PRODROMUS TO

CLASS LOCULOASCOMYCETES

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INTRODUCTION

For a number of years I have worked toward a classification of the members of Class Loculoascomycetes (Ascomycota, Eumyceteae) that would take into account the variations of characteristics that occur in the class, and would provide a useful outline for others to follow. While such a project is not yet, and probably will not be, complete -- partially because collecting and study of the organisms are still in process, partially because relationships are difficult to discern -- the time seems propitious to offer a preliminary arrangement. Outlines of my classification have been proposed already (Barr 1976a, 1979b, 1983) and are continually undergoing revision.

The concern of many individuals that numerous representatives of plants and animals are in imminent danger of extinction and that their presence must be catalogued and acknowledged should extend to fungi also. That it has not is in part due to their size, and in part due to restricted knowledge of the numbers and distribution especially of microscopic fungi. Among these are thousands of ascomycetous fungi that may or may not be of economic importance. The role of the majority of these fungi in decomposition and recycling is vital yet underestimated. Within the Ascomycota, the large class Loculoascomycetes is probably less understood, and consequently their classification more in need of revision. My studies have impressed upon me the difficulties inherent in classification of members of this large and diverse group of organisms. One problem encountered has been the paucity of specimens of many of the species. In many cases only the type collection, or a few collections from a restricted locality, are present in herbaria. Vast regions of temperate North America seem scarcely to have been sampled and distribution of species is hardly known. Probably one reason is that collectors with specimens in hand have difficulty with the literature presently available, and give up in despair. Certainly, the information is scattered, and for many taxa incomplete, so that such a case would not be surprising. Another problem has been failure to integrate lichenized and nonlichenized taxa, a task that calls for cooperation among specialists.

This manual has two main purposes. One is to express in outline my ideas for the systematics of Loculoascomycetes. I view it as a progress report that will be enlarged and modified as needed. The second purpose is to aid those who find and study these fascinating organisms to identify their collections, at least to genus. Not coincidentally, the additional information obtained, new records, and the inevitable discovery of species that will not fit into recognized taxa, should contribute to improving the arrangement. The classification and recognition of diversity in the Loculoascomycetes, as in any group of organisms, provides the necessary background for all other

inquiries on aspects of their biology. It will also increase distributional and ecological knowledge and permit a more realistic approach to monographic studies.

Attempts to identify pyrenomycetous fungi often result in frustration and failure. Some genera are readily recognizable, but only relatively few have been monographed, and species identification poses many questions. In North America, Ellis and Everhart's (1892) "North American Pyrenomycetes" is the only manual that catalogs a number of these organisms. Both taxonomy and classification are much outdated; many more species have been described, still others await recognition, and a number have proved to be redundant. "British Ascomycetes" (Dennis 1978) presents a more modern approach, and is presently the most complete work available for identification of genera and some species. There are differences in the mycota between Great Britain and many areas of temperate North America, however, and the species described and illustrated by Dennis are not necessarily those that occur on this continent. The keys presented by Luttrell (1973) and von Arx and Müller (1975) provide much valuable information, and should be utilitzed to aid in reaching identification to genus. Families of lichenized Loculoascomycetes were outlined by Poelt (1974a) and synoptic keys for many genera and species, mostly European, have been prepared (Poelt 1974b; Poelt and Vêzda 1977). The annual editions of "Outline of the Ascomycetes" (O. Eriksson and Hawksworth 1985, 1986) offer a different view of the arrangement of families and orders, but do not provide explanation of some details.

In the following, the classification utilized is that of Barr (1979b, 1983) with some modifications. A dichotomous key aids in separating the orders. A brief description of characteristics of an order precedes the key to families. The families are delimited and a dichotomous key leads to the genera included in most families. Outline drawings show some of the variations within a family. The majority of drawings are based upon North American taxa. Some families are included in the keys but are not considered beyond that point, as is the case for the entire order Verrucariales. An asterisk following the name of a family in a key denotes only brief mention but no further treatment.

The class Loculoascomycetes is accepted here as defined by Luttrell (1955, as subclass), having bitunicate asci borne in an ascostroma. Neither the Meliolales nor the Erysiphales are Loculoascomycetes in my opinion. The Meliolaceae have been arranged with unitunicate Ascomycetes (Luttrell 1951; Müller and von Arx 1973; Barr 1983) or with bitunicate Loculoascomycetes (Nannfeldt 1932; O. Eriksson 1981; O. Eriksson and Hawksworth 1985). Apparent similarities between asterinaceous fungi and the Meliolaceae are several: biotrophic superficial habit, presence of hyphopodia on hyphae, typically dark ascospores with rounded end cells. The differences between the members of the two groups are more fundamental. In the Meliolaceae, a small periphysate or

setose ostiole is formed, broad, septate, thick-walled paraphyses are produced (Graff 1932; Luttrell 1980). Asci, although thick walled when young, have a minute chitinoid apical apparatus, apparently not functional in ascospore discharge because the ascus wall becomes very thin, deliquesces apically at maturity without extension of an endotunica. During development of the ascoma, the peridium forms after the ascogonium is visible. I would now suggest a relationship with the Sordariales, based upon the occurrence in both groups of coarse peridium cells and small apical pore, either periphysate or composed of short dark setae. The habits, asci and ascospores differ to such an extent that ordinal separation is essential. The Erysiphales have been included among Loculoascomycetes by Nannfeldt (1932), Gäumann (1949), (O. Eriksson 1981), but among the Ascomycetes by Luttrell (1951), Müller and von Arx (1973). By the production of asci that split apically and discharge the ascospores violently, and the formation of the peridium following sexual stimulus, the members of the Erysiphales must be placed in Class Hymenoascomycetes. Interpretation of the ascus as bitunicate (O. Eriksson 1981) strains the definition beyond acceptable limits. Their anamorphic states too are alien to those of the Loculoascomycetes.

The families accepted in this study are each based upon a combination of characteristics. Not all of these are found in every taxon within a family, but the unique features recur time after time. Character states utilized in the keys to separate families differ somewhat from one order to another. Unavoidably, some new taxa are erected or new combinations proposed; validation of these is made separately (Barr 1987b).

ACKNOWLEDGMENTS

Throughout this work, my indebtedness to the knowledge of others will be evident by citation of their studies. Nomenclatorial information on family and ordinal names was provided by the studies of Cooke and Hawksworth (1970), O. Eriksson (1981, 1982) and O. Eriksson and Hawksworth (1985, 1986). The volumes of ING (Farr et al., 1979) are invaluable in questions of typification of genera.

I thank the curators of herbaria (BPI, DAOM, FH, IMI, NY, UPS) for permission to study fungi in their keeping. For suggestions on various aspects of the manuscript, my appreciation goes to Drs. Jean Boise, Marie L. Farr, Richard Harris, David Hawksworth, and Clark Rogerson.

BASES OF CLASSIFICATION

The systematics of ascomycetous fungi are presently in a state of flux. From the extensive tabulation of proposed classifications in Hawksworth et al. (1983) and Hawksworth (1985a), and the outline of orders and families provided by O. Eriksson and Hawksworth (1985, 1986), it is obvious that various

arrangements have degrees of merit. The theoretical basis of a classification lies in one's perception of the importance of different character states. My outline of orders and higher taxa of ascomycetous fungi (Barr 1983) stressed the absence of a dicaryophase in the life cycle to separate the Endomycetales and Protomycetales from all other ascomycetous fungi. Within the Dicaryomycotera, the long-lived dicaryophase separated the Taphrinales from the Ascomycota. This division in turn contains four classes, two unique in different ways and each containing a single order (Ascosphaerales and Laboulbeniales), the other two of "typical" ascomycetes, separated by timing of establishment of dicaryon in combination with type of ascus. While Class Hymenoascomycetes is not considered further here, Class Loculoascomycetes is examined more closely. Table I summarizes the supraordinal classification that I utilize as background to more detailed studies. In the Loculoascomycetes 11 orders are recognized, although the Verrucariales are not treated beyond their inclusion within the class.

TABLE I
AN OUTLINE OF SUPRAORDINAL CLASSIFICATION OF ASCOMYCETOUS FUNGI

Supradivision Monocaryomycotera
- Division Endomycota
  - Class Endomycetes

Supradivision Dicaryomycotera
- Division Taphrinomycota
  - Class Taphrinomycetes
- Division Ascomycota
  - Class Ascosphaeromycetes
  - Class Laboulbeniomycetes
  - Class Hymenoascomycetes
    - Subclass Plectoascomycetidae
    - Subclass Parenchymatomycetidae
    - Subclass Anoteromycetidae
    - Subclass Edaphomycetidae
  - Class Loculoascomycetes
    - Subclass Loculoplectoascomycetidae
    - Subclass Loculoparenchymatomycetidae
    - Subclass Loculoanoteromycetidae
    - Subclass Loculoedaphomycetidae

The character states that appear to be valid to determine subclasses are primarily those of the centrum, the absence or presence of a hamathecium and the types of hamathecial tissues. Ordinal separation within a subclass depends upon finer distinctions of hamathecium, apothecioid or perithecioid ascomata, and on the way in which the fungus obtains nutrient. Table II lists a number of character states that have been used to define subclasses and orders; only certain of these are valid at these levels of classification. Indeterminate growth of the ascoma and the absence of a peridium, resulting in irregular

shapes, combined with scattered asci or asci interspersed among paraphysoids separate subclass Loculoplectoascomycetidae from the rest of the Loculoascomycetes where growth is determinate, a peridium is formed, the shape of ascomata is regular, and asci are arranged in a fascicle or hymenium. The Myriangiales includes saprobic, epiphytic or biotrophic organisms whose asci are often scattered in a cellular matrix, while the Arthoniales is separated for lichenized, biotrophic, or epiphytic organisms whose asci stand more or less at one level in an apothecioid ascoma, interspersed by paraphysoids whose tips are thickened and form a pseudoepithecium.

Subclass Loculoparenchymatomycetidae includes the fungi that do not have a hamathecium, and the asci push up among disintegrating cells of the centrum. The Asterinales is restricted here to a group of superficial leaf biotrophs that has in common rather coarse dark mycelium, a thin peridium, often composed of only one row of cells, opening by a slit or deliquescing of apical cells, and short, subglobose or ovoid or rarely oblong asci. The Capnodiales is restricted to "sooty mould" taxa, epiphytic, having superficial mycelium and ascomata, thin peridium opening by a pore, and oblong, ovoid or saccate asci. The Dothideales includes numerous and varied taxa, saprobic, biotrophic or epiphytic, usually immersed or erumpent but occasionally superficial, with coarse or thin mycelium, peridium that may be thin or thickened, but is typically composed of several rows of cells, opening by a pore or occasionally by crumbling of a small upper region of the peridium, and ovoid, saccate, oblong, or clavate asci.

The other taxa in the Loculoascomycetes produce a hamathecium of some sort. In subclass Loculoanoteromycetidae periphysoids distinguish two orders: the Verrucariales are all perithecioid and lichenized, and the Chaetothyriales are perithecioid or lenticular, hemibiotrophic, epiphytic or saprobic. Subclass Loculoedaphomycetidae includes orders having paraphysoids or pseudoparaphyses. Paraphysoids with free ends often branched or thickened and encrusted as a pseudoepithecium are typical of the Opegraphales and Patellariales. In both of these orders ascomata open widely and are apothecioid. The taxa of the Opegraphales are lichenized and may have a thalline margin surrounding the peridium. Those of the Patellariales are saprobic. Pseudoparaphyses are found in the Pleosporales and the Melanommatales and ascomata are typically perithecioid. Narrowly or widely cellular pseudoparaphyses, asci usually basal and ascospores often showing bipolar asymmetry are features of the Pleosporales. Narrowly trabeculate or sometimes unbranched pseudoparaphyses, asci usually peripheral and ascospores mostly showing bipolar symmetry are features of the Melanommatales. Members of the Pleosporales vary in habit from saprobic to biotrophic, epiphytic or lichenized, whereas those of the Melanommatales are saprobic or lichenized, sometimes epiphytic.

TABLE II
CHARACTER STATES USED TO DEFINE ORDERS

State	Myr	Art	Ast	Cap	Dot	Cha	Ver	Ope	Pat	Ple	Mel
Indeterminate	+	+									
Irregular	+	+									
Apothecioid	+	+						+	+		
Symbiotic		+					+	+		+/0	+/0
Holobiotrophic	+		+		+/0	+/0				+/0	
Superficial	+/0	+/0	+	+	+/0	+		+	+/0	+/0	+/0
No peridium	+	+									
Peridium 1 row			+	+/0		+/0					
Scattered asci	+	+									
Iodine plus		+	+	+/0		+/0	+	+	+/0		
No hamathecium	+	+	+	+	+						
Periphysoids						+	+				
Paraphysoids		+						+	+		
Pseudoparaphyses										+	+
Ascospores asymmetric	+	+/0	+	+	+	+	+/0		+/0	+/0	
Anamorphs coelomycetous	+				+					+	+
hyphomycetous			+	+	+	+				+	

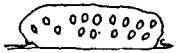
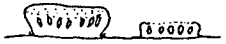
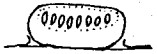
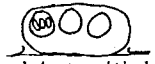
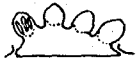
MORPHOLOGICAL AND OTHER IMPORTANT FEATURES

Ascomata:

The ascoma in members of the Loculoascomycetes supplies a number of characteristics that are important at the level of the family or of the genus. Some taxa produce their asci in locules within a stromatic tissue. The stroma may be indeterminate in growth and the asci scattered singly or a few grouped in the cellular interior as in some of the Myriangiales. More frequently, the stroma contains one or several definite locules, oriented with apical pore toward the surface, the asci forming in the cellular interior or within a narrow region of compressed cells which forms the peridium. Table III shows some variations in stromata and locules, and the families where they occur. The majority of taxa in the Loculoascomycetes have unilocular ascomata although two or more may be connected laterally. These may be apothecioid, opening widely at maturity, or perithecioid, opening by more-or-less well-developed apical pore, or cleistothecioid, without an apical opening. They may be connected by abundant mycelium that forms pseudostromata incorporating host tissues and surrounding or supporting the ascomata.

The position of ascomata in relation to substrate may be quite consistent within a taxon or may vary to some extent. A number of taxa develop superficially on the substrate, attached by hyphae that penetrate to a lesser or greater degree. Some are subcuticular on leaves, and their hyphae may penetrate a short

TABLE III
TYPES OF STROMATAL CONFIGURATION

	Myriangiales	Arthoniales	Asterinales	Capnodiales	Dothideales	Chaetothyriales	Opegraphales	Patellariales	Pleosporales	Melanomatales
 crustose, asci scattered	Myriangiaceae Seuratiaceae Cookellaceae Elsinoaceae Schizothyriaceae									
 crustose with locules					Dothideaceae				Venturiaceae Polystomellaceae	
 discoid	Myriangiaceae	Arthoniaceae Phillipsiellaceae			Mycoporaceae Lichenotheliaceae		Opegraphaceae Roccellaceae	Patellariaceae		
 pulvinate, single locule					Dothioraceae					
 pulvinate with locules					Dothioraceae Pseudosphaeriaceae				Botryosphaeriaceae	
 locules erumpent from stroma			Parmulariaceae		Dothideaceae Dothideaceae				Venturiaceae Botryosphaeriaceae Cucurbitariaceae Venturiaceae	
 peltate stroma										

distance into leaf tissues. Many taxa develop within the substrate, some within the outermost layers of periderm, some beneath the epidermal or the periderm layers, others deep in the substrate. Some of these remain immersed, with only the tip of the apex reaching the surface. Others become raised or erumpent as they enlarge and may throw off the outermost covering, then are described as erumpent becoming superficial. Still other taxa, although they evidently begin development within the substrate, are at maturity quite superficial with only the bases of ascomata firmly attached to the substrate.

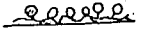
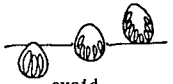
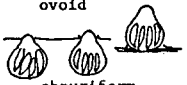
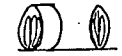
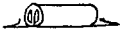
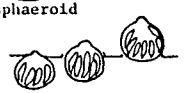
The shapes of ascomata provide much information. From above, most are rounded, but ovoid, ellipsoid, elongate, compressed (conchate or dolabrate) or branched ascomata may be recognized. In side view, the majority of ascomata are globose, sphaeroid, ovoid or obpyriform. Fewer are scutate or dimidiate, conoid or lenticular. Table IV summarizes some ascoma shapes and the families in which they occur. A number of species have ascomata that collapse upon drying, and are collabent, often with a central papilla in the depression. Sizes of ascomata vary within a range for each taxon, but it is useful to have in mind some general size classes. In this study, "minute" denotes ascomata up to 150 µm wide, "small" 150-250(-300) µm wide, "medium" 250-600 µm wide, and "large" over 600 µm wide. Stromata are usually larger than ascomata (1-2 mm or more) and are frequently pulvinate with a broad quite plane upper surface; some are dotted with apical papillae of the locules.

Arrangement of ascomata or stromata is one of the features best determined by use of a dissecting microscope. Some may be scattered and well separated from one another, others may be gregarious, and still others closely grouped with some fusion of lateral peridia possible. The ascomata may be connected by sparse or well-developed hyphal subiculum. Hyphal appendages may clothe the ascomata and often merge imperceptibly with a subiculum or trail away as hyphae. Another surface feature of ascomata is the presence of setae, usually apical in position as dark stiff bristles. Some ascomata have a roughened surface, caused by protruding clumps of cells; others are quite smooth and may be dull or shining. Pigmentation of ascomata in the Loculoascomycetes is mostly dark, black or brownish black from the surface, but a few taxa have light brown, yellowish or pallid ascomata.

Perithecioid ascomata may open by a small or large pore in a rounded or plane apex but more frequently a papilla is formed. This may be short and abrupt or large and conspicuous, rounded or compressed. In some taxa, the obpyriform or conoid shape of ascomata results in a tapered apical region that may be prolonged and beaklike. Some taxa have the papilla composed of short dark or hyaline setae, while in others the ostiolar canal may be stuffed with brightly colored cells, visible as a dot of differing color under low magnification. Ascomata may open widely by a longitudinal slit, as in the Hysteriaceae, where ascomata are typically elongate or ellipsoid seen from above.

TABLE IV

TYPES OF ASCOMATAL CONFIGURATION

	Myriangiales	Arthoniales	Asterinales	Capnodiales	Dothideales	Chaetothyriales	Opegraphales	Patellariales	Pleosporales	Melanommatales
 dimidiate-scutate, lenticular	Schizothyriaceae		Asterinaceae Parmulariaceae			Chaetothyriaceae Trichopeltidaceae			Arthopyreniaceae Micropeltidac. Polystomellaceae	Micrthyriac.
 superficial from hyphae			Englerulaceae Parodiopsidaceae		Antennulariellaceae				Dimeriaceae	
 conoid-applanate					Kriegeriellaceae				Pleosporaceae Pleomassariac. Leptosphaeriac. Hysteriaceae Tubeufiaceae Cucurbitariaceae Parodiellaceae	Massariaceae Platystomac. Melanommataceae
 obovoid, turbinate										
 ovoid				Capnodiaceae	Pseudosphaeriaceae	Metacapnodiaceae Coccodiniaceae			most families	Fenestellaceae Melanomm. Fenestellac.
 obpyriform									Pyrenophoraceae Leptosphaeriac. Dacampiaceae	
 conchate, dolabrate										Mytilinidiaceae
 elongate	Elsinoaceae Schizothyriaceae	Arthoniaceae	Asterinaceae Parmulariaceae		Dothioraceae		Opegraphaceae	Patellariaceae	Hysteriaceae Phaeosphaeriac.	Mytilinidi.
 sphaeroid					most families	Strigulaceae Chaetothyriaceae Herpotrichiellaceae Coccodiniaceae			most families	Acrocor. Pyrenul. Didymos.
 globose			Englerulaceae Parodiopsidaceae		Euantennariaceae Antennulariellaceae	Coccodiniaceae Herpotrichiellaceae			most families	most families

In the rounded top a longitudinal slit opens to expose the hymenium. This may remain open, whereupon the pseudoparaphyses tips tend to become darkened, or may close and reopen as microclimatic conditions change from dry to moist. Members of the Patellariaceae are similar in aspect, but the pigmented pseudoepithecium of open ascomata is strongly darkened. In the Mytilinidiaceae ascomata are short or elongate in side view, conchate or dolabrate. The upper region may be crested sharply (cristate) or more rounded, and opens by a longitudinal slit. Some genera in other families may have ascomata that are somewhat elongate and open by a longitudinal slit, so the character is one to be used with care. Some taxa whose ascomata are globose and papillate have a compressed apical regions, rather than rounded, and the ostiole is slotlike or definitely elongate. These taxa are for the most part arranged in the Lophiostomataceae of the Pleosporales or the Platystomaceae of the Melanommatales, but there are exceptions: species whose ascomata are entirely immersed in the substrate, without a definite papilla, may have an elongate opening; species that are elongate, with a longitudinal slit, but not characteristic of the Hysteriaceae or Mytilinidiaceae otherwise; species with large globose ascomata whose low ridge and longitudinal slit appear as an afterthought. By other characters these taxa are placed in families most of whose members form a rounded apical papilla.

The peridium of ascomata may be composed of one, two, or three layers of cells. Most ascomata have an innermost narrow layer of one or few rows of pallid, compressed cells, although at times such a layer is scarcely recognizable. The outer one or two layers are more conspicuous. They may be composed of pseudoparenchymatous cells, small or large, and these may be much thickened and sclerotial or thin walled. In some taxa the outer layer(s) are composed of rows of elongate, compressed cells sometimes referred to as prosenchymatous. In still others, the cells are quite cubical and often in radiating rows. From the surface, the outermost cells may have the aspect of textura globulosa or textura angularis or textura prismatica. Some taxa develop heavy pigmentation over the surface so that this aspect is completely occluded. In those Loculoascomycetes that develop a clypeal covering over the ascomata, some variations are found. The clypeus may be so closely integrated with peridium cells that the two are scarcely separable and the aspect is of a thickened peridium above, i.e., a reduced pseudostroma, and a thin, often pallid true peridium at the lower sides and base. In other cases, the clypeus may be more of a shield over the upper regions and may extend outward in the substrate as strands of hyphae, a more recognizable pseudostroma. An "internal clypeus" of darkened compact cells in the upper region of the centrum is known for a few species.

The ostiolar region may open irregularly or widely by splitting between cells or by the breakdown of cells above the centrum. Often a defined region is filled with cells or pseudoparaphyses when young and opens as a rounded or compressed

slotlike pore. This region may be lined by peridium cells or by short periphyses. As yet there is not consistent correlation of the presence of periphyses with other features of the ascoma to utilize them as a valid character. A few genera, noted earlier, have the papilla formed by short hyaline or dark setae, and some relatives may have setae rather than periphyses lining the ostiole.

Centrum -- Hamathecium and asci:

Most conspicuous in the centrum are the asci. In position the asci may develop as a fascicle from a compact subhymenium; they develop into a region of disintegrating cells and pseudoparaphyses are not formed. Asci frequently form a basal layer that may extend laterally for a short distance. In the case of species in the Dothideales that show this arrangement, the asci push into the pseudoparenchyma and gradually compress the cells so that at maturity there remain relatively few interthecial tissues. In taxa where pseudoparaphyses occupy the developing and enlarging centrum, the asci push between these structures. Sometimes the pseudoparaphyses are deliquescent and visible only as thin strips at maturity but in many taxa the pseudoparaphyses remain visible between and above the asci at maturity. Asci may form a peripheral layer, lining most of the inner peridium, interspersed with pseudoparaphyses.

Asci in the Loculoascomycetes have a diversity of shapes, ranging through globose, subglobose, saccate, oblong, clavate to cylindric. They may be stipitate or sessile and usually have a footlike base. Their bitunicate nature is evident in mature asci by fissitunicate dehiscence, the breaking of the inelastic ectotunica and extension of the elastic endotunica. Typically an unbroken ascus shows a small or large ocular chamber protruding apically into the endotunica. Some asci have a light-refractive ring that surrounds the ocular chamber. Some asci do not have an endotunica visible at maturity and have been termed "vestigial bitunicate asci" (Hall and Sivanesan 1972). Considerable variation may be observed in the thickness and layering of ascus walls, and in complexity of the apical region, for example in the presence of rodlike structures in the ocular chamber. For detailed study with the light microscope and various stains one should consult O. Eriksson (1981). Most asci contain eight ascospores, but in some taxa less than eight mature and in others multiples of eight are formed.

The tissues that make up the hamathecium have noteworthy variations, and centrum structure is of prime importance in my delimitation of subclasses. Periphysoids are short downward-growing filaments that fringe the upper region of the inner peridium. Paraphysoids are attached at both base and apex in young ascomata that become apothecioid at maturity. With disintegration of the upper covering, the apical tips are freed; these may regenerate and branch or enlarge as a pseudoepithecium. Pseudoparaphyses are downward-growing or derived from stretching of cells occupying the centrum. They may be composed of

obviously septate filaments (X450 magnification) -- cellular pseudoparaphyses -- that may branch and anastomose and that may be embedded in a gel matrix. They may be rather distant so that individuals are readily recognizable, or they may be so numerous as to give the appearance of a dense curtain above the asci. Trabeculate pseudoparaphyses are thin, do not appear septate at X450 magnification, and branch and anastomose. They are typically rather distant from one another and are embedded in a gel matrix so that the hamathecium is quite refractive. This type of sterile filament is typical of the Melanommatales, but in the Pyrenulaceae the pseudoparaphyses are not or only slightly branched and it has been suggested that they are true paraphyses with free apical ends.

Ascospores:

Ascospores of the Loculoascomycetes possess a number of character states that are valid in diagnosis of a particular species or genus. One must recognize that some variation is possible within a species, but that variation does occur within reasonable limits. For example, ascospores are not pigmented when first formed. Some ascospores remain hyaline to full maturity, whereas some develop a light pigmentation at maturity; these may comfortably be included in the "hyaline or lightly pigmented" category. Other ascospores develop pigmentation as they mature. The results differ widely: greenish to olivaceous, yellowish browns, reddish browns, clear browns, very dark to nearly black at full maturity. Sometimes the tips of ascospores remain hyaline or become only lightly pigmented while the mid regions are strongly pigmented -- often a useful specific or even generic character. Some ascospores develop pigment strongly in the septa, although the contents and wall are less pigmented; such ascospores may collapse between septa upon drying.

Bipolar symmetry or asymmetry of ascospores is a recognizable character state that determines the shape of the structure. Ascospores showing bipolar symmetry may be globose (rare in Loculoascomycetes), ellipsoid, fusoid, oblong or filiform, while ascospores showing bipolar asymmetry may be ovoid, obovoid or elongate with long taper; qualifying terms denote whether the ascospores are broadly or narrowly of a shape. (Length:width ratios can be useful, especially in recognizing groups of species within a genus.) The ends of ascospores may be rounded, or obtusely or acutely pointed, or mucronate. Radial symmetry or asymmetry seems to be a less useful feature in diagnosis. Frequently ascospores will show radial asymmetry with one side flattened or slightly indented. The strongly radially asymmetric ascospores that are allantoid, i.e., oblong without taper to ends, diagnostic of species in members of the Diatrypaceae or Calosphaeriaceae of Class Hymenoascomycetes, are not found in Class Loculoascomycetes.

Ascospore septation is a characteristic classically used in some systems (e.g., Saccardo 1882 and later) and is of considerable value. Relatively few taxa in the Loculoascomycetes

produce nonseptate ascospores. Taxa with one transverse septum in the ascospore are numerous; here variation in position of the septum, especially the basal position that is apiospory, separates a few taxa easily. Two, three or more transverse septa occur in a great number of species and the position of septa, the sequence in which they form, whether they constrict the ascospore or not are all features to be observed. The presence of a longitudinal septum in one or more cells of a transversely septate ascospore is termed "occasional" when it is not a constant character of the species. Muriformly septate ascospores are characteristic of a considerable number of species that may be quite divergent in other characters. The sequence in which longitudinal as well as transverse septa form and the extension or not of longitudinal septa into end cells are features to be noted.

The taxa with distoseptate ascospores pose a special problem in classification. The temptation to segregate such taxa is strong, because the features of distoseptate ascospores are striking. However, analyses of ascomata and centra show that many different types produce distoseptate ascospores. According to Harris (in litt.) the distoseptate ascospores of many of the lichenized Melanommatales are initially euseptate. Discussions of euseptate and distoseptate ascospores and/or conidia are detailed by Luttrell (1963), Sutton (1969) and Alcorn (1983) among others. The classification arrived at recognized distoseptate taxa, usually at the generic level and occasionally at the family level, but gives more prominence to ascomata and centra. Several families in different orders contain genera whose representatives produce distoseptate ascospores; some genera have a few species with distoseptate ascospores whereas the majority of species have euseptate ascospores.

The appearance of the contents of ascospores at maturity varies: homogeneous and sometimes refractive in aspect, guttulate or with one or more globules, either rounded or angular. This information is of minor rather than diagnostic importance in a taxon in general. Ascospore walls also vary in thickness and depth of pigmentation. Walls may be ornamented in different ways and are described as foveolate (surface appearing punctate), verruculose, longitudinally striate (evident as ridges under SEM). In some dark-walled ascospores an elongate germ slit is formed, in others one or more germ pores. A number of taxa have the ascospores enveloped in a gel coating that may be narrow or broad, equal in width or indented in places. Terminal pulvinate or tapered appendages may be formed. The arrangement of ascospores within an ascus depends upon the shapes of both structures. Arrangement, as in uniseriate, biseriate, or in a fascicle, tends to be consistent within a taxon.

Anamorphs:

It is difficult to attempt conclusions about the anamorphs of the Loculoascomycetes. Some are well known and are connnected without question in the life cycle of the holomorph. Some are

known only by association, and these could be hyperparasitic or coincidental. The anamorphs that are known may be hyphomycetous or coelomycetous. Conidiogenesis may be thallic or blastic. Phialidic conidiogenesis is found only in pycnidial anamorphs in contrast to Class Hymenoascomycetes, where phialidic hyphomycetous anamorphs are well known. Some anamorphic states are more collected and better known than their teleomorphs. These anamorphic states, as in those of the Pyrenophoraceae, are conspicuous and help to delimit the family. On the other hand, some anamorphic states, perhaps spermatial, are not yet very useful in a classification. An exception should be made for some lichenized taxa where the presence and structure of either micro- or macroconidial states are useful at the family level. Many more connections between teleomorph and anamorph are needed to determine just how valuable anamorphic states are in the systematics of Loculoascomycetes. The known and suspected correlations are noted with each family in the following text; much of the information is summarized by Sivanesan (1984).

Mode of nutrition:

Life styles and habitats among the Loculoascomycetes are extremely varied. The life styles range from lichenized taxa, to holobiotrophs that may or may not cause spotting or hypertrophy of tissues, to hemibiotrophs that begin their development on living tissues and complete their life cycles on dead tissues (often after overwintering), to saprobes of primary incidence, to saprobes of secondary incidence (hypersaprobes that develop after or over other fungi), and to epiphytes that develop over secretions by insects (Luttrell, 1974). Habitats could be said to include stages in development of almost any vascular plant. Lichen thalli, larger algae, bryophytes, and other fungi are not exempt, nor are scale insects or the partially digested material of animal dung. Many of the fungi are quite restricted in habitat. Some are limited to a particular host plant or group of plants. As with other major groups of fungi, generalizations are necessary; sometimes at the ordinal or familial level or more often at the generic level more precise definitions of habitat may be made.

SUGGESTIONS FOR STUDY

The use of a dissecting microscope prior to examination under the compound microscope is essential. In many cases one discovers ascomata that would otherwise be overlooked. Under such low magnification one may observe the position, arrangement, and shape of ascomata, the presence of any setae, hyphal appendages, subiculum, or stromatic tissues, any spotting or pigmentation of the substrate. Freehand vertical sections, using a sharp razor blade, can be cut under low magnification. The sectioning gives additional information about texture and consistency of the ascoma. By trial and error, one learns whether to cut the dry specimen or to moisten it for best

results. Ascomata of some taxa section well when dry, whereas others fracture. One may rehydrate a specimen in a simple damp chamber of moist towelling in a petri plate. Collapse or fracture when sectioned of an ascoma is a clear indication of overmature material, and this knowledge can save much futile slide preparation and examination. The transfer of sections to the slide bearing a drop of mounting medium (usually water) can be frustrating, but by the simple expedient of moistening the blade the sections can be picked up easily (Munk, 1957). Much of the observation under the compound microscope is made on sections in water mount. In this way pigmentation and gel coating or appendages are not obscured and asci spread better. When desired, the water may be drawn out and other mounting media or stains added. O. Eriksson (1981) provided information on the use of various stains, particularly to emphasize ascus structure. Low power of the compound microscope (X100) confirms and refines the observations on ascomata, as well as the position of asci in the centrum. To observe the type of sterile tissues in the centrum, whether remains of centrum cells, paraphysoids, cellular pseudoparaphyses, trabeculate or unbranched pseudoparaphyses, or periphysoids, magnification X400 is usually sufficient. Under an oil-immersion lens (X900-1000) details of peridium, asci and ascospores are determined, and measurements made. At times one may need to prepare a squash mount or to pick out a portion of centrum to determine features of asci and ascospores.

