity which discharges between the sterile terminal appendiculate cells. Perithecium stalked.

Single species recorded,

M. nigrescens Thaxt.

On *Atheta inornata* ... p : 35

5. Enarthromyces Thaxt. (Plate III; Fig. 6)

Receptacle consisting of a simple series of superposed cells, the distal ones bearing sterile appendages, those below giving rise to antheridia. Perithecia or remaining sterile. Antheridia compound, terminally pointed and perforate, the six antheridial cells converging upward to a general cavity, into which they empty through narrow necks. Trichogyne simple, 2-celled Perithecia stalked, I or more, formed by direct budding from the cells of the receptacle.

Single species recorded,

E. indicus Thaxt.

On *Pheropcophus* sp. ... p : 35

6. Dichomyces Thaxt. (Plate IV ; Fig. 7)

Receptacle flattened, sub-triangular ; consisting of a single basal cell followed by three transverse series of cells symmetrically placed, the distal row bearing a pair of perithecia symmetrically placed, or a single perithecium the fellow of which is undeveloped, together with certain sterile appendages, the sub-distal row producing a pair of compound antheridia symmetrically placed and subtended by 1 or more sterile appendages. Perithecia symmetrical. Spore 1-septate. Antheridia conical, compound, forming a sharp tooth-like projection on one side. Appendages simple, continuous, separated from the cell which bears them, by a prominently constricted, usually blackened septum.

3 species recorded.

(1) *D. furciferus* Thaxt.

On *Philonthus* sp. ... p : 35

(2) *D. hybridus* Thaxt.

On *Philonthus gemellus* ... p : 35

(3) *D. vulgatus* Thaxt.

On *Philonthus longicornies* ... p : 35

PLATE IV Figs. 7

Fig. 7—*a-b—Dichomyces furciferus* : (*a*) anterior view (x600); (*b*) posterior view (x600) ; (*c—f. hybridum*: (*c*) anterior view of individuals (x60); (*d*) posterior view showing perithecia of appendiculate type (x600) ; (*e-f*) posterior and anterior views of tips of perithecia (x1800.) (*g-l*) *D. vulgatus* : (g-h) anterior view s showing two types of forms (x600) ; (*j*) posterior view of appendiculate tip of perithe cium (x1800) ; (*k*) anterior view of appendiculate tip of perithecium (x1800) ; (*l*) anterior view of individual in which the perithecial appendages are absent (x600).

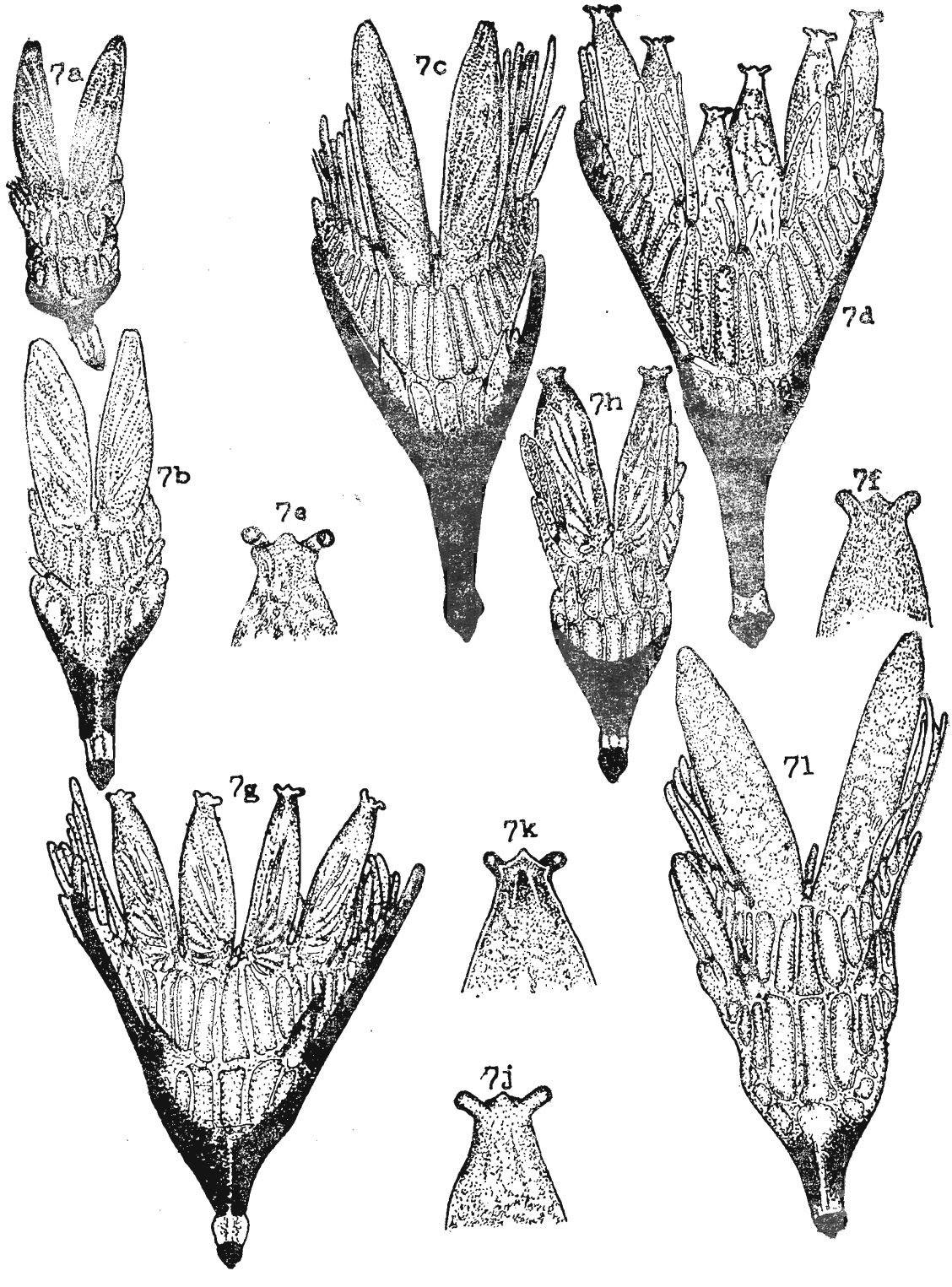

PLATE Fig.—7

7. Herpomyces Thaxt. (Plate V ; Fig. 8)

Sexual organs normally separated on different individuals. Antheridia simple. Male individual consisting of several superposed cells terminated by a characteristically modified spine or by a small foot-like process or both ; the basal cell attached by a small, normal, blackened foot. One or more of the distal cells giving rise to short branches which may bear from one to several antheridia terminally, or become more or less conspicuously branched ; the branchlets terminated by antheridia or in some cases sterile. Antheridia long, flask shaped. The sub-basal cell of the receptacle sometimes producing a fertile branch, as in the female individual, from which are produced receptacles which give rise to antheridial branches.

Female individual consisting primarily of several superposed cells similarly modified at the tip, and attached by a small normal foot ; the basal and sub-basal cells constituting a 'primary' receptacle, the latter giving rise to a variably developed fertile branch, from which is developed a single secondary receptacle or as a result of branching, more than one. Secondary receptacles consisting of a partly double series of cells, variable in number, one or more of which may be fertile, the rest sometimes specially differentiated or unmodified; those in contact with the host, perforating the chitinous integument by means of fine haustoria. Trichogyne short, filamentous simple or sparingly branched. Perithecium borne on variably developed stalk cells, the aecigerous portion including 3 tiers of wall-cells more or less clearly distinguished from the distal portion, the wall-cells of which are more or less differentiated, 4 or 5 in each row. Spores minute, of the usual type, normally discharged in pairs, the members of which produce male and female individuals. Asci apparently 8-spored.

Single species recorded.

H. panesthiae Thaxt.

On *Panesthia lobipennis* .. p: 35

8. Arthrorhynchus Colenati (Plate V ; Fig. 9)

Rhizoidal apparatus highly developed, which penetrates the soft body cavity of the host and arises from a slightly swollen extension of the basal cell. From this intrusion, is produced a mass of copiously branching hyaline filaments, which become interlaced in a mass, so dense, that the course of individual filaments cannot be followed in detail.

The antheridia assume a more or less distinctly whorled arrangement on the cells of the appendage.

Single species recorded.

A. nycteribiae (Peyritsch) Thaxt.

On *Pencillidia jenynsi* .. p: 35

PLATE V Figs. 8—11

Fig. 8—*Herpomyces penestiae* : (*a*) female individual with secondary receptacle and primary receptacle (enlarged) ; (*b*) female individual (enlarged).

Fig. 9—*Arthrorhynchus nycteribiae* : (*a*) mature form showing a perithecium in optical section (x300) ; (*b*) mature individual with perithecium in surface view (x300); (*c*) antheridial appendage (x600) ; tip of perithecium (x600).

Fig. 10—*Stigmatomyces pseudopyrelliae* : (*a-b*) Two mature individuals (enlarged).

Fig. 11—*Carpophoromyces cybocephali* : (*a*) highly developed type, posterior view (enlarged) ; (*b*) simple type with perithecial branch, (enlarged) ; (*c*) antheridia (enlarged).

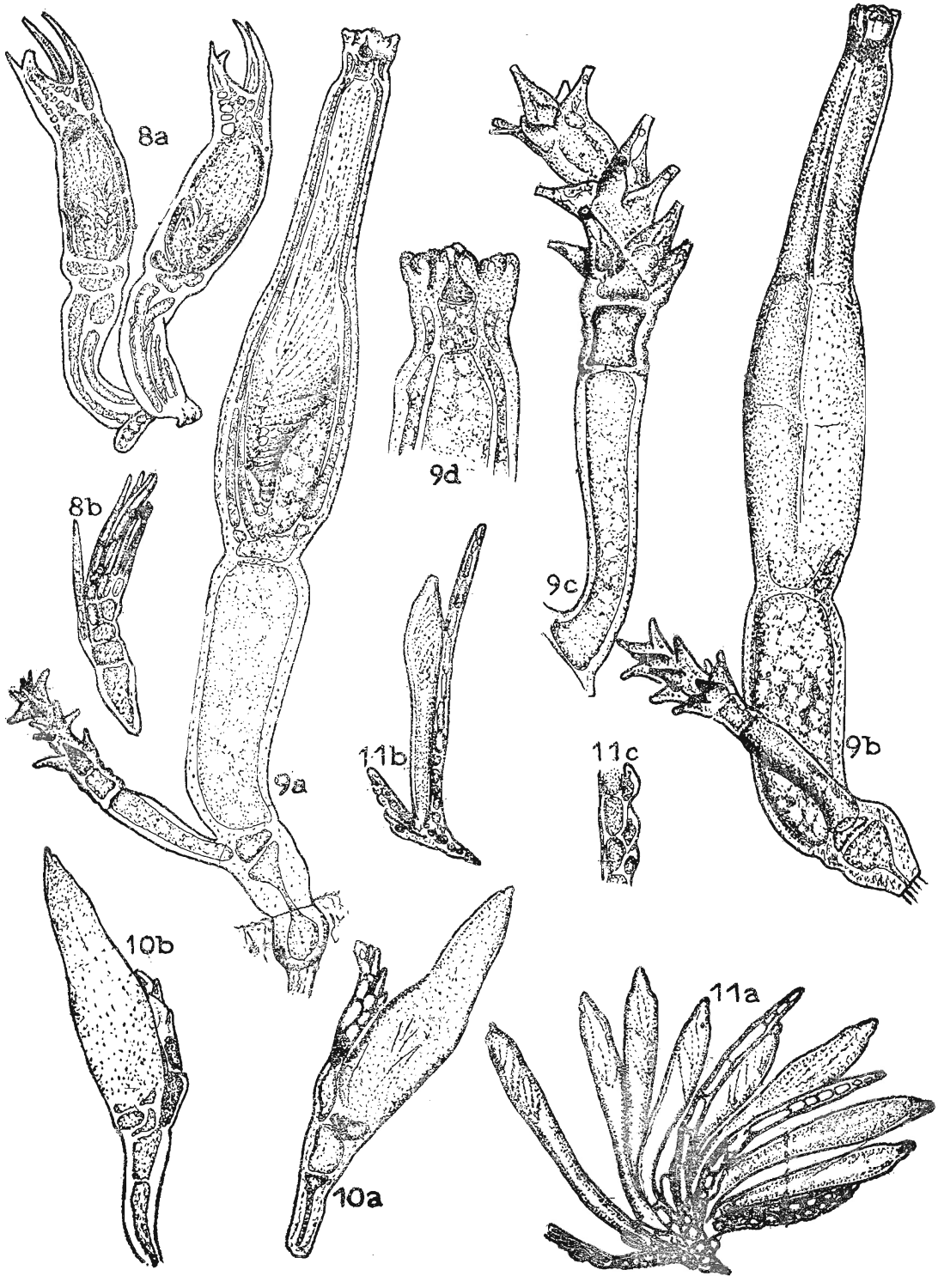

PLATE V Figs. 8—11

9. Stigmatomyces H. Karst. (Plate V; Fig. 10)

Receptacle consisting of two superposed cells, the upper giving rise to the single perithecium on one side and to the single appendage on the other. The perithecium various in form, stalked or sessile, sometimes appendiculate. Appendage consisting of an axis of superposed cells from which are developed on one side a single row of superposed antheridia separated from them by a septum or by a small cell. The antheridial cells flask shaped, the venters more or less united, the necks projecting independently. Trichogyne simple, short, filamentous. Spores 1-septate.

4 species recorded.

(1) *S. baeri* (Knoch.) Peyritsch.
On *Pseudopyrellia* sp. .. p : 36

(2) *S. limnophorae* Thaxt.
On Luciliae and perhaps on *Anthomyia bisetosa* .. p : 36

(3) *S. pseudopyrelliae* Thaxt.
on *Pseudopyrellia* sp. .. p : 36

(4) *S. stillci* Thaxt.
On *Actobius basalis.* .. p : 36

10. Carpophoromyces Thaxt. (Plate V; Fig. 11)

Axis consisting of a variable number of superposed cells continuous with an elongate terminal primary appendage ; one or more of the axis cells, above the basal cell giving rise to secondary axis, which may consist of single cells subtending an antheridial appendage and a perithecium or of several cells forming a short axis which ends in an antheridial appendage, more than one of the basal cells of which give rise to a perithecium. Perithecia subtended by a small basal cell, above which the lumen, which includes the basal and stalk cell regions, is continuous with the aecigerous cavity. Antheridial appendages simple, elongate, multicellular; a variable number of the cells bearing, in more or less continuous serieson the lower side, large stout, appressed antheridia with short abruptly distinguished necks.

Single species recorded.

C. cybocephali Thaxt.
On *Cybocephalus glaberrimus.* .. p : 35

11. Chaetomyces Thaxt. (Plate VI; Fig 12)

Receptacle consisting of a slender rigid series of superposed cells from which arise, successively in a unilateral series, the appendages and rarely two perithecia. Perithecium flattened, stalked. Appendages one from each cell, simple or branched, one or more below

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PLATE VI Figs. 12—14

Fig. 12—*Chaetomyces pinophili* : (*a*) two mature individuals (enlarged ; (*c*) a spore (enlarged).

Fig. 13—*Laboulbenia proliferans* variety *interposita* (*a-b*) individuals, showing bases of appendage. (note partial blackening) (*c-d*) same in variety *divaricata.* (all enlarged).