KEY TO ORDERS OF CLASS LOCULOASCOMYCETES

1. Growth of ascomata indeterminate, margin and shape irregular; peridium absent; asci arising singly, often scattered.....2
1. Growth of ascomata determinate, margin and shape regular; peridium present; asci forming hymenium.....3
    2. Saprobic, epiphytic or biotrophic; asci separated and overarched by pseudoparenchymatous cells; hymenial gel not bluing in iodine.....Myriangiales
    2. Lichenized or epiphytic; asci separated by vertically oriented cells serving above as paraphysoids with free tips forming pseudoepithecium; hymenial gel bluing in iodine.....Arthoniales
3. Hamathecium absent, centrum enlarged by disintegration of cells or asci remaining separated by interthecial cells.....4
3. Hamathecium present, centrum enlarged by insertion of sterile filaments of various kinds.....6
    4. Ascomata superficial, biotrophic, with coarse, dark mycelium, opening by splitting, crumbling or gelatinizing of thin peridium .....Asterinales
    4. Ascomata immersed erumpent or superficial, saprobic, epiphytic, biotrophic, hemibiotrophic, opening by rounded pore.....5

5. Ascomata superficial, epiphytic, in well-developed subiculum of coarse or thin mycelium.....Capnodiales
5. Ascomata immersed erumpent, if superficial not in subiculum, saprobic, hemibiotrophic, biotrophic or epiphytic....Dothideales
6. Hamathecium composed of short periphysoids.....7
6. Hamathecium composed of paraphysoids or pseudoparaphyses 8
7. Ascomata perithecioid; lichenized, thallus crustose..... .....Verrucariales*
7. Ascomata perithecioid or lenticular; saprobic or biotrophic.. .....Chaetothyriales
8. Ascomata apothecioid; hamathecium composed of paraphysoids, free ends enlarged and/or branched and encrusted as pseudoepithecium.....9
8. Ascomata typically perithecioid; hamathecium composed of pseudoparaphyses.....10
9. Lichenized; thallus crustose or fruticose.....Opegraphales
9. Saprobic, without thallus.....Patellariales
10. Pseudoparaphyses cellular, narrow or wide; asci usually in basal layer; ascospores usually with bipolar asymmetry.. .....Pleosporales
10. Pseudoparaphyses trabeculate or unbranched, narrow; asci usually in peripheral layer; ascospores usually with bipolar symmetry.....Melanommatales

*Not considered beyond inclusion in this key.

MYRIANGIALES

Starbäck, Bih. K. Svenska Vetensk.-Akad. Handl. III,25(1): 37. 1899.

Ascomata indeterminate in growth; superficial or immersed erumpent, separate or merged or grouped on basal stroma; rounded, elongate, lobed or irregular in face view, in section pulvinate, rounded, discoid or dimidiate-scutate, small to medium sized; without apical pore, opening by one or more slits between cells or by disintegration of covering cells; tissue pseudoparenchymatous, gelatinizing at times, often soft and pallid, brown encrusted toward surface, hyphae rather narrow, light brown or hyaline. Hamathecium lacking. Asci globose, subglobose or ovoid, at times broadly oblong, arising at various heights or as a single layer in pallid pseudoparenchymatous tissues. Ascospores hyaline or light brown or reddish brown, usually obovoid, asymmetric, ends obtuse, one celled or one to several septate or muriform, at times surrounded by gel coating.

Anamorphs where known coelomycetous, in acervuli or in sporodochial groups on stroma.

Epiphytic over scale insects, insect secretions, resin glands, trichomes, or biotrophic or saprobic on leaves or twigs, or hyperparasitic on other fungi.

The present concept of the Myriangiales differs somewhat from my earlier version (Barr 1979b). The order Arthoniales is

recognized as related to the Myriangiales by indeterminate habit of growth and the formation of irregular, not or scarcely margined ascomata. The taxa of the Arthoniales at maturity have a hamathecium of septate paraphysoids that form a pseudoepithecium above the asci. The ascus wall or subhymenial cells usually blue in iodine. The Piedraiaceae according to Shoemaker and Egger (1982) has thin-walled rather than bitunicate asci; they suggested that it might belong in the Prototunicatae of Gaumann. O. Eriksson (1981, 1982) retained the Piedraiaceae close to myriangiaceous fungi but for the present I exclude the family. The Saccardinulaceae and the Stephanothecaceae are removed from the Asterinales and are relegated to synonymy under the Elsinoaceae. The Schizothyriaceae is also removed from the Asterinales and reassigned to the Myriangiales. Recent arrangements of the myriangiaceous fungi (von Arx 1963; Luttrell 1973; von Arx and Müller 1975; O. Eriksson and Hawksworth 1985, 1986) also vary in the numbers and positions of the families included. This is an indication of some of the problems that exist, not only among these taxa, but throughout the Loculoascomycetes.

Most taxa in the Myriangiales are tropical in distribution, and dichotomous keys have not been prepared to separate the few genera in each family that are found in temperate regions. For details on additional genera, the study by von Arx (1963) should be consulted, as well as the keys presented by Luttrell (1973) and von Arx and Müller (1975).

Key to Families

1. Ascomata rounded in outline, crustose or discoid in side view, single or several from rather well-developed stromatic basal tissues; epiphytic on branches over scale insects, insect secretions or resin droplets.....Myriangiaceae

1. Ascomata rounded, elongate, lobed, or irregular in outline, rounded, discoid, crustose or dimidiate-scutate in side view, lacking well-developed stromatic basal tissues; variable in habit.....2

2. Ascomata irregular or crustose in side view; composed of pallid cells in conspicuously gelatinous matrix.....3

2. Ascomata rounded, crustose or dimidiate-scutate in side view; composed of brown to pallid cells not in conspicuously gelatinous matrix.....4

3. Ascomata epiphytic on leaves or twigs over insect secretions; ascospores one septate; anamorphic state producing triradiate conidia separately or grouped in sporodochia on stroma.....Seuratiaceae

3. Ascomata hyperparasitic on other fungi; ascospores transversely septate or muriform; anamorphs not known....Cookellaceae

4. Ascomata biotrophic, immersed in or erumpent from host tissues, crustose in side view; anamorphs coelomycetous where known.....Elsinoaceae

4. Ascomata epiphytic, dimidiate-scutate or thin crustose in side view, flat on substrate; anamorphs not known.....Schizothyriaceae

Myriangiaceae Nylander, Flora (Regensb.) 37: 233. 1854.

Ascomata single or several developing from stromatic tissues of irregular shape, crustose or discoid in side view; tissues composed of pallid to brown pseudoparenchymatous cells. Asci globose or subglobose, at various heights or in single rather irregular layer, embedded in pseudoparenchymatous tissues. Ascospores light brown, obovoid, transversely septate or muriform.

Epiphytic on branches over scale insects or their secretions or on resin droplets, temperate and tropical regions.

Myriangium is a genus of warm temperate and tropical regions, with stromata developing over scale insects. The stromata bear one or several discoid ascomata in which the asci are embedded at various heights. The ascospores are muriform. *Hemimyriangium* is typified by *H. betulae* Reid & Pirozynski (1966) and was well illustrated in their article. This fungus develops as a crust over resin droplets and the ascospores are transversely septate.

The family Phymatosphaeriaceae Speg. (An. Soc. Ci. Argent. 26: 57. 1888), with the type genus *Phymatosphaeria*, is treated as a synonym of the Myriangiaceae following von Arx (1963).

Seuratiaceae Vuillemin ex Barr, Mycotaxon 29: 501. 1987.

Seuratiacées Vuillemin, Bull. Soc. Mycol. France 21: 79. 1905 (nom. inval., ICBN, Art. 18).

Ascomata irregular in outline, in section irregular or in crustose layer; composed of chains of pallid cells in gel matrix. Asci globose or subglobose, scattered or in small groups. Ascospores hyaline to light brown, one septate.

Anamorphs sporodochial, conidia triradiate (described as *Atichia*).

Epiphytic on leaves or twigs, often over insect secretions, mostly tropical.

There is a single genus *Seuratia* Pat. The name Atichiaceae Millardet ex Racib. (Parasitische Algen und Pilze Javas, Theil I-III: 41. 1900) and *Atichia* Flotow have been utilized to designate the taxa, but the names refer to the anamorphic state, and Seuratiaceae and *Seuratia* designate the holomorphs. Meeker (1975a, b) has presented details of both teleomorph and anamorph. O. Eriksson (1981) and O. Eriksson and Hawksworth (1985, 1986) arranged this family as adjunct to the Arthoniales.

Elsinoaceae von Höhnel ex Saccardo & Trotter in Saccardo, Syll. Fung. 22: 584. 1913.

Elsinoeen von Höhnel, Sitzungsber. Kaiserl. Akad. Wiss. Math.-Naturwiss. Cl. Abt. 1, 118: 373. 1909 (nom. inval., ICBN, Art. 18).

Ascomata immersed in and often erumpent from substrate, irregular, elongate or rounded in outline, crustose or rounded in side view, composed of pallid to brown pseudoparenchymatous cells. Asci subglobose, in a layer or irregularly at various

heights. Ascospores hyaline or light brown, transversely septate or muriform.

Anamorphs coelomycetous, acervular where known (described as *Sphaceloma* in *Elsinoë*).

Biotrophic in living plants, temperate and tropical regions.

Numerous species of *Elsinoë* have been described. They form hypertrophied or scabby or spotted areas in leaves, branches and fruits. The ascospores are transversely septate. *Diplotheca tunae* (Sprengel: Fr.) Starb. is parasitic on members of the Cactaceae. Ascomata are rounded with a central foot in stoma of the host. The scattered asci contain muriform ascospores.

Four families have been segregated from the Elsinoaceae, but do not appear to differ. The Plectodiscellaceae Woron. (Mykol. Centralbl. 4: 232. 1914) is typified by *Plectodiscella piri* Woron. = *Elsinoë piri* (Woron.) Jenkins. The Myxomyriangiaceae (Theissen) Theissen in Theissen & H. Sydow (Ann. Mycol. 15: 438. 1917) is typified by *Myxomyriangium rickii* Rehm = *Saccardinula rickii* (Rehm) von Hohnel. *Saccardinula guarantica* Speg. is the type of the Saccardinulaceae Arnaud (Ann. Sci. Nat. Bot. ser. 10, 7: 647. 1925; as Saccardinulacées, nom. inval., ICBN, Art. 18). *Stephanotheca micromera* H. Sydow is the type of the Stephanothecaceae Petrak (Ann. Mycol. 29: 345. 1931, nom. inval., ICBN, Art. 32). O. Eriksson (1981) determined that the type species are leaf parasites and should be referred to the Elsinoaceae.

Cookellaceae von Höhnel ex Saccardo & Trotter in Saccardo, Syll. Fung. 22: 585. 1913.

Cookellaceen von Höhnel, Sitzungsber. Kaiserl. Akad. Wiss. Math.-Naturwiss. Cl. Abt. 1, 118: 354. 1909 (nom. inval., ICBN, Art. 18).

Ascomata irregular or crustose in face and side views; composed of pallid cells in gel matrix. Asci globose, scattered at various heights. Ascospores hyaline to light brown, muriform.

Hyperparasitic on other fungi (*Articularia, Microstoma*) on leaves.

Cookella microscopica Sacc. is found on infected leaves of *Quercus* in warmer regions of the north temperate zone. Species of *Uleomyces*, for example *U. sandwicensis* (Ellis & Everh.) von Arx, a Hawaiian species, parasitize various foliicolous ascomycetes in tropical regions. The family name Uleomycetaceae Moreau (Les Champign. 2: 1384. 1954) was not validly published as Uléomycetacées (ICBN, Art. 18).

Schizothyriaceae von Höhnel ex Trotter et al. in Saccardo, Syll. Fung. 24: 1254. 1928.

Schizothyrieen von Höhnel, Ber. Deutsch. Bot. Ges. 35: 417. 1917 (nom. inval., ICBN, Art. 18).

Ascomata rounded or elongate, scutate or thin crustose in side view, often fringed by delicate weft of hyphae. Asci subglobose or obovoid, in a layer separated by sparse cells. Ascospores hyaline to light brown, one to several septate.

Saprobic epiphytes on surface of leaves or branches, temperate and tropical regions.

The small and delicate ascomata are easily removed from the substrate. Three genera are represented in warm temperate regions, all with one-septate ascospores: *Leptophyma* with pallid yellowish to orange ascomata, *Plochmopeltis* with dark ascomata whose upper layer is composed of intricately lobed cells, and *Schizothyrium* with dark ascomata whose upper layer is composed of rounded or angular cells.

The Microthyriellaceae Luttrell (Univ. Missouri Stud. 3: 80. 1951, nom. inval., ICBN, Art. 36) was based on *Microthyriella rickii* (Rehm) von Höhnel = *Schizothyrium scutelliforme* (Rehm) von Arx. The Aulographaceae (Arnaud) Luttrell (The Fungi IVA: 209. 1973, nom. inval., ICBN, Art. 36) may belong in or close to the Schizothyriaceae. The few examples that I have studied are elongate and open by an irregular long slit. They lack the strong pigmentation and hyphopodia typical of hyphae in members of the Asterinales.

ARTHONIALES

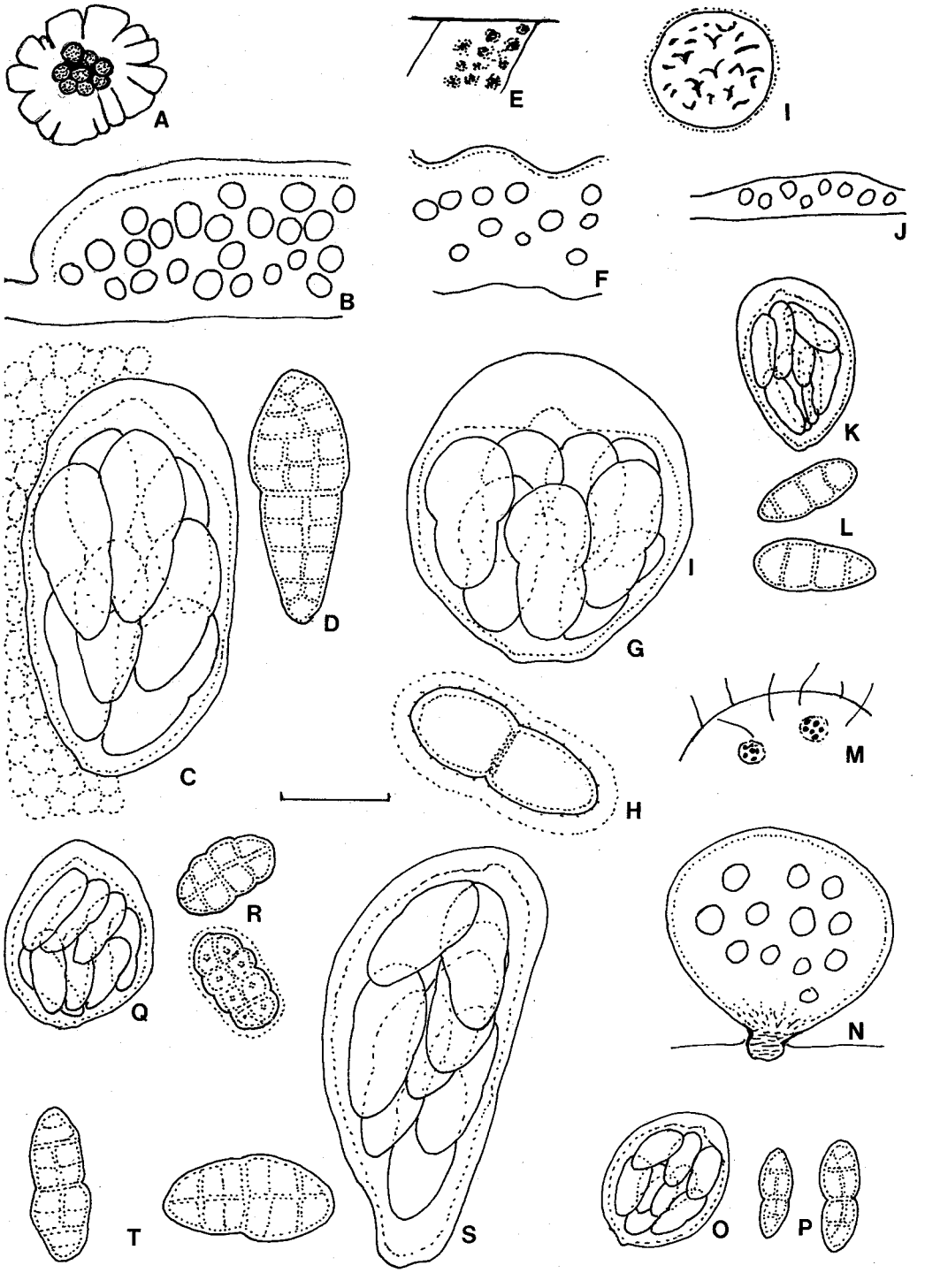
Henssen ex D. Hawksworth & O. Eriksson, Systema Ascomycetum 5(1): 177. 1986.

Ascomata indeterminate in growth; immersed in and erumpent from lichen thallus or epiphytic on leaves; irregular in shape in face view, discoid in section, small to medium sized; peridium scarcely differentiated; opening by disintegration of covering cells. Hamathecium at maturity of septate and sometimes anastomosing paraphysoids that form pseudoepithecium above asci. Asci clavate or subglobose, wall often bluing or reddening in iodine, semifissitunicate or fissitunicate. Ascospores hyaline or lightly pigmented, obovoid or ellipsoid, asymmetric, one to several septate, with longitudinal septa in some.

Anamorphs not known.

Lichenized in crustose thalli, lichen biotrophs, or epiphytic on living leaves.

Plate 1. Features of Myriangiales. A-D. Myriangiaceae: *Myriangium superficialis* (Peck & Clinton) Barr: A. habit of lobed stroma bearing ascomata; B, portion of vertical section through ascoma; C, ascus in tissues; D, ascospore. E-H. Seuratiaceae: *Seuratia millardetii* (Racib.) Meeker: E, habit on leaf; F, portion of vertical section through ascoma; G, ascus; H, ascospore. I-P. Elsinoaceae: I-L. *Elsinoë ledi*: I, habit of ascomata on spot in leaf; J, portion of vertical section through ascoma; K, ascus; L, ascospores. M-P. *Diplotheca tunae*: M, habit on cactus pad; N, vertical section through ascoma; O, ascus; P, ascospores. Q-T. Cookellaceae: Q, R. *Cookella microscopica*: Q, ascus; R, ascospores. S, T. *Uleomyces sandwicensis*: S, ascus; T, ascospores. Standard line = 150 µm for ascomata, 15 µm for asci and ascospores. Habit not to scale.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The Arthoniales, showing indeterminate growth and consequently forming irregular nonmargined or slightly margined ascomata, have these important features in common with the Myriangiales, where I had included them earlier (Barr 1979b). The Arthoniales differ from the Myriangiales in forming at maturity a hamathecium of septate paraphysoids whose tips above the asci are darkened as a pseudoepithecium; the ascus wall often blues in iodine. In the Arthoniaceae most taxa are lichenized whereas in the Phillipsiellaceae they are epiphytic. The family Chrysothricaceae Zahlbruckner (in Engler & Prantl, Die naturl. Pflanzenfam. 1(1*): 117. 1905) has also been referred to the Arthoniales (Poelt 1974a; O. Eriksson and Hawksworth 1986).

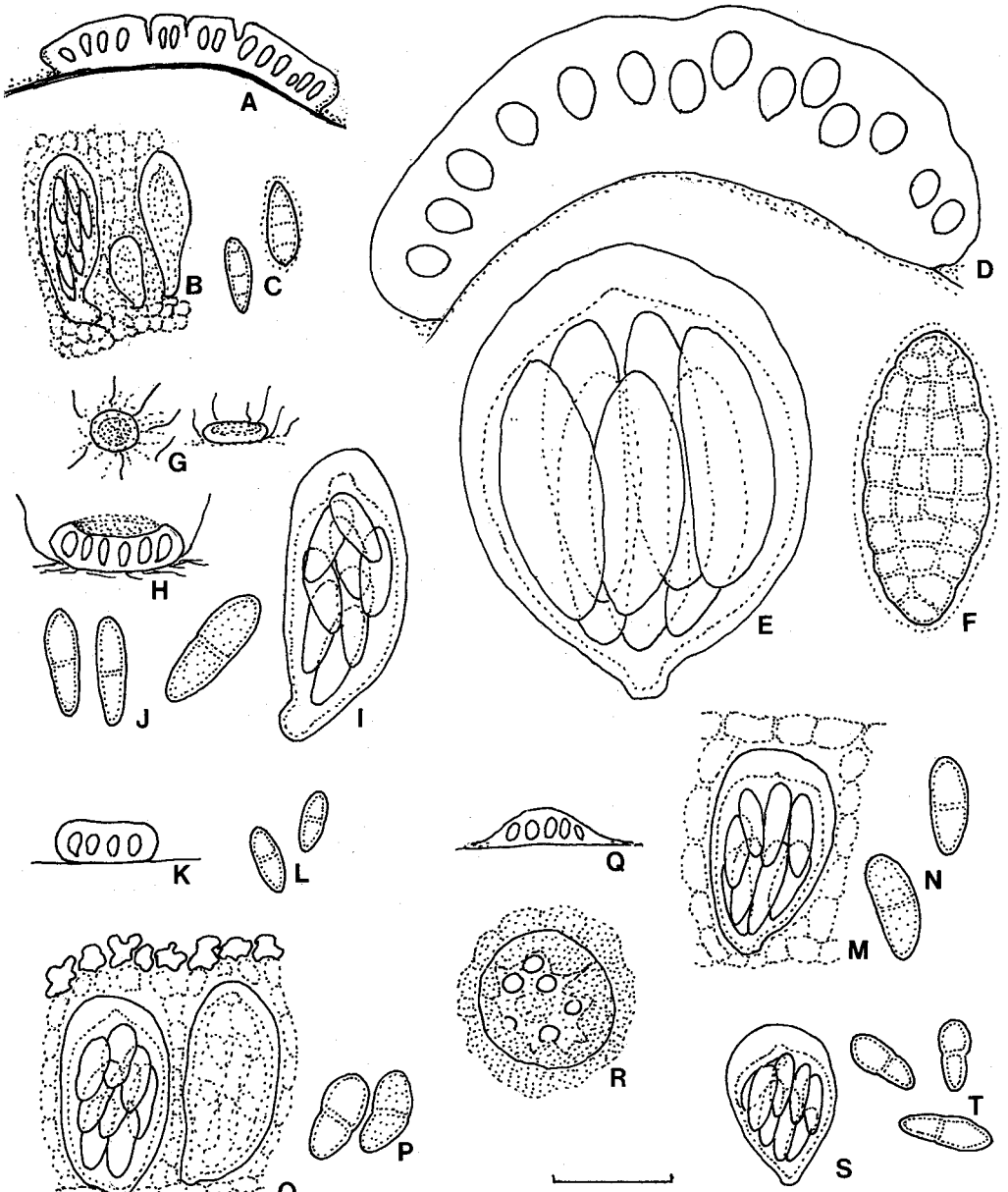
Arthoniaceae Reichenb. ex Reichenb. Der deutsche Botaniker 1. Das Herbarienbuch. Abt. 1: XXVII. 1841.

Ascomata rounded, elongate or irregular in face view, discoid in side view, composed of brown or yellowish to red pseudoparenchymatous cells. Hamathecium of paraphysoids, forming pseudoepithecium above. Asci in single layer or at various heights or scattered in small groups, oblong or obovoid or subglobose. Ascospores hyaline to light brown, transversely septate or muriform.

Usually lichenized, developing in inconspicuous crustose thallus, or nonlichenized on branches and leaves, temperate and tropical regions.

The genera *Arthonia* and *Arthothelium* are both represented in temperate regions, with transversely and muriformly septate ascospores respectively. Santesson (1952) discussed the complex synonymy of these genera and recognized also *Stirtonia* and *Cryptothecia*, with asci scattered or aggregated on the thallus and with transversely or muriformly septate ascospores respectively. The Cryptotheciaceae A. L. Smith (Trans. Brit. Mycol. Soc. 11: 190. 1926) then falls into synonymy with the Arthoniaceae. Nonlichenized taxa have been separated into the Celidiaceae (Massal.) Schröter (in Cohn, Kryptogamenflora

Plate 2. Features of Arthoniales and Myriangiales. A-F. Arthoniaceae: A-C. *Arthonia radiata* (Pers.) Ach.: A, vertical section through ascoma; B, asci in tissues; C, ascospores. D-F. *Arthothelium spectabile* Massal.: D, vertical section through ascoma; E, ascus; F, ascospore. G-L. Phillipsiellaceae: G-J. *Johansonia cupulata* (Ellis & G. Martin) Barr: G, habit of ascomata; H, ascoma in vertical section; I, ascus; J, ascospores. K, L. *Phillipsiella atrata* Cooke: K, ascoma in vertical section; L, ascospores. M-T. Schizothyriaceae: M, N. *Leptophyma aurantiacum* (Ellis & Everh.) Sacc.: M, ascus in tissues; N, ascospores. O, P. *Plochmopeltis intricata* (Ellis & G. Martin) Theissen: O, asci in tissues; P, ascospores. Q-T. *Schizothyrium perexiguum* (Rob. in Desm.) von Hohnel: Q, ascomata in vertical and R, face view; S, ascus; T, ascospores. Standard line = 150 µm for ascomata, 15 µm for asci and ascospores. Habit not to scale.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Schlesiens 3(2): 122, 133. 1893). Another family name that has been utilized is Coniocarpaceae Reichenb. (Der deutsche Botaniker 1. Das Herbarienbuch. Abt. 1: XXVIII. 1841), based on *Coniocarpon cinnabarinum* DC. = *Arthonia cinnabarina* (DC.) Wallr. *Tarbertia* Dennis (1974) may belong here, but perhaps is better arranged in the Phillipsiellaceae.

Phillipsiellaceae von Höhnel, Sitzungsber. Kaiserl. Akad. Wiss. Math.-Naturwiss. Cl. Abt. 1, 118: 359. 1909.

Ascomata rounded in face view, discoid in side view, often surrounded by a delicate weft of hyphae; setae present at times on hyphal weft or margin of ascoma; peridium scarcely differentiated, narrow, of upright few rows of pseudoparenchymatous cells. Hamathecium of paraphysoids that above are enlarged and form a pseudoepithecium. Asci subglobose to obovoid, subhymenium at times bluing in iodine. Ascospores hyaline or light brown, one or several septate or with longitudinal septa.

Saprobic, epiphytic on leaves, often around trichomes, warm temperate and tropical regions.

Von Höhnel (1909) described both the Phillipsiellaceae (p. 359) and the Saccardiaceae (p. 369) in the same article. It is difficult to separate two families so that only one is recognized here. Von Arx and Müller (1975) combined the two, under the name Saccardiaceae; earlier von Arx (1963) had included the fungi belonging here in the Myriangiales. In 1979 I arranged the Saccardiaceae in the Asterinales and the Phillipsiellaceae in the Hysteriales. O. Eriksson (1981) considered the Saccardiaceae to be of uncertain position and O. Eriksson and Hawksworth (1985, 1986) included the Phillipsiellaceae with the Patellariaceae in the Patellariales. The differences in peridium and paraphysoids between members of the Phillipsiellaceae and Patellariaceae are those of degree. The delicate, soft ascomata in the Phillipsiellaceae are scarcely margined and the paraphysoids, originating as rows of cells between asci, are quite irregular and deliquescent whereas the firm dark ascomata in the members of the Patellariaceae are definitely margined and paraphysoids are quite strandlike and permanent.

The small discoid ascomata are usually surrounded by an extensive but delicate hyphal weft. Two genera with didymospores illustrate the family: *Johansonia* forms setae on the hyphal weft, whereas *Phillipsiella* has a glabrous hyphal weft. Ascospores are several septate in *Cyanodiscus occidentalis* Müller and M. L. Farr, with blue-green ascomata that bear short setae (Müller and Farr, 1971).

ASTERINALES

Barr ex D. Hawksworth & O. Eriksson, Systema Ascomycetum 5(1): 177. 1986.

Ascomata superficial, uniloculate, minute or small, or forming locules in stroma, rounded or elongate or irregular in face view, dimidiate-scutate, discoid, globose or sphaeroid in side view, without definite apical pore, opening by

disintegration of upper cells of peridium or by irregular slits between cells; peridium thin, of one or few rows of pseudoparenchymatous cells, radiating outward or irregularly arranged, glabrous or setose, with ample and conspicuous superficial mycelium, dark, often hyphopodiate, or lacking superficial mycelium and with intramatrical hypostroma. Hamathecium lacking; remnants of gelatinizing hyphae or discharged ascus walls often present. Asci bitunicate, in basal layer, often only one or two in small ascomata, broadly ovoid or oblong, endotunica wide, at times surface bluing in iodine. Ascospores brown, rarely remaining hyaline, broadly ovoid, oblong, rarely tapered to ends, mostly one septate, some one celled or with additional septa; wall thickened and often surrounded by narrow gel coating.

Anamorphs hyphomycetous or coelomycetous where known; conidiogenesis blastic or tretic, conidia septate, dark brown.

Biotrophic, mostly tropical or warm temperate.

This order is much reduced from my earlier arrangement (Barr 1979b) of Asterinales to a more homogeneous group of taxa. The Schizothyriaceae and Stephanothecaceae are removed to the Myriangiales, the Saccardiaceae to the Arthoniales, the Capnodiaceae to the Capnodiales, and the Vizellaceae to the Pleosporales. Perhaps the Brefeldiellaceae also belongs in the Asterinales, although information available to me on these tropical fungi is not sufficient to be certain of position for the taxa of this family. The ascus shapes suggest that the family is not asterinaceous. Müller and von Arx (1962) assembled information on this family.

Within the order as circumscribed, the Parmulariaceae and Parodiopsidaceae seem readily separated, but family lines between the Asterinaceae and Englerulaceae are difficult to draw, e.g., the ascomata of *Asterina orbicularis* Berkeley & Curtis deliquesce at maturity as in the Englerulaceae, but they develop beneath the mycelium and have radiating basal tissues as in the Asterinaceae. Several taxa in the Asterinaceae and Englerulaceae have in common the bluing in iodine of the slimy surface of asci (O. Eriksson 1981); I have observed this reaction also in Swedish specimens of *Hysteropeltella moravica* Petrak (Holm and Holm 1978), which seems best disposed in the Parmulariaceae. Certain of the anamorphs in the Asterinaceae in *Clypeolella* and in the Englerulaceae in *Schiffnerula* have features in common (Hughes 1983). Hughes (1984) has now consigned *Clypeolella* to synonymy with *Schiffnerula*, thus eliminating these conflicts.

Relatively few taxa of the Asterinales occur in temperate North America, and the following information is limited to the genera that I have examined. For keys to taxa from tropical regions, one should consult Müller and von Arx (1962), Luttrell (1973), von Arx and Müller (1975). Sivanesan (1984) illustrated many species in both teleomorphic and anamorphic states.

Key to Families

1. Hyphae developed in substrate; ascomata frequently forming locules in enlarged stromata.....Parmulariaceae
1. Hyphae superficial, conspicuous; ascomata typically single or grouped and appearing as locules in stroma.....2
    2. Ascomata developing beneath mycelium, dimidiate-scutate, small to medium sized; peridium of radiating rows of cells, opening by irregular slits or by deliquescence of cells.....Asterinaceae
    2. Ascomata developing on mycelium, often from short side branches, globose or sphaeroid, cells of peridium not in radiating rows, opening by deliquescence of cells 3
3. Ascomata opening by disintegrating cells of upper peridium.....Englerulaceae
3. Ascomata opening by disintegrating cells of apical pore region.....Parodiopsidaceae

Asterinaceae Hansford, Mycol. Pap. 15: 188. 1946.

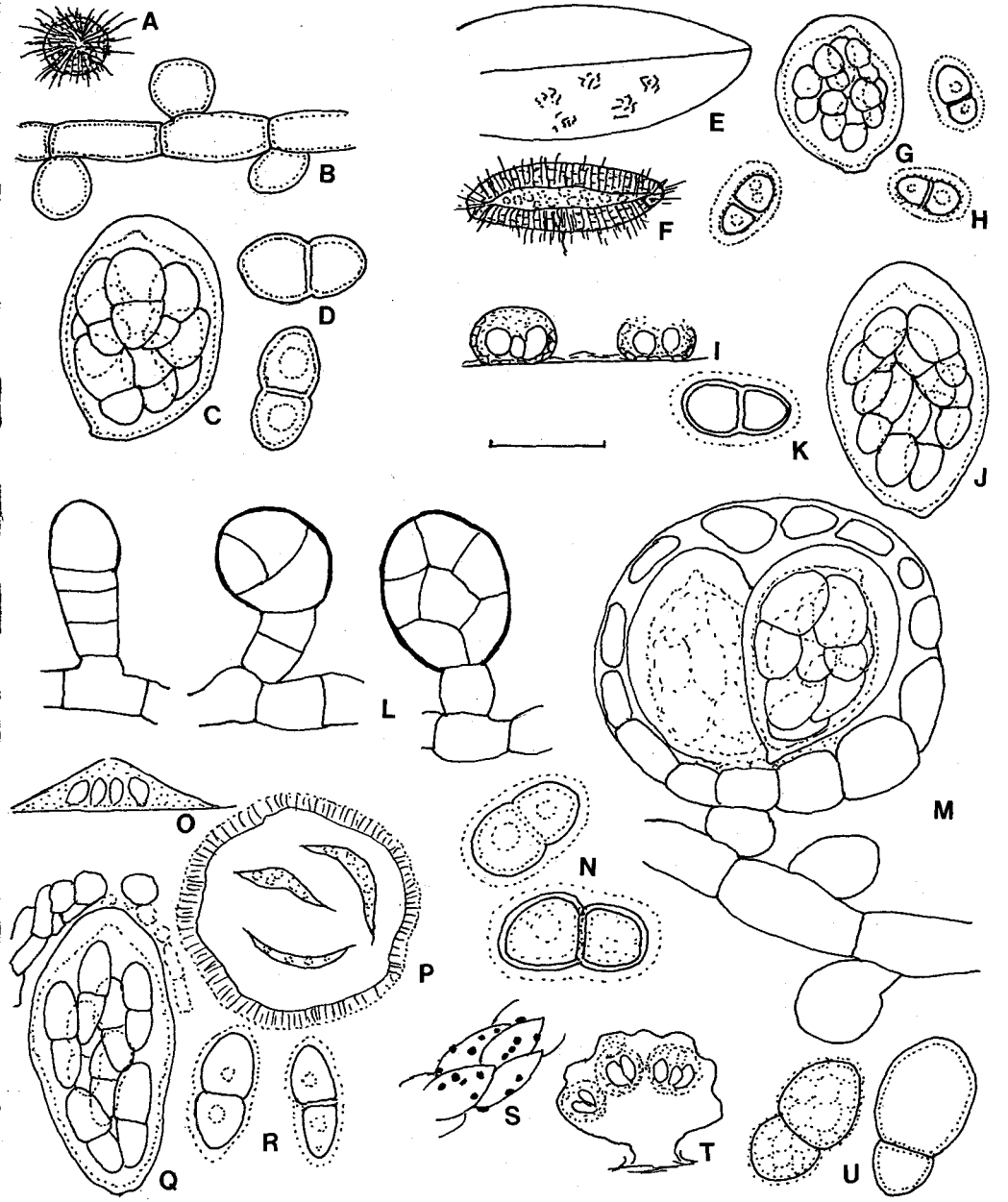
Ascomata rounded or elongate, dimidiate-scutate in side view, opening by irregular slits in upper regions or by deliquescence of cells; peridium dark, often composed of radiating rows of more or less isodiametric cells; superficial mycelium coarse, dark, often hyphopodiate, immersed mycelium subcuticular. Asci ovoid or subglobose. Ascospores brown at maturity, one septate, obovoid, asymmetric.