Fig. 14—*Misgomyces lispini* (*a-b*) stout individuals (enlarged); (*c*) slender individuals (enlarged) ; (*d*) an appendage showing antheridia (enlarged) (*e*) flagellated appendage (enlarged).

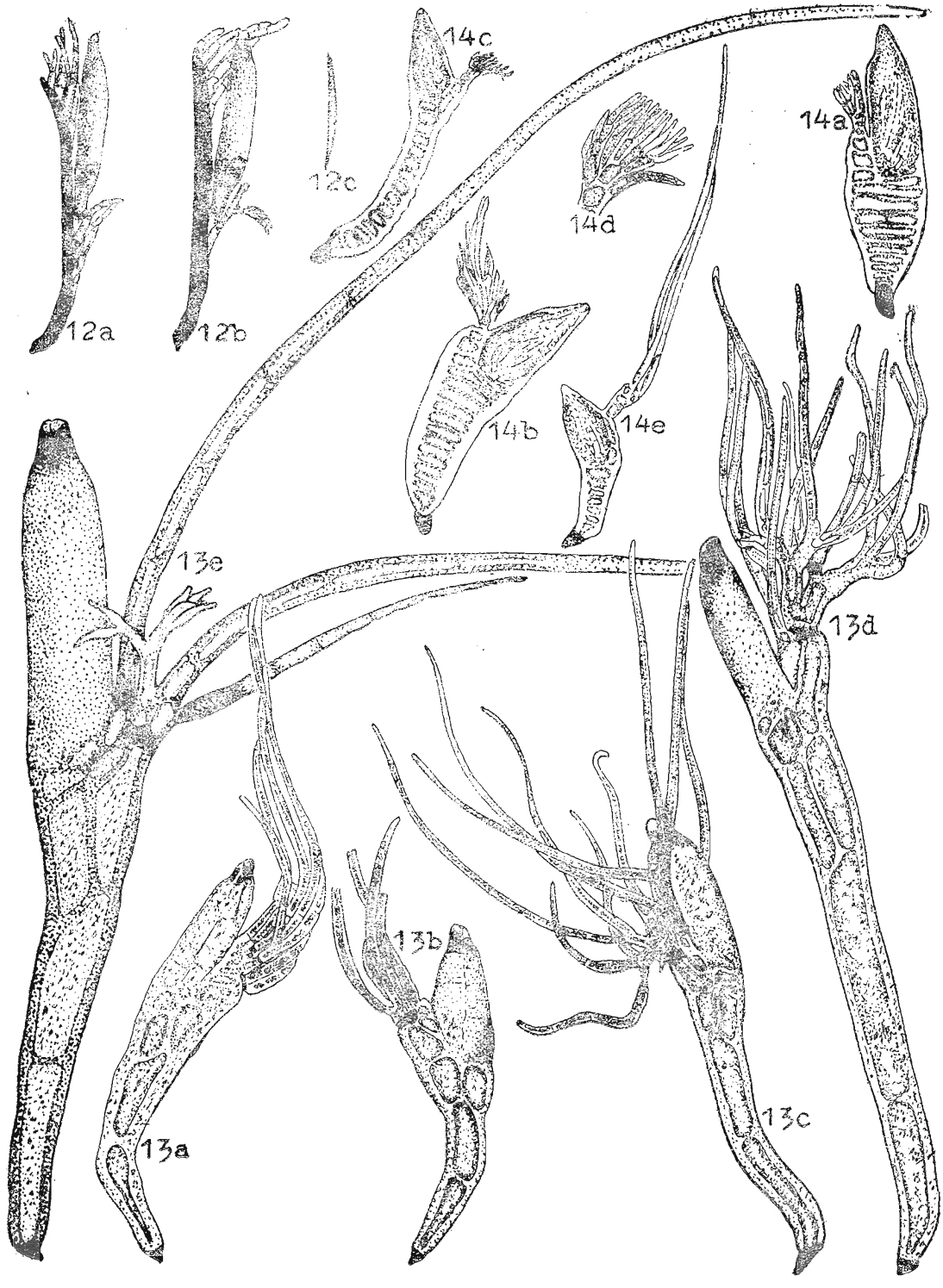


PLATE VI Figs. 12—14

the origin of the perithecium, the rest above it. Spores 1-septate. This well marked type differs from other genera from the fact that as may as 3 of the cells of the receptacle lying below the origin of the perithecia may give rise to appendages, apparently fertile. The lowest of the latter which form the series above the perithecium also seem to be fertile producing a small number of rather slender flask-shaped cells, but no discharge of antherozoids has been observed from them. The cells immediately above the origin of perithecia bear no appendage but the lowest sometimes produces a second perithecium. The perithecium appears to have 4 cells in each series of wall-cells, but it has not been possible to determine this beyond question.

Single species recorded

C. pterogenii (Thaxt.) Thaxt.
On *Pterogenius nictneri* .. p : 35

12. Laboulbenia Mont. & Robin, (Plate VI ; Fig. 13)

Receptacle consisting typically of 7 cells, exclusive of 3 small cells which form the base of the perithecium ; 2 lower superposed and forming the receptacle proper ; the cells above them arranged in an anterior and posterior series, latter consisting of 2 cells, a lower and an upper, the inner upper portion of which is separated as a third cell, the former consisting of a lower and an upper obliquely superposed. Appendage arising from a blackened insertion cell avove cells 4 to 5. Perithecium solitary, compressed asymmetrical or nearly symmetrical, rarely appendiculate, sessile or stalked, having 4 wall-cells in each longitudinal row. Appendage sometimes numerous but typically consisting of 2 basal cells from the outer of which arises one, from the inner, two branches or series of branches, the inner fertile bearing the flask shaped antheridia, single, or more or less irregularly grouped. Ascogenic cells two, lateral. Asci 4-spored. Spores 1 - septate. Trichogyne filamentous, simple or branched.

9 species recorded.

(1) *L. anaplogenii* Thaxt.
On *Abeacetus costatus.* .. p : 35

(2) *L. ceylonensis* Thaxt. .. p : 35

(3) *L. dineutis* Thaxt.
On *Dineutes* sp. .. p : 35

(4) *L. flagellata* Peyritsch.
On *Colpodes ruficeps.* .. p : 35

(5) *L. helluodis* Thaxt.
On *Helluodes nebrioides.* .. p : 35

(6) *L. manubriolata* Thaxt.
On a carabid .. p.: 35

(7) *L. pheropsophi* Thaxt.
On *Pheropsophus* sp. .. p : 35

(8) *L. proliferans* Thaxt.
On *Chlaenius* sp. .. p : 35

(9) *L. spiralis* Thaxt.
On *Helluodes nebrioides.* .. p : 35

13. Misgomyces Thaxt. (Plate VI ; Fig. 14)

Receptacle indeterminate, consisting of numerous cells, each ending distally, in an appendiculate portion, not clearly distinguished from the receptacle and a solitary perithecium, the two related to one another somewhat as the corresponding structures are related in *Laboulbenia.*

3 species recorded.

(1) *M. lispini* Thaxt.
On *Lispinus impressicollis* .. p : 31

(2) *M. ornatus* Thaxt.
On *Perigona* sp. .. p : 35

(3) *M. stomonaxi* Thaxt
Host not stated. .. p : 35

14. Teratomyces Thaxt. (Plate VII ; Fig. 15)

Receptacle consisting of 3 superposed cells surmounted by a more or less cup shaped terminal portion divided by vertical and oblique septa into a series of numerous small cells arranged peripherally, from which arise numerous appendages which completely surround the point of origin of perithecia. Perithecium one-several, symmetrical with single stalk cells. Appendages consisting of a short series of sympodial branches, bearing sympodial branchlets directed outward, many terminating in sharply pointed, beak-like, sterile terminal cells. Antheridia flask shaped on beak like cells, free from one another superposed in a single vertical external row arising from the lower segments of the appendages. Trichogyne copiously branched and septate. Spores 1-septate.

Single species recorded

I. brevicaulis Thaxt.
On *Actobius basalis* .. p : 36

PLATE VII Figs. 15—18

Fig. 15—*Terratomyces brevicaulis* : (*a*) mature individual with 3 perithecia (enlarged) ; (*b*) single appendage (enlarged) ; (*c*) spore, (enlarged).

Fig. 16—*Rickia elegans* : (*a*) mature type, (enlarged) ; (*b*) secondary appendage, (enlarged).

Fig. 17—*Diaphoromyces marginatus* : (*a*) mature individual, (enlarged) ; (*b*) young axis showing basal cells (enlarged) ; (*c*) young individuals (enlarged) ; (*d*) young individuals, with primary appendage (enlarged) ; (*e*) foot of an adult (enlarged).

Fig. 18—*Euphoriomyces cybocephali* : (*a-b*) mature individuals showing perithecia (enlarged) ; (*c*) young individual (enlarged).

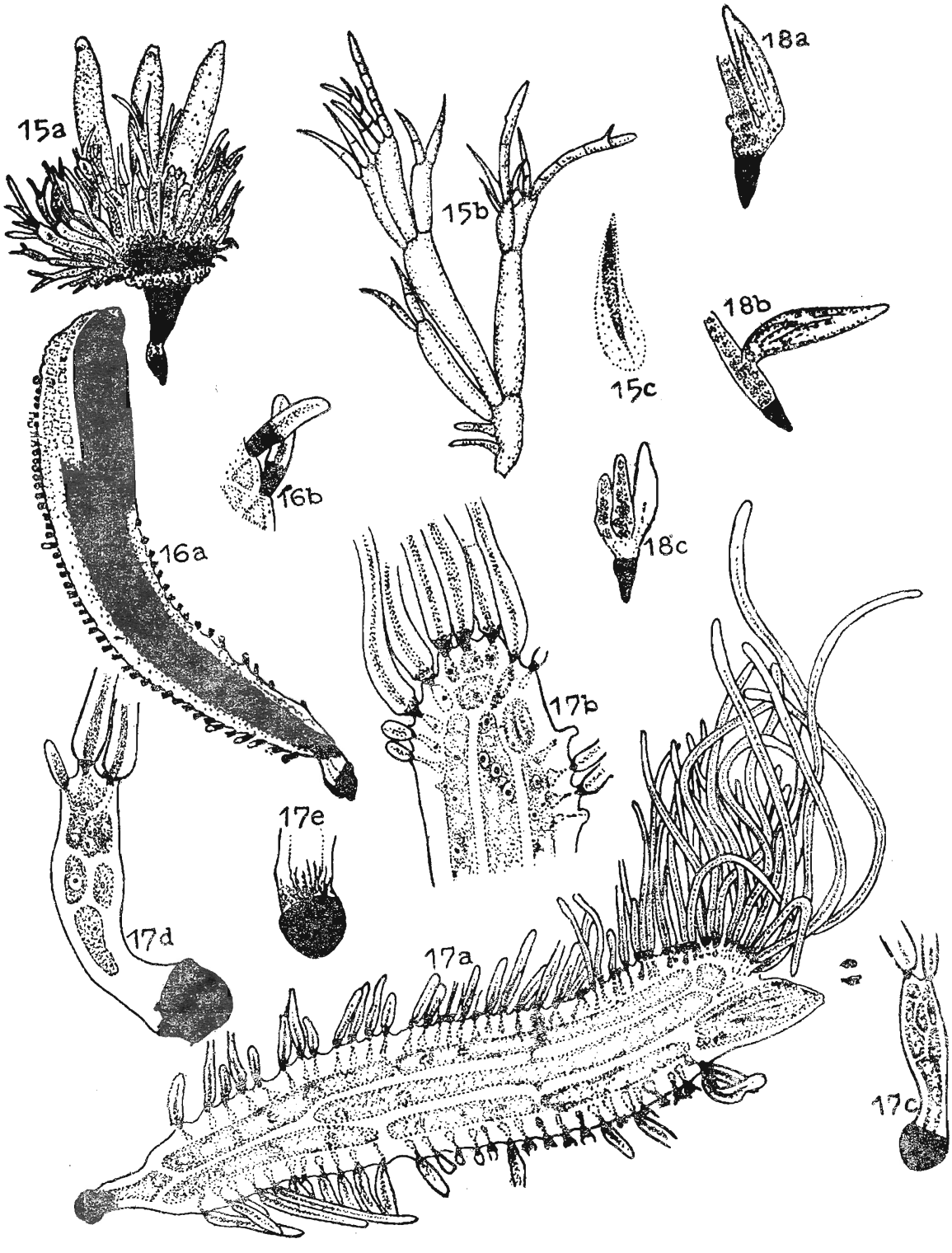


PLATE VII Figs. 15—18

15. Rickia Cav. (Plate VII ; Fig. 16)

Receptacle consisting of a single basal cell surmounted by a cellular portion, the cells of which are arranged in general in 3 vertical series ; a posterior series, each cell of which may cut off externally 1 or 2 small cells bearing secondary sterile appendages or antheridia and which is terminated by a single primary appendage borne on a two-celled base ; anterior series similar to the posterior, but terminating in a perithecium and a median series ending opposite the base of the primary appendage and extending down ward to the basal cells of the other two series. Antheridia irregularly disposed, the numbers varying in different individuals, wholly free, subtended by a blackened septum, flask shaped, compound. Perithecium normal, solitary.

7 species recorded.

(1) *R. beriesiana* (Bacc.) Paoli
On *Passalus* and its infecting termites .. p : 35

(2) *R. biseriata* Thaxt.
On a passaline beetle .. p : 35

(3) *R. discopomae* Thaxt
On *Discopoma* sp. .. p : 35

(4) *R. elegans* Thaxt.
On *Discopoma* sp. .. p : 35

(5) *R. nutans* Thaxt .
On passaloid beetle. .. p : 35

(6) *R. onthophagi* Thaxt.
On *Onthophagus* sp. .. p : 35

(7) *R. tormari* Thaxt.
On *Tomarus taprobensis.* .. p : 35

16. Diaphoromyces Thaxt. (Plate VII ; Fig. 17)

Receptacle consisting of 3 vertical series of cells above a normal basal cell; the median series consisting of a single large elongated cell terminated by a small appendiculate cell lying posterior to the perithecium ; both lateral series consisting of a small number of more or less vertically elongated cells all of which, or only the distal ones may bear linear series of secondary appendage along their margin ; the appendages unicellular, simple or branched, with blackened bases ; the posterior series ending in the two-celled base of the primary appendage, which may be single on the upper of its basal cells or become surrounded by adventitious primary appendages developed from the lower cell, each distinguished by a basal cell. Perithecium normal and solitary. Antheridium absent.

Single species recorded

D. marginatus (Thaxt.) Thaxt.
On *Heterophaga punctulata* .. p : 35

17. Euphoriomyces Thaxt. (Plate VII ; Fig. 18)

Axis consisting of a variable number of superposed cells, those above the 2 or 3 lowest, dividing longitudinally to form a corresponding number of horizontal tiers of 2-many cells, which extend right and left from the median line and end in cells which may

produce simple appendages or perithecia, the latter sometimes also intercalary. Perithecia relatively large, subtended by the cell of the tier from which they are developed and which acts as a stalk-cell, the proper stalk - and basal cells all losing their identity and usually becoming disorganised at maturity, so that both regions are combined to form the continuous lumen of the perithecium. Spores 1 septate. Ascogenic cell single. Antheridium unknown.

Single species recorded

E. cybocephali (Thaxt.) Thaxt.
On *Cybocephalus* sp. .. p : 35

CLASS PYRENOMYCETES

Members of this class produce a **perithecium** (Fig. *b*, Plate II). A typical perithecium consists of a more or less hollow structure within which there is formed a hymenium of unitunicate asci lining the perithecial wall or forming a cluster at the base. The perithecia are provided with an opening, the **ostiole**, which is typically apical and rarely lateral. Usually the **paraphyses** arising from the vegetative mycelium are intermingled with the asci. Near the apex of the perithecial cavity, the sterile hairs are referred to as **periphyses**. In many cases the vegetative mycelium growing over the perithecial wall forms a more or less distinct stromatic layer. The perithecia may be seated on the mass of tissue termed the **stroma** or may be imbedded in it, with only the ostioles visible at the surface. Stromata vary in size and shape. A very large proportion of the species have asexual reproduction by means of conidia.

A single order treated.

ORDER SPHAERIALES

This order is treated here in a very broad sense to include Sphaeriales *s. str.*, Diaporthales, Xylariales, Claviceptales, and Hypocreales (Muller and von Arx 1973). The most significant characteristic of this order is the nearly constant form of the perithecium. It is spherical, hemispherical or flask shaped, mostly with an apical ostiole, and fleshy, membranous or carbonous wall. Perithecia are borne singly, free or partly embedded in the substratum or on a weft of hyphae or seated on or imbedded in a independent elaborate stroma. Perithecia in the stromatic forms are arranged just below and at right angles to the surface of the stroma. Their development may be preceded by the formation of conidia which often cover young stromata with a white or brown powder. Asci are spherical, clavate, fusiform or cylindrical. Ascospores one-celled to may -celled, hyaline or colored.

KEY TO THE GENERA OF THE ORDER SPHAERIALES

1. Apical structure of the ascus amyloid .. .. .. *Xylaria* (18)
   Apical structure of the ascus not amyloid 2
2. Asci with refractive apical caps or rings 3
   Asci without refractive caps or rings 7
3. Ascospores separating into part spores within the ascus 4
   Ascospores not separating into part spores occasionally separating outside the ascus 5

4.	Stromata formed as byssoid subiculum	*Torrubiella* (19)
	Stromata fleshy or horny often completely smothering the host, ascomata immersed	*Hypocrella* (20)
5.	Stromata formed as byssoid subiculum	*Podonectria* (21)
	Stromata arising from endosclerotial structures in insects	6
6.	Ascospores fragment into their component cells	*Cordyceps* (22)
	Not as above	*Ophiocordyceps* (23)
7.	Ascospores 2-celled	8
	Ascospores more than 2-celled	10
8.	Perithecia with a stilboid base	*Sphaerostilbe* (24)
	Perithecia without a stilboid base	9
9.	Ascospores elongate	*Nectria* (25)
	Ascospores elliptic	*Lisea* (26)
10.	Perithecia brightly coloured	11
	Perithecia not brightly coloured	*Stereocrea* (27)
11.	Ascospores elliptic or fusiform	*Calonectria* (28)
	Ascospores vermiform, filiform or aciculate	*Ophionectria* (29)

18. **Xylaria** Hill ex Grev. (Plate VIII ; Fig. 19)

Stroma more or less stalked cylindrical to fusiform, sometimes forked, black or nearly so, but sometimes partly covered with light colored conidia when immature ; perithecia in a single layer usually inserted beneath a black crust, in a few species superficial, flesh of the stroma usually white. Asci large, cylindrical to fusoid. Ascospores ellipitic, fusiform or pear shaped, dark brown, 1-celled.

Single species recorded.

X. furcata Fr.

From termite nests. .. p : 27

19. **Torrubiella** Boud.

This genus is found chiefly on scale insects and is similar to *Cordyceps* but without a clava, the perithecia being borne on a thin byssoid membranous stroma. Asci are long cylindric with a characteristic apical plug. The ascospores filiform, hyaline, many-septate and fragment into their component cells.

6 species recorded.

(1) *T. alba* Petch

On Spiders. Nuwara Eliya. .. p : 31

(2) *T. flava* Petch

On Spiders Hakgala. .. p : 31

(3) *T. gibellulae* Petch
On Spiders. .. p : 31

(4) *T. hemipterigena* Petch
On leaf-hoppers, Nuwara Eliya. .. p : 31

(5) *T. luteorostrata* Zimm
On scale insects. .. p : 31

(6) *T. tenuis* Petch
On scale insects. .. p : 31

20. Hypocrella Sacc.

This genus forms massive stromata enveloping the host, on white flies or scale insects. Within the stroma a large pycnidial state of the form-genus *Aschersonia* is formed. Pycnidia brightly colored, hemispherical on cushion shaped stromata, somewhat sunken, opening by wide pores, or rupture which join to form irregular cracks ; conidiophores slender, branched ; conidia hyaline, usually 1-celled, but sometimes reported as being septate, fusoid. Perithecia imbedded on the surface of a stroma. Asci cylindric with a thickened apical cap ; ascospores long cylindric, multiseptate and fragmenting into part spores in the ascus.

11 species recorded.

(1) *H. ceramichroa* (B. &. Br.) Petch
On *Lecanium*. .. p : 29

(2) *H. discoidea* (B. & Br.) Sacc.
On *Aleyrodes*. .. p : 29

(3) *H. hypocreoidea* Petch
On *Aleyrodes*. .. p : 29

(4) *H. javanica* (Penz. & Sacc.) Petch
On *Lecanium*. .. p : 29

(5) *H. mollii* Koord
On *Aleyrodes*. .. p : 29

(6) *H. oxystoma* (Berk.) Petch
On scale insects. .. p : 29

(7) *H. palmicola* P. Henn.
On *Aleyrodes*. .. p : 29

(8) *H. raciborskii* Zimm
On *Aleyrodes*. .. p : 29

(9) *H. reineckeana* P. Henn.
On *Lecanium*. .. p : 29

(10) *H. sphaeroidea* Syd.
On *Lecanium*. .. p : 29

(11) *H. tubulata* Petch
On *Aleyrodes*. .. p : 29

21. Podonectria Petch (Plate VIII ; Fig. 20)

Perithecia on a byssoid stroma as in *Torubiella*. Asci thick walled cylindric to fusoid with a poorly developed apical cap. Ascospores elongated, fusiform, multiseptate, biseriate in the ascus. Conidial state is *Tetracrium* P. Henn. Conidia in sporodochium. Conidiophores short moniliform ; conidia detached in clusters, united at the base by a small lozenge shaped cell, individual conidia cylindric, hyaline, multiseptate usually with long acuminate aseptate tip.

2 species recorded

(1) *P. coccicola* (Ell. & Everh) Petch
On *Lepidosaphes* sp. .. p : 31

(2) *P. echinulata* Petch
On *Lepidosaphes*. .. p : 31

PLATE VIII Figs. 19—23

Fig. 19—*Xylaria furcata* : (*a*) conidial stroma (natural size) ; (*b*) perithecial stroma (natural size) ; (*c*) cross section through perithecial stroma showing peripherally arranged perithecia (enlarged) ; (*d*) asci and paraphyses (enlarged).

Fig. 20—*Podonectria coccicola*: (*a*) conidia (x400); (*b*) Conidia (x 200); (*c*) Conidia (x 200) (*d*) ascospores (x400).

Fig. 21—*Cordyceps barnessii* : (*a*) stroma (natural size) ; (*b*) *C. dipterigene* typical species, stroma (x4) ; (*c*) *C. dipterigena* variant stroma ; (*d*) *C. dipterigena*, abnormal head ; (*e*) *C. pruinosa*, ascus (x600).

Fig. 22—*Sphherostilbe aurantiicola*: (*a*) perithecial stage (x2) ; (*b*) perithecium (x60) ; (*c*) conidia (x500 l) (*d*) small curved conidium (x500) ; (*e*) *S. coccidophthora*, perithecium (x60) ; (*f*) old, conidia; state (enlarged) ; (*g*) ascus (enlarged) ; (*h*) ascospore (much enlarged).

Fig. 23—*Nectria* : (*a-d*) *N. barbata*, (*a*) perithecium (x80); (*b*) hairs from the perithecium (x300) ; (*c*) ascus (x600) ; (*d*) ascospores (x600) ; (*e*) *N. diploa*, ascospores (enlarged) ; (*f-g*) *N. epicoccmu* (*f*) ascus (enlarged) ; (*g*) ascospores (enlarged).

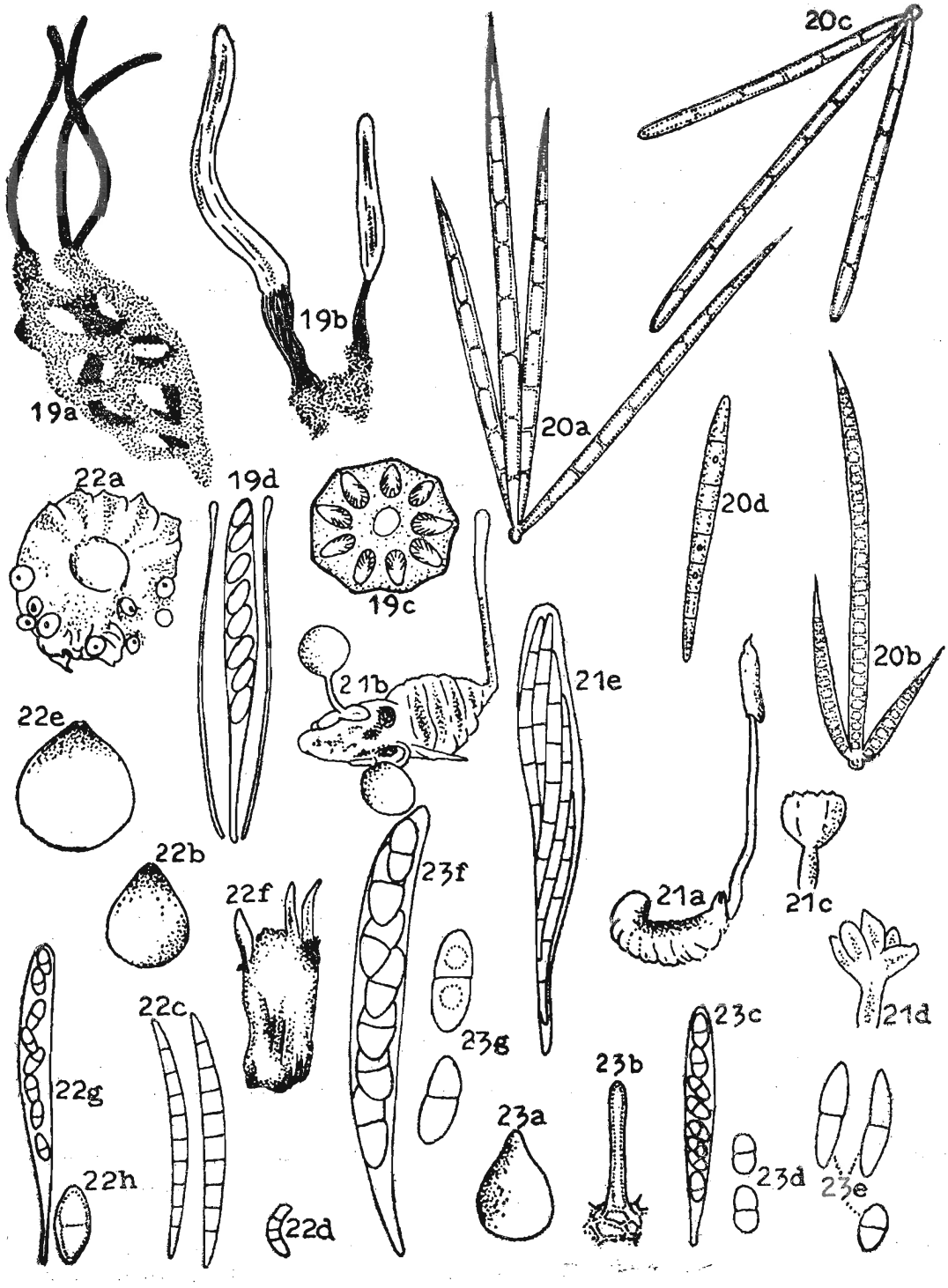


PLATE VIII Figs. 19—23

22. Cordyceps (Fr.) Link (Plate VIII ; Fig. 21)

Nearly all species occur on insects or spiders, except for a few species on the subterranean fungi *Elaphomyces*. Mycelium penetrate the body of the insect and turn it into a sclerotial mass. From this sclerotium, there arises a conidial state which usually consists of a stalked synnema with conidiophore hyphae produced in a head or along the sides of the synnema bearing various conidia. This stalk later expands to form a clavate or globose head within or upon which the perithecia develop. Conidial state in the form-genera *Isaria, Hirsutella, Hymenostilbe, Akanthomyces, Stilbum, Tilachlidium, Insecticola, Synnematium* have been reported. Asci are long cylindric with a thickened apical cap-like wall penetrated by a canal. Ascospores are long cylindric, hyaline, many-septate and fragment into their component cells.

Species occur on all stages of insects, larvae, pupae and mature adults.

9 species recorded.

(1) *C. barnesii* Thwaites ex B. & Br.
On larvae of Cockchafers. .. p : 28

(2) *C. coccinea* Penz. & Sacc.
On larvae of Coleoptera. .. p : 28

(3) *C. dipterigena* B. & Br.
On flies. .. p : 28

(4) *C. falcata* Berk.
On larvae of Coleoptera. .. p : 28

(5) *C. myrmecophila* Cos.
On ants. .. p : 28

(6) *C. pruinosa* Petch
On pupae. .. p : 28

(7) *C. sobolifera* (Hill ex Berk.)
On Cicada nymph. Hakgala. .. p : 28

(8) *C. translucens* Petch
On larvae of Coleoptera. .. p : 28

(9) *C. tuberculata* (Lebert.) Maire
On *Lepidoptera*. .. p : 28

23. Ophiocordyceps Petch.

Stromata similar to those of *Cordyceps*, but asci have fusoid apex with a poorly developed thickened apical cap. Ascospores elongated, fusoid, hyaline, multiseptate, overlapping in the ascus and do not fragment into part spores.

2 species recorded

(1) *O. blattae* (Petch) petch.
On *Blatta germanica* Hakgala. .. p : 31

(2) *O. unilateralis* (Tul.) Petch
On ants, Anuradhapura. .. p : 31

24. Sphaerostilbe Tulsane (Plate VIII ; Fig. 22)

The genus has a wide variety of conidial states connected with its aecigerous states. They include the form-genera *Fusarium, Heliscus, Microcera Acrostalagmus, Cylindrocarpon, Gliocladium, Verticillium, Cephalosporium, Tubercularia, Stilbella, Dendrodochium, Spicaria, Graphium.*

Perithecia occuring in clusters on a small stroma formed beneath the scale insect. The stroma subglobose to pear shaped, often collapsing when dry and then appearing cup shaped, smooth or finely warted, brightly colored, usually with orange or reddish tints, Asci cylindrical 8-spored atleast at first. Ascospores uniseriate, elliptical, 1-septate, hyaline or rarely becoming light brown.

2 species recorded

(1) *S. aurantiicola* (B. & Br.) Petch
On scale insects. .. p : 31

(2) *S. coccidophthora* (Zimm.) Petch
On scale insects. .. p : 31

25. Nectria Fries (Plate VIII ; Fig. 23)

Perithecia distinct, clustered, or scattered, sometimes produced on a fleshy stroma that has previously borne conidia, clear coloured, usually red or orange. Asci cylindric or clavate, 8-spored. Ascospores, hyaline, elongate, 1-septate.

3 species recorded.