Anamorphs hyphomycetous; conidiogenesis blastic; conidia dark brown, septate; or coelomycetous with minute conidia (described as *Asterostomella, Clasterosporium, Pirozynskia, Septothyriella, Sporidesmium, Triposporium*).

Biotrophic on leaves, warm temperate and tropical regions.

Elongate ascomata and hyphae without hyphopodia separate *Lembosina* from the other genera with temperate-zone representatives whose ascomata are rounded or irregular and whose hyphae bear lateral hyphopodia. Species of *Maurodothina* were described and illustrated by Pirozynski and Shoemaker (1970). This genus was merged with *Eupelte* by von Arx and Müller (1975)

Plate 3. Features of Asterinales. A-H. Asterinaceae: A-D. *Asterina delitescens* Ellis & G. Martin: A, face view of ascoma; B, hyphopodiate hypha; C, ascus; D, ascospores. E-H. *Lembosina quercina* (Ellis & G. Martin) von Arx: E, habit on leaf; F, ascoma in face view; G, ascus; H, ascospores. I-K. Englerulaceae: *Rhytidenglerula carnea*: I, two ascomata in vertical section; J, ascus; K, ascospore. L-N. Parodiopsidaceae: *Balladynocallia* sp.: L, stages in formation of ascomata; M, ascoma on hyphopodiate hypha; N, ascospores. O-U. Parmulariaceae: O-R. *Hysterostomella sparsa:* ascomata in O, vertical and P, face view; Q, ascus; R, ascospores. S-U. *Coccodothis sphaeroidea*: S, habit of stromata on leaves; T, stroma in vertical section; U, ascospores. Standard line = 150 µm for ascomata except for M, 15 µm for asci and ascospores and ascoma M. Habits not to scale.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but Sivanesan (1984) retains two genera based upon anamorphic states. *Dothidasteromella* is now represented from temperate North America by *D. magnoliae* (Tracy & Earle) M. L. Farr (Farr 1986).

Englerulaceae P. Hennings, Hedwigia 43: 353-354. 1904.

Ascomata superficial, at times borne on short stalk, on dark brown usually hyphopodiate hyphae; small, sphaeroid; peridium of one or two rows of lightly pigmented cells, deliquescing from above and leaving asci exposed in gel matrix. Asci ovoid. Ascospores becoming brown, obovoid, one septate, usually surrounded by gel coating.

Anamorphs hyphomycetous; conidiogenesis blastic, conidia dark brown, several septate; or coelomycetous (described as *Capnodiastrum, Mitteriella, Questieriella, Sarcinella*).

Biotrophic on leaves, warm temperate and tropical regions.

Müller and von Arx (1962) described and illustrated taxa of this small family. Hughes (1983) elaborated on the *Sarcinella* and *Questieriella* synanamorphs of *Schiffnerula pulchra* (Sacc.) Petrak and two additional but undescribed species of *Schiffnerula* in temperate North America. The family is illustrated here by *Rhytidenglerula carnea* (Ellis & G. Martin) von Höhnel.

Parodiopsidaceae Toro, J. Agric. Univ. Puerto Rico 36: 66. 1952.

Ascomata superficial, often stalked, on short side branches of dark, superficial mycelium, mycelium at times hyphopodiate or setose; ascomata globose, small or medium sized; peridium narrow, one or two rows of dark cells, opening by deliquescence of small or large apical pore. Asci ovoid. Ascospores hyaline or brown, one or several celled, usually surrounded by gel coating.

Anamorphs hyphomycetous; conidiogenesis blastic, conidia dark brown, septate (described as *Septoidium, Tretospora*).

Biotrophic on leaves, warm temperate and tropical regions.

These fungi are scarcely known from temperate North America, although one may expect to find them in warmer regions and the family is included for that reason. Previously, I had (Barr 1972) incorporated it under the Pseudosphaeriaceae of the Dothideales, but affinities are more with asterinaceous fungi. Luttrell (1973) and von Arx and Müller (1975) provided keys to genera. Sivanesan (1981, 1984) illustrated a number of species. The family is illustrated by an undescribed species of *Balladynocallia* on leaves of *Melodinus* (Apocynaceae) from China. *Stomatogene*, arranged in the family by Müller and von Arx (1962), has the peridium composed of several rows of cells and produces small ascospores; the genus belongs in the Dothideales according to my understanding.

The Parodiellinaceae Arnaud (Les Asterinées, 21. 1918; nom. inval., ICBN, Art. 18), Parodiopsidaceae Luttrell (Univ. Missouri Stud. 24(3): 78. 1951; nom. inval., ICBN, Art. 36), and the Perisporiopsidaceae Müller and von Arx (Beitr. Kryptogamen-Flora Schweiz 11(2): 167. 1962; nom. inval., ICBN, Art. 36) are other names for this family.

Parmulariaceae Müller & von Arx ex Barr, Mycologia 71: 944. 1979.

Parmulariaceae Müller & von Arx, Beitr. Kryptogamen-Flora Schweiz 11(2): 29. 1962; nom inval., ICBN, Art. 36.

Ascomata superficial or subcuticular, arising from more or less well-developed subcuticular or epidermal or intramatrical hypostroma, without superficial hyphae; ascomata single or more often compound as locules in stroma; stroma discoid, pulvinate or crustose; locules in side view discoid or dimidiate-scutate, often elongate; peridium of single row of cells, irregular or radiating in arrangement of cells, opening by deliquescence or by irregular slits. Asci oblong or obovoid. Ascospores hyaline or light to dark brown, obovoid, asymmetric, one or several septate; often surrounded by narrow gel coating.

Anamorphs scarcely known, hyphomycetous; conidiogenesis blastic.

Biotrophic on leaves or stems, warm temperate and tropical regions.

Tropical taxa make up the majority of this family. For information on many genera one should consult Müller and von Arx (1962). Thus far, I have seen representatives of few genera in warm temperate North America. *Hysterostomella sparsa* (Peck & Clinton) Barr is an earlier name for *H. sabalicola* Tracy & Earle and has crustose stromata containing elongate locules. *Coccodothis sphaeroidea* (Cooke) Theissen & H. Sydow, on *Juniperus*, has pulvinate stromata containing rounded locules.

CAPNODIALES

Woronichin, Ann. Mycol. 23: 177. 1925.

Ascomata superficial in usually well-developed hyphal subiculum, minute to small sized, globose, sphaeroid, ovoid or vertically elongate, apex with small lysigenous pore, apparently without periphyses, surface glabrous or setose or bearing hyphal appendages; peridium composed of one or several rows of pseudoparenchymatous cells or compressed cells, surface mucilaginous at times; hyphae light or dark brown, cylindric or moniliform, smooth or roughened, repent, platelike, or upright, forming spongy masses at times. Hamathecium lacking. Asci oblong, ovoid or saccate, wall bluing in iodine at times, in basal fascicle. Ascospores hyaline or light to dark brown, asymmetric, obovoid or ellipsoid, one or several septate or with longitudinal septa.

Anamorphs coelomycetous and/or hyphomycetous.

Saprobic, often epiphytic over insect or plant exudates, on woody or occasionally herbaceous plants.

This narrow concept of the order for sooty moulds having a dothideaceous centrum excludes the Coccodiniaceae, included by Woronichin (1925), as well as the Chaetothyriaceae and Metacapnodiaceae, included by O. Eriksson and Hawksworth (1985, 1986). These families, with a hamathecium of short apical periphysoids, are arranged in the Chaetothyriales. The order Capnodiales is segregated from the Asterinales by nonhyphopodiate mycelium, small lysigenous apical pore, habit, and differing

anamorphs. From the Dothideales, the Capnodiales is separated by production of superficial ascomata in abundant subiculum and by differing anamorphs.

Hughes (1976) summarized much of the information on both teleomorphs and anamorphs in these families as well as in their counterparts that I assign to the Chaetothyriales. In a differing interpretation, Reynolds (1986) recognized the Capnodiaceae in the suborder Capnodioideae of the Dothideales and included within it the three families of the Capnodiales ss. meo as well as the Metacapnodiaceae.

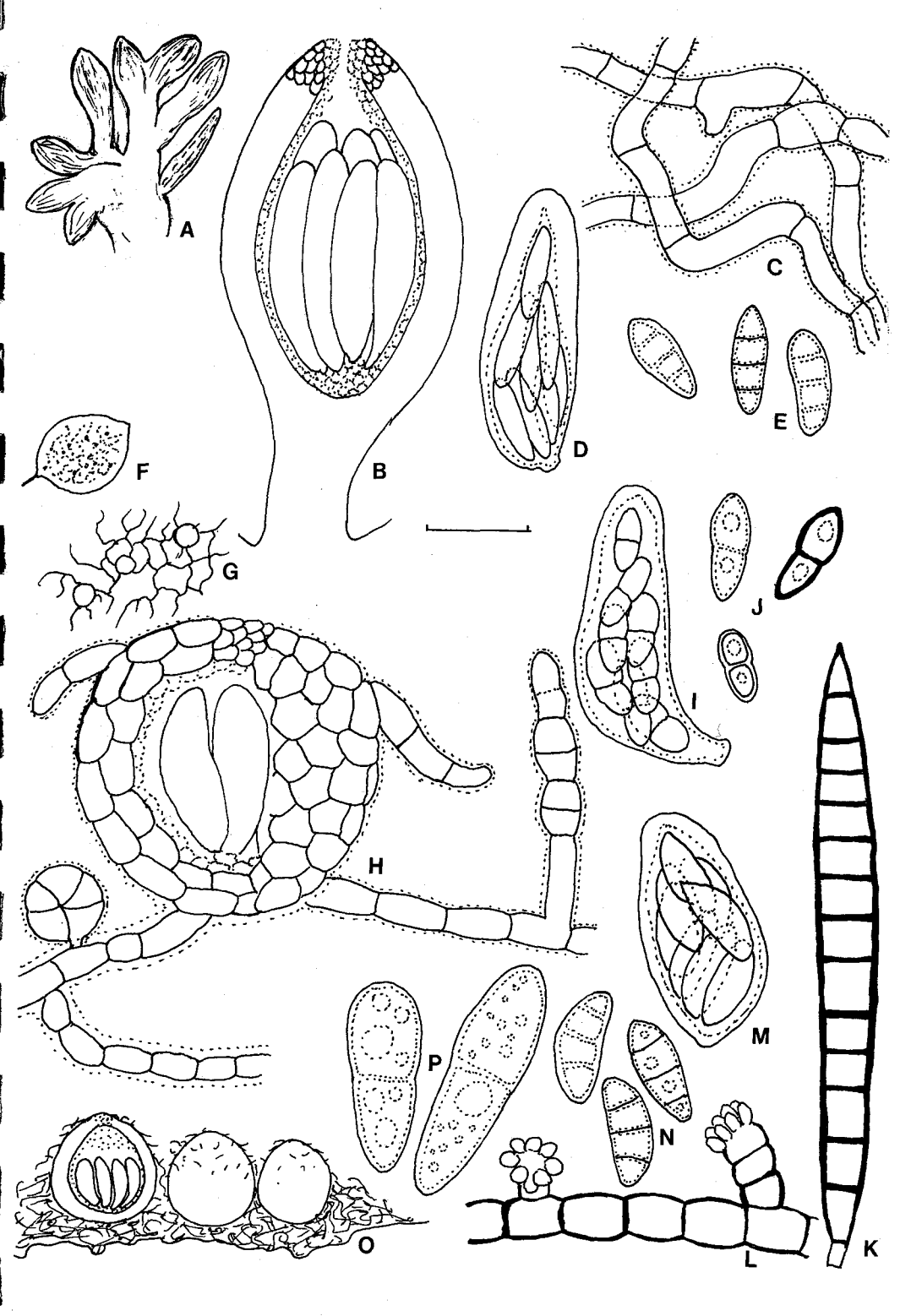
Key to Families

1. Hyphae more or less cylindric, surrounded by mucilaginous coating, often forming spongy masses; ascomata ovoid to vertically elongate; peridium with mucilaginous coating, glabrous or setose.....Capnodiaceae
1. Hyphae moniliform or more or less cylindric, not surrounded by mucilaginous coating, ascomata globose, ovoid or sphaeroid.....2
    2. Hyphae more or less cylindric to moniliform, dark brown, as turf of repent and upright branches; ascomata globose or ovoid, peridium of one or few rows of cells, bearing hyphal appendages or glabrous.....Antennulariellaceae
    2. Hyphae more or less cylindric, light to dark brown, as flattened weft or platelike layer and with upright fascicles; ascomata sphaeroid or globose, peridium composed of several rows of cells, bearing hyphal appendages.....Euantennariaceae

Capnodiaceae (Sacc.) Theissen & H. Sydow, Ann. Mycol. 15: 471. 1917.

Ascomata minute to small sized, often ovoid or vertically elongate, superficial in more or less cylindric hyphae, light to dark brown, walls mucilaginous; peridium narrow, composed of one or few layers of large pseudoparenchymatous cells, surface encrusted with mucilaginous layer, glabrous or setose; hyphae as repent layer or forming spongy masses. Asci saccate, in fascicle. Ascospores brown, narrowly or broadly obovoid, asymmetric, transversely septate or muriform.

Plate 4. Features of Capnodiales. A-E. Capnodiaceae: *Scorias spongiosa:* A, outline of habit, portion of spongy mass; B, ascoma in vertical section; C, hyphae; D, ascus; E, ascospore. F-J. Antennulariellaceae: *Antennulariella alpina*: F, habit on leaf; G, habit enlarged; H, ascoma in vertical section, blastoconidia; I, ascus; J. ascospores. K-P. Euantennulariaceae: K-N. *Euantennaria rhododendri* (Woronichin) Hughes: K, blastoconidium; L, phialoconidia on short hyphal branches; M, ascus, N, ascospores. O-P. *Rasutoria abietis*: O, habit of ascomata on leaf surface; P, ascospores. Standard line = 150 µm for A and O, 15 µm for remainder except for habits. Habits not to scale.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Anamorphs coelomycetous; pycnidia elongate or stipitate; producing macroconidia (described as *Fumagospora*, *Phaeoxyphiella*) or microconidia (described as *Conidiocarpus*, *Polychaeton*, *Scolecozyphium*).

Epiphytic on leaves and branches, often over insect exudates. Cosmopolitan.

Key to Genera

1. Ascospores muriform; ascomata glabrous.....*Capnodium*
1. Ascospores transversely septate.....2
   2. Ascomata glabrous.....*Scorias*
   2. Ascomata setose.....*Phragmocapnias*

The narrow concept of the Capnodiaceae follows the separation of this family from other sooty moulds summarized by Hughes (1976). The family is recognized by the mucilaginous coating over hyphae, ascomata and pycnidia, as well as by the shapes of ascomata and pycnidia. As far as I can determine, apical periphysoids are not formed, despite Reynolds' (1978) claims, although delicate periphyses may be present in the ostiolar region in species of *Capnodium*. *Scorias spongiosa* (Schwein.) Fr. illustrates the family. This taxon when well developed forms spongy black masses over leaves and twigs of *Fagus* in eastern North America.

Antennulariellaceae Woronichin, Ann. Mycol. 23: 178. 1925.

Ascomata minute or small, globose or ovoid, superficial, sessile or borne on short stalk, developed from terminal or intercalary cell of aerial hyphae, surface glabrous or with hyphal appendages; hyphae irregular, cylindric to moniliform, dark, smooth or rough walled, repent or upright as turf; peridium narrow, often only one or two cells thick. Asci ovoid, in fascicle. Ascospores hyaline or light to dark brown, obovoid, 1-(3-)septate.

Anamorphs coelomycetous or hyphomycetous; conidiogenesis holoblastic (described as *Antennariella*, *Capnodendron*).

Epiphytic on various plants, cosmopolitan.

Species of *Antennulariella* have ascomata bearing hyphal appendages whereas those of *Achaetobotrys*, not yet known from North America, have glabrous ascomata. An example of *Antennulariella* from California is *A. alpina* (W. B. Cooke) Barr. According to the paratype (W. B. Cooke 15711, MICH) as well as W. B. Cooke 20479 (MICH) and 32943 (MASS), on leaves of *Pentstemon*, the small ascomata, 70-106 µm diam, develop from hyphal cells, bear short hyphal appendages, and contain a fascicle of oblong asci, 40-64 x 9.5-13.5 µm, with obovoid ascospores yellow to dark brown, one septate, 10.5-14.5 x 4-5 µm. The subiculum is composed of dark, cylindric or moniliform hyphae, smooth or rough walled. No pycnidia containing conidia were observed, but "chlamydospores" on hyphae are probably immature pycnidia. Blastoconidia of the *Capnodendron* state are 9-10 x 6-7.5 µm.

According to the description and illustration by Farr (1979), *Dimeriella hirtula* Speg., the type species of that genus, should also belong in the Antennulariellaceae. The hyphae of the subiculum are in part moniliform, the minute ascomata bear hyphal appendages, and asci and ascospores are in accord with those of the family.

Euantennariaceae Hughes & Corlett in Hughes, New Zealand J. Bot. 10: 238. 1972.

Ascomata sphaeroid or globose, minute to small sized, superficial in hyphal subiculum, hyphae more or less cylindric, cells usually longer than wide, light to dark brown, smooth or rough walled, repent or platelike and bearing erect branches; peridium of several rows of cells, bearing hyphal appendages. Asci oblong saccate, in fascicle. Ascospores light to dark brown, ellipsoid fusoid, one or several septate or muriform, ends mucronate at times.

Anamorphs hyphomycetous; conidiogenesis holoblastic or enteroblastic phialidic (described as *Antennulata, Capnokyma, Hormisciomyces, Plokamidomyces, Trichothallus*).

Epiphytic on various woody plants, cosmopolitan.

Hughes and Corlett (in Hughes 1972) included only *Euantennaria* and *Trichopeltheca* in the family. The latter genus is southern hemispheric in distribution (Hughes 1965). Another group of species that has many characteristics of the Euantennariaceae includes those on leaves of conifers studied by Farr (1963) who termed it a single species *Dimeriella balsamicola* (Peck) Petrak, and by Shoemaker (1965) who recognized several species in *Epipolaeum*. These specimens were recently reassigned by Farr (1984) as *Eudimeriolum tsugae* (Dearness) M. L. Farr. Earlier she (Farr 1979) had recognized *Eudimeriolum* as pleosporaceous with pseudoparaphyses, when she synonymized *Epipolaeum* with *Lasiostemma*. Both *Eudimeriolum* and *Lasiostemma* are arranged in the Dimeriaceae, Pleosporales. The species in question (I agree with Shoemaker in recognizing at least four) have cylindric hyphae that form a subiculum, superficial ascomata bearing hyphal appendages, peridium of several rows of cells, aparaphysate saccate asci, and hyaline to light brown, one-septate, obovoid ascospores. None has been recorded as producing an anamorph, which is a deviation from the other members of the family; even so, the teleomorphic features are those of the Euantennariaceae. No genus name seems to be available to accommodate these organisms and the genus *Rasutoria* acknowledges the contributions made by R. A. Shoemaker to understanding of these as well as many other ascomycetous fungi. The genus includes *R. abietis* (Dearness) Barr and related species (Barr 1987b). Centrum organization in representatives of both *Euantennaria* and *Trichopeltheca* was described and illustrated by Corlett, Hughes and Kaufert (1973).

DOTHIDEALES

Lindau in Engler & Prantl, Nat. Pflanzenfam. 1(1): 373. 1897.

Ascomata immersed, erumpent or superficial at times, minute, small or medium sized; uniloculate or as few or many locules in pulvinate, rounded, peltate or crustose stromata; globose, sphaeroid, ovoid or conoid; opening by apical pore formed lysigenously or schizogenously, ostiolar canal at times periphysate; stromatic tissues and outer peridium of ascomata of pseudoparenchymatous cells or cells in radiating rows, rarely forming cephalothecoid plates, inner peridium of few layers of compressed, pallid cells. Hamathecium lacking; disintegrating cells or interthecial cells often visible above asci. Asci ovoid, saccate, oblong or clavate, in basal layer or basal fascicle. Ascospores hyaline, lightly pigmented or dark brown, variable in shape and size, symmetric or asymmetric, straight or inequilateral; occasionally one celled, frequently one or several septate or muriform at times.

Anamorphs either coelomycetous or hyphomycetous where known; conidiogenesis holoblastic or enteroblastic.

Biotrophic, saprobic, hypersaprobic, on herbaceous or woody plants.

The present concept of the Dothideales is considerably restricted from the all-inclusive Dothideales (= Loculoascomycetes) of von Arx and Müller (1975) or the broad concept of O. Eriksson and Hawksworth (1985, 1986). It also deviates in several respects from my earlier versions (Barr 1972, 1979b). The order Capnodiales is separated to emphasize differences in habit, presence of abundant subiculum, superficial ascomata and unique anamorphs. The family Herpotrichiellaceae is removed to the Chaetothyriales, based on the presence of a hamathecium of short periphysoids. The Mycoporaceae and Lichenotheliaceae are recognized, each for some distinctive taxa. A new family Kriegeriellaceae accommodates taxa that are hypersaprobic, having superficial conoid ascomata with applanate bases, and lateral peridium of radiating rows of cells. The monotypic family Eremomycetaceae, with cleistothecioid ascomata and cephalothecoid peridium, is tentatively included here (Malloch and Cain 1971).

Key to Families

1. Ascomata superficial in sparse weft of narrow hyphae or in crustose layer of pseudoparenchymatous cells, saprobic or hypersaprobic.....2
1. Ascomata immersed erumpent or if superficial with innate hyphae or hypostromatic foot.....4
    2. Ascomata epiphytic, hypersaprobic, in sparse hyphae, conoid with applanate base; peridium of radiating rows of cells.....Kriegeriellaceae
    2. Ascomata saprobic, in weft of hyphae or crustose layer of pseudoparenchymatous cells, sphaeroid or discoid; peridium of pseudoparenchymatous cells.....3

3. Ascomata in weft of yellowish to grayish hyphae; ascospores hyaline to light brown, wall thin.....Mycoporaceae
3. Ascomata in pseudoparenchymatous crust; ascospores light to dark brown, wall thick and often verrucose.....Lichenotheliaceae
4. Ascomata globose or sphaeroid, uniloculate; interthecial tissues present, often separating asci; asci oblong, ovoid or saccate, in basal layer; ascospores hyaline or lightly pigmented, occasionally brown, usually surrounded by broad gel coating.....Pseudosphaeriaceae 44
4. Ascomata globose, sphaeroid, pulvinate or as locules in stroma; interthecial tissues present but disintegrating cells not visible above asci; ascospores hyaline or shades of brown, gel coating narrow when formed.....5
5. Ascomata pulvinate or sphaeroid, locule broad, ringlike at times, opening widely by lysigenous breakdown at maturity; asci oblong or clavate, numerous, in basal layer or from protruding cushion of hypothecial cells; ascospores hyaline or lightly pigmented, usually containing minute guttules in each cell.....Dothioraceae 43
5. Ascomata sphaeroid, globose or ovoid or as locules in stromata, opening by small lysigenous or schizogenous pore at maturity; asci oblong, ovoid or saccate, few or numerous in narrow or broad basal fascicle; ascospores hyaline or shades of brown, usually containing one or two globules in each cell.....Dothideaceae 39

Dothideaceae Chevalier, Flore générale des environs de Paris...1: 446.1826.

Ascomata uniloculate or as multiloculate stromata, immersed, erumpent or superficial with innate hyphae; globose, ovoid or sphaeroid, minute or small to medium sized; stromata pulvinate, peltate or crustose; apical pore simple, opening by disintegrating cells, or schizogenous with short periphyses formed in canal; peridium narrow, of compressed rows of cells within outer row(s) of pseudoparenchymatous cells. Asci oblong, ovoid or saccate, few to numerous in fascicle. Remnants of locule cells often visible above and around asci. Ascospores hyaline or shades of brown, obovoid, fusoid or elongate, unicellular or one or several septate or muriform; gel coating present at times; contents usually with one or two globules per cell.

Anamorphs coelomycetous or hyphomycetous where known; conidiogenesis holoblastic, sympodial, basipetal or percurrent; microconidial states often formed (described as *Aureobasidium, Cercoseptoria, Cercospora, Cladosporium, Lecanosticta, Ovularia, Pazschkiella, Polythrincium, Ramularia, Septoria, Stenella*).

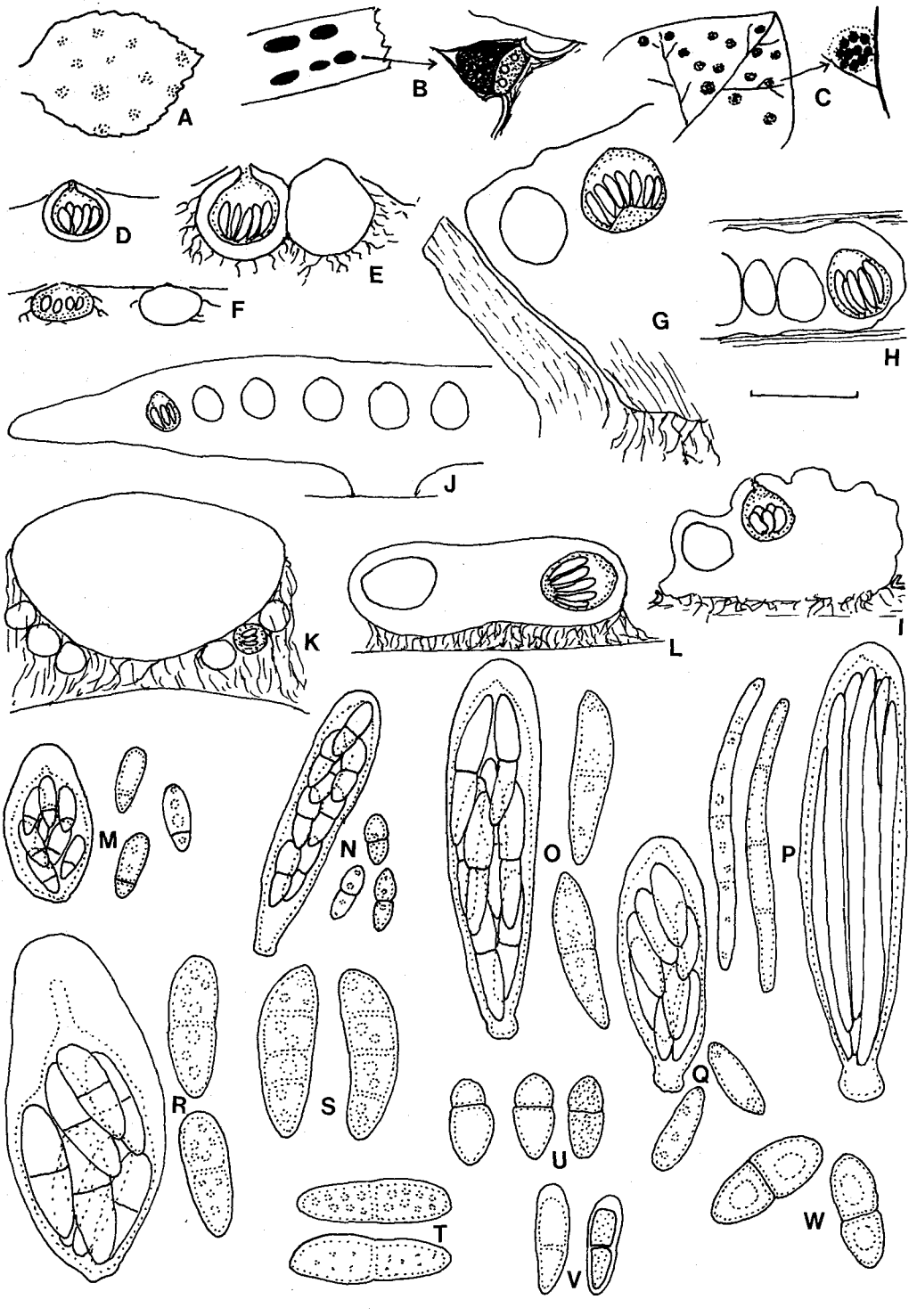
Biotrophic, hemibiotrophic or saprobic, on numerous substrates, cosmopolitan.

The family Dothideaceae is accepted in a broad sense that also includes taxa placed in the Mycosphaerellaceae by von Arx and Müller (1975), O. Eriksson and Hawksworth (1985, 1986). Additional synonymous names include Ascosporaceae Bonorden

(Handbuch der allgeimen Mykologie: 62. 1851), Sphaerellaceae Nitschke (Verh. Naturhist. Preuss. Rheinl. 26: 74. 1869), and Mycosphaerellaceae Lindau in Engler & Prantl (Die naturl. Pflanzenfam. 1(1): 421. 1897). I have been unable to find consistent features to recognize two families. Character states that seemed plausible, such as woody vs. herbaceous substrates, stromata containing numerous locules vs. separate or grouped ascomata often with hyphal connections, lysigenous vs. schizogenous ostioles, each provided a different assortment of genera. These characters are useful at generic or specific but not familial levels.

The Dothideaceae includes some multiloculate taxa from my earlier concept (Barr 1972) of the Dothioraceae, i.e., *Coccoidella, Scirrhia* and *Plowrightia*. Following Holm and Holm (1978) *Scirrhodothis, Scirrhophragma* and *Metameris* are included under *Scirrhia*. *Plowrightia* is reinstated and transferred to the Dothideaceae; even though the stromata have the aspect of the Dothioraceae they contain separate locules, each opening by a small pore, rather than a broad hymenium that opens widely at maturity. I follow here L. Holm (1957, 1975a) who includes *Scleropleella* in this family, separating it from *Leptosphaerulina* in the Pseudosphaeriaceae where I had originally consigned the genus (Barr 1972). Two lichenicolous genera with one-septate ascospores -- *Endococcus* (Hawksworth 1979) and *Stigmidium* (Hawksworth 1975) also belong in the family.

Plate 5. Features of Dothideales. Dothideaceae: A-C. Habit sketches: A, ascomata in leaf of *Mycosphaerella punctiformis* (Pers.: Fr.) Starb.; B, erumpent stromata of *Dothidea puccinioides* Fr.; C, superficial stromata of *Lasiobotrys lonicerae* (Fr.) Kunze. D-L. Ascomata and stromata: D, *Mycosphaerella punctiformis*, ascoma; E, *Sphaerulina tarda* (Harkness) Barr, ascomata; F, *Scleropleella personata* (Niessl) von Höhnel, ascomata; G, *Dothidea puccinioides*, part of erumpent stroma; H, *Scirrhia osmundae* (Peck & Clinton) von Arx, part of crustose stroma; I, *Cymadothea trifolii* (Pers.) Wolf, erumpent crustose stroma; J, *Coccoidella scutula* (Berkeley & Curt.) von Höhnel, part of superficial peltate stroma; K, *Lasiobotrys lonicerae*, superficial stroma with separate ascomata; L, *Rhizogene impressa* (Ellis & Everh.) Barr, superficial stroma with marginal locules. M-W. Asci and/or ascospores: M, *Omphalospora stellariae* (Lib.) Theissen & H. Sydow; N, *Mycosphaerella punctiformis*; O, M. *ranunculi* (Karst.) Lind; P, *Sphaerulina tarda*; Q, *Discosphaerina fagi* (Hudson) Barr; R, *Cymadothea trifolii*; S. *Scleropleella personata*; T, *Coccoidella scutula*; U, *Rhizogene impressa*; V, *Scirrhia osmundae*; W, *Dothidea tuberculiformis* Ellis. Standard line = 150 µm for D-L, 15 µm for M-W. Habits not to scale.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Mycosphaerella is accepted for an unwieldy group of fungi that shows considerable variation in both teleomorph and anamorph (von Arx 1983) and that should be reassessed. The detailed study of three species on pines (Evans 1984) sets an example for future investigations. *Cymadothea* does seem to be separable. *Diplosphaerella polyspora* (Johans.) Grove seems more a polysporous member of the Dothideaceae than a species of *Delphinella* in the Dothioraceae. Some of the genera in the following key are not known as yet from temperate North America, e.g., *Euryachora* and *Dictyodothis* (see Barr 1981). *Microcyclus tinctoria* (Tulasne) von Arx has been reported from North America but the specimens I have seen under this name, collected in New York, South Carolina, and California, are *Dothidea puccinioides*, often immature or overmature. *Dothidea* Fr. and *Stylodothis* von Arx and Müller do not seem to be separate genera; *Dothidea tuberculiformis* shows type of stroma and fascicle of asci from a low mound as in *D. puccinioides* (the type of *Stylodothis*), but ascospores as in *D. sambuci* (the type of *Dothidea*).