(1) *N. barbata* Petch
On *Lepodosaphes* Glenugie. .. p : 30

(2) *N. diploa* Berk & Curt.
On *Fiorinia* & *Lepodosaphes.* .. p : 30

(3) *N. villis* (Syd.) Petch
On *Lepidosaphes.* .. p : 30

26. Litsea Sacc.

Perithecia crowded, superficial globose with a papillate ostiole, 0.2-0.25 mm. high, .15-.18 mm diameter ; appearing black. Asci are cylindric, 8-spored, without paraphyses. Ascospores elliptic, obtuse, 1-septate, not constricted, hyaline or slightly, brownish.

Single species recorded.

L. parlatoriae Zimm.

On *Chionaspis* Peradeniya. .. p : 29

27. Stereocrea Syd.

Stroma erumpent, superficial, composite, clustered like grapes. Perithecia immersed in stroma. Asci 8-spored, aparaphysate. Ascospores elongated, clavate, many-celled, hyaline.

Single species recorded

S. coccophila Petch

On a scale insect. Nuwara Eliya .. p : 31

28. Calonectria de Not. (Plate IX ; Fig. 24)

Conidial states, *Fusarium, Cylindrocladium, Acremonium, Verticillium.* Perithecia superficial borne on a basal stroma, scattered, yellow or red in colour. Ascospores hyaline, or somewhat coloured ellipsoid, fusoid or elongate cylindric, with more than 1 septum.

Single species recorded

C. pruinosa Petch

On a leaf hopper Nuwara Eliya. .. p : 28

29. Ophionectria Sacc. (Plate IX ; Fig. 25)

Perithecia superficial upon flake-like stromata. Asci clavate, shortly pedicillate, thick walled, 8-spores, spores in a parallel bundle. Paraphyses stout, branched, slightly inflated at the apex. Ascospores long cylindrical multisepate.

Single species recorded

O. coccorum Petch

On *Fiorinia juniperi* Peradeniya. .. p : 31

PLATE IX Figs. 24—28

Fig. 24—*Calonectria coccidophaga* : (*a*) perithecium (enlarged) ; (*b*) ascospore (x400.)

Fig. 25—*Ophionectria coccorum* : (*a*) entire conidial stroma (x20) ; (*b*) part of stroma with single sporodochium (x20) ; (*c*) part of stroma, the stalked form (x10) ; (*d*) conidia (x500) ; (*e*) entire perithecial stroma (x20) ; (*f*) repent hyphae (x300) ; (*g*) ascus (x800) ; (*h*) ascospores (x600) : (*i*) setae (x300.)

Fig. 26—*Peziza epispartia* : (*a*) entire apothecium (xl); (*b*) ascus with paraphyses (enlarged.)

Fig. 27—*Septobasidium sp* : (*a*) conidial state ; (*b*) vertical section through a portion of the fungus showing a scale insect and hymenium on the upper surface ; (*c*) section of hymenium showing hypobasidia and fully developed basidia with basidiospores (all enlarged.)

Fig. 28—*Entoloma microcarpum* ; (*a*) entire baisidiocarp (natural size.)

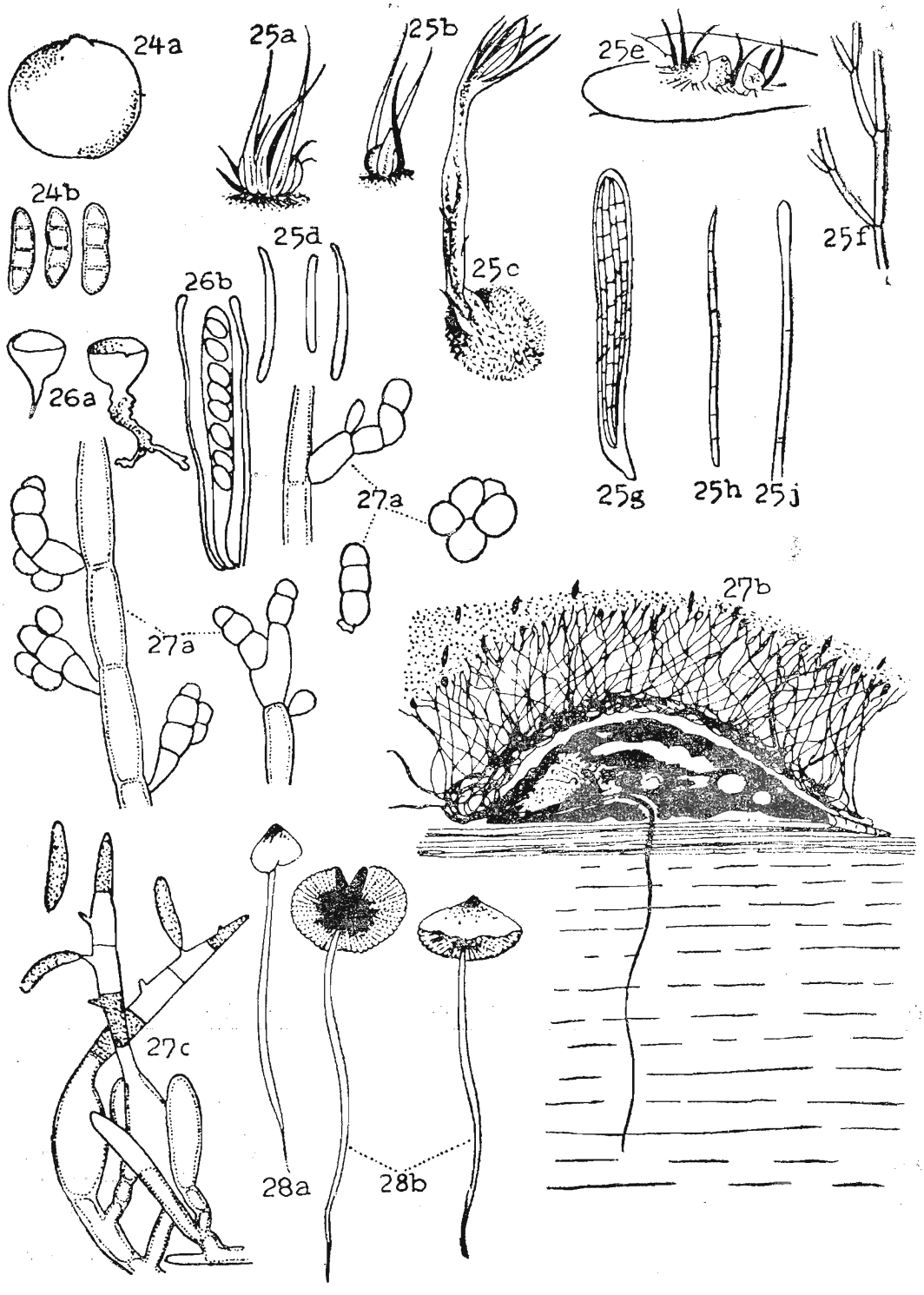


PLATE IX Figs. 24—28

CLASS DISCOMYCETES

Ascocarps of this class bear an open hymenium of paraphyses and asci, fully exposed to the air at maturity and is called an **apothecium**. A typical apothecium is disc or saucer shaped or cup-like, hence the name 'cup fungi'. Apothecia range in size from a few millimeters to a few centimeters in diameter and in colour from pale brown to black and some times red, orange or yellow. The texture is usually fleshy, fragile to tough, and sometimes leathery. They may be sessile or stalked, may be free or seated on a subiculum, on or in a stroma or spring from a sclerotium. The uppermost portion of a mature apothecium is the **hymenium** which consists of asci intermingled with paraphyses. In some species the apices of the paraphyses may branch, and the branches together form a tissue called the **epithecium** In a few others the apices may be merely immersed in a amorphous substance and then referred to as a **pseudoepithecium**. Immediately below the hymenium is a layer of light coloured hyphae running parallel to the surface of the hymenium. This layer may be thin or fairly thick and is referred to as the **hypothecium**. The hypothecium grades into a fairly large basal portion and called the **excipulum** which may be differentiated into a inner **medullary excipulum** and an outer **ectal excipulum**. The outer surface of the excipulum resembles an epidermis. The different layers, of a typical apothecium is illustrated in Plate II e^1, e^2.

In the excipulum, stalk, sclerotium and stroma from which an apothecium may arise, the hyphae become organised into several tissue types; globose cells with intercellular spaces, brick shaped short hyphal cells ; interwoven hyphae with parallel thin walled or thick walled hyphae.

The outside of the apothecium is often ornamented with characteristic hairs especially around the margin. The shape and colour of these hairs are of diagnostic value. The dehiscence of the ascus is also a major feature in distinguishing the orders. Asci cylindrical to clavate, two to many spored, spores of various shapes.

Some of the members of this order have an apothecium modified in various ways, complexity varying from group to group.

A single order treated.

ORDER PEZIZALES

This order is characterised by their fleshy or sometimes brittle to leathery rarely gelatinous apothecium bounded by a more or less definite peridium, more or less globose at first and is later pushed open by the growth of a conical mass of paraphyses giving the mature fruit body it's cup or saucer or almost completely plane shape. Asci are arranged in a distinct hymenium, typically cylindrical to clavate and characteristically open by an apical or subapical lid or operculum and rarely by a vertical apical slit, usually 8-spored but some contain 2-16 or more spored. Ascospores hyaline or brown, typically 1-celled.

Most pezizales are saprobic living on dead wood soil or humus.

A single genus treated.

30. Peziza Dill (Plate IX ; Fig. 26)

Ascophore sessile, but sometimes narrowed to a short stem-like base, fleshy and brittle, closed at first, then expanding until cup shaped, saucer shaped or in some species quite plane or even convex ; disc even, nodulose or veined ; externally warted, scurfy or rarely almost glabrous ; cortical cells irregularly polygonal ; ascus cylindrical 8-spored ; obliquely 1-seriate, elliptical, one celled, hyaline. Paraphyses present.

Single species recorded

P. epispartia B. & Br.
On termite nests. .. p : 20

SUB-DIVISION BASIDIOMYCOTINA

Mycelium well developed, usually richly branched and septate. Many members show the presence of clamp connections. Characteristic spore bearing structure is the basidium, bearing spores exogenously, usually on projections termed sterigmata. Number of spores per basidium is typically four but two-spored basidia are quite common. Some members produce their spores in sori but many others have complex fruit bodies or basidiocarps in which the spores are formed. Basidia may be simple, septate or deeply divided. Basidiospore is typically unicellular, uninucleate, hyaline or pigmented, and of various shapes.

Single class treated.

CLASS HYMENOMYCETES

This is the largest group of Basidiomycetes including the mushrooms, toadstools, jelly fungi, bracket fungi, coral fungi etc. The principal features of this group are (*a*) the basidia are arranged in a hymenium, a characteristic which gives the name to the entire group (*b*) the hymenium is fully exposed from the first or at all events before the spores are mature and (*c*) the basidiospores are actively discharged when mature. The class is subdivided on the basis of the structure of the basidium and the nature of the basidiocarp.

KEY TO THE ORDERS OF THE CLASS HYMENOMYCETES

Basidia septate or forked — TULASNELLALES P : 43

Basidia aseptate — AGARICALES P : 44

ORDER TULASNELLALES

This order includes members which are commonly referred to as the jelly fungi because they develop fructifications, of a jelly like consistency, the jelly substance swelling markedly when wet but the mass collapsing and nearly dissappearing when it is dry giving a dry hornlike consistency. However there are a number of species which form waxy or cartilagenous fructifications. The basidium is divided by transverse or longitudinal septa or of the tuning fork type. The order is further divided into families primarily on the nature of the basidium. The genera associated with insects belong to the family septobasidiaceae which have a transversely septate basidum. The basidium is 4 celled.

KEY TO THE GENERA OF THE ORDER TULASNELLALES

Annual ; basidia not well developed ; fructification grow over individual scale insects. — *Uredinella* (31)

Perennial; basidia well developed ; fructification grow over the colonies of scale insects. — *Septobasidium* (32)

31. Uredinella Couch

Forms minute circular flat patches overgrowing and parasitic on scale insects, colour, chesnut brown toward outer part, greyish near center. In section up to 250μ thick through the insects centre, composed of hymenium and subiculum, the latter made up of completely arranged septate, brownish hyphae. Hymenial cells of two types : one is deep brown thick-walled spherical or pyriform teleutospores and other an elongated somewhat thinner walled brown teleutospores-like structure which gives rise to an allantoid spore. Basidia apparently arising from the spherical or pyriform teleutospore, cylindrical, 4-celled with pointed apical cell. Basidiospores bent elliptic, hyaline smooth.

Single species recorded.

U. spinulosa Couch and Petch apud Couch
With *Aspidiotus* on leaves of *Psychotria* sp. Nuwara Eliya. .. p : 47

32. Septobasidium Pat. (Plate IX ; Fig. 27)

Pileus effuse, coriaceous, not gelatinous. Wall of probasidium thick and whole structure resembles a spore ; the promycelium (basidium) is 4-celled, transversely septate, each cell giving a sterigma producing a basidiospore. Basidiospore 1-celled, oblong and hyaline.

Single species recorded.

S. accumbens (B. & Br.) Bres.
Associated with scale insects. .. p : 45

ORDER AGARICALES

This includes those fungi whose fruit bodies are commonly called the mushrooms and toadstools. The mycelium is perennial in the substratum. The general form of a mature fruit body is umbrella shaped, with a stem the stipe, supporting an expanded upper portion of cap- the pileus. The cap bears on its lower surface, flat radially arranged plates- the gills or lamellae, extending from the margin, of the cap to the stem, like spokes of a wheel. In the boleti there are vertical tubes opening to the exterior by individual pores. The fertile layer which produces the spore is called the hymenium. This covers the face of the gills or lines the tubes (Plate II ; g^1,-g^3)

KEY TO THE GENERA OF THE ORDER AGARICALES

Spore print white	.. *Collybia* (33)
Spore print pink	.. *Entoloma* (34)

33. Collybia (Fr.) Kummer

Pileus fleshy membranous regular margin incurved or involute when young ; stem different in substance from the pileus but confluent with it, hollow central, cartilagenous often with rooting bases (pseudorhizas). Gills soft membranous free or attached to the stem. Spore print white, vary in size from a small coin to 5" across.

Single species recorded

C. albuminosa (Berk.) Petch
Growing from termite nests. .. p : 54

34. Entoloma (Fr.) Kummer (Plate IX ; Fig. 29)

Pileus rather fleshy, margin incurved when young ; stem fleshy or fibrous, central continuous with the flesh of the pileus; gills sinuate, adnexed, often separate from the stem, at first white then usually pink ; spores rosy.

Single species recorded

E. microcarpum (B. & Br.) Sacc.
Associated with termite nests. .. p : 55

SUB-DIVISION DEUTEROMYCOTINA

This is an assemblage of fungi where many reproduce by spores which are formed without nuclear fusion and meiosis-ie no sexual reproduction. Some species of great economic importance occur regularly as sterile mycelia on natural substrate and remain sterile when isolated in culture. This sub-division is not a part of the main taxonomic classification of the fungi. It is a part of an additional special purpose classification in which the imperfect states (sterile states and conidial states) of Ascomycotina Basidiomycotina and sometimes certain Zygomycotina are grouped together. It also includes states whose perfect state is unknown or lacking. The imperfect states are grouped into form-genera and form-species for convenience in identification and nomenclature. The form-species included in a form-genus are related to each other by the form of their conidia and conidiogenous apparatus but not necessarily by phylogeny. The form-genera in this group are not taxa of the same kind as the genera in the main taxonomic classification. In practice however the prefix 'form' is understood but usually omitted. The form genera are grouped into form-families form-orders and form-classes. The classification presented here is that of Saccardo with slight modifications.