Key to Genera

1. Ascomata as locules in erumpent or superficial, pulvinate or peltate stromata.....2
1. Ascomata immersed erumpent, separate and uniloculate or grouped with ample connecting hyphae or as locules in rounded or elongate stromata that are not widely erumpent.....9
2. Ascospores brown; stromata saprobic or hemibiotrophic...3
2. Ascospores hyaline or lightly pigmented.....4
3. Ascospores one septate.....*Dothidea*
3. Ascospores muriformly septate.....*Dictyodothis*
4. Stromata erumpent from substrate.....5
4. Stromata superficial with free hyphae, biotrophic.....7
5. Ascospores one celled; biotrophic.....*Melanodothis*
5. Ascospores one (three) septate.....6
6. Stromata saprobic or hemibiotrophic.....*Plowrightia*
6. Stromata biotrophic.....*Microcyclus*
7. Stromata peltate with footlike hypostroma; ascospore septum median.....*Coccoidella*
7. Stromata pulvinate; ascospore septum supramedian.....8
8. Stromata containing marginal locules.....*Rhizogene*
8. Stromata without locules, ascomata separate and free around base of stroma in hyphae.....*Lasiobotrys*
9. Ascomata as rounded or elongate crustose stromata containing several small locules.....10
9. Ascomata separate and uniloculate or grouped with ample connecting hyphae.....13
10. Ascospores apiosporous; asci saccate.....*Omphalospora*
10. Ascospores medianly septate; asci oblong.....11
11. Stromata subcuticular; locules, asci and ascospores minute.....*Euryachora*
11. Stromata intraepidermal or deeper; locules, asci and ascospores larger sized.....12

12. Stromata elongate, containing immersed locules.*Scirrhia*
12. Stromata crustose, rounded, bearing erumpent ascomata..
.....*Cymadothea*
13. Ascospores one celled.....*Discosphaerina*
13. Ascospores one or more septate.....14
14. Ascospores one septate.....*Mycosphaerella*
14. Ascospores several septate.....15
15. Ascospores narrowly elongate (ratio 5-6:1).....*Sphaerulina*
15. Ascospores shorter (ratio 3-3.5:1).....*Scleropleella*

Dothioraceae Theissen & H. Sydow, Ann. Mycol. 15: 444. 1917.

Ascomata immersed erumpent, separate or often gregarious; pulvinate or sphaeroid, small to large, stromatic in aspect but uniloculate with broad sphaeroid or at times ringlike locule; apex opening by crumbling of cells forming large pore or excavated region; peridium of large, dark, pseudoparenchymatous cells, often with abundant brown hyphae in substrate. Asci oblong or clavate, in broad basal layer or at times raised over protruding mound of hypothecial cells, octo- or polysporous. Cellular remnants often abundant around and over asci. Ascospores hyaline, yellowish or dull brown, mostly obovoid, one celled or one or several septate or muriform; contents with numerous guttules; wall smooth, at times surrounded by narrow gel coating.

Anamorphs coelomycetous where known; conidiogenesis holoblastic (described as *Dothichiza, Sclerophoma*); *Hormonema* state produced in culture.

Biotrophic or hemibiotrophic, usually on woody branches or conifer leaves or cone scales, widespread.

This concept of the Dothioraceae excludes a number of genera that I had included earlier (Barr 1972). One important change is the removal of *Botryosphaeria*, not only from the family but to the Pleosporales. More observations have shown that other investigators were correct in ascribing pseudoparaphyses within the locules in species of *Botryosphaeria*. Only in younger stages do these locules resemble those of members of the Dothioraceae. Genera with small locules in a stroma, i.e., *Coccoidella, Scirrhia, Plowrightia*, are removed to the Dothideaceae. Thus reduced, the Dothioraceae is a rather consistent grouping of taxa having large or small ascomata and broad locules, in which genera are separated chiefly by ascospore septation and numbers of ascospores within the ascus. Froidevaux (1973) provided a detailed survey of European species in the family. He utilized *Pringsheimia saepincola* (Fr.) von Höhnel for *Saccothecium saepincola* (Fr.) Fr. as did von Arx and Müller (1975) and others. L. Holm (1975b) argued for lectotypification of *Saccothecium* Fr. 1835 by *S. saepincola* (Fr.) Fr. 1849; *Saccothecium* Montagne 1834 is a *nomen nudum*. The Pringsheimiaceae Chadefaud (Traité de Bot. Syst. 1: 584. 1960) is an illegitimate name (ICBN, Art. 18).

Key to Genera

1. Ascospores one celled, hyaline.....*Bagnisiella*
1. Ascospores septate, hyaline, yellowish or light dull brown..2
2. Ascospores one septate; asci polysporous.....*Delphinella*
2. Ascospores more than one septate, often muriform.....3
3. Asci polysporous.....*Sydowia*
3. Asci octosporous.....4
4. Ascomata sphaeroid; asci arising over protruding mound of hypothecial cells.....*Saccothecium*
4. Ascomata pulvinate or sphaeroid; asci arising over flat base.....*Dothiora*

Pseudosphaeriaceae von Höhnel, Sitzungsber. Kaiserl. Akad. Wiss. Math.-Naturwiss. Cl. Abt. 1, 116: 129. 1907.

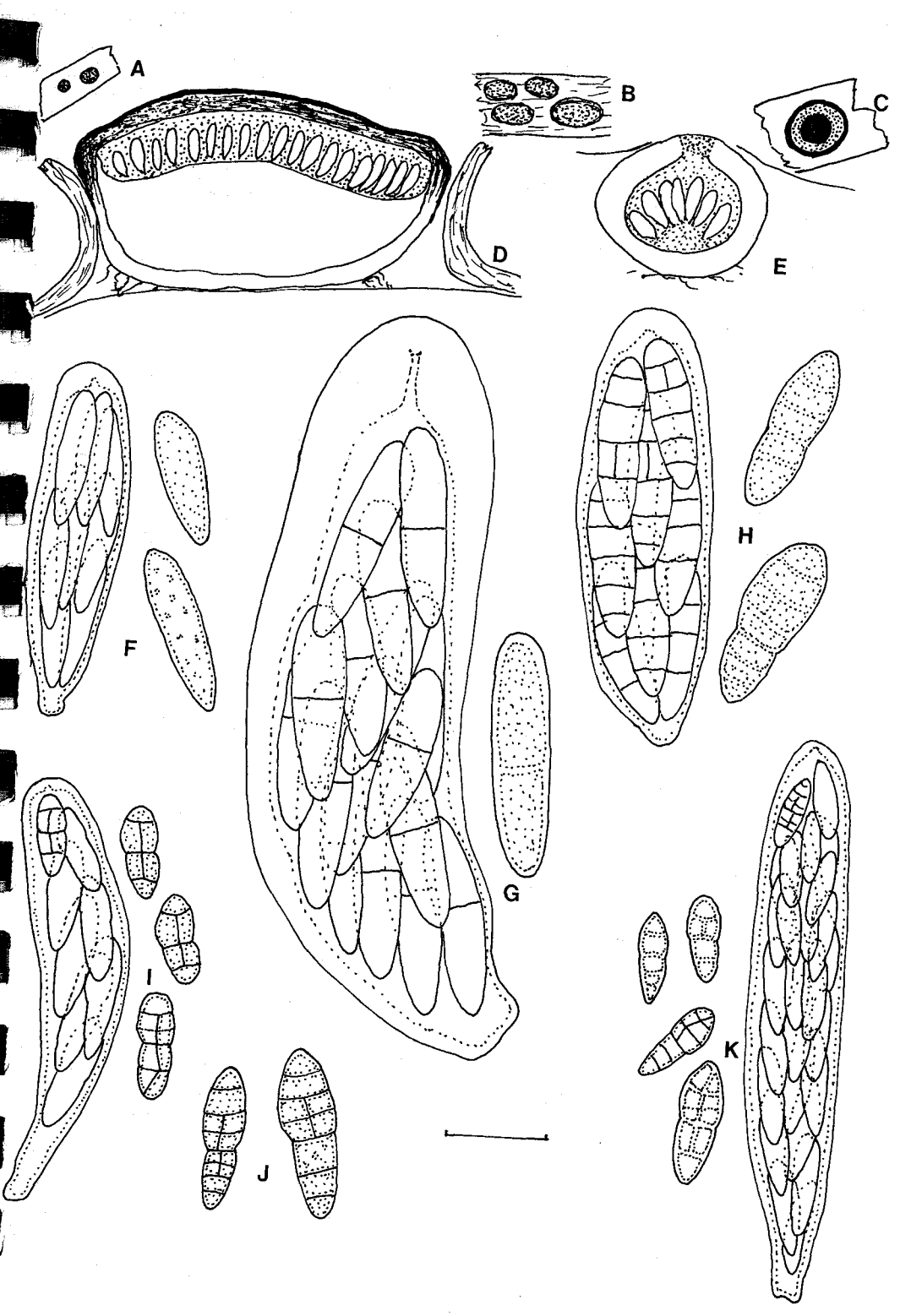
Ascomata immersed erumpent or superficial with hyphae into stomatal cavity and deep into tissues, minute to small sized, globose or sphaeroid, apical pore opening by disintegrating cells or dehiscing in caplike fashion; peridium broad or narrow, composed of pseudoparenchymatous cells. Asci saccate, ovoid or oblong, relatively few in basal layer. Remnants of interthecial tissues often remaining between and above asci. Ascospores hyaline, yellowish or light brown, rarely becoming dark brown, obovoid or elongate fusoid, one or several septate or muriform; typically surrounded by gel coating, wall verruculose in age; contents with one globule or several guttules per cell.

Anamorphs not known for most taxa (holoblastic *Pithomyces* for *Leptosphaerulina chartarum* Roux; Roux 1986).

Biotrophic or saprobic, usually on herbaceous plants or monocot leaves and culms, widespread, especially in colder regions.

Several changes have developed in the arrangement of genera of the Pseudosphaeriace since my earlier study (Barr 1972). The family Parodiopsidaceae is removed to the Asterinales but *Stomatogene* is retained in the Pseudosphaeriaceae because of similarities of peridium and interthecial tissues to other members of this family. *Dermatina (= Mycoporum)* and *Extrawettsteinina* are both removed to separate families in the Dothideales. *Pyrenophora* has been separated as the type genus of

Plate 6. Features of Dothideales. Dothioraceae: A-C. Habit sketches of ascomata: A, *Bagnisiella australis* Speg.; B, *Dothiora harknessii* (Ellis & Everh.) Barr; C, *D. pyrenophora* (Fr.) Fr., sectioned horizontally to show peripheral hymenium. D, E. Ascomata in vertical section: D, *Bagnisiella australis*; E, *Saccothecium saepincola*. F-K. Asci and ascospores: F, *Bagnisiella australis;* G, *Delphinella balsameae* (Waterman) Müller; H, *Saccothecium saepincola*; I, *Dothiora harknessii*; J, *D. pyrenophora*; K, *Sydowia dothideoides* Dearness & Bartholomew. Standard line = 150 µm for D, E, 15 µm for F-K. Habits not to scale.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the Pyrenophoraceae in the Pleosporales (Barr 1979b). *Macroventuria* (van der Aa, 1971) is added; it is obviously related to *Leptosphaerulina* by cultural characteristics. *Norrlinia* is another relative of *Leptosphaerulina*, parasitic in lichen thalli, and was placed here by Hawksworth (1980). *Scleropleella* is separated from *Leptosphaerulina* and removed to the Dothideaceae; the narrowly obovoid-fusoid, transversely septate ascospores of the former are quite different from the broadly obovoid often muriform ascospores of the latter. The recent article by Shoemaker and Babcock (1987) presents a revision of the species of *Wettsteinina* and removes a number of taxa from that genus.

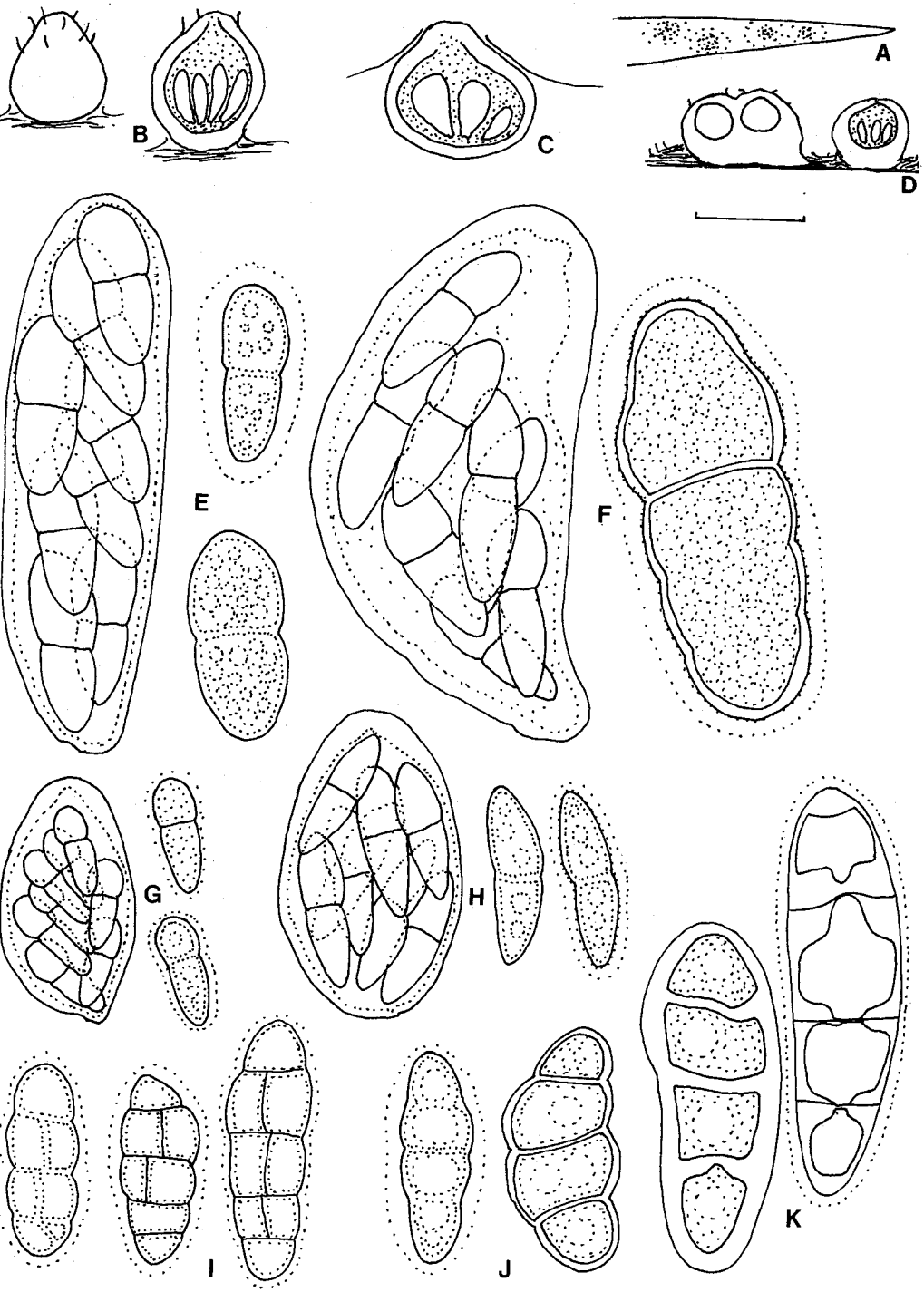
Key to Species

1. Ascomata small to medium sized; peridium relatively broad; ascospores with broad gel coating.....*Wettsteinina*
1. Ascomata minute to small sized; peridium relatively narrow; ascospores with broad or narrow gel coating.....2
    2. Ascomata setose over apex; ascospores hyaline, broadly obovoid, one septate, septum median and constricted.....*Macroventuria*
    2. Ascomata glabrous or bearing trailing hyphal appendages; ascospores hyaline or becoming brown, obovoid, ellipsoid or elongate fusoid, one or several septate or muriform.....3
3. Ascospores usually muriform, obovoid or ellipsoid; biotrophic and causing leaf spots or saprobic.....*Leptosphaerulina*
3. Ascospores one (three) transversely septate.....4
    4. Ascospores one septate, fusoid; saprobic....*Monascostroma*
    4. Ascospores one (three) septate, obovoid; ascomata superficial, biotrophic on leaf spots in Agavaceae....*Stomatogene*

Mycoporaceae Zahlbruckner in Engler & Prantl, Nat. Pflanzenfam. 1(1): 77. 1903; non emend. Riedl, 1962.

Ascomata superficial in thin hyphal weft or immersed erumpent, small to medium sized, uniloculate and sphaeroid or as locules in pulvinate stromata, discoid in side view; stroma tissues of pseudoparenchymatous cells, peridium not separable, with broad pore opening by disintegrating cells, discoid when dried, thallus as a hyphal weft. Asci basal in interthecial tissues, saccate or oblong. Interthecial tissues at times

Plate 7. Features of Dothideales. Pseudosphaeriaceae: A. Habit sketch of *Stomatogene agaves* (Ellis & Everh.) Theissen. B-D. Ascomata in vertical section: B, *Macroventuria wentii* van der Aa; C, *Wettsteinina mirabilis* (Niessl) von Höhnel; D, *Stomatogene agaves*. E-K. Asci and ascospores: E, *Macroventuria wentii*; F, *Wettsteinina mirabilis*; G, *Stomatogene agaves*; H, *Monascostroma innumerosa* (Desm.) von Höhnel; I, *Leptosphaerulina australis* McAlpine; J, *Wettsteinina dryadis* (Rostrup) Petrak; K, *W. macrotheca* (Rostrup) Müller. Standard line = 150 μm for B-D, 15 μm for E-k. Habit not to scale.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stretched and aligned between asci, resembling broadly cellular pseudoparaphyses. Ascospores hyaline becoming brown, obovoid, one or several septate or muriform, usually surrounded by narrow gel coating.

Anamorphs not known.

Saprobic on woody substrates.

The circumscription of this family is in accord with that of Henssen and Jahns (1974) and O. Eriksson (1981), not with that of von Arx and Müller (1975), which follows Riedl's (1962, 1964) emendation. The latter interpretation also includes pleosporaceous taxa that belong in the Arthopyreniaceae. Only *Mycoporum* is included in the restricted family.

Lichenotheliaceae Henssen in O. Eriksson and Hawksworth, Systema Ascomycetum 5(1): 137. 1986.

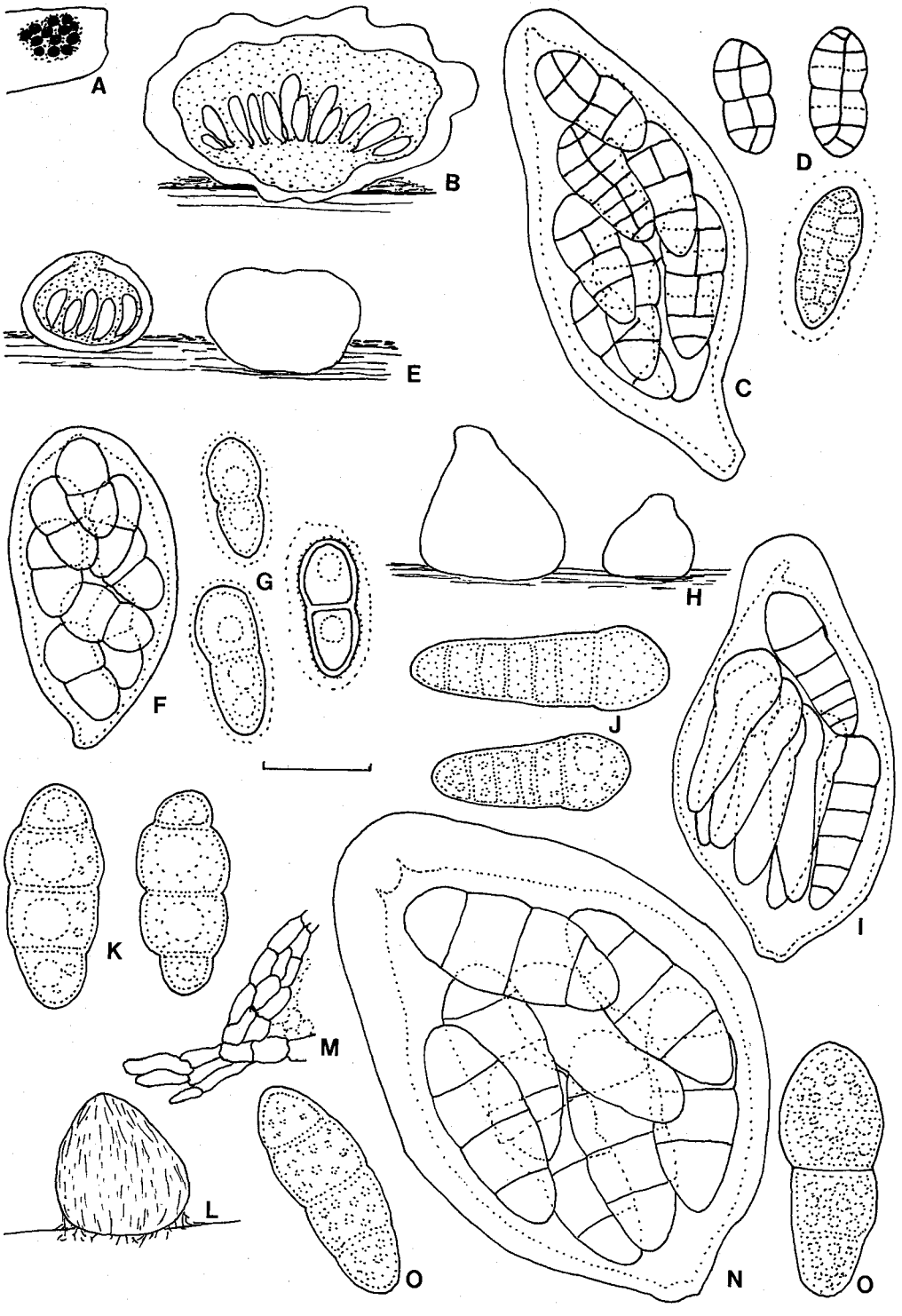
Ascomata superficial in crust of dark pseudoparenchymatous cells, small to medium sized, uniloculate, sphaeroid or apothecioid, often discoid in side view; peridium of dark pseudoparenchymatous cells. Asci ovoid or clavate, basal. Interthecial cells often present between and above asci (pseudoparaphyses according to Henssen 1987). Ascospores becoming dark brown, obovoid or ellipsoid, one or several septate, wall thickened, at times verrucose, surrounded by narrow gel coating.

Anamorphs coelomycetous (microconidia) and hyphomycetous, conidiogenesis enteroblastic or holoblastic (macroconidia).

Saprobic, on rocks (often associated with cyanobacteria) or over lichens.

The genera *Lichenothelia* D. Hawksworth and *Lichenostigma* Hafellner are included in the family. The nature of the crustose layer and the thick-walled ascospores separate the family from the Mycoporaceae. Henssen (1987) has presented a general account of ecology, distribution and diversity in morphology among the species of *Lichenothelia* and enriched the genus with descriptions of 18 new species.

Plate 8. Features of Dothideales. A-D. Mycoporaceae: *Mycoporum elabens* (Schaerer) Flotow: A, habit sketch; B, ascoma in vertical section;C, ascus; D, ascospores. E-G. Lichenotheliaceae: *Lichenothelia cf. scopularia* (Nyl.) D. Hawksworth: E, ascomata in vertical section; F, ascus; G, ascospores. H-O. Kriegeriellaceae: H-J. *Kriegeriella mirabilis*: H, ascomata in outline; I, ascus; J, ascospores. K, ascospores of *Extrawettsteinina minuta*. L-O. *E. andromedae*: L, ascoma in outline; M, portion of lower side and basal peridium with radiating short hyphae; N, ascus; O, ascospores. Standard line = 150 µm for B, E, H, L, 15 µm for C, D, F, G, I, J, M-O. Habit not to scale.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Kriegeriellaceae Barr, Mycotaxon 29: 502. 1987.

Ascomata superficial on substrate, conoid, bases applanate, minute to small sized, black, opening by small lysigenous pore; cells of peridium forming radiating rows in surface view, peridium composed of two or three layers of brown pseudoparenchymatous cells, basal peridium narrow, pallid; at times forming narrow pellicle of radiating hyphae around base of ascoma. Asci bitunicate, few in basal layer, saccate or oblong. Remnants of disintegrating centrum cells visible above asci. Ascospores hyaline to light brown, obovoid or ellipsoid, asymmetric or symmetric, one to several septate, constricted or not constricted at septa; wall usually surrounded by gel coating; contents guttulate.

Anamorphs not known.

Saprobic, hypersaprobic, on old conifer leaves or old leaves and branches of angiosperms, north temperate regions.

Von Höhnel (1918) described *Kriegeriella* as a member of the Microthyriaceae because of the structure of the peridium. The centrum in representatives of that family contains pseudoparaphyses whereas in *Kriegeriella* and relatives only disintegrating cells of the centrum surround the asci. I was not aware of *Kriegeriella* in describing *Extrawettsteinina* (Barr 1972) to encompass species with symmetric as well as asymmetric ascospores. I agree fully with von Arx and Müller (1975) that *E. pinastri* Barr is identical with *Kriegeriella mirabilis* von Höhnel which is the type of the genus and which has asymmetric ascospores. *Extrawettsteinina* is reinstated for species whose ascospores are symmetric in shape, having a nearly median primary septum. These two genera form the basis for the new family, a logical extension of the acceptance of families with similar ascomata in the other orders of Loculoascomycetes.

Kriegeriella is known from Europe and North America by *K. mirabilis* von Höhnel (synonym *Extrawettsteinina pinastri* Barr 1972; Gremmen 1960 as *Lophiostoma pinastri* Niessl) on fallen leaves of conifers. *Kriegeriella transiens* von Höhnel was described at the same time as a somewhat smaller species with more asci and (3-)4-septate ascospores and is as yet not known in North America. *Extrawettsteinina* is typified by *E. minuta* Barr, with three-septate ascospores 21-24 x 8-9 um, on leaves of *Juniperus*. *Extrawettsteinina mediterranea* (Müller) Barr is quite similar and is known from leaves of *Quercus* in southern Europe. Holm (1975a) observed that ascomata of *Wettsteinina andromedae* (Auersw.) Barr were superficial, lacked a basal peridium and were fringed by somewhat meandering hyphae; he suggested that this species was aberrant in *Wettsteinina*. Further study on some specimens from the Canadian arctic (Barr 1959) proved their identity with the Swedish ones, and confirmed Holm's observations. Several other small collections that have ascospores with different shapes and patterns of septation are known; these wait the discovery of additional specimens before publication.

CHAETOTHYRIALES

Batista & Ciferri ex Barr, Mycotaxon 29: 502. 1987.
Chaetothyriales Batista & Ciferri, Sydowia Beih. 3: 4. 1962; nom. inval. ICBN, Art. 36.

Ascomata superficial or subcuticular, separate or grouped, at times forming locules in stroma, darkly or lightly pigmented, at times nearly translucent, globose, sphaeroid, ovoid or lenticular, apical papilla short, opening by periphysate pore or pore composed of short setae; surface bearing setae or hyphal appendages or glabrous, seated under hyphal weft or on compact or slight hyphal subiculum or in thin crustose thallus; hyphae cylindric or moniliform, pallid to dark brown; peridium composed of one or two or few rows of pseudoparenchymatous cells, usually irregular in surface view but at times in radiating rows. Hamathecium of short periphysoids from upper innermost cells of peridium; in some apparently growing downward between asci. Asci basal, in layer or fascicle, saccate or broadly oblong to short clavate; gel matrix around asci bluing in iodine at times. Ascospores hyaline, yellowish, rosy, or shades of brown, oblong, fusoid, obovoid or elongate, often asymmetric, one or several septate or muriform; wall thin or thickened and verruculose, occasionally bearing setose appendages or surrounded by narrow gel coating; contents granular or with one globule per cell.

Anamorphs hyphomycetous or coelomycetous where known; conidiogenesis holoblastic or enteroblastic; conidia various.

Epiphytic, biotrophic, saprobic or hypersaprobic on a variety of substrates.

The order originally included the Chaetothyriaceae, Phaeosaccardinulaceae and Euceramiaceae (Batista and Ciferri 1962), all of which are arranged under the Chaetothyriaceae at present. The order was enlarged (Barr 1979b) to include taxa whose centrum contains short periphysoids. The majority of these fungi are superficial on the substrate, but *Strigula* forms both a thin thallus and ascomata beneath leaf cuticle. Some families--the Chaetothyriaceae, Coccodiniaceae and Metacapnodiaceae -- have been grouped under "sooty moulds" (O. Eriksson and Hawksworth 1985, 1986). Reynolds submerged the Metacapnodiaceae with his expanded Capnodiaceae after (Reynolds 1985) he utilized *Limacinula* Neger for both *Metacapnodium* and *Ophiocapnocoma*. The taxa assigned to the Chaetothyriales vary considerably in shape of ascomata and in consistency and types of hyphae. Median sections of ascomata are essential to observe the short periphysoids, although eventually one comes to recognize members of the order by their other features.

Key to Families

1. Ascomata lichenized, in sheathing or crustose thallus.....2
1. Ascomata biotrophic, hypersaprobic or saprobic, epiphytic, on or beneath thin or well-developed subiculum.....4

2. Thallus composed of sheathing mycelium around *Scytonema* filaments; ascospores smoky black.....Pyrenothricaceae*

2. Thallus crustose; ascospores hyaline to grayish brown..3

3. Thallus subcuticular, ascomata sphaeroid; ascospores hyaline. .....Strigulaceae

3. Thallus superficial as thin crust; ascomata globose; ascospores grayish brown.....Microtheliopsidaceae*

4. Ascomata lenticular (scutate with both upper and lower walls developed), surface of radiating rows of cells..... .....Trichopeltidaceae

4. Ascomata globose, sphaeroid or ovoid, surface not of radiating rows of cells.....5

5. Hyphae forming subiculum often abundant, dark brown, moniliform with short broad cells constricted at septa, tapering to ends; ascomata globose or ovoid; epiphytic; ascospores brown. .....Metacapnodiaceae

5. Hyphae forming subiculum or thin pellicle pallid or dark, cylindric, sometimes branching at right angles; ascomata globose, ovoid or sphaeroid, collabent at times.....6

6. Ascomata formed beneath pellicle of light brown hyphae; superficial epiphytes (?biotrophs) on leaves; ascospores hyaline or lightly pigmented (yellowish, rosy)..... .....Chaetothyriaceae

6. Ascomata formed on pallid or dark brown sparse or well-developed subiculum.....7

7. Ascomata small to medium sized, glabrous or bearing hyphal appendages or setae; saprobic; ascospores hyaline, yellowish or clear to reddish brown.....Coccodiniaceae

7. Ascomata minute to small sized, usually short setose, occasionally glabrous; saprobic or hypersaprobic; ascospores hyaline or mostly grayish brown .....Herpotrichiellaceae

*The lichenized families Microtheliopsidaceae O. Eriksson and Pyrenothricaceae Zahlbruckner are not considered in more detail at this time. Santesson (1952) provided a detailed description of *Microtheliopsis uleana* Mull. Arg.; O. Eriksson (1981) noted many similarities between this organism and species in the Herpotrichiellaceae. O. Eriksson (1981) also compared *Pyrenothrix nigra* Riddle to *Coccodinium bartschii* Massal.

Chaetothyriaceae Hansford ex Barr, Mycologia 71: 943. 1979.

Chaetothyriaceae Hansford, Mycol. Pap. 15: 139. 1946, nom. inval., ICBN, Art. 36.

Ascomata sphaeroid, often collabent at maturity, small, formed beneath thin pellicle of brown, cylindric narrow hyphae, often branched at right angles; apex short papillate, pore periphysoid; peridium thin, of few rows of soft brown cells. Hamathecium of short apical periphysoids. Asci basal, oblong, saccate or ovoid. Cellular remnants or old ascus walls breaking down as gel matrix, lightly blued in iodine. Ascospores hyaline (rosy brown in mass), fusoid, narrowly obovoid or oblong cylindric, (one)several septate or muriform, contents guttulate.

Anamorphs not known.

Epiphytic, mostly tropical, a lesser number temperate in distribution.

Hansford (1946) described the morphology of the ascomata and their development beneath a thin pellicle. Reynolds (1972) clarified what had been confusion between *Phaeosaccardinula* and *Limacinula*, the latter genus assigned in this study to the Coccodiniaceae. Hughes (1976) summarized information on the Chaetothyriaceae in separating this family from other sooty mould taxa. The family names Phaeosaccardinulaceae Batista & Ciferri (Sydowia Beih. 3: 31. 1962; nom. inval., ICBN, Art. 36) and Euceramiaceae Batista & Ciferri (Sydowia Beih. 3: 121. 1962; nom. inval., ICBN, Art. 36) are both merged under the Chaetothyriaceae.

Only a few taxa are known from temperate regions, and are separated in the following key to genera. Pohlad and Reynolds (1974) described and illustrated *Treubiomyces pulcherrimus* von Höhnel from a Florida collection. The type genus is included in the key, but is tropical in distribution. Other tropical genera with phragmospores could be *Actinocymbe* with greatly elongate ascospores and *Yatesula* with short ascospores (von Arx and Müller 1975). Didymosporous taxa could be *Microcallis* with setae and *Akaropeltis* without setae on the pellicle, according to Müller and von Arx (1962), although von Arx and Müller (1975) later relegated *Akaropeltis* to synonymy with *Stomiopeltis* (see Micropeltidaceae, Pleosporales).

Key to Genera

1. Ascospores transversely septate.....2
1. Ascospores muriform.....3
   2. Ascomata and/or pellicle setose.....*Chaetothyrium*
   2. Ascomata and/or pellicle glabrous.....*Ceramothyrium*
3. Ascomata and/or pellicle setose.....*Treubiomyces*
3. Ascomata and/or pellicle glabrous.....*Phaeosaccardinula*

Coccodiniaceae von Höhnel ex O. Eriksson, Opera Bot. 60: 42. 1981.

Coccodiniaceae von Höhnel, Sitzungsber. Kaiserl. Akad. Wiss. Math.-Naturwiss. Cl. Abt. 1, 127: 386. 1918; nom. inval., ICBN, Art. 18.

Ascomata small to medium sized, globose, ovoid or sphaeroid and collabent on drying, apex rounded or short papillate, pore periphysate; peridium relatively soft, composed of several rows of pseudoparenchymatous cells, setose or glabrous, at times with deep sterile base; hyphae cylindric, light brown, as delicate weft, or dark as thin crust or well-developed subiculum. Hamathecium of short periphysoids. Asci basal, ovoid, saccate or broadly oblong, in gel matrix that blues in iodine. Ascospores hyaline, yellowish or reddish brown, one to several septate or muriform.

Anamorphs forming rosettes of phialidic conidiogenous cells

from ascospores (Hughes 1976) or hyphomycetous (described as *Microxyphium*).

Epiphytic or biotrophic, widespread in distribution.

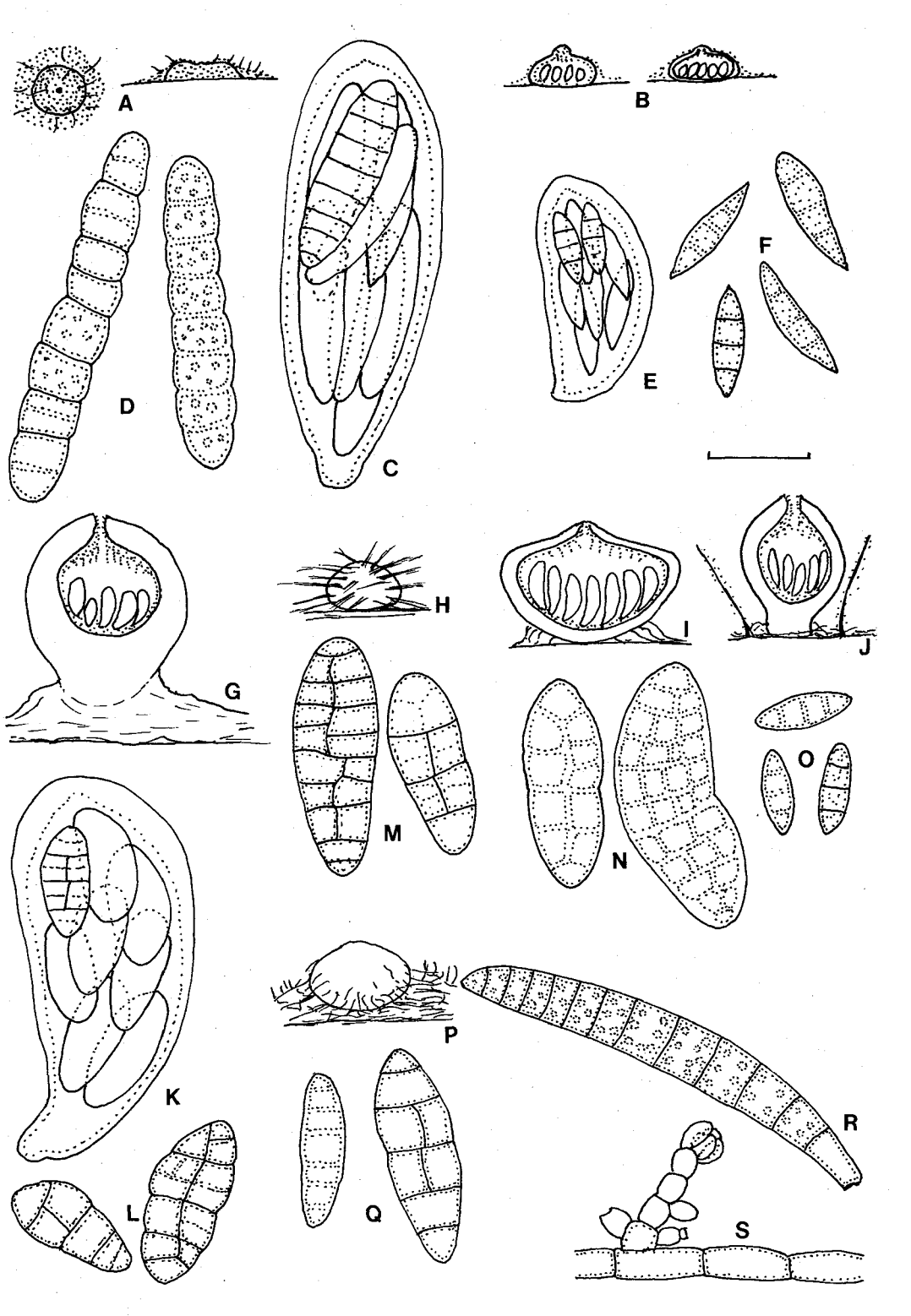
O. Eriksson (1981) clarified the confusion that had existed in the literature between *Coccodinium* and *Naetrocymbe*. *Naetrocymbe* and the family Naetrocymbaceae belong in the Arthopyreniaceae of the Pleosporales. In both genera ascomata are superficial and frequently collabent on a dark subiculum. *Coccodinium bartschii* Massalongo forms periphysoids above the asci and the hymenial gel often turns blue briefly in iodine, whereas *Naetrocymbe fumago* (Wallr.) Dalla Torre & Sarnth. forms pseudoparaphyses between and above asci and the hymenium does not blue in iodine. O. Eriksson and Hawksworth (1986) recognized three genera in the family: *Coccodinium, Limacinula* and *Dennisiella*. Reynolds (1972) has monographed *Limacinula*.

Strigopodia (Hughes 1968) is tentatively inserted in the Coccodiniaceae. The subiculum is well developed, composed of both repent and erect, cylindric, branched hyphae. Both holoblastic phragmosporous conidia (*Hormisciella*) from hyphae and phialides and phialoconidia from hyphae and ascospores (*Capnophialophora*) are produced. Ascomata bear hyphal appendages, short periphysoids are present in the centrum above the saccate asci, ascospores are brown and dictyosporous (Corlett, Hughes and Kaufert 1973). This genus was not assigned to family by Hughes (1968) but von Arx and Müller (1975), Hawksworth et al. (1983), and O. Eriksson and Hawksworth (1986) have it in the Capnodiaceae s. lat. That family is treated in the much restricted sense of Hughes (1976) as part of the Capnodiales, and *Strigopodia* does not fit in that concept.

Key to Genera

1. Ascospores several septate, occasionally muriform in one or two cells.....2
1. Ascospores conspicuously muriform.....3
    2. Ascospores light brown; ascomata setose.....*Dennisiella*
    2. Ascospores dark brown; ascomata bearing hyphal appendages .....*Strigopodia*

Plate 9. Features of Chaetothyriales. A-F. Chaetothyriaceae: A, B, Ascomata of: *Chaetothyrium cf. vermisporum* Hansford; B, *Ceramothyrium linnaeae* (Dearness) Hughes. C-F, Asci and ascospores of: C, D, *Chaetothyrium vermisporum*; E, F, *Ceramothyrium linnaeae*. G-S. Coccodiniaceae: G-J. Ascomata of: G, *Coccodinium bartschi*; H, *C. corticola* (Ellis & Everh.) Barr; I, *Limacinula samoensis* von Höhnel; J, *Dennisiella cf. babingtonii* (Berkeley) Batista & Ciferri. K-O. Asci and ascospores: K, L, *Coccodinium bartschi*; M, *C. corticola*; N, *Limacinula samoensis;* O. *Dennisiella babingtonii*. P-S. *Strigopodia batistae* Hughes: P, ascoma, Q, ascospores, R, conidium, S, phialides. Standard line = 150 µm for A, B, G-J, P, 15 µm for C-F, K-O, Q-S.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3. Ascospores hyaline, yellowish or light brown; foliicolous.... .....*Limacinula*
3. Ascospores brown, often with reddish tinges; usually on branches or periderm of woody plants.....*Coccodinium*

Herpotrichiellaceae Munk, Dansk Bot. Arkiv 15(2): 131. 1953.

Ascomata superficial or at times partially embedded in substrate, minute or small, globose or sphaeroid, collabent at times, or forming locules in stroma, pallid or blackish, short papillate; surface setose or bearing dark cells, occasionally glabrous, with brown hyphae at lower sides; peridium relatively narrow, pallid, grayish brown or dark brown, composed of few rows of compressed cells; hypostroma slight as crust or well developed as stromatic tissues. Hamathecium of short periphysoids. Asci basal, saccate or oblong clavate, endoascus often thick apically, with narrow elongate ocular chamber; octosporous or polysporous. Ascospores grayish brown or remaining hyaline, obovoid with obtuse ends or fusoid with acute ends, usually inequilateral, asymmetric, one or several transversely septate or muriform; wall smooth, darkened, at times surrounded by narrow granular coating; contents guttulate, granular, finally one globule in each cell; biseriate or crowded in the ascus.

Anamorphs hyphomycetous where known; conidiogenesis holoblastic sympodial or holoblastic in acropetal chains (described as *Cladosporium-like, Exophiala, Helicodendron, Ramichloridium, Rhinocladiella*).

Saprobic or hypersaprobic, typically on woody substrates over and among other fungi, widespread but overlooked.

These small, typically setose fungi are most readily recognized by the color of the ascospores, brown with a grayish tinge rather than the yellowish or clear or reddish brown of most Loculoascomycetes. In the early developmental stages of some ascomata, the periphysoids have been seen to arise from sides as well as upper region of the locule, and then to serve as "paraphyses" for a short time. Because of their size and relative unimportance they have been ignored for the greater part, but numbers of unnamed taxa have been accumulated. Müller et al. (1987) added substantially to and provided a key for the species that they recognized, as well as several additional anamorph connections. These authors recognized only two genera--*Acanthostigmella* for species with pallid peridium, hyphae and ascospores, and *Capronia* for species with brown or grayish brown peridium, hyphae and ascospores. They concluded that polysporous and octosporous asci, and size, shape and septation of ascospores were of specific rather than generic value. I prefer for the present to recognize four genera in addition to *Acanthostigmella*, two with transversely septate ascospores (an occasional longitudinal septum is acceptable) and two with muriform ascospores, each pair of genera separated by octosporous or polysporous condition of the ascus. Polyspory is regarded as a generic feature here, as it is in separating genera of the Dothioraceae in the Dothideales. Within the genera some species

have locules in or protruding from a well-developed basal stroma, e.g., *Berlesiella nigerrima* (Bloxam) Sacc. and the glabrous, larger-spored *B. episphaeria* (Peck) Barr (the two are separate entities contrary to Barr in Bigelow and Barr 1969). Other species have closely gregarious ascomata or separate ascomata, and were formerly in *Dictyotrichiella*. *Didymotrichiella* is included under *Herpotrichiella* although the shape and relative width of the uniseptate ascospores may eventually be considered as a generic character. O. Eriksson and Hawksworth (1985, 1986) include in the family *Berkelella* (Sacc.) Sacc. and questionably *Pleomelogramma* Speg., both extralimital to this study.

Key to Genera

1. Ascomata and setae pallid to light brown; asci octosporous; ascospores transversely septate, hyaline to faintly pigmented in mass.....*Acanthostigmella*
1. Ascomata and setae brown, grayish brown, blackish; asci octosporous or polysporous; ascospores shades of grayish brown..2
2. Ascospores transversely septate.....3
2. Ascospores muriform.....4
3. Asci polysporous.....*Polytrichiella*
3. Asci octosporous.....*Herpotrichiella*
4. Asci polysporous.....*Capronia*
4. Asci octosporous.....*Berlesiella*

Metacapnodiaceae Hughes & Corlett in Hughes, New Zealand J. Bot. 10: 239. 1972.

Ascomata globose or ovoid, small to medium sized, superficial in sometimes massive subiculum of moniliform hyphae, hyphae with tapered ends and constricted septa that separate short broad cells, walls thick, often verruculose; ascomata bearing short tapered hyphal appendages or glabrous with protruding cells; apex rounded or short papillate, apical pore periphysate; peridium narrow, composed of pseudoparenchymatous cells. Hamathecium of short periphysoids. Asci basal in somewhat of a fasciculate arrangement, oblong or saccate. Ascospores yellowish to dark brown, oblong, obovoid, fusoid or elongate, one to several septate, longitudinal septa in some cells at times; wall thick, brown, smooth or verruculose; contents guttulate.

Anamorphs hyphomycetous; conidiogenesis phialidic (*Capnodiophora*), holoblastic sympodiospores (*Capnobotrys, Capnocybe*), porospores (*Capnosporium, Hormiokypsis*), arthrospores (*?Torulopsiella*).

Epiphytic, often over insect secretions or resin droplets, widespread.

The Metacapnodiaceae comprises only a few taxa at present. These "sooty mould" organisms have a centrum typical of the Chaetothyriales (Corlett 1970; Corlett, Hughes and Kaufert 1973). Variations illustrated include the fungus most recently known as *Xenomeris juniperi* (Dearness) Barr and Müller in Müller and

von Arx (1962). This fungus differs from *Xenomeris hemisphaerica* Müller (Müller 1959) in forming ascomata on a subiculum whose hyphae may penetrate a droplet of resin on the leaf, but do not form a pallid hypostroma within the leaf tissues. Although these two fungi have a superficial similarity, they are in fact representatives of genera in two different orders. The genus *Sthughesia* was formally described (Barr 1987b) for *S. juniperi* (Dearness) Barr. Ascomata are small, dark, globose, with short tapered hyphal appendages, seated in a subiculum of moniliform hyphae. Short delicate periphysoids are present above the asci which are fasciculate and oblong saccate. Ascospores are yellowish brown to dark brown, obovoid, one septate, with verruculose wall. Phialides have been observed, but no other anamorphic state.

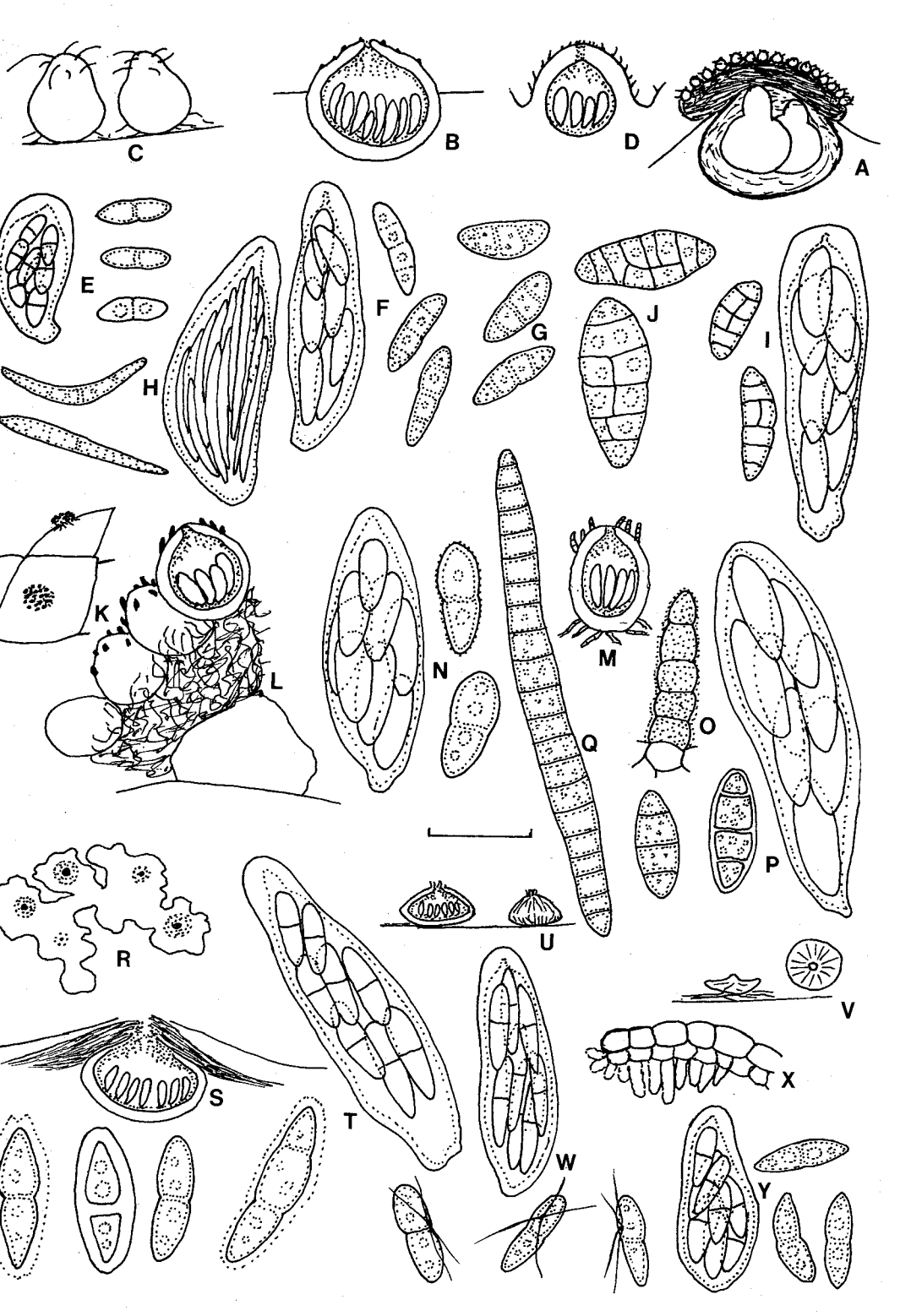
Key to Genera

1. Ascospores one septate.....*Sthughesia*
1. Ascospores several septate.....2
    2. Ascospores oblong fusoid.....*Metacapnodium*
    2. Ascospores elongate.....*Ophiocapnocoma*

Strigulaceae Fries, Systema Orbis Veget. 110. 1825.

Thallus crustose, small, subcuticular. Ascomata immersed with blackened upper regions erumpent, flattened sphaeroid to nearly scutate; apex opening by rounded pore; peridium narrow, composed of several rows of compressed cells. Hamathecium of short periphysoids. Asci basal, oblong to saccate. Ascospores hyaline, fusoid, one septate.

Plate 10. Features of Chaetothyriales. A-J. Herpotrichiellaceae: A, *Berlesiella nigerrima*, habit of ascomata in stroma over diatrypaceous fungus; B-D, ascomata of B, *Herpotrichiella porothelia* (Berkeley & Curtis) Barr; C, *Acanthostigmella genuflexa* von Höhnel; D, *Berlesiella nigerrima*. E-J, asci and ascospores of E, *Acanthostigmella pallida* Dennis & Barr; F, *Herpotrichiella porothelia*; G, *H. parasitica* (Ellis & Everh.) Barr; H, *Polytrichiella polyspora* Barr; I, *Berlesiella nigerrima*; J, *B. episphaeria*. K-Q. Metacapnodiaceae: K, *Sthughesia juniperi*, habit of ascomata. L, M, ascomata of L, *Sthughesia juniperi*; M, *Metacapnodium moniliforme* (Fraser) Hughes. O, detail of appendage of *M. moniliforme*. N, P, Q, asci and ascospores of N, *Sthughesia juniperi*; P, *Metacapnodium moniliforme*; Q, *Ophiocapnocoma phloiophilia* (Fisher) Hughes. R-T. Strigulaceae: *Strigula elegans*: R, habit of ascomata in crustose thallus; S, ascoma; T, ascus and ascospores. U-Y. Trichopeltidaceae: U,V, ascomata of U, *Trichothyrina cf. cupularum*; V, *Trichothyrium reptans* (Berkeley & Curtis) Hughes. X, detail of upper wall showing periphysoids in *T. reptans*. W, Y, asci and ascospores of W, *Trichothyrina cupularum*; Y, *Trichothyrium reptans*. Standard line = 150 µm for B-D, L, M, S, U, V, 15 µm for E-J, N-Q, T, W-Y. Habits not to scale.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Anamorphs coelomycetous.

Typically on coriaceous leaves, warm temperate and tropical regions.

My discovery of periphysoids in the upper centrum of *Strigula elegans* (Fée) Müll. Arg. prompts disposition of the family in the narrow sense into the Chaetothyriales, a position at variance from that of Harris (1975). O. Eriksson and Hawksworth (1986) did not insert the family into an order, but said probably Dothideales. Members of the Strigulaceae are unique in the subcuticular position of the crustose thallus and sphaeroid, nearly scutate ascomata. Santesson (1952) provided details of species in *Strigula* and *Raciborskiella*.

Trichopeltidaceae Theissen, Zentralbl. Bakt. Parasitkund, Abt. 2, 39: 629. 1913.

Ascomata minute or small, superficial on thin weft of cylindric hyphae or beneath hyphae, lenticular, i.e., scutate with both upper and lower peridia developed, separate or gregarious, developed from terminal or intercalary cell(s) of hyphae, often shining black, apex short papillate, small rounded pore rimmed with dark cells or short setae; peridium narrow, compressed, composed of one or two rows of quadrangular cells in radiating arrangement. Hamathecium of short periphysoids. Asci oblong or saccate, basal. Ascospores hyaline or occasionally brown, obovoid oblong or fusoid, one or several septate; wall thin, ciliate at times; contents with two globules per cell.

Anamorphs hyphomycetous where known; conidiogenesis holoblastic; staurosporic (*Isthmospora*); minute pycnidia known for several taxa.

Hyperbiotrophic on other ascomycetes or apparently saprobic, most abundant in warmer regions.

The name Trichothyriaceae Theissen (Beih. Bot. Zentralbl. 32: 13. 1914) is more familiar but is predated by the Trichopeltidaceae. O. Eriksson (1981) and O. Eriksson and Hawksworth (1986) included the genera under the Microthyriaceae. Because of the presence of short periphysoids in the upper centrum, I am compelled to keep the family separate and insert it in the Chaetothyriales. The lenticular ascomata add another dimension to variation in this order. Periphysoids are clearly visible in J. P. Ellis's (1977b) Fig. 16 of *Trichothyrina cupularum* J. P. Ellis. Many of the species are tropical in distribution, but several are known from temperate regions. J. P. Ellis (1977b) enumerated the British species of *Trichothyrina* and *Actinopeltis*. Hughes (1953) described and illustrated the development of isthmospores as well as their teleomorphs.

Key to Genera

1. Hyphae forming thin pellicle over meliolaceous fungi.....
.....*Trichothyrium*
1. Hyphae not forming thin pellicle over meliolaceous fungi.....2

2. Ascomata glabrous.....*Trichothyrina*
2. Ascomata bearing setae or hyphal appendages.....3
3. Ascomata bearing setae.....*Actinopeltis*
3. Ascomata bearing hyphal appendages.....*Trichothyrinula*

OPEGRAPHALES

M. Choisy ex D. Hawksworth & O. Eriksson, Systema Ascomycetum 5(1): 180. 1986.

Opegraphales M. Choisy, Bull. Soc. Linn. Lyon 23: 104. 1954; nom. inval., ICBN, Art. 36; O. Eriksson, Mycotaxon 15: 212. 1982; nom. inval., ICBN, Art. 36.

Ascomata apothecioid or hysterothecioid, rounded or elongate, opening widely to expose darkened or whitish hymenial surface; developing in crustose or fruticose lichen thallus; peridium narrow or wide, composed of small pseudoparenchymatous cells or erect hyphae, surrounded at times by thalline margin; subhymenium dark, with dark elements intruding into hymenium. Hamathecium of cellular paraphysoids, free upper ends enlarged or branched and coralloid, forming a pseudoepithecium, matrix bluing in iodine. Asci basal, clavate, ocular chamber small. Ascospores hyaline or lightly pigmented, symmetric, fusoid or elongate, several septate.

Anamorphs not known.

Lichenized, widespread.

This order is separated from the Pleosporales by apothecioid ascomata, dark subhymenial elements intruding into the hymenium, and paraphysoids whose free ends are enlarged or branched and coralloid and form a pseudoepithecium. Two families Opegraphaceae and Roccellaceae are recognized by the structure of the lateral peridium: in the Opegraphaceae this is composed of small dark cells and is at times surrounded by a thalline margin, in the Roccellaceae this is composed of erect hyphae, always surrounded by a thalline margin. Thalli in the Opegraphaceae are crustose, whereas those in the Roccellaceae are crustose or fruticose.

Opegraphaceae Stizenberger, Ber. Tät. St Gall. naturw. Ges. 153. 1862.

Ascomata apothecioid or hysterothecioid, in crustose thallus, opening widely to expose hymenial surface; thalline margin present or absent; peridium composed of small dark cells; subhymenium dark, some elements intruding into hymenium. Hamathecium of paraphysoids, branched and coralloid above asci, forming a pseudoepithecium. Asci basal, clavate. Ascospores hyaline to light brown, fusoid or elongate, several septate; wall smooth, usually surrounded by gel coating.

Lichenized, on woody substrates, widespread.

Several family names were cited as synonyms by O. Eriksson and Hawksworth (1985): Lecanactidaceae Stizenberger (Ber. Tät. St Gall. naturw. Ges. 155. 1862); Bactrosporaceae Rabenhorst (Kryptogamen-Flora von Sachsen... 60. 1870); Chiodectonaceae

Zahlbruckner in Engler & Prantl (Nat. Pflanzenfam. 1(1*): 102. 1904); Herpothallaceae Tomaselli ex Tomaselli (Archo Bot. Sist. Fito. Geogr. Genet. 26: 103. 1950). *Opegrapha varia* (Pers.) Fr. and *Lecanactis californica* Tuckerman illustrate the family; these taxa have respectively hysterothecioid ascomata without thalline margin and apothecioid ascomata with thalline margin. Ascospores in the two are quite similar.

Roccellaceae Chevalier, Flore générale des environs de Paris... 604. 1826.

Ascomata apothecioid, in crustose or fruticose thallus, erumpent from thallus, opening widely to expose darkened hymenial surface; peridium composed of erect hyphae, surrounded by thalline margin; basal peridium and subhymenium dark, with dark elements intruding into hymenium. Hamathecium of paraphysoids, at maturity free ends enlarged or branched and coralloid, forming a pseudoepithecium. Asci basal, clavate. Ascospores hyaline, fusoid, several septate; wall smooth.

Lichenized, warm temperate regions.

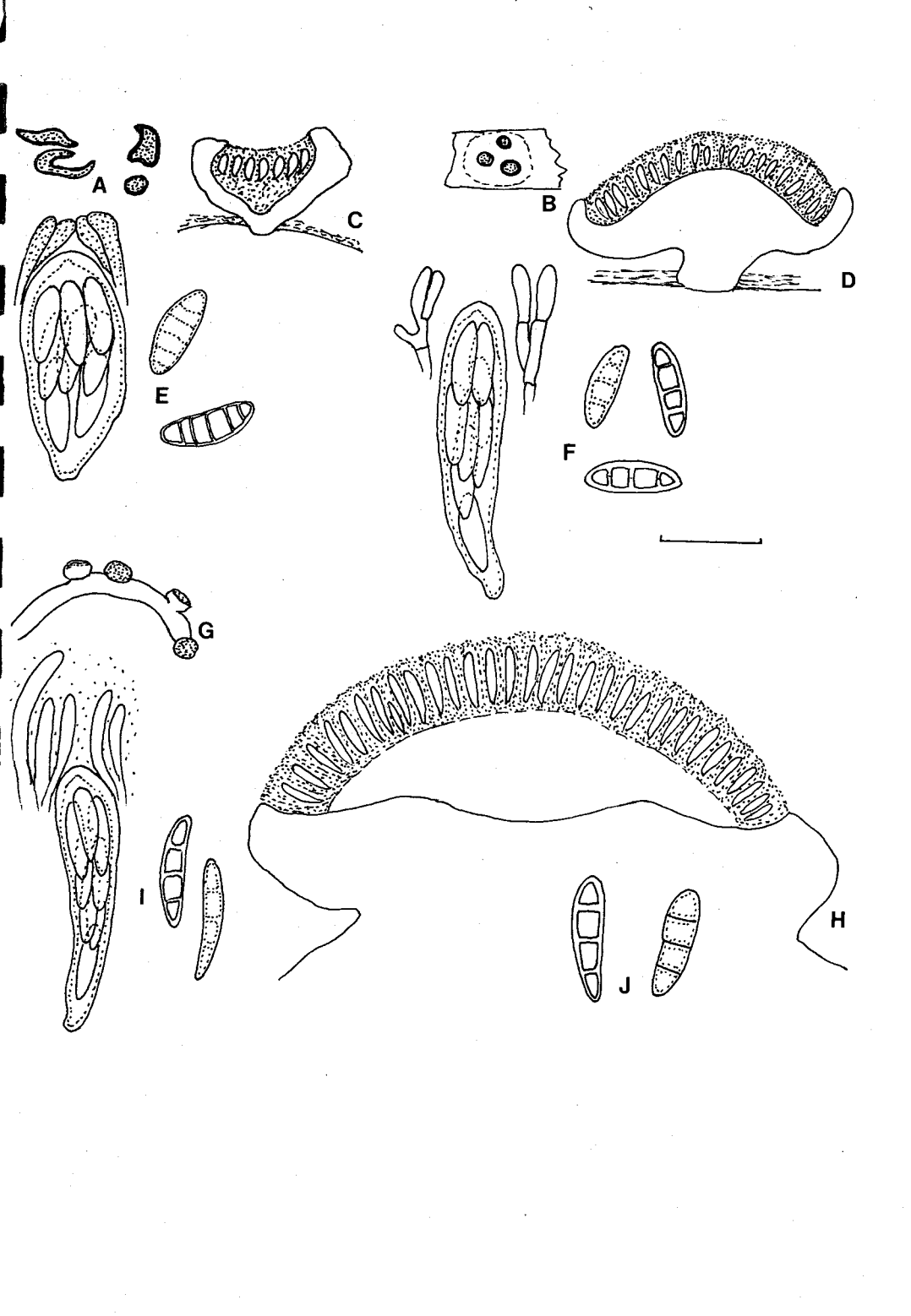
The members of this family are typically maritime in distribution. The family is illustrated by representatives of two genera: *Roccella tinctoria* DC. (orchil) is a fruticose species, whereas *Dirina californica* Tuckerman is a crustose species. Santesson (1949) recognized the bitunicate nature of the asci. Two families were originally established based upon the nature of the thallus. Weber (1965) reduced the Dirinaceae Zahlbruckner in Engler & Prantl (Nat. Pflanzenfam. 1(1*): 105. 1905) to synonymy under Roccellaceae and compared the genera that he recognized in the one family.

PATELLARIALES

D. Hawksworth & O. Eriksson, Systema Ascomycetum 5: 181. 1986.

Ascomata apothecioid or hysterothecioid, rounded or elongate, opening widely at maturity; peridium rather soft, composed of vertically oriented rows of small pseudoparenchymatous cells, surface occasionally encrusted and darkened, cells frequently thin walled and pallid toward base. Hamathecium of paraphysoids, at maturity tips free, enlarged or branched, usually encrusted with pigment and forming pseudo-epithecium; matrix at times bluing in iodine. Asci basal, broadly clavate, oblong or cylindric. Ascospores hyaline or shades of brown, variable in shape and septation.

Plate 11. Features of Opegraphales: A-F. Opegraphaceae: A, B, habit sketches of A, *Opegrapha varia*; B, *Lecanactis californica*. C, D, ascomata of same. E, F, ascus, tips of paraphysoids and ascospores of same. G-J. Roccellaceae: G, habit of *Roccella tinctoria*. H, ascoma of *Dirina californica*. I, ascus, tips of paraphysoids and ascospores of *Roccella tinctoria*; J, ascospores of *Dirina californica*. Standard line = 150 μm for C, D, H, 15 μm for E, F, I, J. Habits not to scale.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Anamorphs coelomycetous where known; conidiogenesis phialidic, conidia minute (described as *Aposphaeria-like, Sphaeronema*) or conidiogenesis holoblastic; (described as *Corniculariella, Diplodia-like*).

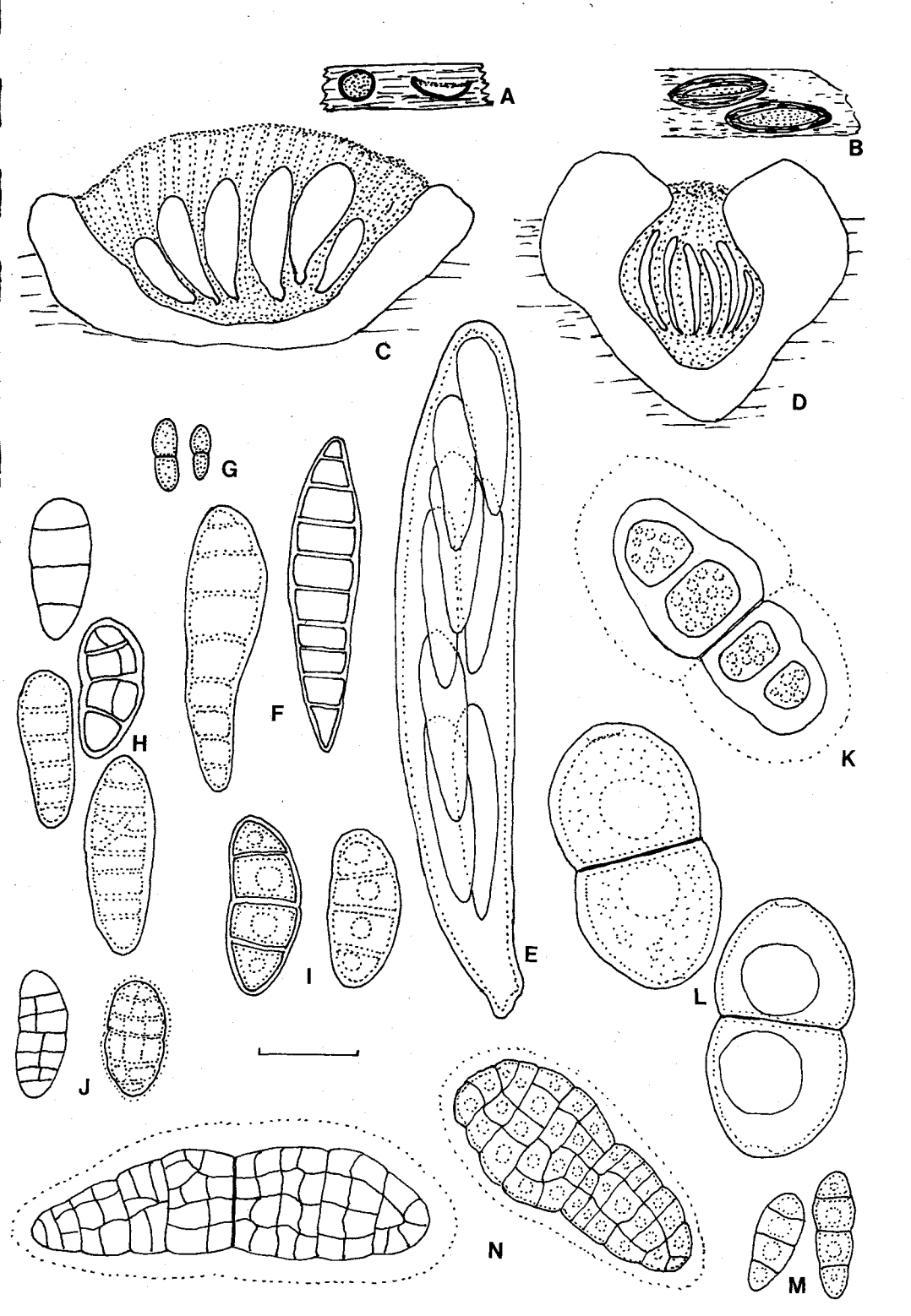
Saprobic on woody substrates; endophytic at times; widespread in distribution.