KEY TO THE CLASSES OF THE SUBDIVISION DEUTEROMYCOTINA

Reproductive structures borne in pycnidia	....	*Coelomycetes*	(P:62)
Reproductive structures not borne in pycnidia	....	*Hyphomycets*	(P:46)

CLASS — HYPHOMYCETES

This constitute the largest form-class of the Deuteromycotina, including over 10,000 form-species. This class includes fungal pathogens of man, plants, insects and arthropods, many of the industrially important fungi, common contaminants of microbiological laboratories and many soil fungi which are saprophytic, playing a significant part in the soil economy. Conidiophores may be simple or branched ; in form they may or may not be greatly different from somatic hyphae. The coniditiophores may be annelophores (Plate X Fig. c^{11}) sympodulae (PlateX Fig. c^{13}) or phialides (Plate X Fig. c^{10}). The spores can be thallospores or conidia. The conidiophores may be discrete and simple arising free from the mycelium or sometimes grouped into compound sporophores called synnema (Plate XIV, Fig. 51*a*) or a sporodochium (Plate XIV Fig. 52*a*). Conidia are of various shapes, sizes, septation, and walls smooth or ornamented (Plate X).

Single order treated.

ORDER — MONILIALES

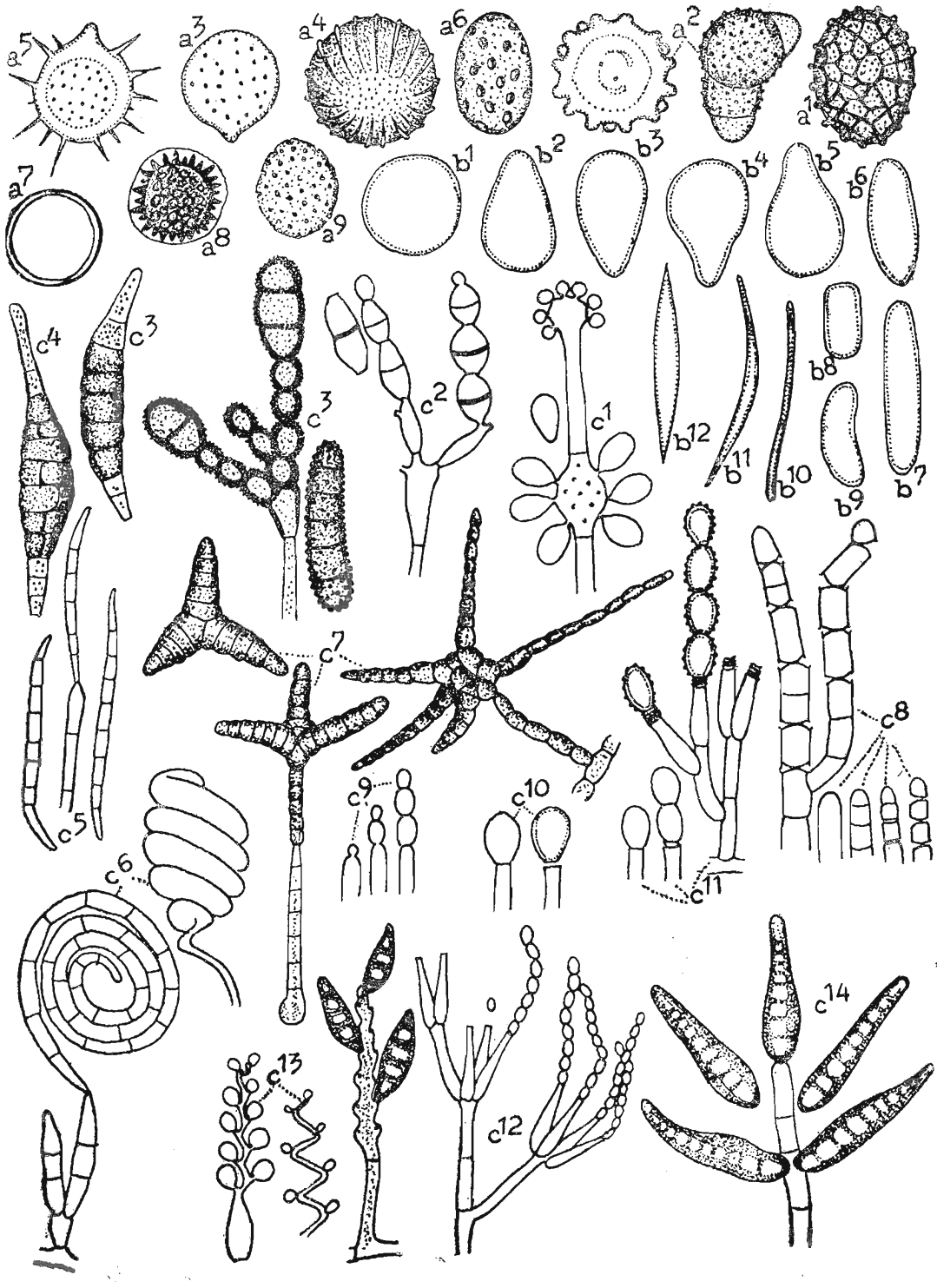
Characters are those of the form-class Hyphomycetes.

PLATE X

a^1—a^9 Spore ornamentation (a^1) reticulate ; (a^2) verrucose ; (a^1— punctate ; (a^3) striate ; (a^4) echinulate ; (a^5) alveolate ; (a^6) smooth ; (a^7) aculate ; (a^8) pitted.

b^1—b^2 spore shapes ; (b^1) spherical ; (b^2) ovate ; (b^3) obovate ; (b^4) pyriform ; (b^5) obpyriform ; (b^6) ellipsoid ; (b^7) cylindrical ; (b^8) oblong; (b^9) allantoid; (b^{10}) filiform (b^{11}) falacate , (b^{12}) fusoid or fusiform,

c^1—c^{14} spore types ; (c^1) amerospore ; (c^2) didymospore ; (c^3) phragmospore ; (c^4) dictyospore ; (c^5) scolecospore; (c^6) helicospore; (c^7) staurospore; (c^8) arthrospore; (c^9) blastospore (c^{10}) aleurospore; (c^{11}) annellospore : (c^{12}) phialospore ; (c^{13}) sympodulospore ; (c^{14}) porospore.


a5
a3
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a2
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a8
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b1
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c2
c1
b12
b11
b10
b8
b9
b7
c7
c5
c9
c10
c8
c6
c11
c13
c12
c14

PLATE X

KEY TO THE GENERA OF THE ORDER MONILIALES

1. Conidiophores compacted into sporodochia or synnemata 17
   Conidiophores not as above 2

2. Both conidia and coinidiophores hyaline or brightly colored (Moniliaceae) .. 3
   Either conidia or conidiophores or both with distinct dark pigment (Dermatiaceae) 16

3. Conidia typically 1—celled 4
   Conidia typically more than 1—celled 14

4. Conidiophores simple or sparingly branched ; phialides if present not tightly clustered 5
   Conidiophores mostly branched ; phialides if present in groups or in heads 8

5. Conidia catenulate 6
   Conidia not catenulate 7

6. Conidiophores inflated immediately below each septum .. .. *Gonatourdiella* (35)
   Conidiophores not as above .. .. .. *Oospora* (36)

7. Phialides aggregated into false heads .. .. .. *Cephalosporium* (37)
   Phialides lateral at a node or scattered .. .. .. *Acremonium* (38)

8. Conidia catenulate 9
   Conidia not catenulate 12

9. Phialides in heads on simple conidiophores .. .. *Aspergillus* (39)
   Phialides not in heads, conidiophores usually branched 10

10. Conidiophores grouped into loose layer or column .. .. *Metarhizium* (40)
    Conidiophores not in layer or column 11

11. Conidia phialospores .. .. *Spicaria* (41)
    Conidia annelospores .. .. *Scopulariopsis* (42)

12. Conidia produced at or near apex of phialides or branches of conidiophores .. *Verticillium* (43)
    Conidia attached both at apex and side of condiophore and its branches .. 13

13. Fertile portion of conidiophore zig-zag, rachis-like .. .. *Beauveria* (44)
    Not as above .. .. *Rhinotrichum* (45)

14. Conidia typically 2—celled .. .. .. *Cladobotryum* 46)
    Conidia typically more than 2—celled 15

15. Conidia of two types, larger one sickle shaped .. *Fusarium* (47)
    Conidia of one type, not sickle shaped .. .. .. *Blastotrichum* (48)

16. Conidia 1—celled (amerospores) .. .. .. *Aspergillus* (39)
    Conidia more than 1-celled .. .. .. *Periconia* (49)

17. Conidiophores united into sporodochia (Tuberculariaceae) .. 18
    Conidiophores united into synnemata (Stilbaceae) 21

18. Conidia 1—celled 19
    Conidia more than 1—celled 20

19.	Conidia hyaline or brightly colored	*Volutella* (50)
	Conidia with distinct dark pigment	*Aegerita* (51)
20.	Conidia of two types	*Fusarium* (47)
	Conidia of one type only	*Patoullardiella* (52)
21.	Parasitic on insects or spiders	22
	Not parasitic on insects or spiders	25
22.	Phialides in globose or wedge shaped heads	*Gibbelula* (53)
	Phialides not in heads	23
23.	Phialides short, in compact layer	*Hymenostilbe* (54)
	Phialides not in compact layer	24
24.	Phialides elongated, slender ; conidia covered with mucus	*Hirsutella* (55)
	Phialides not elongated ; conidia dry	*Isaria* (56)
25.	Conidia in terminal heads	26
	Conidia not confined to terminal heads	*Isaria* (56)
26.	Conidia dry	*Coremium* (57)
	Conidia in gelatinous mass	*Stilbum* (58)

35. **Gonatorrhodiella** Thaxt. (Plate XI ; Fig. 29)

Conidiophores up to .2 mm high, simple sometimes branched near the base, sub-erect, lax, hyaline, septate, inflated immediately below each septum, terminating in an ovato-conoid or lanceolate segment. Conidia in chains arising from slight protruberence or cylindrical sterigmata up to 1.5μ high situated in whorls below septum and scattered over the terminal segment and along the conidiophores. Conidia hyaline, white in mass, 1-celled, ovoid or globose or ellipsoid.

Single species recorded

G. coccorum Petch

On *Lecanium Aleyrodes*, aphids and leaf-hoppers p : 75

PLATE XI Figs. 29-34

Fig. 29 —*Gonatourdiella* : (*a*) conidiophore and conidia (enlarged) ; (*b*) apex of a branch of a conidiophore showing sterigmata, (enlarged).

Fig. 30 —*Oospora insectorum* : (*a*) lateral conidiophore (x1000) ; (*b*) terminal conidiophore (x1000) ; (*c*) conidium (1000).

Fig. 31 —*Cephalosporium lecanii* : (*a*) heads of conidia in outline (enlarged) ; (*b*) simple conidiophores (enlarged) ; (*c*) head of conidia (enlarged) ; (*d*) conidia (much enlarged) ; (*e*) different types of branched conidiophores (enlarged) ; (*f*) upper part of conidiophores from culture (enlarged); (*g*) vegetative hyphae from culture (enlarge) ; (*h*) abnormal mycelium and conidiophores (enlarged) ; (*l*) *C. indicum*, conidiophores (x 650); (*m*) *c. indicum* abnormal conidiophore from culture (x650).

Fig. 32 —*Acremonium* (*a—b*) *A. griseum*, (*a*) simple conidiophore (enlarged) ; (*b*) branched conidiophore from a tuft (x1000) ; (c—*e*) *A. aranearum* (*c*) hyphae bearing turgid and collapsed phialide enlarged) ; (*d*) phialide at a node (enlarged) ; (*e*) two phialides on a globose prophialide (x1000).

Fig. 33 —*Aspergillus depauperatus* : (*a*) conidiophore with developing conidia (enlarged) ; (*b*) conidiophore with chains of conidia (x1000).

Fig. 34 —*Metarhizium anisopliae* : (*a*) sporulating fungus on an insect larva (natural size) ; (*b—e*) conidiophores of different types with conidia (enlarged).

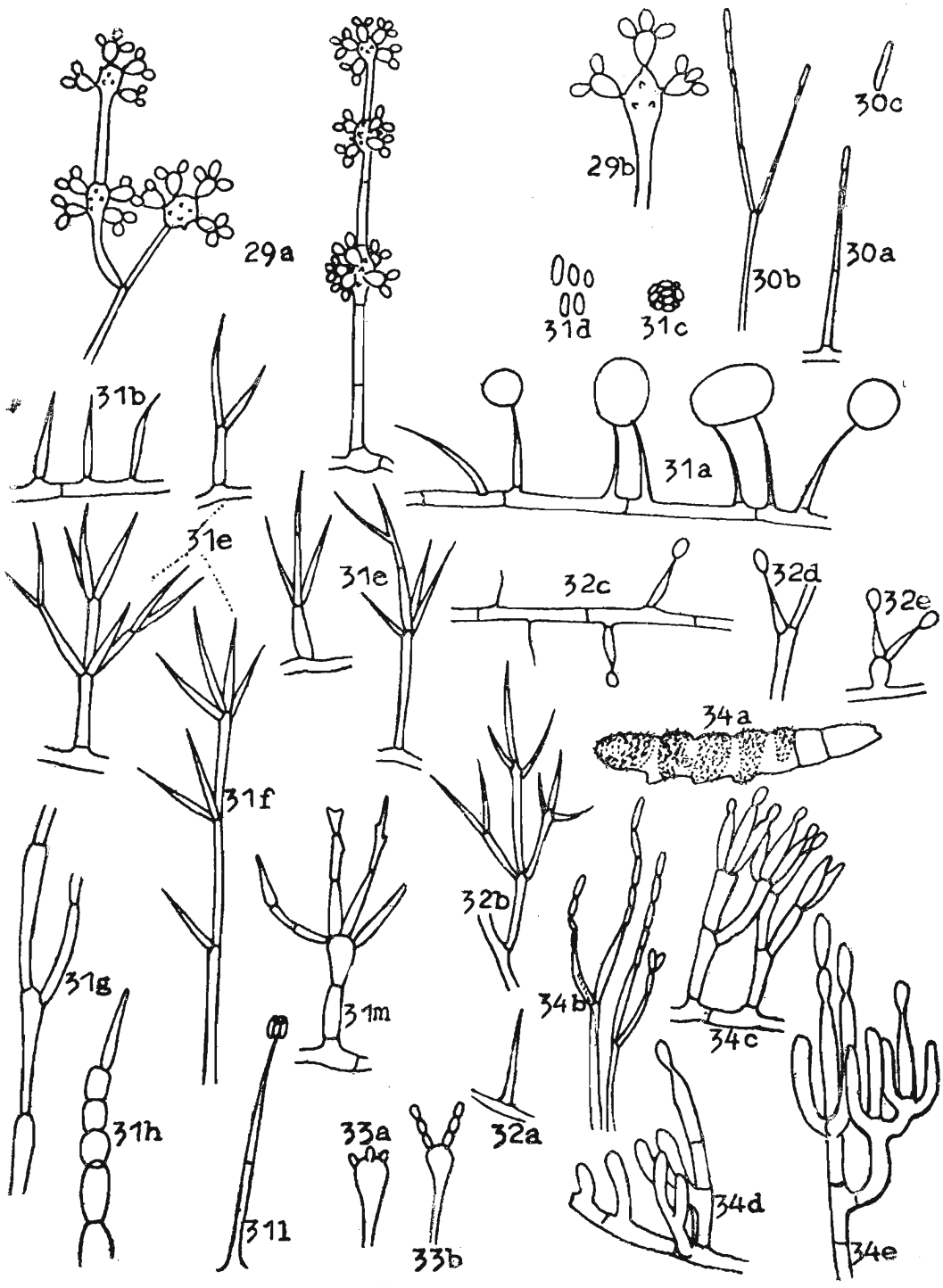

PLATE XI Figs. 29—34

36. Oospora Wallr. (Plate XI ; Fig. 30)

Tufts delicate, effused or pulvinate, lax or rather compact ; fertile hyphae short, slender, simple or sparingly branched. Conidia in chains, globose or elliptic hyaline or clear colored.