Luttrell (1973) recognized the presence of paraphysoids at maturity as denoting a separate structural type of ascoma. O. Eriksson and Hawksworth (1986) separated the Patellariales to include the families Patellariaceae, Arthrorhaphidaceae Poelt & Hafellner (Phyton 17: 220. 1976), and Phillipsiellaceae von Hohnel. *Phillipsiella atrata* Cooke is a small, discoid, superficial fungus on a delicate hyphal weft, with a narrow undifferentiated peridium and stretched cells as paraphysoids between the short clavate asci, forming a pseudoepithecium at maturity. It has a myriangiaceous aspect, and the Phillipsiellaceae are inserted in the Arthoniales in this study. I am not familiar with the members of the Arthorhaphidaceae and include in the order only the Patellariaceae at this time. Recently, the Phaneromycetaceae Gamundi & Spinedi (Sydowia 38: 112. 1986[1985]) was described to accommodate *Phaneromyces* Speg. & Hariot, as a family near to the Patellariaceae. In 1981 O. Eriksson considered *Patellaria* to be an invalid name, and he utilized *Lecanidion* and proposed the replacement name Lecanidiaceae. O. Eriksson and Hawksworth (1985, 1986) again use the names *Patellaria* and Patellariaceae.

The numbers of genera assigned to the Patellariaceae vary depending upon the author and on our state of knowledge of some lichenized taxa. Some confusing discomycetous fungi on weathered wood are being re-examined to determine their position (Sherwood-Pike 1986; Sherwood-Pike and Boise 1986). The genera included in the following key form a far from complete listing. Several others were illustrated by Hafellner (1979), i.e., *Buelliella, Karschia, Poetschia, Schrakia*.

The separation of the Patellariaceae in the Patellariales from the Hysteriaceae in the Pleosporales is difficult at times because there are many superficial similarities. Although many of the taxa in the Patellariaceae are rounded discoid and

Plate 12. Features of Patellariales, Patellariaceae: A, B, habit of ascomata of A, *Patellaria atrata* Fr.; B, *Rhytidhysteron rufulum* (Spreng.: Fr.) Petrak. C, D, ascomata in vertical section of the same. E-N, ascus and ascospores of E, F, *Patellaria atrata*; G, *Rhizodiscina lignyota* (Fr.) Hafellner; H, *Teichosporella dura* (Fuckel) Sacc.; I, *Rhytidhysteron rufulum;* J, *Melittosporium hysterinum* (Fr.) Gillet; K, *Endotryblidium insculptum* (Cooke) Petrak; L, *Holmiella sabina* (de Not.) Petrini, Samuels & Müller; M, *Hysteropatella prostii* (Duby) Rehm; N, *Tryblidaria fenestrata (Cooke & Peck) Rehm*. Standard line = 150 μm for C, D, 15 μm for E-N. Habits not to scale.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apothecioid, some produce elongate ascomata that open widely at maturity, much as in members of the Hysteriaceae. According to the relatively few studies, e.g., Pirozynski and Reid (1966), Luttrell (1973), Samuels and Müller (1979), O. Eriksson (1981), Bezerra and Kimbrough (1982), the hamathecium is composed of free-ended paraphysoids that form a pseudoepithecium in the Patellariaceae (but true paraphyses according to Muthappa 1970; Bellemere et al. 1986). The hamathecium in the taxa of the Hysteriaceae is composed of pseudoparaphyses (Luttrell 1951); these may become darkened in mature ascomata. The differences may be difficult to discern in mature specimens. Some other characteristics are helpful in assigning a taxon to one or the other family. The peridium in many of the Patellariaceae is composed of quite vertical rows of small cells, rather soft in texture, and tends to be thin and pallid at the base, whereas in the Hysteriaceae the peridium is three layered, with a firm dark outer layer, a middle layer of several rows of pseudoparenchymatous cells, and a thin, pallid inner layer. This peridium is usually thick at the base. The asci in the Patellariaceae tend to be broadly clavate or oblong but in the Hysteriaceae are more cylindric clavate. *Rhytidhysteron rufulum* illustrates the problem: paraphysoids and a well-developed pseudoepithecium are conspicuous, but the structure of the peridium, thickened base of ascoma, cylindric asci, are all features attributed to members of the Hysteriaceae. When the heterogeneous family Patellariaceae is revised, *Rhytidhysteron* should be segregated in its own family. The diversity of ascospore pigmentation, shape and septation suggests that several other families may also be required. Considerable similarity is evident in the ascospores of *Hysteropatella prostii* and *Melittosporium hysterinum;* these two genera were included in the Hysteriaceae by O. Eriksson and Hawksworth (1986) but they appear to be more in accord with the Patellariaceae.

Key to Genera

1. Ascospores small (less than 15 µm long), brown, one septate in clavate asci; ascomata apothecioid.....*Rhizodiscina*
1. Ascospores medium or large sized.....2
2. Ascospores medium sized (ca. 15-35 µm long).....3
2. Ascospores large sized.....6
3. Ascomata apothecioid; ascospores hyaline to brown, usually muriform, in oblong-clavate asci.....*Teichosporella*
3. Ascomata hysterothecioid; ascospores brown.....4
4. Hymenial surface orange, red, bright brown; ascospores ellipsoid in cylindric asci, one or three septate or muriform.....*Rhytidhysteron*
4. Hymenial surface brownish black; ascospores obovoid in broadly oblong asci.....5
5. Ascospores transversely septate.....*Hysteropatella*
5. Ascospores muriform.....*Melittosporium*

6. Ascomata apothecioid; pigment blue, hymenial surface bluish black; ascospores hyaline, elongate fusoid, transversely septate in oblong asci.....*Patellaria*

6. Ascomata apothecioid or hysterothecioid; ascospores brown, broadly ellipsoid or obovoid in broadly clavate asci.....7

7. Ascospores muriform; pigment blue or brown, hymenial surface black.....*Tryblidaria*

7. Ascospores transversely septate; pigment brown and hymenial surface brownish black.....8

8. Ascomata with narrow pallid base; ascospores one to three septate.....*Endotryblidium*

8. Ascomata with well-developed brown base; ascospores one septate.....*Holmiella*

PLEOSPORALES

Luttrell ex Barr, ordo nov.

Pleosporales Luttrell, Mycologia 47: 520. 1955; nom. inval., ICBN, Art. 36.

Ascomata saprobici vel symbiotici vel hemibiotrophici vel biotrophici globosa vel sphaeroidea vel conica vel ovoidea vel obpyriformia immersa vel superficialia; asci bitunicati cylindrici vel clavati vel oblongi; pseudoparaphyses cellularis; ascosporae hyalinae vel brunneae asymmetricae bipolares vel symmetricae unicellulosae vel septatae. Familia typica: Pleosporaceae Nitschke.

Ascomata perithecioid, hysterothecioid or cleistothecioid, immersed, erumpent or superficial; globose, sphaeroid, turbinate, ovoid, obpyriform, conoid, doliiform, dimidiate, (minute) small to large sized; apex short or conspicuously papillate, papilla at times composed of short setae, rounded or compressed, pore rounded or compressed, ostiole periphysate or not; surface smooth or roughened, glabrous or setose or bearing hyphal appendages; peridium of large or small pseudoparenchymatous cells, at times cell walls thickened and cells sclerotial, at times cells compressed, at times in radiating rows; pseudostroma, subiculum or clypeus present at times. Hamathecium of wide to narrow cellular pseudoparaphyses, deliquescing at maturity in some. Asci bitunicate, usually basal, at times extending laterally, cylindric, clavate, oblong or saccate. Ascospores variable in pigmentation, shape and septation, usually with bipolar asymmetry but some symmetric.

Anamorphs hyphomycetous or coelomycetous where known.

Saprobic, lichenized, hemibiotrophic, biotrophic.

The Pleosporales includes the most complex array of organisms in the Loculoascomycetes, consequently the arrangement of genera and families is not yet satisfactory. Considerable diversity is evident in as well as among families. Some of the major characteristics that serve to separate the families are habit, position and shape of ascomata, structure of peridium and type of anamorphic states. Several families have been added since my earlier outline (Barr 1979b), in an effort to clarify

the situation by segregating taxa that are closely related. On the other hand, suborders are not included in this presentation; they would be restricted in many cases from those proposed earlier (Barr 1979b).

This order is separated from the Melanommatales by a combination of character states: narrowly or broadly cellular pseudoparaphyses, asci in a basal layer, peridium usually pseudoparenchymatous, ascospores that exhibit bipolar asymmetry. Just as for the Melanommatales, any one of these features may deviate in a particular taxon.

Key to Families

1. Ascomata superficial (rarely subcuticular) in origin, at times with immersed footlike stroma or hyphae, holobiotrophic or saprobic.....2
1. Ascomata immersed in origin, often erumpent and becoming quite superficial but with bases embedded in the substrate, holo- or hemibiotrophic or saprobic.....8
2. Ascomata dimidiate scutate, superficial or subcuticular.3
2. Ascomata variously shaped but not dimidiate scutate.....5
3. Ascomata saprobic, uniloculate; base narrower than sides.....Micropeltidaceae
3. Ascomata holobiotrophic; base about equal in width to sides..4
4. Ascomata often multiloculate; hyphae quite cylindric.....Polystomellaceae
4. Ascomata uniloculate; hyphae flattened and ribbonlike.....Vizellaceae*
5. Peridium soft, often lightly pigmented.....6
5. Peridium firm and dark.....7
6. Ascomata small to medium sized, hypersaprobic or biotrophic on scale insects or other fungi; anamorphs hyphomycetous.....Tubeufiaceae
6. Ascomata minute to small, biotrophic or epiphytic on leaves, stems, trichomes or other fungi; anamorphs coelomycetous.....Dimeriaceae
7. Ascomata globose, ovoid or obovoid with sterile base, small to medium sized; ascospores hyaline or brown; anamorphs coelomycetous.....Parodiellaceae
7. Ascomata sphaeroid or globose, minute or small sized; ascospores green or olivaceous; anamorphs hyphomycetous.....Venturiaceae p.p.
8. Ascomata hysterothecioid, opening by long slit; peridium relatively thick, three layered; anamorphs hyphomycetous or coelomycetous.....Hysteriaceae
8. Ascomata perithecioid, or if elongate and opening by a slit peridium not thick nor three layered.....9
9. Peridium composed of relatively large pseudoparenchymatous or sclerotial cells.....10
9. Peridium composed of small pseudoparenchymatous or compressed cells.....14

10. Ascomata sphaeroid or low conoid with applanate base..11
10. Ascomata sphaeroid, globose or obpyriform; peridium about equal throughout.....13
11. Peridium wider laterally, narrower above and below; ascospores often large and distoseptate; anamorphs coelomycetous, conidia often distoseptate; on woody substrates..Pleomassariaceae
11. Peridium about equal or wider above, cells often sclerotial; ascospores euseptate; on herbaceous or woody substrates.....12
12. Asci relatively wide, endotunica thickened or thin above; anamorphs hyphomycetous.....Pleosporaceae
12. Asci relatively narrow, endotunica thin above; anamorphs coelomycetous.....Leptosphaeriaceae
13. Ascospores often unicellular; anamorphs coelomycetous, conidia unicellular or euseptate.....Botryosphaeriaceae
13. Ascospores transversely septate or muriform; anamorphs hyphomycetous, conidia distoseptate.....Pyrenophoraceae
14. Ascomata bearing minute inconspicuous papillla on rounded or plane apex.....15
14. Ascomata bearing small or conspicuous papilla.....16
15. Ascomata turbinate, globose or ovoid; peridium three layered, often thickened at base; hemibiotrophic, often erumpent in crowds; anamorphs coelomycetous.....Cucurbitariaceae
15. Ascomata as locules in erumpent stroma; peridium two layered; biotrophic.....Coccoideaceae*
16. Ascomata biotrophic, with light soft peridium; ascospores ellipsoid or subglobose, reddish to dark brown with ornamented wall.....Mesneriaceae*
16. Ascomata hemibiotrophic or saprobic, with relatively dark peridium; ascospores differing from above.....17
17. Ascomata small or minute, often bearing short setae; ascospores green or olivaceous, one septate; anamorphs hyphomycetous. .....Venturiaceae p.p.
17. Ascomata small to medium sized, glabrous or setose; ascospores hyaline or shades of brown; anamorphs coelomycetous.....18
18. Ascomata obpyriform, ovoid or globose, apex broad; peridium three layered, relatively wide in upper regions.... .....Dacampiaceae
18. Ascomata sphaeroid or globose, apex short papillate or papilla conspicuously rounded or compressed (or ascomata cleistothecioid); peridium two layered.....19
19. Ascomata saprobic, mostly coprophilous or in plant debris, seeds or soil; perithecioid or cleistothecioid....Phaeotrichaceae
19. Ascomata hemibiotrophic or saprobic, lichenized or biotrophic; perithecioid.....20
20. Ascomata in uppermost layers of periderm of woody plants, often in inconspicuous thallus, usually clypeate, apex short papillate becoming eroded with broad pore; saprobic or lichenized.....Arthopyreniaceae
20. Ascomata without above combination of characters; hemibiotrophic, saprobic, occasionally biotrophic.....21

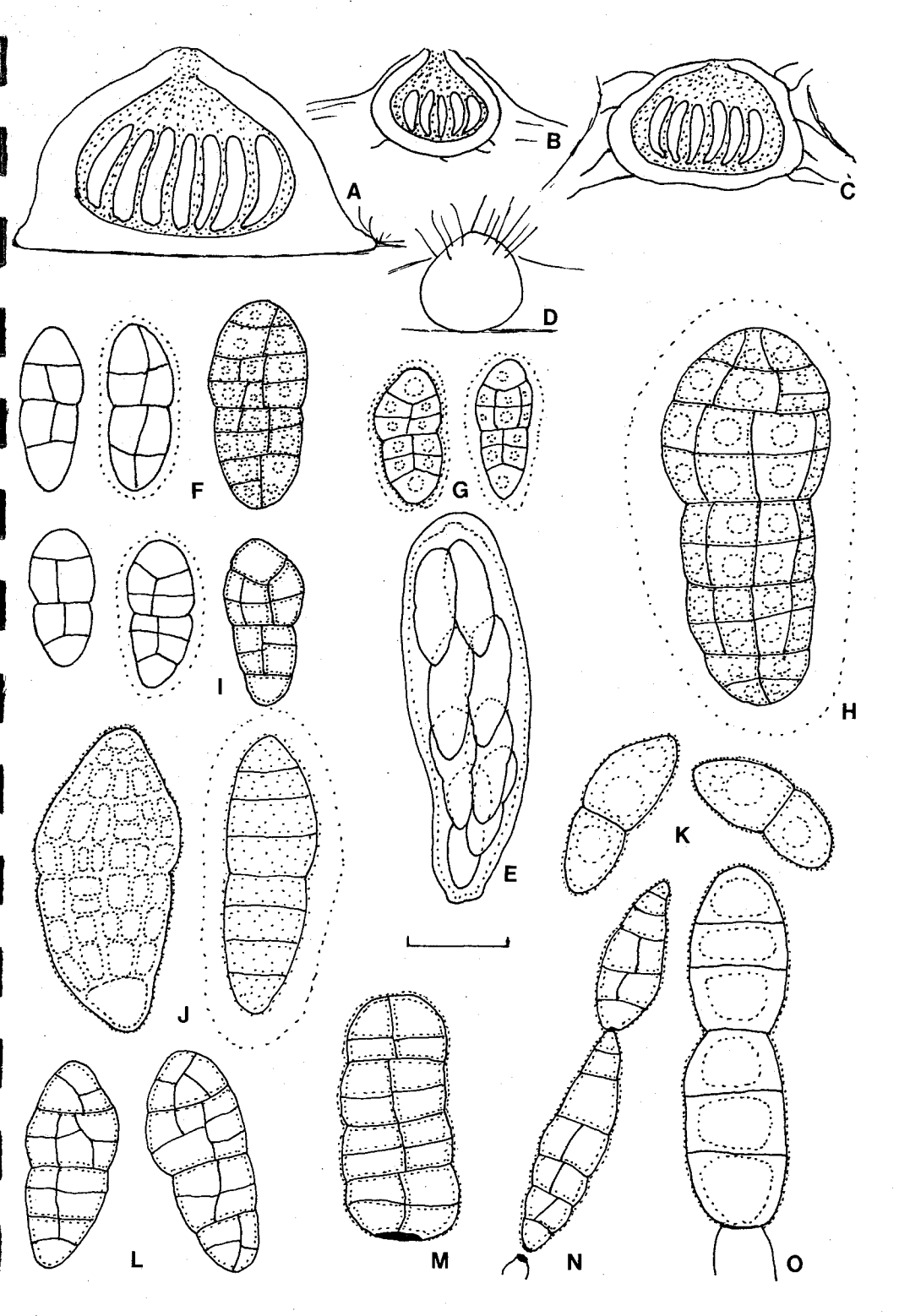
21. Ascospores typically constricted at primary septum and in each hemispore; pseudoparaphyses numerous and sheetlike in centrum.....Lophiostomataceae
21. Ascospores constricted or not at primary septum but not usually in each hemispore; pseudoparaphyses rather sparse in centrum.....Phaeosphaeriaceae

*The southern hemispheric family Vizellaceae is distinguished by superficial, flat, ribbonlike hyphae with alternating dark and hyaline bands, and by superficial scutate ascomata. When Swart (1971) erected the family, he observed some similarity to members of the Botryosphaeriaceae. Von Arx and Müller (1954) had the taxa (as Entopeltidaceae) next to the Parodiopsidaceae. Luttrell (1973) placed *Entopeltis* and *Vizella*, now regarded as congeneric, in the Munkiellaceae and *Blasdalea* in the Parmulariaceae on the basis of ascoma shape. O. Eriksson (1981) noted similarities with the Asterinaceae and Microthyriaceae both. The family seems best arranged in proximity to the Polystomellaceae. The Coccoideaceae at present includes only *Coccoidea*; the genus is Asian and seems related to but separable from the Parodiellaceae. It deviates in several respects from the Venturiaceae where it was placed by von Arx and Müller (1975). The leaf parasites belonging to the Mesnieraceae have distinctive dark reddish-brown sculptured ascospores; the known species are African (Pirozynski 1972).

Pleosporaceae Nitschke, Verh. Naturhist. Preuss. Rheinl. 26. Corr.-bl. 2: 74. 1869.

Ascomata perithecioid, rarely cleistothecioid, small or medium sized, rarely large, immersed erumpent, at times superficial at maturity, sphaeroid or globose, at times with applanate base; apical papilla short, pore rounded, usually stuffed with small cells; somewhat collapsing at times but not truly collabent; surface glabrous, tomentose or setose; peridium narrow or wide, of several rows of relatively large pseudoparenchymatous cells, thick walled or sclerotial, firm, with narrow pallid inner layer. Hamathecium of narrowly or broadly cellular pseudoparaphyses. Asci bitunicate, basal to lateral, few to numerous, clavate, oblong or cylindric; endotunica usually wide especially toward apex. Ascospores light clear brown, yellow or red brown,

Plate 13. Features of Pleosporales. Pleosporaceae: A-D, ascomata of A, *Kirschsteiniothelia aethiops* (Berkeley & Curtis) Hawksworth; B, *Pleospora herbarum* (Fr.) Rabenhorst; C, *P. richtophensis* Ellis & Everh.; D, *P. helvetica* Niessl. E, ascus of *P. richtophensis*. F-L, ascospores of F, *P. herbarum*; G, *P. richtophensis*; H, *P. montana* Wehmeyer; I, *Lewia eureka* Simmons; J, *Clathrospora heterospora* (de Not.) Wehmeyer; K, *K. aethiops*; L, *Pleospora alfalfae* Simmons. M-O, conidia of M, *P. alfalfae*; N, *Lewia eureka*; O, *K. aethiops*. Standard line = 150 µm for A-D, 15 µm for E-O.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dark brown, symmetric or asymmetric, ellipsoid, fusoid, clavate, obovoid, ends obtuse or acute, terete or compressed laterally, one or several septate or muriform; wall smooth or verruculose, gel coating present at times; contents with one or several globules; overlapping uniseriate or biseriate in the ascus.

Anamorphs hyphomycetous where known; conidiogenesis holoblastic or enteroblastic tretic; conidia brown, usually several septate or muriform (described as *Alternaria, Dendryphion, Dendryphiopsis, Stemphylium*).

Hemibiotrophic or saprobic, chiefly on leaves and stems of herbaceous plants, both monocots and dicots, also on woody substrates, cosmopolitan.

The present concept of the Pleosporaceae provides a much reduced number of taxa from the concepts of other recent workers, e.g., Luttrell (1973), von Arx and Müller (1975). It includes species with ascomata mostly immersed, sphaeroid to globose, peridium composed of relatively large pseudoparenchymatous or sclerotial cells, usually clavate asci having a wide endotunica toward the apex, and hyphomycetous anamorphs. The Pyrenophoraceae is retained as a separate but closely related family, also with hyphomycetous anamorphs. The production of distoseptate conidia is a common feature of the members of Pyrenophoraceae, as is the formation of pale ascospores in large ascomata. Separation of the Leptosphaeriaceae, with ascomata having a similar peridium but conoid or globose shape, narrower asci with a thinner endotunica, and coelomycetous anamorphs, removes a number of species that have been included in the Pleosporaceae. The species of the Venturiaceae could be sought in this family, because several have hyphomycetous anamorphs, but the Venturiaceae form minute to small ascomata with relatively narrow peridium of small cells and greenish or olivaceous ascospores.

Pleospora has been accepted as a genus containing many species (Wehmeyer 1961). Recent revisionary studies have removed a number of disparate elements (Crivelli 1983); Simmons (1986b) delimited *Pleospora* more precisely and (1986a) separated *Lewia* from *Pleospora*. Although placed as a synonym of *Pleospora* by Barr (1981), *Curreya* is now removed to the Leptosphaeriaceae. *Clathrospora* produced no anamorph (Harr 1972), and Simmons (pers. comm.) now regards his report (Simmons 1952) of an *Alternaria* state as being instead of a contaminant. *Kirschsteiniothelia* is somewhat anomalous in growing on woody substrates although both ascomata and anamorph are pleosporaceous. The genus was monographed by Hawksworth (1985b). No phragmosporous taxa are included in the family at present although the fungus known as *Melanomma subdispersum* (P. Karsten) Berlese & Voglino (Sivanesan 1984) seems to be a candidate; no suitable genus is known to me for this species.

Key to Genera

1. Ascospores one septate; on woody substrates.....
.....*Kirschsteiniothelia*
1. Ascospores muriform; usually on herbaceous substrates.....2
2. Ascospores laterally compressed, longitudinal septa not visible in side view.....*Clathrospora*
2. Ascospores terete, longitudinal septa visible in both face and side views.....3
3. Ascomata small to medium sized,peridium relatively soft and narrow; asci oblong to cylindric, endotunica narrow; anamorphs in *Alternaria*.....*Lewia*
3. Ascomata (small) medium to large sized, peridium relatively wide and firm; asci usually clavate or oblong, endotunica wide; anamorphs in *Stemphylium*.....*Pleospora*

Pyrenophoraceae Barr, Mycologia 71: 948. 1979.

Ascomata immersed erumpent, medium to large sized, rarely small, sphaeroid or globose or obpyriform, apex rounded or short papillate or short beaked; surface glabrous, tomentose, setose or bearing conidiophores; peridium wide, composed of large-celled pseudoparenchyma, cells often sclerotial, especially outermost rows, base stromatic and short columnar at times. Hamathecium of broadly or narrowly cellular pseudoparaphyses. Asci bitunicate, basal, relatively few, clavate, oblong or cylindric, at times with refractive apical ring surrounding ocular chamber or long cylindric and thin walled at maturity. Ascospores hyaline, yellowish or light brown, obovoid, oblong, fusoid or filiform, several septate or muriform; wall thin or thickened, smooth or verruculose, at times surrounded by gel coating that may form elongate appendages at ends; contents granular or minutely guttulate; biseriate or when filiform in spirally wound fascicle in the ascus.

Anamorphs hyphomycetous; conidiogenous cells enteroblastic tretic; conidia distoseptate (described as *Bipolaris, Curvularia, Drechslera, Exserohilum*).

Hemibiotrophic or biotrophic; anamorphic state parasitic on living monocotyledonous hosts, teleomorphic state in overwintered substrate; many heterothallic species, thus teleomorphic state known only in culture of compatible strains.

The features that separate the Pyrenophoraceae from the Pleosporaceae are habit, the parasitic anamorphs that form distoseptate conidia, and the relatively large and light brownish ascospores. Many of the taxa have broad asci with a thick endotunica surrounded by a refractive apical ring, but species of *Cochliobolus* have a narrow endotunica and have been described as vestigially bitunicate (Hall and Sivanesan 1972). Alcorn (1983) has provided a thoughtful discussion of asci in *Cochliobolus*.

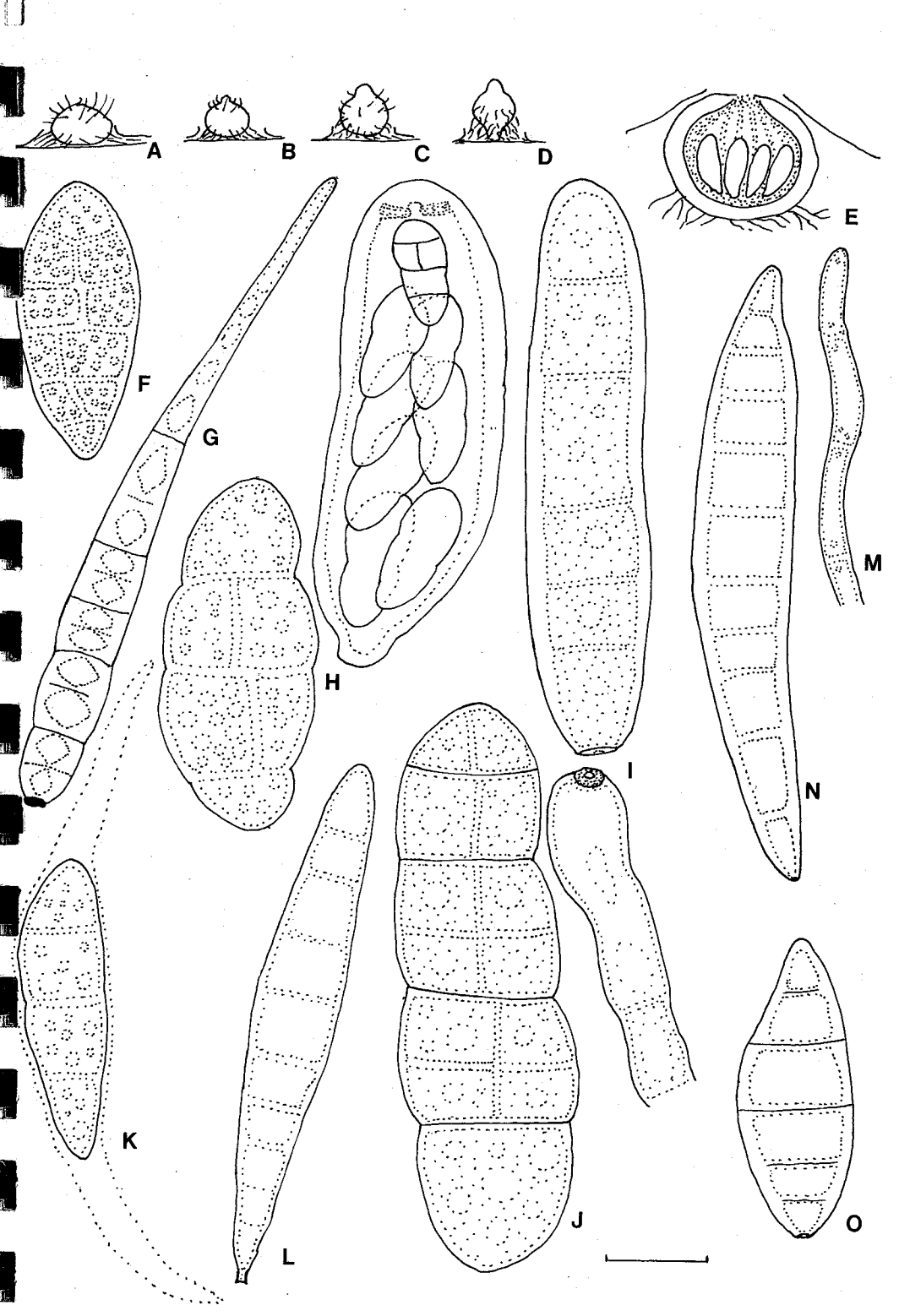
Much information has been published in recent years, e.g., Shoemaker (1961, 1962), Luttrell (1958, 1963, 1964, 1969), Leonard and Suggs (1974), Leonard (1976), Tsuda et al. (1978). Although earlier I had included *Pyrenophora* as a member of the

Pseudosphaeriaceae in the Dothideales (Barr 1972) and von Arx and Müller (1975) also retained the genus in that family, the conspicuous anamorphic states of this and related genera help delimit a separate family. The sterile tissues of the centrum are pseudoparaphyses, and the family is better accommodated in the Pleosporales than in the Dothideales. *Pyrenophora phaeocomes* (Reb.: Fr.) Fr. and *Pleospora herbarum* (Fr.) Rabenhorst, the type species of their respective genera, differ substantially in ascoma size and texture, ascus apical region, as well as shape, pigmentation and septation of ascospores and conidia. O. Eriksson (1981) originally accepted two families, but by 1984 he did not, agreeing with Crivelli (1983) that the Pyrenophoraceae were not separable from the Pleosporaceae. In part, this difference in opinion is based upon misunderstanding of the true nature of *Pleospora herbarum*, now clarified by Simmons (1986b). The genus *Pseudocochliobolus* has been segregated from *Cochliobolus* because of the formation of a stromatic base beneath the ascoma and species of *Curvularia* as anamorphic states rather than *Bipolaris* (Tsuda et al. 1978). Alcorn (1983) presented reasoning to reunite the teleomorph genera, while recognizing that the anamorph genera are separate entities. *Macrospora* is retained as a separate genus; Simmons (pers. comm.) is completing a study of the anamorphic state.

Key to Genera

1. Ascospores transversely septate.....2
1. Ascospores muriform.....3
2. Ascospores fusoid; anamorphs *Exserohilum*.....*Setosphaeria*
2. Ascospores filiform, usually coiled in the ascus; anamorphs *Bipolaris* or *Curvularia*.....*Cochliobolus*
3. Ascomata small to medium sized, glabrous; anamorphs *"Alternaria"*.....*Macrospora*
3. Ascomata medium to large sized, usually setose or bearing conidiophores; anamorphs *Drechslera*.....*Pyrenophora*

Plate 14. Features of Pleosporales. Pyrenophoraceae: A-D, habit sketches of A, *Pyrenophora phaeocomes*; B, *Setosphaeria prolata* Leonard & Suggs; C, *Cochliobolus heterostrophus* (Drechsler) Drechsler; D, *C. nisikadoi* (Tsuda et al.) Alcorn. E, *Macrospora scirpicola* (DC.: Fr.) Fuckel, ascoma in vertical section. F-O, ascus, ascospores, and conidia: F, ascospore, G, conidium of *M. scirpicola*; H, ascus and ascospore of *Pyrenophora trichostoma* (Fr.) Fuckel; I, conidium and tip of conidiophore of *Drechslera graminea* (Rab. ex Schlecht) Shoemaker; J, *Pyrenophora phaeocomes*, ascospore; K, L, *Setosphaeria prolata*, K, ascospore, L, conidium of *Exserohilum* state; M, N, *Cochliobolus heterostrophus*, M, portion of ascospore, N, conidium of *Bipolaris* state; O, conidium of *Curvularia coicis* Castellani. Standard line = 150 µm for E, 30 um for ascus in H, 15 µm for F-O. Habits not to scale.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Hysteriaceae Dumortier, Anal. Fam.: 73, 75. 1829.

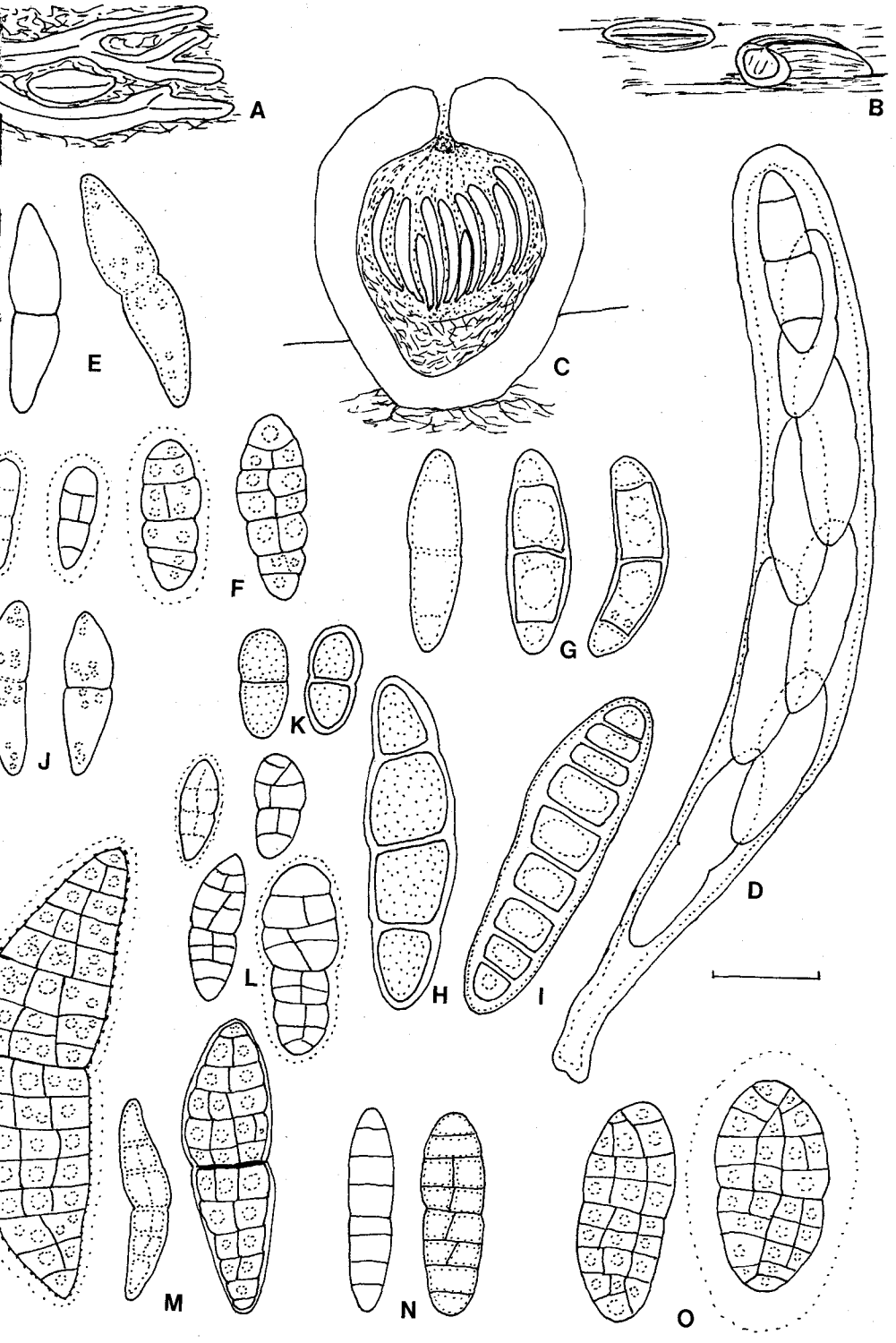
Ascomata immersed erumpent or superficial, short ellipsoid to greatly elongate, sometimes branched or triradiate, in vertical section globose, ovoid or obovoid, separate or gregarious, apex rounded or plane, opening by longitudinal slit, reclosing or remaining open and exposing hymenium; surface smooth or longitudinally striate, subiculum present at times; peridium wide, composed of three layers of small pseudoparenchymatous cells, the outermost thin and often heavily encrusted with dark pigment, the middle wider, lighter brown, the innermost thin, pallid, of more compressed cells. Hamathecium of narrowly cellular pseudoparaphyses, in granular matrix, tips darkened at maturity. Asci bitunicate, basal, clavate or cylindric. Ascospores hyaline or light to dark brown, obovoid, clavate, ellipsoid or fusoid, one or several septate or muriform; wall smooth, foveolate or verruculose, at times surrounded by gel coating; contents granular; overlapping biseriate in the ascus.

Anamorphs where known coelomycetous or hyphomycetous (described as *Coniosporium*, *Septonema*, *Sphaeronema*, *Sporidesmium*).

Saprobic or hemibiotrophic on woody substrates, cosmopolitan.

The classical family grouping has been divided into two (Zogg 1962): the Hysteriaceae, now placed in the Pleosporales, and the Lophiaceae, in the Melanommatales under the earlier name Mytilinidiaceae. The presence of elongate ascomata that open by a longitudinal slit is not solely a perrequisite of the Hysteriaceae, so some care must be taken to note the consistency of the peridium. In this family it is firm, quite thick, three layered, composed of small pseudoparenchymatous cells that are heavily pigmented externally. The relationship of some members seems to be with the Cucurbitariaceae, as Luttrell (1953) suggested, or with the Pleosporaceae. The ascospores of species in *Gloniopsis* are quite similar to those found in the Lophiostomataceae. The most recent study of genera and species is that of Zogg (1962). Lohman's (1937) paper on *Glonium* in southeastern North America and his earlier detailed examination of cultural features in several representatives of the family (Lohman 1932, 1933, 1934, for example) repay thorough reading.

Plate 15. Features of Pleosporales. Hysteriaceae: A, B, habit sketches of A, *Glonium stellatum* Muhlenberg: Fr.; B, *Hysterium pulicare* Pers.: Fr. C, ascoma of *H. pulicare*. D, ascus of *H. pulicare*. E-O, ascospores of: E, *Glonium stellatum*; F, *Gloniopsis smilacis* (Schwein.) Underwood & Earle; G, *Hysterium pulicare*; H, *H. macrosporium* Gerard in Peck; I, *H. sinense* Teng; J, *Glonium clavisporum* Seaver; K, *Psiloglonium lineare* (Fr.) Petrak; L, *Hysterographium mori* (Schwein.) Rehm; M, *H. flexuosum* (Schwein.) Sacc; N, *H. subrugosum* (Cooke & Ellis) Sacc.; O, *H. fraxini* (Pers.: Fr.) de Not. Standard line = 150 µm for C, 15 µm for D-O. Habits not to scale.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Taxa of the genera *Farlowiella*, with one-celled brown ascospores that have a small hyaline basal cell, and *Gloniella*, with several-septate hyaline ascospores, have not yet been reported from temperate North America. *Hysterocarina* is known only from the original specimens of *H. paulistae* Zogg from Brazil (Zogg 1962).

Key to Genera

1. Ascospores typically one septate, but with additional septa developing in elongate ascospores.....2
1. Ascospores typically more than one septate.....3
    2. Ascomata immersed then erumpent from woody substrate, broad bases remaining immersed; ascospores asymmetric, narrowly or broadly obovoid.....*Psiloglonium*
    2. Ascomata superficial on woody substrate, on or in superficial subiculum; ascospores symmetric, fusoid or tapered to caudate base.....*Glonium*
3. Ascospores hyaline or slightly yellowish, obovoid, muriform; ascomata immersed erumpent, bases grown with substrate.*Gloniopsis*
3. Ascospores soon brown, transversely septate or muriform.....4
    4. Ascospores transversely septate; ascomata erumpent or nearly superficial.....*Hysterium*
    4. Ascospores muriform; ascomata immersed erumpent..... .....*Hysterographium*

Venturiaceae Müller & von Arx ex Barr, Mycologia 71: 947. 1979.
Venturiaceae Müller & von Arx, Ber. Schweiz. Bot. Ges. 60: 388. 1950; nom. inval., ICBN, Art. 36.

Ascomata small to medium sized, rarely large, globose, sphaeroid or ovoid or as locules in stroma, immersed, erumpent or superficial, apex short papillate, opening by rounded pore, often bearing dark setae from upper regions of peridium, occasionally from superficial hyphae also; hyphae in substrate, subcuticular or intramatrical, or superficial, some forming compact pseudoparenchymatous stromatic tissues, immersed or erumpent; peridium narrow or relatively wide, composed of pseudoparenchymatous or somewhat compressed rows of cells. Hamathecium of narrowly cellular pseudoparaphyses, often deliquescing at maturity. Asci bitunicate, basal or extended laterally, oblong, obovoid, saccate or cylindric. Ascospores hyaline, green, yellowish green, olivaceous brown or becoming dark brown, obovoid, oblong or fusoid, usually asymmetric, ends obtuse or acute, one septate, septum median, supramedian or submedian, constricted or not; walls smooth or verruculose, at times surrounded by gel coating; contents guttulate; usually overlapping biseriate in the ascus.

Anamorphs where known hyphomycetous; conidiogenous cells holoblastic, sympodial, or percurrent (described as *Cladosporium, Dictyodochium, Fusicladium, Pollacia, Spilocaea, Stigmina, Virgariella*).

Biotrophic or saprobic in leaves, herbaceous stalks or woody branches, rarely on mosses or dung, cosmopolitan.

Some changes in my concept of the Venturiaceae have occurred since my earlier study (Barr 1968). Three genera are removed to the Polystomellaceae: the subcuticular, multiloculate, hemispheric *Atopospora* and the species of *Hormotheca* that are separated from *Coleroa*, also tentatively *Trichodothis* with radiating hyphae over a scutate, multiloculate stroma anchored by a short hypostromatic foot in the substrate. Within the family, species from subgenus Venturioides of *Gibbera* are reassigned to *Protoventuria*. *Gibbera* in the strict sense is a compact group of species whose ascomata develop from an erumpent hypostroma and do not produce superficial hyphae. *Dibotryon* is revived for *D. morbosum* (Schwein.: Fr.) Theissen & H. Sydow; this species differs from *Apiosporina collinsii* (Schwein.) von Höhnel by forming an extensive hypostroma mixed with cells of the substrate, and no superficial hyphae, as well as turbinate rather than globose ascomata. Sivanesan (1977, 1984, 1985) has enlarged understanding of both teleomorphic and anamorphic states in this family substantially.

Key to Genera

1. Superficial mycelium lacking; ascomata immersed, erumpent or superficial.....2
1. Superficial mycelium present; ascomata superficial.....9
    2. Ascomata immersed to erumpent, separate with varying amounts of intramatrical hyphae or as locules in stroma....3
    2. Ascomata erumpent superficial, separate or grouped as locules in stroma or with bases of ascomata fused to erumpent hypostroma.....4
3. Ascomata separate, with varying amounts of intramatrical hyphae, usually setose around apex.....*Venturia*
3. Ascomata as nonsetose locules in intramatrical stroma..... .....*Platychora*
    4. Stromatic tissues subcuticular; ascomata setose...*Coleroa*
    4. Stromatic tissues intramatrical (also subcuticular at times) or in stomatal opening.....5
5. Hypostromatic foot in stomatal opening of conifer leaves, bearing single small, nonsetose ascoma.....*Phaeocryptopus*
5. Hypostroma intramatrical, typically bearing several ascomata.6
    6. Ascomata or locules medium sized to large on erumpent hypostroma, setose or nonsetose; asci cylindric.....*Gibbera*
    6. Ascomata or locules small; asci oblong or saccate.....7
7. Hypostroma remaining immersed, bearing setose ascomata..... .....*Pyrenobotrys*
7. Hypostroma erumpent, bearing nonsetose ascomata or locules...8
    8. Hypostroma platelike; ascospore septation nearly median.. .....*Xenomeris*
    8. Hypostroma extensive and large; ascospore septation submedian (apiospores).....*Dibotryon*
9. Ascomata nonsetose; ascospore septation submedian (apiospores) .....*Apiosporina*
9. Ascomata setose; ascospore septation median or supramedian..10

10. Ascomata and superficial hyphae setose; ascospores becoming dark brown.....*Acantharia*
10. Ascomata but not hyphae setose; ascospores greenish to olive brown.....11
11. Subcuticular thin stromatic layer formed beneath ascomata.....*Metacoleroa*
11. Intramatrical as well as superficial hyphae formed beneath ascomata.....*Protoventuria*

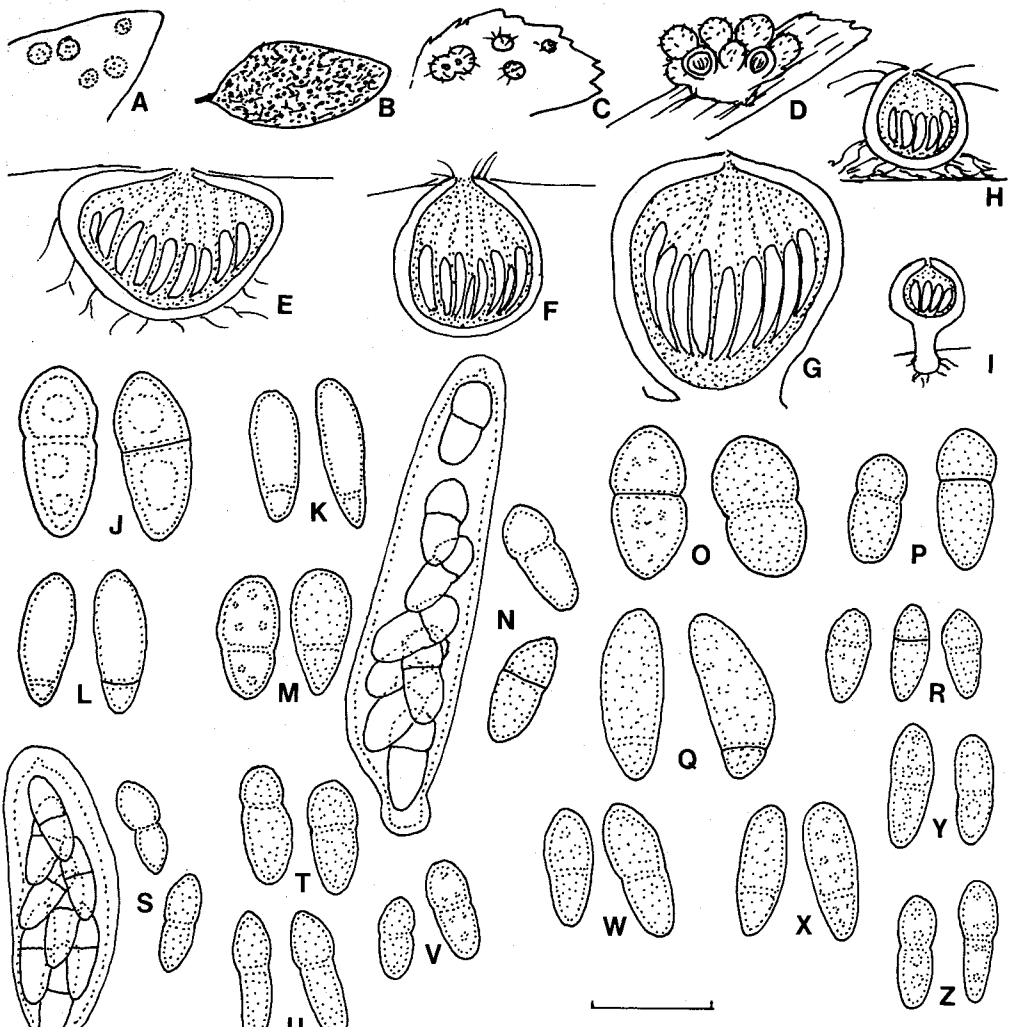
Tubeufiaceae Barr, Mycologia 71: 948. 1979.

Ascomata superficial, separate or gregarious, small to medium sized, pallid, yellowish, brownish, ovoid, globose, turbinate or cylindric; apex rounded or truncate or short papillate, opening by small to large rounded pore; surface smooth or roughened by protruding cells, setae or hyphal appendages; peridium soft and fleshy, often three layered with the middle layer most conspicuous in upper regions, composed of small pseudoparenchymatous cells. Hamathecium of narrowly cellular pseudoparaphyses. Asci bitunicate, basal, clavate or cylindric. Ascospores hyaline, yellowish, pinkish or light vinaceous brown, narrowly oblong, ellipsoid, fusoid or cylindric, one or several septate; wall smooth; contents guttulate or with one globule per cell; overlapping biseriate or in fascicle(s) in the ascus.

Anamorphs hyphomycetous where known; conidiogenesis holoblastic; conidia helicosporous, staurosporous or dictyosporous (described as *Helicoma, Helicosporium, Monodictys-like, Pendulispora, Tetracrium* and others); *Asteromella* spermatial state present at times.

Biotrophic over scale insects or on leaves, hyperbiotrophic on foliicolous fungi, hypersaprobic on other fungi or previously colonized substrates, widespread.

Plate 16. Features of Pleosporales. Venturiaceae: A-D, habit sketchs of A, *Venturia rumicis* (Desm.) Winter; B, *Apiosporina collinsii*; C, *Coleroa chaetomium* (Kunze: Fr.) Rabenhorst; D, *Gibbera vaccinii* (Sowerby: Fr.) Fr. E-I, ascomata in vertical section of E, *Venturia rumicis*; F, *V. inaequalis* (Cooke) Winter; G, *Dibotryon morbosum*; H, *Protoventuria maculosa* (Ellis) Barr; I, *Phaeocryptopus nudus* (Peck) Petrak. J-Z, asci and/or ascospores of J, *Acantharia echinata* (Ellis & Everh.) Theissen & H. Sydow; K, *Apiosporina collinsii*; L, *Dibotryon morbosum*; M, *Coleroa chaetomium*; N, *Venturia inaequalis*; O, *Gibbera vaccinii*; P, *G. vacciniicola* (Dearness & House) Barr; Q, *Platychora alni* (Peck) Petrak; R, *Protoventuria maculosa*; S, *Phaeocryptopus nudus*; T, *Pyrenobotrys conferta* (Fr.) Theissen & H. Sydow; U, *P. compacta* (Peck) B. Eriksson; V, *P. pulchella* (Cooke & Peck) Barr; W, *Venturia acerina* Plakidas ex Barr; X, *V. adusta* (Fuckel) Müller; Y, *Metacoleroa dickiei* (Berkeley & Broome) Petrak; Z, *Xenomeris raetica* (Müller) Petrak. Standard line = 150 µm for E-I, 15 µm for J-Z. Habits not to scale.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While some genera are represented in temperate regions (Barr 1980), several additional taxa are hyperbiotrophic on foliicolous fungi in tropical regions. Pirozynski (1976) detailed some of these, as did Rossman (1979) and more recently in detail (Rossman 1987). *Podonectria coccicola* (Ellis & Everh.) Petch is known from southern USA; Rossman (1978) monographed that genus. *Letendraea helminthicola* (Berkeley & Broome) Weese is European and could be expected to occur in North America. *Rebentischia* includes two widespread temperate-zone species, *R. massalongii* (Mont.) Sacc. and *R. unicaudata* (Berkeley & Broome) Sacc. Several species of *Tubeufia* are present in temperate regions (Barr 1980) but the genus seems more frequent in the tropics. The genera with temperate-zone taxa may be separated conveniently on the basis of ascospore shape and septation as well as habit. Goos (1987) has summarized information and provided illustrations of several of the helicosporous anamorphs; Sivanesan (1984) shows much of the variation in teleomorphs as well as anamorphs.

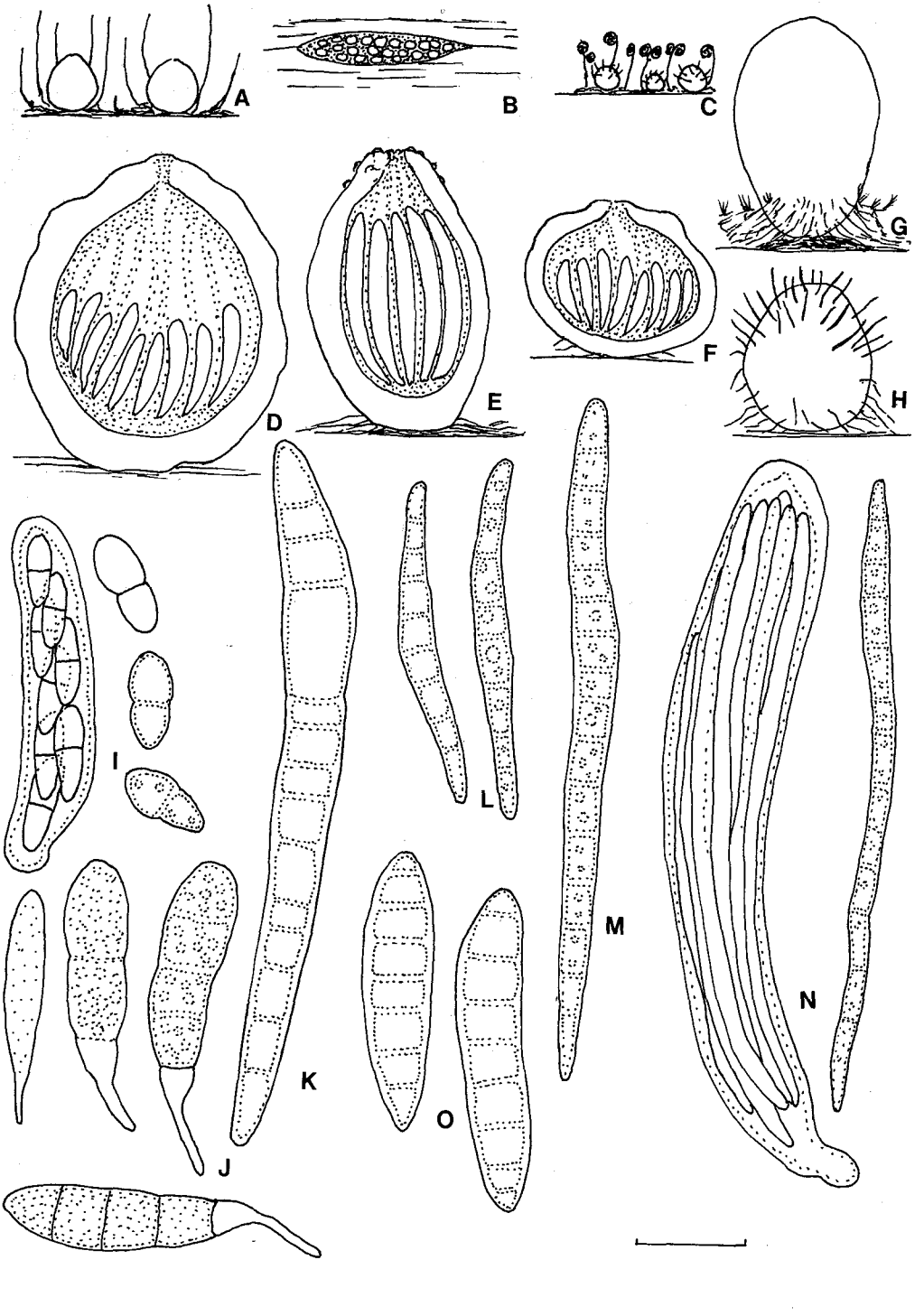
Key to Genera

1. Ascomata biotrophic over scale insects on leaves; ascospores cylindric.....*Podonectria*
1. Ascomata hypersaprobic on other fungi or previously colonized substrates.....2
    2. Ascospores one septate.....*Letendraea*
    2. Ascospores several septate.....3
3. Ascospores ellipsoid with lower cell extended as tapering narrow portion.....*Rebentischia*
3. Ascospores elongate fusoid to cylindric, without conspicuous tapering narrow portion.....*Tubeufia*

Botryosphaeriaceae Theissen & H. Sydow, Ann. Mycol. 16: 18. 1918.

Ascomata or stromata immersed becoming erumpent to nearly superficial, separate, gregarious or closely grouped and connected at sides, small or medium sized, sphaeroid or globose; apex rounded, short papillate at times, pore rounded; stromata pulvinate, locules globose or ovoid; surface glabrous or roughened by protruding cells or at times by hyphal tomentum;

Plate 17. Features of Pleosporales. Tubeufiaceae: A-C, habit sketches of A, *Letendraea helminthicola*; B, *Tubeufia cerea* over pyrenomycetous stroma; C, *T. scopula* (Cooke & Peck) Barr. D-H, ascomata in vertical section or surface view of D, *Rebentischia massalongii*; E, *Tubeufia paludosa* (Crouan & Crouan) Rossman; F, *T. cerea*; G, *Podonectria coccicola*; H, *T. scopula*. I-O, ascus and ascospores of I, *Letendraea helminthicola*; J, *Rebentischia massalongii*; K, *Podonectria coccicola*; L, *Tubeufia cerea*; M, *T. helicoma* (Phill. & Plowr.) Pirozynski; N, *T. scopula*; O, *T. pezizula* (Berkeley & Curtis) Barr. Standard line = 150 µm for D-H, 15 µm for I-O. Habits not to scale.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peridium relatively wide, composed of large pseudoparenchymatous cells, internal layers pallid and compressed, often with coarse brown hyphae from lower sides and base. Hamathecium of broadly cellular pseudoparaphyses. Asci bitunicate, basal or from pulvinate hypothecium, clavate or broadly oblong. Ascospores hyaline, yellowish or light to dark brown, obovoid or rhomboid and asymmetric or ellipsoid or fusoid and symmetric, one celled or one to three septate; wall thin or thickened, smooth or verruculose, with gel coating and/or caplike appendages in some; contents granular or minutely guttulate, or one or more large globules per cell; overlapping biseriate in the ascus.

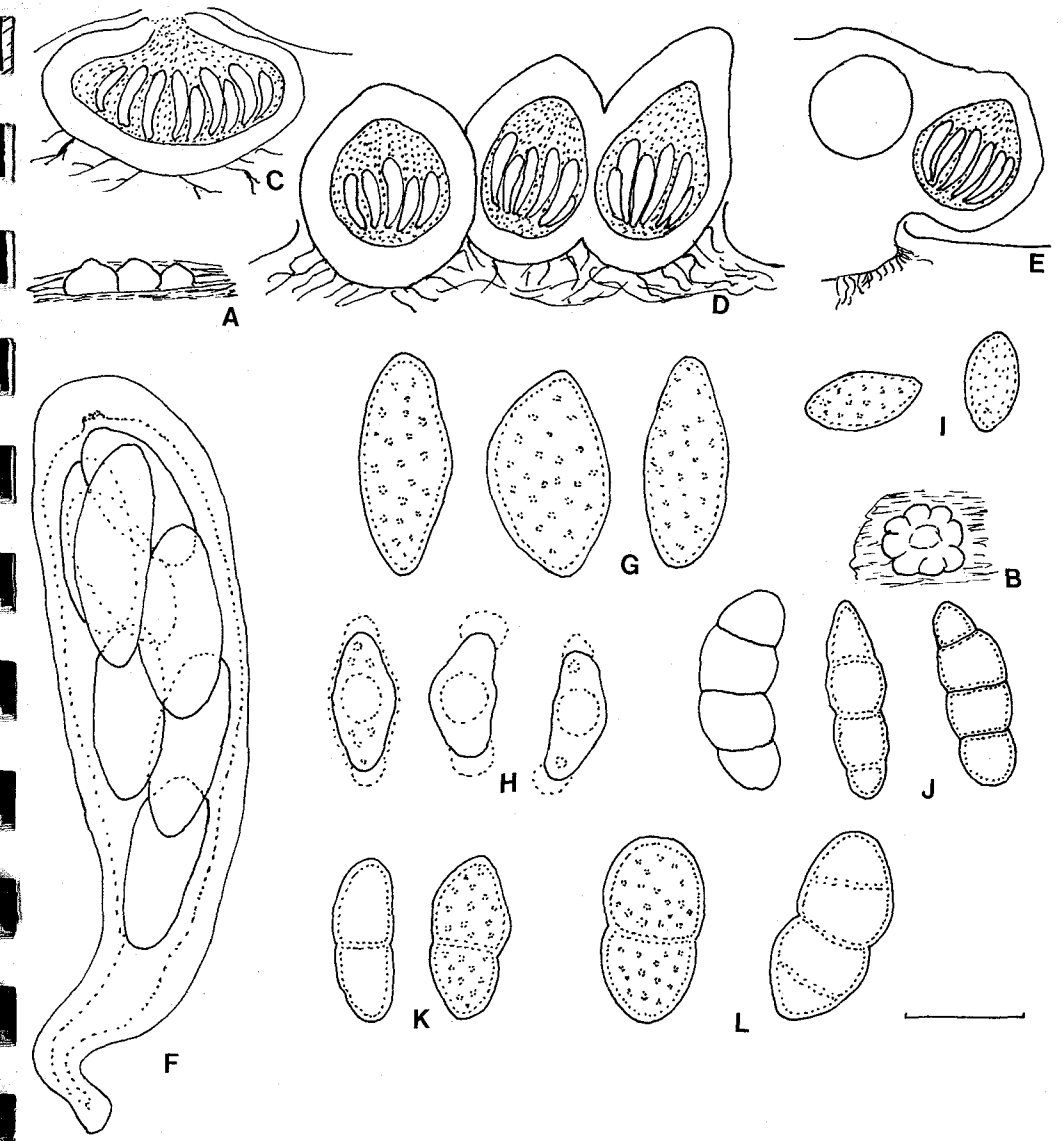
Anamorphs coelomycetous where known; conidiogenous cells holoblastic, conidia hyaline or brown, one celled or one or two septate (described as *Botryodiplodia, Diplodia, Dothiorella, Lasiodiplodia, Sphaeropsis*) or conidiogenous cells enteroblastic phialidic, conidia hyaline or light brown, one celled (described as *Colletotrichella, Fusicoccum, Kabatia, Placosphaeria, Selenophoma*).

Biotrophic, hemibiotrophic or saprobic, on woody branches, herbaceous leaves or stems, culms of monocots, gymnosperm leaves and twigs, lichen thalli, cosmopolitan.

The major differences between the Botryosphaeriaceae and the Dothioraceae, where earlier I had disposed of some taxa (Barr 1972, 1979b), have become apparent to me when various stages of development were available. I now accept the Botryosphaeriaceae as a family of the Pleosporales. Nonseptate ascospores do not provide the sole criterion, although the majority of species do show this condition. The coarse hyphae and cells of the peridium, thick-walled, wide, usually clavate asci, and the coelomycetous anamorphs when present, are the main features of this family.

Botryosphaeria and *Discochora* (to replace *Guignardia*; see Bissett 1986) are both species-rich genera differing especially in ascospore shape and substrate preferences. Taxa with locules in a pulvinate stroma include *Auerswaldiella puccinioides* (Speg.) Theissen & H. Sydow with amerospores and *Homostegia piggotii* (Berkeley & Broome) Karsten with phragmospores. *Auerswaldia* and *Phyllachorella* are two genera of tropical regions whose species form pulvinate stromata containing several locules. *Dothidotthia* is removed from *Gibbera* (von Arx 1954; Shoemaker 1963) and is utilized for species with ascomata as in *Botryosphaeria* whose uniseptate ascospores range in pigmentation from yellow brown to dull dark brown. I had employed *Neodeightonia* for *Dothidotthia ramulicola* (Peck) Barr (Barr et al. 1986) but that genus is surely identical with *Botryosphaeria* as von Arx and Müller (1975) recognized. The European *Leptoguignardia* has ascomata much like those of *Discochora* and hyaline ascospores with septa near each end.

Plate 18. Features of Pleosporales. Botryosphaeriaceae: A, B, habit sketches of A, *Botryosphaeria dothidea* (Mougeot in Fr.) Ces. & de Not.; B, *Homostegia piggottii*. C-E, ascomata in



vertical section of C, *Discochora philoprina* (Berkeley & Curtis) Bissett; D, *Botrysphaeria dothidea*; E, *Auerswaldiella puccinioides*. F, ascus of *B. dothidea*. G-L, ascospores of G, *B. dothidea*; H, *Discochora philoprina*; I, *A. puccinioides*; J, *Homostegia piggottii*; K, *Dothidotthia andersonii* (Shoemaker) Barr; L, *D. ramulicola*. Standard line = 150 μm for C-E, 15 μm for F-L. Habits not to scale.

Key to Genera

1. Stromata pulvinate, erumpent, containing numerous locules....2
1. Ascomata separate, gregarious or grouped closely and surrounded by well-developed stroma, ascomata then erumpent.....3
2. Lichenicolous; ascospores three septate.....*Homostegia*
2. On vascular plants; ascospores one celled..*Auerswaldiella*
3. Ascospores mostly one septate, yellow brown, dull brown or dark brown.....*Dothidotthia*
3. Ascospores one celled, occasionally one or two septate in age, hyaline or finally brownish in age.....4
4. Ascospores medium to large sized, ellipsoid, obovoid or fusoid, usually without gel coating or appendages; often on twigs, conifer leaves, larger grasses.....*Botryosphaeria*
4. Ascospores nearly rhomboid, small to medium sized, usually with caplike appendages; often on leaves..*Discochora*

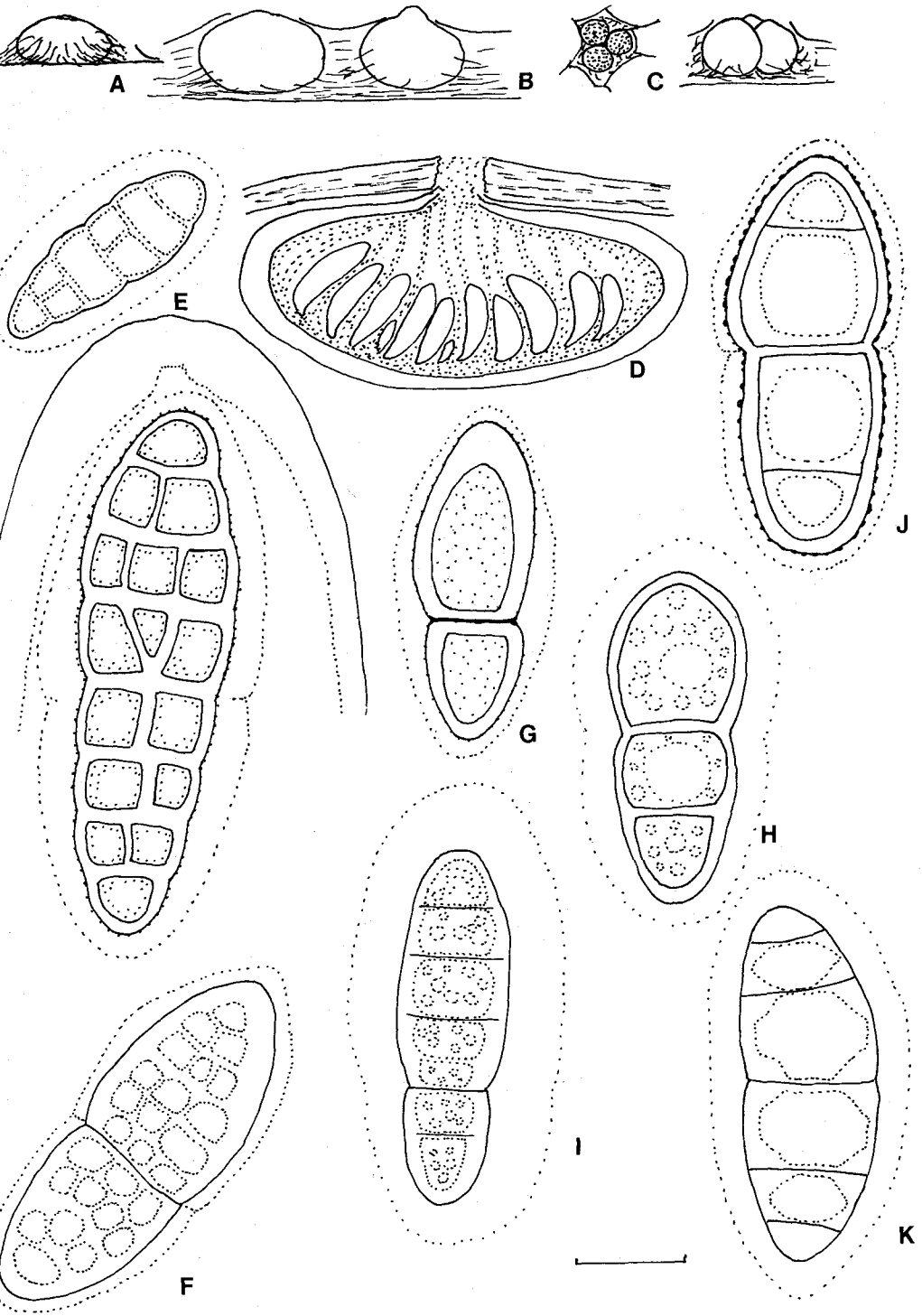
Pleomassariaceae Barr, Mycologia 71: 949. 1979.