This genus is considered a nomen illegitimum by Hughes.

Two species recorded

(1) *O. insectorum* Petch
On insects and spiders. Nuwara Eliya. .. p : 76

(2) *O. subfaciculata* Petch
On a millipede and a pupa. .. p : 76

37. Cephalosporium Corda (Plate XI ; Fig. 31)
Tilachlidium Preuss (Ainsworth 1978)

Conidiophore and phialides slender, mostly simple ; conidia (phialospores) hyaline, 1-celled, collecting in a slime drop. Certain species of *Fusarium* are similar and may be confused.

4 species recorded.

(1) *C. aranearum* Petch
On spiders. Nuwara Eliya. .. p : 72

(2) *C. falcatum* Petch
On a fly. .. p : 72

(3) *C. indicum* Petch
On larva of *Chilo simplex, Kandy.* .. p : 72

(4) *C. zeylanicum* Petch
On a leaf hopper, Nuwara Eliya. .. p : 72

One more species described under the Genus *Tilachlidium.*

(5) *T. larvarum* Petch
On larvae of a micro-lepidopteron Nuwara Eliya. p : 79

38. Acremonium Link ex Fr. (Plate XI ; Fig. 32)

Mycelium cover spider with a white loose more or less pulvinate mass. The mycelium bears phialides laterally, either at a node or scattered along the hyphae, sometimes only 2μ apart. These phialides are elongated flask shaped or conoid, with an obtuse apex or oval with a fine short sterigma, solitary or they may arise in pairs from an oval prophialide. Such phialides bear a single oval conidium and after the abscission of the conidium it collapses into a very fine thread, arising from the scar of attachment. Conidia hyaline, 1-celled, apical solitary and oval.

2 species recorded.

(1) *A. aranearum* Petch
On spiders. Nuwara Eliya. .. p : 72

(2) *A. griseum* Petch
On spiders, rarely on insects. .. p : 72

39. Aspergillus Mich & Fries (Plate XI ; Fig. 33)

Vegetative mycelium composed of septate, branching hyphae, colourless or brightly coloured. Conidiophore septate or non-septate, usually becoming broader above and terminating in a vesicle. Phialides usually present on the vesicle. Conidia cut off successively from the tips of phialides by septa and forming unbranched chains. Conidia 1-celled variable in shape size and colour, smooth or with markings on the cell wall.

Single species recorded.

A. depauperatus Petch.
On *Aspidiotus* Nuwara Eliya .. p : 72

40. Metarhizium Sorok (Plate XI; Fig. 34)

Conidiophores forming a sporulating layer ; hyaline, short, erect, simple or branched terminating in phialides ; phialides single, in pairs or in whorls ; conidia (phialospores) produced in basipetal chains, compacted into columns, long ovoid to cylindrical, 1-celled, hyaline or slightly pigmented, olive-green in mass.

2 species recorded.

(1) *M. album* Petch
On a leaf-hopper on rice. .. p : 76

(2) *M. anisopliae* (Metsch.) Sorokin
On insects and insect larvae. .. p : 76

41. Spicaria Harting (Plate XII ; Fig. 35)

Sterile hyphae creeping, branched, septate, fertile hyphae erect, septate, repeatedly verticillately, branched toward the apex, ultimate branchlets each bearing a diverging chain of elliptic or oblong pale or colourless 1-celled conidia. The genus is much like *Penicillium* but the spore bearing apparatus is less compact and the phialides are more spreading.

5 species recorded.

(1) *S. clavulifera* Petch
On a spider. Nuwara Eliya. .. p : 78

(2) *S. javanica* Bally
On insects. .. p : 78

(3) *S. prasina* (Maubl.) Saw
On insects. .. p : 78

(4) *S. velutiformis* Petch
On spiders. .. p : 78

(5) *S. violacea* Petch
On a Tineid case Nuwara Eliya. .. p : 75

PLATE XII Figs. 35—41

Fig. 35 —(*a*—*c*) *Spicaria clavulifera* : (*a*) terminal cluster of conidiophores (enlarged) ; (*b*) lateral cluster of conidiophores (enlarged) ; (*c*) phialides (enlarged) : (*d*) *S. violacea* lateral cluster (enlarged) ; *e*) *S. gracilis* developing conidiophore (enlarged) ; (*g*—*j*) *S. prasina* (*g*) conidiophores (enlarged); (*h*) whorls of phialide and conidia (enlarged) ; (*h*) whorls of phialide and conidia (enlarged) ; (*j*) conidia in chains (x500) ; (*k*) *s. farinosa* from coremia on naturally infected insects (1).

Fig. 36 —*Scopulariopsis* : (*a*) portion of conidiophore bearing conidia in chains (enlarged) ; (*b*) tips of conidiophores showing annellations (enlarged) ; (*c*) conidia (enlarged).

Fig. 37 —*Verticillium lecanii* : See fig 31 ; *V. hemipterigena* : (*a*) conidiophore (enlarged) ; (*b*) phialide with conidia (enlarged) ; (*c*) conidium (enlarged).

Fig. 38 —*Beauveria laxa* : (*a*) developing phialide (enlarged) ; (*b*) phialides and a chain of conidia (x1000) ; (*c*—*d*) *B. bassiana* ; (*c*) conidiophore from a slide culture (enlarged) (*d*) single conidiophore (much enlarged).

Fig. 39 —*Rhinotrichum* : (*a*) mycelium (*b*) conidiophore enlarged ((*c*) conidia (enlarged).

Fig. 40 —*Cladobotryum ovulisporum* : (*a*) conidiophore (x100) (*b*) phialide (much enlarged) ; (*c*) phialide and conidia (much enlarged) ; (*d*) phialide with branched sterigmata (enlarged).

Fig. 41 —*Fusarium larvarum* : (*a*) conidiophores (enlarged) ; (*b*) conidia (enlarged); (*c*) conidiophores with micro-and macroconidia attached (enlarged) ; (*d*) macroconidia (enlarged) ; (*e*) microconidia (enlarged).

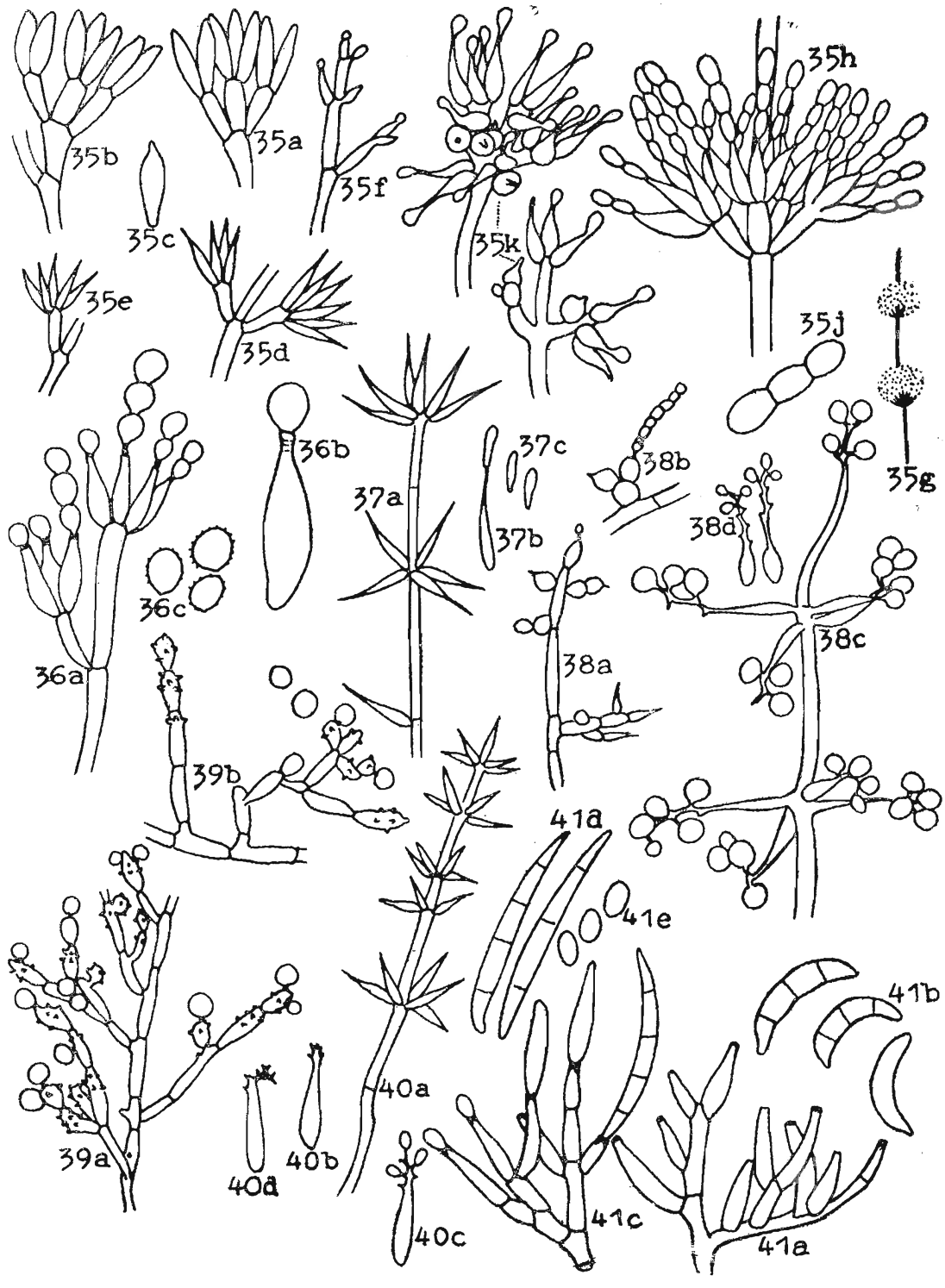

PLATE XII Figs. 35—41

42. Scopulariopsis Bainier (Plate XII ; Fig. 36)

Colonies white to brownish yellow to deep brown, greyish-brown or nearly black, never green, with aerial hyphae at least in part in creeping or anastomosing ropes. Conidiophores short usually produced on the funiculose hyphae. Conidial apparatus variable, somewhat as in *Penicillium* or consisting of varying and irregular groups of branches and annellophores, at times single, scattered on the aerial hyphae. Annellophore phialide-like in shape, tapering gradually from a basal tubular part to a conidium-bearing apex, or narrowly tubular without tapering, cutting off conidia from the apex by cross walls. Conidia rounded or pointed at apex, truncate at base, with a more or less thickened basal ring surrounding a basal germ pore, with walls usually thickened and often variously marked or roughened, often coloured but not green, forming simple chains.

Raper and Thom separate the genus from *Penicillium* on the basis of the colour of the colony which is never green in the former. The 2 genera can be distinguished by annellophores typical of *Scopulariopsis* but not seen in *Penicillium.*

Single species recorded

S. brevicaulis (Sacc.) Bain
On dead insects. .. p : 78

43. Verticillium Nees ex Wall (Plate XII ; Fig. 37)

Mycelium composed of creeping septate branching hyphae hyaline or lightly coloured. Conidiophores erect, septate, simple or branched. Branches of the first order whorled, opposite or alternate ; branches of the second order whorled, dichotomous or trichotomous on the branches of the first order. Terminal elements on main stalk and branch phialides. Phialides flask shaped, somewhat elongate, narrowed toward the apex. Conidia produced singly from the tips of phialides, often held together in slime to form false heads, globose, elliptical, oval, inverted egg-shaped, short fusiform, hyaline or slightly coloured.

3 species recorded

(1) *V. hemipterigenum* Petch
State of *Torrubiella hemipterigena.* .. p : 79

(2) *V. larvarum* Petch
On leipdopterous larvae, Nuwara Eliya. .. p : 79

(3) *V. lecanii*

=*Cephalosporium aphidicola*

=*Cephalosporium longisporum*

=*Cephalosporium thripidum*

=*Cephalosporium lecanii*

On Thrips, *Icerya* sp, and aphids ; *Lecanium.* p : 72

44. Beauveria Vuill...(Plate XII ; Fig. 38)

Mycelium white or slightly coloured with a white fluffy to powdery appearance. Conidiophores simple or branched, single irregularly grouped or in verticillate clusters, oblong, cylindrical or flask shaped, varying in length, bearing laterally or at extremity, vesicles giving rise to sporogenous cells; sporogenous cells generally globose sometimes cylindrical, flask like, curved or straight. Spore borne at thread-like apex of sporogenous cells on a series of branchlets arranged in a zig-zag line more of less comparable to a scorpioid or helicoid dichotomous cyme. Conidia (sympodulospores) hyaline, rounded to ovoid, 1 - celled, dry, borne singly.

3 Species recorded

(1) *B. bassiana* (Bals.) Vuill
On insects. .. p : 72

(2) *B. densa* (Link. (non. Fr.)) Picard.
On insects. .. p : 72

(3) *B. laxa* Petch
On insects and spiders. .. p : 72

45. Rhinotrichum Corda (Plate XII ; Fig. 39)

Mycelium often forming a loose or dense substratam ; conidiophores erect or suberect, simple or branched ; spore bearing cells sometimes enlarged ; conidia (blastospore) 1-celled, globose to ovoid, hyaline or slightly coloured, borne on tooth-like sterigmata.

Single species recorded

R. parvisporum Petch
On *Aspidiotus* and *Lecanium*, Dowalekande. .. p : 77

46. Cladobotryum Corda (Plate XII ; Fig. 40)

Conidiophores erect, rigid, hyaline, scattered or sometimes clustered in small white tufts, often arising from aerial mycelium, branching irregularly or verticillately and repeatedly, terminating in groups of phialides which taper toward the apex. Conidia (phialospores) borne on phialides which are narrow flask-shaped and bear minute cylindrical sterigmata ; apex sometimes slightly inflated. Conidia hyaline, mostly 2-celled (sometimes more) ovoid to oblong, held together in irregular or tangled chains.

Single species recorded

C. ovalisporum Petch
On a frog-hopper. Nuwara Eliya. .. p : 73

47. Fusarium Link ex Fries (Plate XII ; Fig. 41)
= *Microcera* (Ainsworth, 1971)

Mycelium composed of hyaline septate branched hyphae. Conidial masses typically formed in sporodochia or in pinnotes or sometimes scattered in the mycelium. Conidiophores simple or branched once or repeatedly, terminating in phialides which are some-

times formed verticillately, hyaline, septate. Phialides variable in size and shape, but mostly subulate. Conidia of two kinds: micro and macro. Microconidia usually 1-celled, variable in shape, hyaline, either produced singly at tips of phialides or else abstricted in succession at the tips of phialides to form simple chains. Macroconidia usually 3-many septate, fusiform to falcate dorsiventral, straight or curved variously, often with a distinct pedicillate base with the apical part obtuse to broadly rounded to caudate or acuminate, produced singly at the tips of phialides. Chlamydospores usually present, globose, ovoid or pear shaped, 1-2 celled or in chains or sometimes in clusters terminal or intercalary, brownish in colour or becoming tinged with the colour of the stroma. Sclerotia spherical, solid, occuring singly or in groups or absent. Sclerotial stromata occuring in many groups, erumpent, hemispherical smooth or round and cauliflower like, or erect stilboid, sometimes with antler like branching, sessile or stalked. Conidial masses pale or brightly coloured (orange, salmon or ochre).

Single species recorded.

(1) *F. entomophilum* Petch
On *Clittelaria heminopla.* .. p : 74

2 more species described under the Genus *Microcera.*

(2) *M. aurantiicola* Petch .. p : 76
—*Fusarium larvarum* Booth 1959
On scale insects.

(3) *M. coccidophthora* Petch
On scale insects. .. p : 76

PLATE XIII Fig. 42—50

Fig. 42 — *Blastotrichum aranearum*: (*a*) lax conidiophore from the bodies of spider (enlarged); (*b*) rigid conidiophore showing conidia in different stages of development (x100) .

Fig. 43 —*Periconia* sp : (*a*) conidiophore and conidia (much enlarged) ; (*b*) conidia (much enlarged).

Fig. 44 —*Volutella epicoccum* : (*a*) simple stroma (x20) (*b*) stalked stroma (x20 (*c*) conidiophores and setae (x500) (*d*) conidia (x 500).

Fig. 45 —*Aegerita webberi* : (*a*) section through a stroma (enlarged) (*b*) sporodochium showing sterile hyphae and conidium like cells (enlarged).

Fig. 46 —*Gibellula* : (*a*) portion of synnema showing conidia and conidiophores (enlarged) ; (*b*) single conidiphores (enlarged) (*b*) single conidiophore and conidial head (enlarged) (*c*) portion of conidial head teased to show arrangement of phialides (enlarged).

Fig. 47 —*Hymenostilbe* : (*a*) conidiophore and phialide (enlarged) (*b*) conidia, (enlarged).

Fig. 48 —*Hirsutella* : (*a*) portion of synnema (enlarged) ; (*b*) a portion showing phialides (enlarged) ; Phialides —(enlarged) ; (*d*) conidia (enlarged).

Fig. 49 —*Isaria* : (*a*) synnema (enlarged) ; (*b*) apical portion of synnema (much enlarged) (*c*) conidiophores (much enlarged) (*d*) conidia (enlarged).

Fig. 50 —*Stilbum* : (*a*) synnema showing spores in head of slime ; (*b*) portion of synnema (enlarged) ; (*c*) single conidiophore (enlarged); (*d*) phialides (much enlarged;) (*e*) conidia (much enlarged).

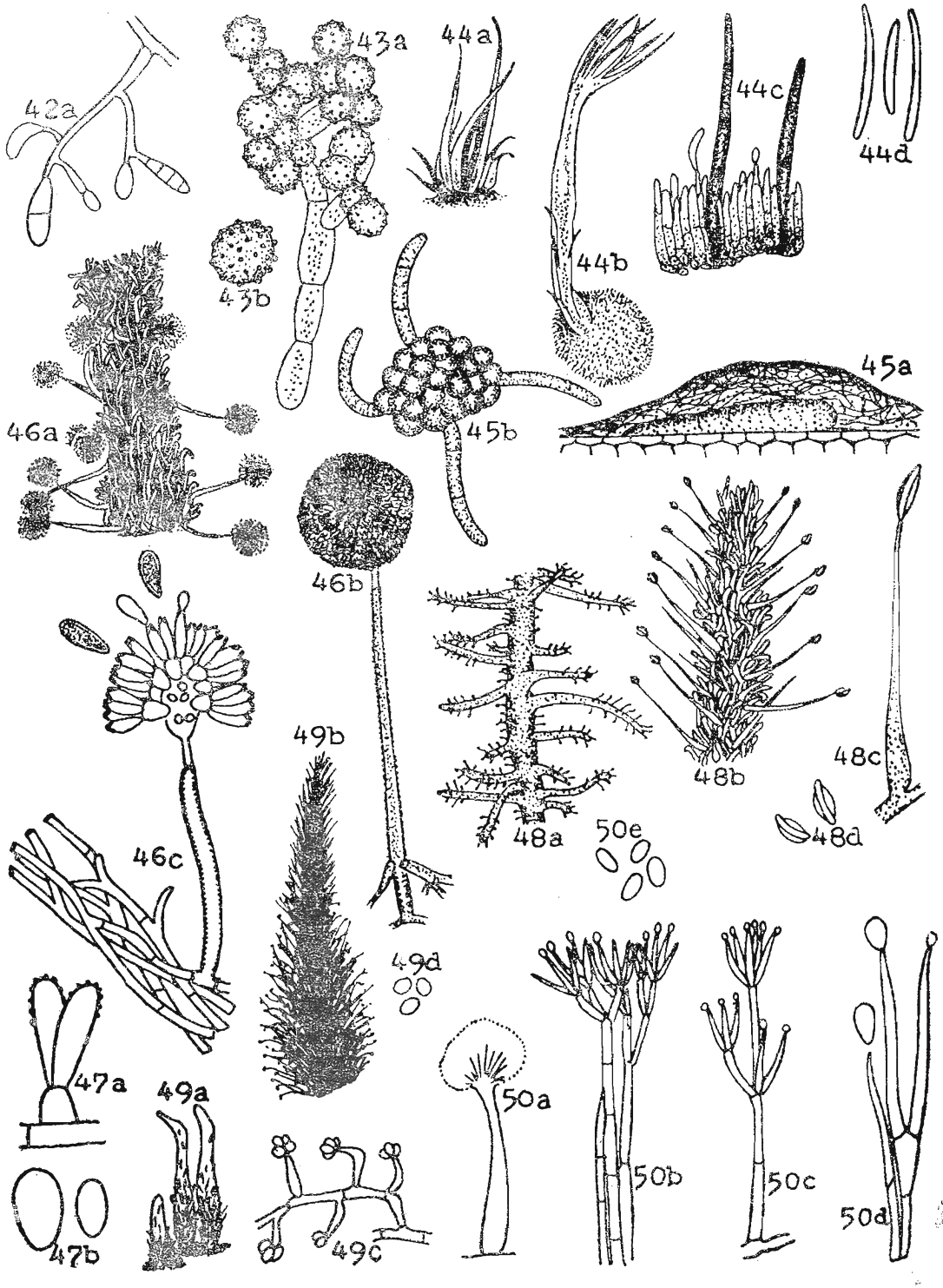

PLATE XIII Figs. 42—50

48. Blastotrichum Corda (Plate XIII ; Fig. 42)

Hyphae hyaline, creeping or ascending, branched, reticulate. Conidia hyaline, fusoid or ovate-oblong, 2-many septate, produced singly at the tips of the branches.

Single species recorded.

B. aranearum Petch
On spiders. Nuwara Eliya .. p : 72

49. Periconia Tode ex Schw. (Plate XIII ; Fig. 43)
= *Sporocybe* (Ainsworth, 1971.)

Conidiophores pale to dark brown, tall, erect or ascending, somewhat enlarged at apex which bears a loose head of conidia. Conidia (blastospores) dark, 1-celled, typically in chains or occasionally single, globose, nearly always rough-walled, produced on sporgenous cells borne directly on the stipe or its branches; conidial chains often branched, developing in acropetalous succession but usually maturing from the apex downward. In some species conidia may be some what fusiform.

Single species described under the Genus *Sporocybe*

S. favicola Petch
On the comb of bees. Hakgala. .. p : 78

50. Volutella Tode (Plate XIII ; Fig. 44)

Sporodochia discoid, with marginal dark setae ; conidiophores usually simple in a compact palisade ; conidia hyaline, 1-celled, ovoid to oblong.

Single species recorded

V. epicoccum Petch
A state of *Ophionectria coccorum*
On scale insects. .. p : 79

51. Aegerita Pers. (Plate XIII ; Fig. 45)

Sporodochia superficial, not at first immersed, nearly spherical, sessile, very short, measly and powdery composed of clusters or radiating hyphae bound together through anastomoses and terminating in conidiophores. Conidiophores hyaline or bright, mostly composed of swollen cells, simple, or branched. Conidia borne on the terminal cells of the conidiophore and its branches, more or less globose, rather large, not easily shed, persistent, spherical, 1-celled.

Single species recorded.

A. webberi Fawcett
On *Aleyrodes*. .. p : 72

52. Patouillardiella Speg.

Sporodochia oval, flattened pulvinate, orange, central mass of conidia slightly darker, waxy, towards the edge radiately floccose with a fimbriate margin. Conidiophores short, stout, once or twice branched, segments slightly inflated. Conidia hyaline, cylindric, ends rounded, 1-septate.

Single species recorded.

P. aleyrodis Petch
On an Aleyrodid, Gikiyankande .. p : 77

53. Gibellula Cav. (Plate XIII ; Fig. 46)

Synnemata light to brown cylindrical, composed of loose, longitudinal hyphae. Conidiophores brownish, terminal cell or cells hyaline, apex enlarged, bearing prophialides and phialides which compose a globose or broadly wedge shaped head. Conidia fusoid to ellipsoid, produced successively singly or in short chains. This contains the conidial stages of *Torrubiella.*

2 species recorded.

(1) *G. alata* Petch
On spiders. Nuwara Eliya .. p : 75

(2) *G. aranearum* (Schw.) Syd.
On spiders .. p : 75

54. Hymenostilbe Petch (Plate XIII ; Fig. 47)

Synnemata nearly cylindrical composed of longitudinal, closely compacted hyphae. Phialides in a layer covering the synnema, produced on short lateral branches, sub-cylindric to clavate, obtuse or narrowed on short sterigmata. Conidia hyaline 1-celled smooth borne singly.

2 species recorded.

(1) *H. aranearum* Petch.
On spiders. Nuwara Eliya .. p : 75

(2) *H. dipterigena* Petch.
On flies
state of *Cordyceps dipterigena* .. p : 75

55. Hirsutella Pat. (Plate XIII ; Fig. 48)

Synnemata cylindric to filiform terete, usually somewhat attenuated upward, simple or branched, consisting of a compact bundle of more or less parallel, longitudinal, septate hyphae. Spore bearing structures scattered to crowded over most of the synnema, mostly arising as lateral cells or buds or terminating short lateral branches along the outer hyphae of the synnema, a few developing as terminal cells of the hyphae of the synnema, occasionally developing on hyphae from the mycelial covering of the host, hyaline inflated below, abruptly or gradually narrowing into long slender sterigmata. Conidia oblong, sub-cylindric, fusoid to cymbiform, 1-celled, hyaline, covered by persistent mucus singly or 2-several, occuring in droplets.

8 species recorded.

(1) *H. arachnophila* (Petch) Petch
On spiders. Peradeniya .. p : 75

(2) *H. citriformis* Spears
On a Pentatomid. Hakgala .. p : 75

(3) *H. clavispora* (Petch) Petch
On caterpillars. State of *Cordyceps tuberculata* .. p : 75

(4) *H. formicarum* Petch
On ants. State of *Ophiocordyceps unilateralis* .. p : 75

(5) *H. nodulosa* Petch
On caterpillars of *Zeuzeran coffeae* .. p : 75

(6) *H. saussurei* (Cooke) Speare.
On *Vespa cincta* .. p : 75

(7) *H. strigosa* Petch
On a leaf-hopper. Nuwara Eliya .. p : 75

(8) *H. versicolor* Petch
On leaf-hoppers. State of *Calonectria pruinosa* .. p : 75

56. Isaria Pers ex Fries (Plate XIII ; Fig. 49)

Synnemata erect, simple or sometimes branched, often imbricated, clavate, composed of loosely compacted hyphae, the tips of which become free along the length of the synnema and bear conidia. Conidia small, 1-celled, globose or elliptical, hyaline.

5 species recorded.

(1) *I. cicadae* Miquel
On cicada pupae. Hakgala
State of *Cordyceps sobolifera* .. p : 76

(2) *I. farinosa* Fr.
On lepidopterous pupae, *Lecanium*, spiders etc. .. p : 76

(3) *I. japonica* Yasuda
On Lepidoptera, Hakgala .. p : 76

(4) *I. orthopterorum* Petch
On Orthoptera .. p : 76

(5) *I. sphaerocephala* Petch
On larvae of Lepidoptera .. p : 76

57. Coremium Link

Mycelium white or variously coloured, synnemata arising from the margin of the scale or from mycelium on its surface. Conidiophores simple or branched, bearing dense whorls of phialides ; phialides flask shaped. Conidia catenulate, hyaline 1-celled.

Single species recorded

C. pulcherrimum Petch
On *Lecanium nigrum*, Peradeniya .. p : 74

58. Stilbum Tode ex Fr. (Plate XIII ; Fig. 50)

Synnemata with a stalk and a head, white or bright coloured ; stalk composed of parallel closely compacted hyphae, becoming free above. Conidiophores slender verticillately branched. Conidia produced singly at the tips of the conidiophores, 1-celled, slimy, forming a gelatinous mass at the tip of the stalk, hyaline sometimes bright coloured in mass.

Single species recorded.

S. coccorum Petch
On *Fiorinia juniperi* Peradeniya .. p : 78

CLASS COELOMYCETES

This includes those fungi which bear the spores in fructification called acervuli or in pycnidia. An acervulus (Fig. 54) is a compound sporophore composed of a basal stromatic layer and short erect conidiophores arranged in a palisade, the whole forming a flat bed covered at first by host tissues and later becoming exposed by their rupture. A pycnidium (Fig. 53) is a globose or a flask shaped structure with a pseudo-parenchymatous peridium, lined on the inside by tissues giving rise to simple or branched conidiophores. Pycnidia may be closed, rupturing at maturity irregularly or they may be ostiolate. In general the type of fructification is more constant in nature than in culture.

Single order treated.

ORDER SPHAEROPSIDALES

The order consists of parasites or saprobes. Pycnidia superficial, semi-immersed, or immersed ; globose discoid or hemispherical ; eustromatic or pseudostromatic ; unilocular, multilocular or convoluted ; dehiscing by a circular or longitudinal cuticle or by disintegration of the upper walls. The conidia usually have a somewhat mucilagenous coating and tend to adhere to one another and to be extruded in long sticky tendrils from the ostiole.

KEY TO THE GENERA OF THE ORDER SPHAEROPSIDALES

1.	Pycnidia ostiolate	—	2	
	Pycnidia not ostiolate	—	3	
2.	Rigid setae present	—	*Pyrenochata*	(59)
	Setae absent	—	*Eriothyrium*	(60)
3.	Pycnidia bright colour	—	*Aschersonia*	(61)
	Pycnidia brown to black	—	*Murucularia*	(62)

PLATE XIV Figs. 51—53

Fig. 51 —(*a*) synnema ; (*b*) synnema (enlarged).
Fig. 52 —(*a*) sporodochium ; (*b*) sporodochium (enlarged); (*c*) loose sporodochium (much enlarged).
Fig. 53 —(*a*) globose ostiolate pycnidium (enlarged) ; (*b*) pycnidium with a long neck (enlarged) ; (*c*) section through a pycnidium showing parenchymatous wall, peripherally arranged conidiophores, and ostiole (enlarged).
Fig. 54 —Acervulus showing ruptured epidermis and cuticle of the host, palisade-like conidiophores and conidia (enlarged).
Fig. 55 —*Pyrenochaeta* : (*a*) pycnidium (enlarged) ; (*b*) conidiophores (much enlarged) ; (*c*) conidia (much enlarged).
Fig. 56 —*Aschersonia* : (*a*) section through stroma and pycnidia (enlarged;) (*b*) conidiophores (enlarged) ; (*c*) conidia (enlarged).

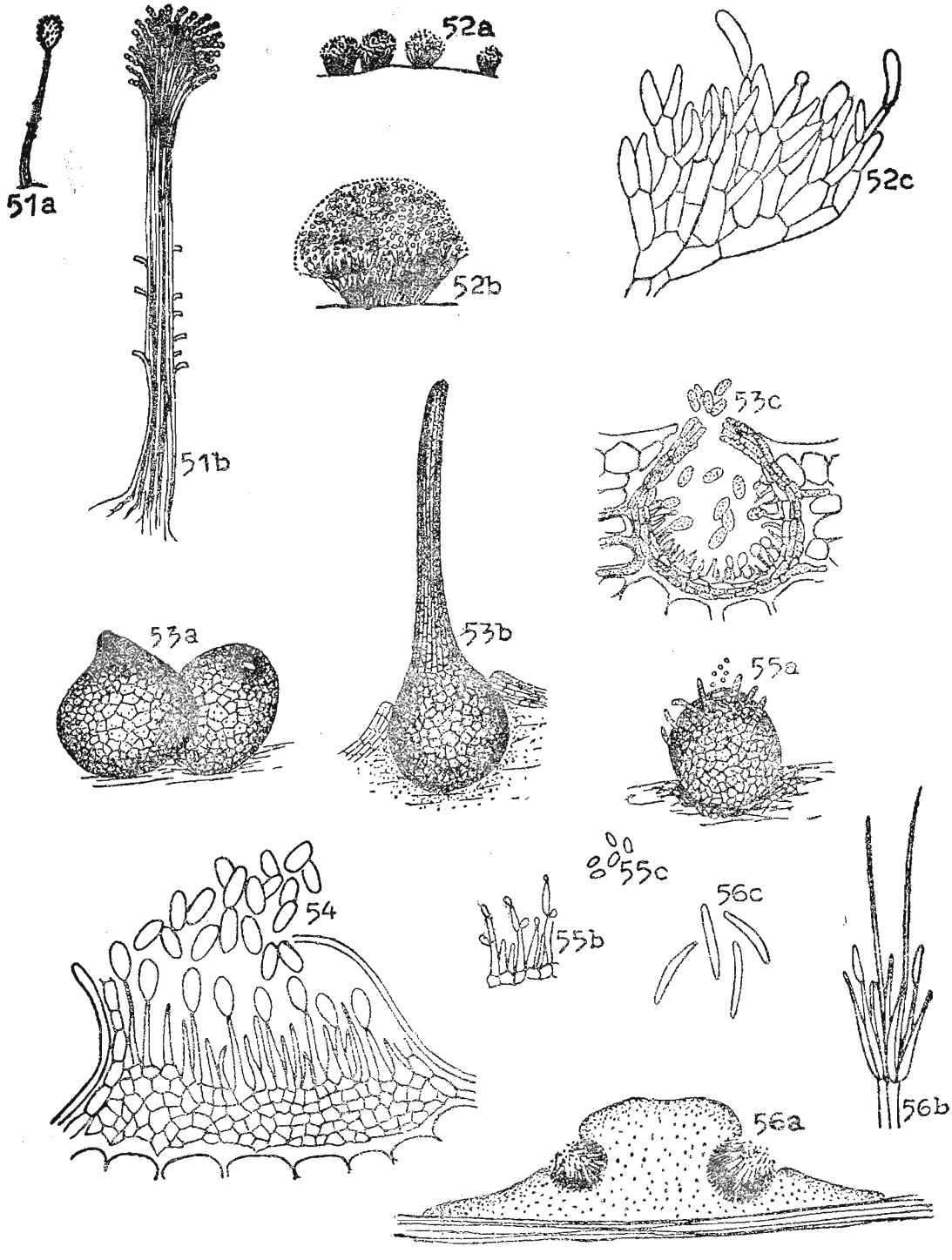

PLATE XIV Figs. 51—53

59. Pyrenochaeta de Not. (Plate XIV ; Fig. 55)

Pycnidia dark, nearly globose, erumpent with a few simple bristles ; conidiophores simple or branched. Conidia 1-celled, hyaline, ovoid to elongate.

Single species recorded.

P. sparsiburba Petch
On *Fiorinia juniperi.* .. p : 71

60. Eriothyrium Speg.

Mycelium irregular, spreading over the scale insect. Pycnidia superficial, flattened, convex, circular to oval, scutate, distinctly ostiolate. Conidia hyaline, 1-celled.

Single species recorded.

E. coccicola. Petch .. p : 69
On *Lepidosaphes.* Peradeniya

61. Aschersonia Mont. (Plate XIV ; Fig. 56)

Pycnidia brightly coloured, hemispherical or cushion shaped, opening by wide pores or rupture, which join to form irregular cracks. Conidiophores slender, branched. Conidia hyaline usually 1-celled, but sometimes reported as being septate, fusoid.

10 species recorded.

(1) *A. badia* Pat.
On *Aleyrodes.* .. p : 68

(2) *A. coffeae* P. Henn.
On *Lecanium.*
State of *Hypocrella javanica.* .. p : 68

(3) *A. confluens* P. Henn.
On *Aleyrodes.* State of *Hypocrella mollii.* .. p : 68

(4) *A. flava* Petch
On *Aleyrodes.* .. p : 68

(5) *A. hypocreoidea* (Cooke and Massee) Petch
On *Aleyroides.*
State of *Hypocrella hypocreoidea.* .. p : 68

(6) *A. marginata* Ell. and Everh. .. p : 68
On *Lecanium.*
State of *Hypocrella reineckeana.* .. p : 68

(7) *A oxystoma* Berk.
State of *Hypocrella oxystoma* .. p : 68

(8) *A. papillata* Petch
On Aleyrodid on *Citrus*, Hatton. .. p : 68

(9) *A. placenta* Berk. apud. B and Br.
On *Aleyrodes.*
State of *Hypocrella raciborskii.* .. p : 68

(10) *A. samoensis* P. Henn
On *Aleyrodes.*
State of *Hypocrella discoidea* .. p : 68

62. Murucularia Sacc.

Pycnidia arising from parenchymatous stroma at the margin of or on a thin byssoid stroma over the scale, clustered, black, ovoid, rugose, not ostiolate, wall parenchymatous opaque. Conidia tetrahedral, triangular in plane with rounded angles and concave sides.

Single species recorded.

M. calva Petch
On Fiorinia juniperi. .. p : 70

GLOSSARY

Acervulus	—	Subcuticular or subepidermal, never superficial, determinate fruiting body, without a peridium or covering of fungus tissue ; usually a discoid, or a flat mass of condiophores arising from a thin hyphal weft , and prolifically producing conidia in a moist mass (plate XIV, fig. 54).
Acrogenous	—	Growing at the apex ; borne at the tip.
Acropleurogenous	—	Spores borne at the tip and the sides.
Acropetal	—	Produced in succession toward the apex.
Aleuriospore	—	A term coined by Vuillemin for certain terminal chlamydospores of conidioid nature, which differ from true conidia in that they are freed only by the destruction of the hyphae which bear them. (Plate X, fig. C^{10}).
Allantoid	—	Sausage-shaped ; somewhat curved with rounded ends (plate X , fig. ^{69}).
Allentospore	—	Unicellular with rounded ends and a curved outline.
Alveolate	—	Pitted like a honey comb. (Plate X ; Fig. a^6).
Amerosporous	—	Having one.—celled spores. (Plate X, Fig. c^1)
Amyloid	—	Staining greyish—to blackish—violet in Melzers reagent, because of the presence of starch of starch-like compound.
Annelospore	—	A spore produced by annellophore (plate X , fig. c^{11})
Annelophore	—	A conidiophore which becomes banded (annellated) due to the production of a succession of single terminal conidia.
Aplanospore	—	A non-motile spore, usually sporangiospore having the spore wall free from the cellwall or sporangial wall.
Arthrospore	—	A seriate or jointed spore ; a spore resulting from the fragmentation of a hypha (plage X, fig. c^3).
Ascigerous	—	Having asci
Ascocarp	—	The ascospore bearing structure of the fungi.
Ascostroma	—	A simple type of fructification of the Ascomycetes, which consists of an undifferentiated mass of tissue or stroma, on or in which the asci develop.
Astomous	—	Fruit body without an ostiole.
Blastospore	—	Bud spores formed by budding of somatic cells of a hyphae or conidiophore or by budding from cells of other types of spores.
Botuliform	—	Sausage shaped or as allantoid (Plate X, Fig. b^9)
Carbonous, carbonaceous (of colour)	—	Dark coloured, almost black; (of consistency) consisting chiefly of substances in which carbon predominates, black and brittle ; charcoal-like.
Catenate	—	In chains (Plate X Fig. C^{12})
Catenulate	—	Formed in parts, united or linked as in a chain.
Chlamydospore	—	A thick walled, secondary spore developed from the hyphae, usually intercalary, but not on basidia or conidiophores.
Claviform, Clavate	—	Club - shaped.
Cleistothecium	—	A closed ascocarp, ascospores being freed by rupture or decay of the ascocarp asci scattered at various levels.
Concrescent	—	Growing together.
Confluent	—	Running into one another.
Coremium	—	A fascicle of parallel conidiophores.
Cylindrical	—	Of the same diameter throughout the length (Plate X ; Fig. b^7).
Decumbent	—	Having the lower end lying against the substratum.
Dendroid	—	Tree like ; having lateral branches
Dictyosporous	—	Muriform, with transverse and longitudinal septa. (Plate X, Fig. c^{14})

Didymosporous — Having two-celled spores. (Plate X ; c^2).

Echinulate — Covered with small pointed process or finely pointed spines (Plate X, Fig. a^5)

Ellipsoid, elliptic — Having the shape of an ellipse i.e. of a foreshortened circle (Plate X, Fig. b^6)

Erumpent — Breaking through ; to burst out. (Plate XIV ; Fig. 54).

Endophialospores — One of a series of spores formed successively endogenously to produce chains or spore heads on phialides.

Eustromata — A stroma consisting of fungus tissue only.

Evanescent — Only slightly developed and soon dissappearing.

Falcate — Sickle shaped. (Plate X ; Fig. b^{11}).

Fascicle — A little bundle.

Filiform — Slender as a thread. (Plate X Fig. b^{10}).

Floccose — Loose cottony or downy-wooly and more or less tufted like cotton flannel.

Funiculose — Occuring in ropes or bundles ; rope-like.

Fusiform — Spindle shaped, tapering at both ends.

Fusiform-elliptical — Fundamentally elliptical, but somewhat fusiform ; more elliptical than fusiform.

Fusoid — Somewhat fusiform.

Geniculate — Bent like a knee.

Globose, globoid — Globular, globulose—spherical or nearly so.

Gloeoid .. Slimy

Helicosporous — Having spores coiled in two or three directions forming a flat or spiral coil. (Plate X Fig. c^6)

Hyaline — Transparent or transluscent ; clear and colourless.

Immersed — Below the surface.

Innate — Forming a part of the surface tissue ; not superficial.

Isogamous — Producing or possessing morphologically similar gametes.

Metulae — The outermost branches from which phialides radiate.

Monopodial — Having the characteristics of or pertaining to a monopodium.

Monopodium — An axis that continues to grow at the apex in the direction of previous growth, while lateral structures of like kind are produced beneath it in a acropetal succession.

Muriform — Having cells arranged like bricks in a wall with both longitudinal and transverse septa (Plate X ; Fig. c^4).

Obclavate — The reverse of clavate.

Obovate — Reversely ovate, with broader end uppermost (Plate X ; Fig. b^3).

Obpyriform — Reversely pear shaped.

Ostiolate — Having a mouth or an ostiole.

Oval, Ovate, Ovoid — Egg shaped with a large end at the base (Plate X, Fig. b^2)

Papillate — Having one or more papillae.

Penicillate — Like a little brush ; pencil shaped.

Penicillus — One of the complex systems of branches bearing conidia producing organs in *Penicillium*.

Perfect — Of the stage or state of pleomorphic fungi in which spores are produced as the result of some sort of sexual process.

Periderm — A Covering.

Peridium — The outer, enveloping coat of a sporangium or fruit body.

Perithecium — A rounded, oval, pyriform or beaked ascocarp, which opens by a pore or slit and within which asci are borne in a characteristic manner. (Plate II ; Fig. *a*)

Phialide	—	Fusiform—truncate, fusiform - beaked, or acuminate terminal portion of a hyphae from the apex of which or within which, conidia are abstricated.
Phialospore	—	Spore formed on a phialide (Plate X ; Fig. c^{12}).
Phragmospore	—	A spore with two or more transverse septa (Plate X , Fig. c^{3}).
Porospore	—	Develops as a bud extruded through a distinct pore in the wall of the conidiophore (Plate X; Fig c ^{14})
Prostrate	—	Lying flat.
Pseudostroma	—	A false stroma ; a stroma consisting of host and fungus tissue.
Pseudostromatic	—	Resembling a stroma ; Consisting of host and fungal tissue.
Pseudothecium	—	Globose, perithecium like furit bodies possessed by the Loculoascomycetes.
Punctate	—	Marked with very small structures such as small dots, points, scales (Plate X ; Fig. a^{3}).
Pycnidium	—	A perithecium-like flask shaped fruit body bearing conidia (plate XIV, Fig. 53)
Pyriform	—	Pear-shaped (Plate X; Fig. b^{4}).
Radulospore	—	A spore borne on a small sterigma or a radula.
Reniform	—	Kidney-shaped
Rhizoidiferous	—	Having rhizoids.
Sclerotium	—	A resting body of variable size composed of a hardened mass of hyphae with or without host tissue.
Scolecoid	—	Long, and filiform, many times as long as they are broad.
Scolecospore	—	Having a scolecoid spore (Plate X ; Fig. c^{5}).
Setose	—	Bristly ; beset with bristles.
Sporangiole	—	A reduced sporangium in which a columella is lacking and the number of spores is reduced.
Sporocarp	—	A many-celled body serving for the formation of spores ; a fruit-body.
Sporodochium	—	An erumpent, determinate, pulvinate cluster of conidiophores, typically stromatic (Plate XIV, Fig. 52).
Staurosporous	—	Having a stellate spore (Plate X ; Fig. c^{7}).
Striate	—	Having longitudinal lines or minute furrows (Plate X ; Fig. a^{4}).
Stroma	—	A cushion - like mass of fungous cells, or mixed fungus cells and host tissue in or on which fructifications develop.
Stylospore	—	A spore borne on a filament or hypha.
Subcutaneous	—	Under the epidermis.
Subiculum	—	Subicle-a more or less dense felt or hyphae covering the substrate, from which the fruit bodies, perithecia etc. arise.
Superficial	—	On the surface and easily removable, as opposed to innate.
Suspensor	—	A club-shaped or conical portion of a hypha suspending a gamete or gametangium and finally the zygospore.
Sympodial	—	Growing by means of a sympodium.
Sympodula	—	Conidiophore with subterminal proliferation, which forms an apical conidium, continues its growth from a new active area developed to one, side of the conidium and then forms another apical conidium. Thin results in a zig-zag conidiophore.
Symopodulospore	—	Spore formed from a sympolulum (Plate X ; Fig.. c^{13}).
Synnema	—	See Coremium.
Verrucose	—	Covered or marked with small rounded process or warts (Plate X ; Fig. a^{2}).
Verticillate	—	Whorled.
Zygospore	—	The thick walled resting spore resulting from the fusion of similar gametangia

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