Ascomata immersed or erumpent superficial, separate or gregarious, medium to large sized, sphaeroid or conoid with applanate bases; apex rounded or short papillate, pore rounded, wide; peridium of large, brown, pseudoparenchymatous cells, typically widest at sides and narrowed toward apex and base or wide laterally and narrow along applanate base; brown hyphae forming conspicuous weft around ascomata in immersed species. Hamathecium of narrowly cellular pseudoparaphyses. Asci bitunicate, basal, oblong or clavate, at times inflated below middle. Ascospores reddish to dark brown, obovoid with bipolar asymmetry or ellipsoid fusoid to oblong with bipolar symmetry, one or several septate or muriform, distoseptate or euseptate; wall smooth, foveolate or verruculose, usually thick, often surrounded by gel coating; contents with one globule per cell; overlapping biseriate in the ascus.

Anamorphs coelomycetous; conidiogenesis holoblastic; conidia brown, rather large, often distoseptate (described as *Macrodiplodiopsis, Myxocyclus, Prosthemium, Scolicosporium, Shearia, Stegonosporium*).

Saprobic or hemibiotrophic on branches or decorticated wood, usually angiospermous but occasionally coniferous, temperate regions.

Plate 19. Features of Pleosporales. Pleomassariaceae: A-C, habit sketches of A, *Pleomassaria carpinea* (Fuckel) Sacc.; B, *Splanchnonema foedans* (Fr.) O. Kuntze; C, *Asteromassaria macrospora*. D, ascoma in vertical secton of *P. siparia* (Berkeley & Broome) Sacc. E, tip of ascus and young and mature ascospores of *P. siparia*. F-K, ascospores of F, *P. carpinea*; G, *S. ampullaceum* (Pers.: Fr.) Shoemaker; H, *S. loricatum* (Tul. & Tul.) Barr; I, *S. argus* (Berkeley & Broome) O. Kuntze; J, *A. macrospora*; K, *A. olivaceo-hirta* (Schwein.) Barr. Standard line = 150 µm for D, 15 µm for E-K. Habits not to scale.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The concept of the Pleomassariaceae was established by Barr (1982b) for the three genera separated in the following key. The family is distinctive by the combination of habit on woody substrates, rather large ascomata with wide lateral walls, large ascospores and conidia, both often distoseptate. Spooner and Kirk (1982) discussed the relationship between *Scolicosporium macrosporium* (Berkeley) Sutton and *Asterosporium asterospermum* (Pers. ex Gray) Hughes (*A. hoffmannii* Kunze), both associated in the literature with *Asteromassaria macrospora* (Desm.) von Hohnel.

Key to Genera

1. Ascospores muriform, typically asymmetric, primary septum usually submedian; ascomata immersed in substrate....*Pleomassaria*
1. Ascospores transversely septate.....2
    2. Ascospores obovoid, asymmetric, primary septum usually submedian.....*Splanchnonema*
    2. Ascospores ellipsoid fusoid or oblong, symmetric, primary septum median.....*Asteromassaria*

Leptosphaeriaceae Barr, Mycotaxon 29: 503. 1987.

Ascomata perithecioid, small, medium or large sized, immersed beneath epidermis and becoming superficial as epidermis is shed, or superficial on stromatic tissues, separate or gregarious, conoid and applanate or obpyriform or sphaeroid; apex relatively wide, short papillate or beaklike, pore rounded, periphysate at times; surface smooth or tomentose; peridium relatively wide, thickened at lower sides or equal in width throughout, composed of thick-walled sclerotial cells, often pallid or light brown within blackened crustose surface, inner layer narrow, composed of compressed cells. Hamathecium of narrowly cellular pseudoparaphyses. Asci bitunicate, basal to lateral, broadly cylindric or oblong, with narrow ocular chamber. Ascospores hyaline, yellowish or shades of brown, ellipsoid, fusoid, obovoid, oblong or elongate, often asymmetric, one or several septate or muriform, septa constricted at times, occasionally separating into partspores; wall firm, smooth or verruculose, at times surrounded by gel coating or bearing appendages; contents granular or with one or two globules per cell; uniseriate, biseriate or in a fascicle in the ascus.

Anamorphs coelomycetous where known; conidiogenesis phialidic; conidia hyaline, one celled (described as *Phoma*); or conidiogenesis holoblastic annellidic; conidia hyaline or brown, one celled or one septate (described as *Coniothyrium*).

Saprobic or hemibiotrophic, on stems or leaves of herbaceous or woody plants, on conifer twigs and cones, cosmopolitan.

This family is separated from the Pleosporaceae because of the coelomycetous rather than hyphomycetous anamorphs as well as the narrower and thinner-walled asci, and from the Phaeosphaeriaceae primarily on the shape of ascomata and large scleroplectenchymatous or thick-walled cells of the peridium. The species-rich central genus *Leptosphaeria* shows some variation in

ascomata and ascospores. The recent study of *Leptosphaeria* by Shoemaker (1984a) includes also the type species of *Syncarpella*, *S. tumefaciens* (Ellis & Everh.) Theissen & H. Sydow. This genus was relegated to synonymy with *Leptosphaeria* by Holm (1968) but is reinstated and removed to the Cucurbitariaceae for species whose ascomata are globose with minute papilla and usually are erumpent in crowds from the infected stems. *Ophiobolus* with *O. acuminatus* (Sowerby: Fr.) Duby has obpyriform ascomata and scolecospores, often separating into partspores at maturity. Some species of *Leptosphaeria* also have scolecospores (e.g., *L. cesatiana* [Mont. ex Ces. & de Not.] Holm), but their ascomata are sphaeroid or conoid; as Holm (1957) did, I prefer to place these species separately from those of *Ophiobolus* (but see Shoemaker 1976 for another viewpoint). Among the other taxa with conoid or sphaeroid ascomata, those with one-septate and hyaline or lightly pigmented ascospores are referred to *Didymolepta*. This taxon has been included under *Didymella* but the species deviate in several respects from true *Didymella* (Corlett 1981; compare his illustrations of *D. exigua* and *D. eupyrena*). The dictyosporous species of the family seem separable into two genera, *Heptameria* and *Curreya*. *Heptameria obesa* (Dur. & Mont.) Sacc. has strongly conoid ascomata and peculiarly septate ascospores (muriform in the mid region, see Plate 20, Q). *Curreya conorum* (Fuckel) Sacc. has more sphaeroid ascomata and "normally" muriform ascospores. The latter genus I had attempted to synonymize under *Pleospora* (Barr 1981), but that is incorrect. Von Arx and van der Aa (1984) have pointed out the differences between the two, although I cannot agree that *Curreya* should include *Cucurbidothis*, nor that it is closely related to *Melanomma*, *Didymosphaeria*, *Paraphaeosphaeria* and *Massarina*. *Curreya* could conceivably include those taxa still residing in *Pleospora* whose anamorphs are coelomycetous, e.g., *P. betae* Bjorling = *P. betae* (Berlese) Newodowski (Webster and Lucas 1959).

Key to Genera

1. Ascospores scolecosporous; ascomata obpyriform.....*Ophiobolus*
1. Ascospores variable in shape but if scolecosporous then ascomata not obpyriform.....2
    2. Ascospores one septate, hyaline or lightly pigmented.....*Didymolepta*
    2. Ascospores several septate, shades of brown.....3
3. Ascospores transversely septate.....*Leptosphaeria*
3. Ascospores muriform.....4
    4. Ascospores fusoid with only the dark central portion containing longitudinal septa.....*Heptameria*
    4. Ascospores ellipsoid or obovoid with longitudinal septa in most cells.....*Curreya*

Cucurbitariaceae Winter in Rabenhorst, Kryptogamen-Flora 1(2): 308. 1885.

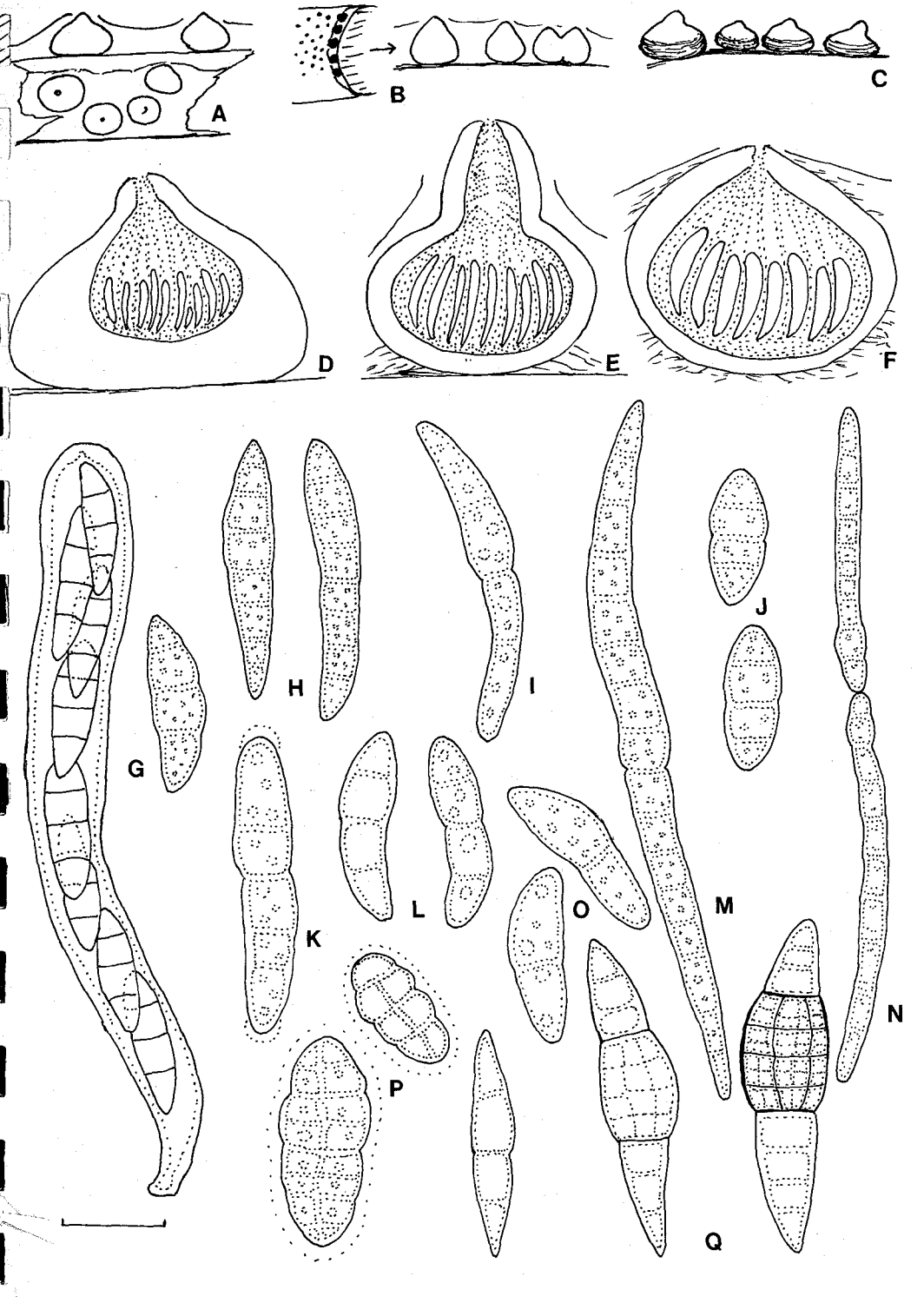
Ascomata immersed becoming erumpent and often appearing superficial when periderm is sloughed, usually gregarious or cespitose, scattered at times, occasionally closely appressed and appearing as locules in stroma, medium to large sized, turbinate, globose or ovoid; apex rounded plane, apical papilla minute, pore small, rounded; seated in subiculum or on compact stromatic tissues or thin crustose layer; surface roughened with warts or tubercles or smooth, dull black, at times apical region pallid; peridium wide, firm, equal in width throughout or apical and/or basal region wider, externally darkly encrusted with pigment, internally lighter brown, yellowish or pallid, three layered, often apparent as two layers of small pseudoparenchymatous or sclerotial cells and narrow innermost layer composed of compressed cells. Hamathecium of narrowly cellular pseudoparaphyses. Asci bitunicate, basal to lateral, cylindric or somewhat clavate or oblong, stipitate at times, with narrow ocular chamber. Ascospores light brown, yellowish brown, or reddish or dark brown, ellipsoid or fusoid and symmetric or oblong or elongate and asymmetric, one or several septate or muriform; wall smooth, foveolate or verruculose, at times surrounded by narrow gel coating; contents guttulate, finally one globule per cell; uniseriate or partially biseriate or in a fascicle in the ascus.

Anamorphs coelomycetous where known; conidiogenesis holoblastic determinate or annellidic or enteroblastic phialidic (described as *Camarosporium, Coniothyrium, Diplodia, Haplosporella, Megaloseptoria, Phaeoseptoria, Pseudodichomera, Pyrenochaeta, Sphaeropsis*).

Saprobic or hemibiotrophic, sometimes causing hypertrophy of plant tissues, on woody twigs and branches, rarely herbaceous stems, or symbiotic with scale insects on conifers, widespread.

Grouped ascomata with minute apical papillae are typical of the family. A number of characteristics are variable within the family and combinations of these variations may be found in a single genus or may define a genus. The variations include: turbinate or globose or ovoid ascomata, warted or nearly smooth surface, cylindric or slightly clavate or oblong shapes of asci,

Plate 20. Features of Pleosporales. Leptosphaeriaceae: A-C, habit sketches of A, *Heptameria obesa*; B, *Leptosphaeria ellisiana* Berlese; C, *L. doliolum* (Pers.: Fr.) Ces. & de Not. D-F, Ascomata in vertical section of D, *L. doliolum*; E, *Ophiobolus acuminatus*; F, *Curreya conorum*. G, ascus and ascospore of *L. doliolum*. H-Q, ascospores of H, *L. millefolii* (Fuckel) Niessl; I, *L. jacksonensis* Shoemaker; J, *L. harknessiana* Ellis & Everh.; K, *L. cylindrospora* Auerswald & Niessl; L, *L. ellisiana* Berlese; M, *L. cesatiana*; N, *Ophiobolus acuminatus*; O, *Didymolepta mimuli* (Wehmeyer) Barr; P, *Curreya conorum*; Q, *Heptameria obesa*. Standard line = 150 µm for D-F, 15 µm for G-Q. Habits not to scale.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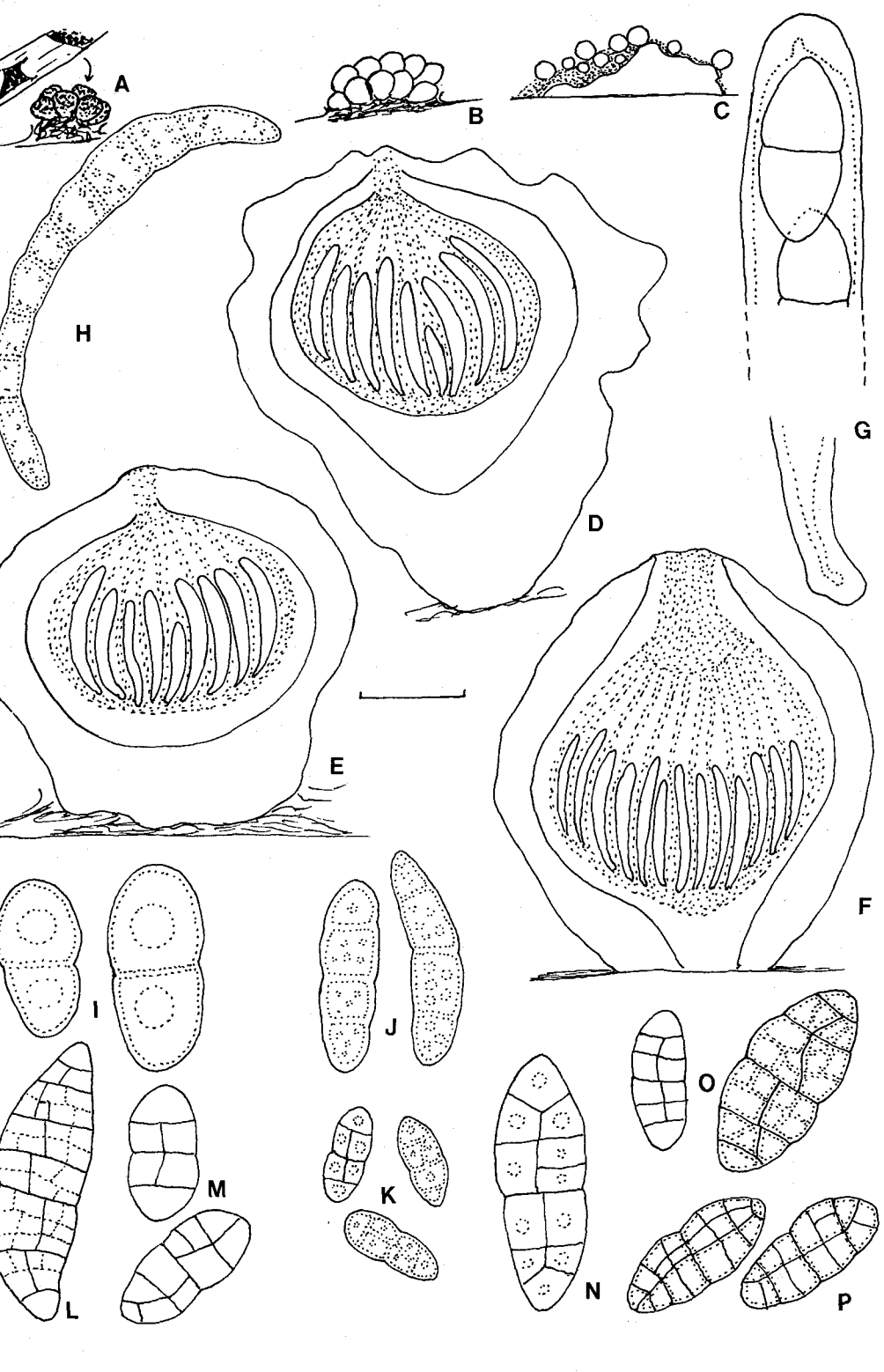
symmetric and ellipsoid or fusoid or asymmetric and oblong or elongate ascospores. In the dictyosporous *Cucurbitaria* the species have various combinations of these features. My concept of the genus is expanded from that of Welch (1926), who studied numerous taxa named as *Cucurbitaria* and accepted only five species, but is stricter than that of Mirza (1968), who recognized many taxa. *Otthia spiraeae* (Fuckel) Fuckel has globose to ovoid ascomata with nearly smooth surface, cylindric asci and symmetric ellipsoid didymospores (Booth 1958). *Rhytidiella moriformis* Zalasky (Zalasky 1968) produces ascomata that are globose and warted, oblong asci containing elongate, several-septate ascospores. Two additional genera are inserted in the family because of ascoma shape, minute apical papillae, peridium of small sclerotial cells. *Syncarpella* includes taxa whose ascomata are globose and nearly smooth, slightly clavate asci, and phragmosporous, asymmetric, quite oblong ascospores. The ascomata tend to be erumpent in close groups or rows, and at times are connected to form stromatic masses. This genus was relegated to synonymy under *Leptosphaeria* by Holm (1968), followed by von Arx and Müller (1975) and Shoemaker (1984a). Differences from *Leptosphaeria* and the Leptosphaeriaceae make it necessary to accept *Syncarpella* and to place it in the Cucurbitariaceae. *Syncarpella tumefaciens* (Ellis & Harkness) Theissen & H. Sydow is the type species; it causes hypertrophy of stems of *Artemisia* in western North America, as do additional species belonging to the genus. *Cucurbidothis pithyophila* (Fr.) Petrak, studied by Holm (1967) and Casagrande (1969), was merged with *Curreya* by von Arx and Müller (1975). This species is similar in many respects to the species of *Syncarpella* and differs in habit.

Dolabra (Booth and Ting 1964) may be related to *Rhytidiella* (Zalasky 1968), but *D. nepheliae* Booth & Ting from Malaya has a more elongated ascoma. The amerosporous *Botryohypoxylon*, recently described by Samuels and Rogers (1986) for *B. amazonense* Samuels & Rogers, with the anamorph *Iledon versicolor* Samuels & Rogers forming both macroconidia and microconidia, seems more likely to belong to the Cucurbitariaceae than to the Botryosphaeriaceae. *Rosenscheldia paraguaya* Speg. has affinity to the family also; ascomata are canker forming and develop on a

Plate 21. Features of Pleosporales. Cucurbitariaceae: A-C, habit sketches of A, *Cucurbitaria berberidis* (Pers.: Fr.) Gray; B, *C. elongata* (Fr.) Grev.; C, *Cucurbidothis pithyophila*. D-F, ascomata in vertical section of D, *Cucurbitaria elongata*; E, *C. moriformis* (Fuckel) Barr; F, *C. obducens* (Fr.) Petrak. G, ascus of *Otthia spiraeae*. H-P, ascospores of H, *Rhytidiella moriformis*; I, *Otthia spiraeae*; J, *Syncarpella tumefaciens*; K, *Cucurbidothis pithyophila*; L, *Cucurbitaria berberidis*; M, *C. ailanthi* Rabenh.; N, *C. longitudinalis* Peck; O, *C. moriformis*; P, *C. obducens*. Standard line = 150 µm for D-F, 15 µm for G-P. Habits not to scale.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stromatic base and the ascospores are elongate fusoid and two septate (Holm 1968).

Key to Genera

1. Ascomata globose, developing from crustose stroma over scale insects; ascospores several septate, at times with longitudinal septum in one or more cells.....*Cucurbidothis*
1. Ascomata not developing from crustose stroma over scale insects.....2
2. Ascospores one septate; ascomata globose to ovoid..*Otthia*
2. Ascospores several septate.....3
3. Ascospores muriform; ascomata turbinate, ovoid or globose.....*Cucurbitaria*
3. Ascospores transversely septate.....4
4. Ascospores elongate, in fascicle in oblong asci; ascomata globose.....*Rhytidiella*
4. Ascospores ellipsoid, fusoid or oblong in clavate asci; ascomata globose or ovoid.....*Syncarpella*

Parodiellaceae Theissen & H. Sydow ex Barr, Mycotaxon 29: 503. 1987.

Parodiellaceae Theissen & H. Sydow, Ann. Mycol. 16: 10, 33. 1918; nom. inval. ICBN, Art. 32.

Ascomata superficial, small to medium sized, globose or ovoid or obovoid with sterile base, seated on sparse hyphae or hyphae abundant and forming subiculum, narrow pallid hyphae penetrating substrate; apex rounded or plane, scarcely papillate, opening by small or wide pore; peridium relatively soft, composed of small pseudoparenchymatous, brown cells, inner rows compressed and pallid. Hamathecium of narrowly or broadly cellular pseudoparaphyses. Asci bitunicate, basal, oblong or broadly cylindric. Ascospores hyaline, light or dark brown, oblong or obovoid fusoid, one septate; wall smooth or veruculose or longitudinally striate; contents with one or several globules in each cell; overlapping biseriate in the ascus.

Anamorphs coelomycetous where known (mostly by association and similarity in appearance to ascomata); conidiogenesis enteroblastic phialidic; conidia one celled (described as *Ascochytopsis, Pyrenochaeta*).

Biotrophic on gymnosperms or angiosperms, widespread.

Few taxa are known in the Parodiellaceae at present. The distinctive features are their biotrophic nature, superficial ascomata with rounded apices, opening by small or large pore, and asci in a basal layer. There are some similarities to the Coccoideaceae, but ascus position and shape separate the two families. The members of the Parodiellaceae seem most closely related to the Cucurbitariaceae in ascoma shape and coelomycetous anamorphs but differ in peridium structure and usually in habit.

Parodiella hedysari (Schwein.) Hughes is common on leguminous leaves in central and southern USA and into tropical regions. *Neopeckia coulteri* (Peck) Sacc. forms a matted

subiculum that binds together leaves of *Pinus* under snow cover in the mountains of western North America. This genus has been incorporated in *Herpotrichia* by some authors (Bose 1961; Müller and von Arx 1962; Sivanesan 1972) but differs in several respects (Barr 1984). *Pododimeria juniperi* (Ellis) Luttrell & Barr develops on leaves of *Juniperus* as does *P. gelatinosa* Luttrell & Barr (Luttrell and Barr 1978) and both are known from Georgia. *Lizonia emperigonia* (Auerswald) de Not. appears to belong in this family also, but this parasite of *Polytrichum* antheridial structures is not yet known from North America.

Key to Genera

1. Ascomata bearing hyphal appendages and seated in a subiculum of brown hyphae, globose.....*Neopeckia*
1. Ascomata without hyphal appendages or well-developed subiculum, globose or obovoid.....2
    2. Ascomata globose, separate, gregarious or coalescent, on leaves of legumes.....*Parodiella*
    2. Ascomata obovoid with sterile base, separate, in overlapping of scalelike leaves of *Juniperus*.....*Pododimeria*

Phaeotrichaceae Cain, Canad. J. Bot. 34: 676. 1956.

Sporormiaceae Munk, Dansk Bot. Ark. 17(1): 450. 1957.

Ascomata immersed erumpent or superficial, globose, ovoid or sphaeroid, perithecioid or cleistothecioid, small to medium sized; apex rounded and entirely closed or with rounded pore, or short papillate with rounded pore, not periphysate; surface smooth, often shining, at times bearing hyphal appendages or elongate dark setae; peridium rather thin, often with outer dark row of cells and several inner hyaline rows of small pseudoparenchymatous cells. Hamathecium of narrow cellular pseudoparaphyses that may disappear by maturity. Asci bitunicate, basal or median in enclosed ascomata, oblong, clavate or ovoid, often stipitate, endotunica reduced in some. Ascospores light to dark brown, fusoid or ellipsoid, quite symmetric, one or several septate or muriform, deeply constricted at septa and readily breaking into partspores; wall smooth, rarely ornamented, at times surrounded by gel coating, at times with elongate germ slit in each cell or with terminal germ pore(s); contents usually with one or two globules per cell; overlapping biseriate, crowded, or forming a fascicle in the ascus.

Anamorphs coelomycetous where known; pycnidia and conidia small (spermogonia?).

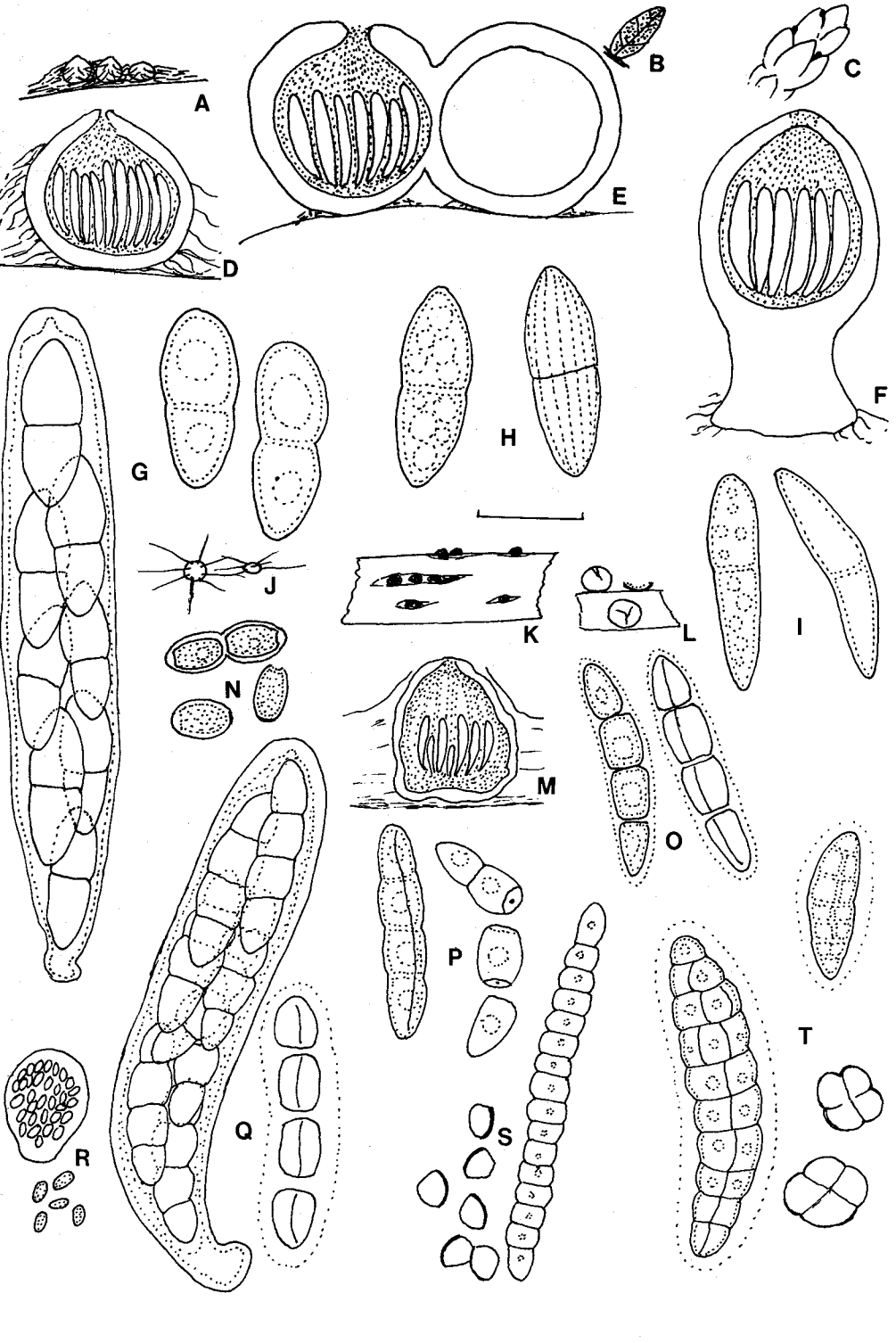
Hypersaprobic on dung, old herbaceous or woody stems and rotting debris, isolated from soil and seeds, cosmopolitan.

The predominantly coprophilous taxa of Loculoascomycetes having brown ascospores show considerable variability in characteristics such as cleistothecioid or perithecioid ascomata, presence of germ slit or germ pore or of gel coating on the ascospores. As a consequence, a number of genera and two families have been recognized. What has also become apparent is

that both pleosporaceous and melanommataceous fungi have been grouped together. Earlier, I had believed (Barr 1979b) that the Phaeotrichaceae belonged in the Pleosporales and the Sporormiaceae in the Melanommatales. The situation is not that simple, however, and my earlier disposal of the Sporormiaceae rested upon species that are not congeneric with *Sporormia*. That genus, restricted in its circumscription by Ahmad and Cain (1972), includes taxa whose ascospores are multiseptate, lack germ slits, form a fascicle surrounded by a narrow gel coating within the ascus, and fall into partspores whose outer walls (of the fascicle) are thicker and darker than the inner walls. The dictyosporous *Pleophragmia* seems to be closely related; the partspores of each spore have thick, dark outer walls and thinner, paler inner walls. The ascospores do not possess germ slits.

Ahmad and Cain (1972) removed most of the species from the narrow delimitation of *Sporormia* to *Sporormiella*. These species, such as *Sporormia minima* Auerswald, have three or more septate ascospores with germ slits in each cell, lie overlapping biseriate in the ascus, are surrounded by a gel coating, and have walls of equal thickness and pigmentation. They are only separated from species of *Preussia* by perithecioid rather than cleistothecioid ascomata, and von Arx (1973) combined them under *Preussia*, the earlier name. I must agree with this decision because several species may open by an apical pore or may be entirely closed. *Sporormiella* itself, i.e., *S. nigropurpurea* Ellis & Everh., has clypeate immersed ascomata, trabeculate pseudoparaphyses and numerous asci in a peripheral layer, all typical of the Didymosphaeriaceae in the Melanommatales. *Ohleriella, i.e., O. neomexicana* Earle, cited as a synonym of *Sporormiella* or of *Preussia*, has medium to large erumpent ascomata, trabeculate pseudoparaphyses, and belongs in the Fenestellaceae of the Melanommatales. (*Delitschia* with *D. didyma* Auerswald [Luck-Allen and Cain 1975] and probably *Semidelitschia* with *S. agasmatica* Cain & Luck [Cain and Luck-Allen 1969] also have the features of the Fenestellaceae.)

Plate 22. Features of Pleosporales. A-I. Parodiellaceae: A-C, habit sketches of A, *Neopeckia coulteri*; B, *Parodiella hedysari*; C, *Pododimeria juniperi*. D-F, ascomata in vertical section of same species. G, ascus and ascospore of *Neopeckia coulteri*. H, I, ascospores of H. *Parodiella hedysari*; I, *Pododimeria juniperi*. J-T. Phaeotrichaceae: J-L, habit sketches of J, *Phaeotrichum hystricinum* Cain & Barr; K, *Preussia sorghophila* (Peck) Barr; L, *P. typharum* (Sacc.) Cain. M, ascoma in vertical section of *P. sorghophila*. N-T, ascus and/or ascospores of N, *Phaeotrichum hystricinum*; O, *Preussia sorghophila*; P, *P. typharum*; Q, P. minima (Auerswald) von Arx; R, *Westerdykella dispersa* (Clum) von Arx; S, *Sporormia fimetaria* deNot.; T, *Pleophragmia leporum* Fuckel. Standard line = 150 μm for D-F, M, 15 μm for G-I, N-T. Habits not to scale.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Taxa of *Westerdykella* have small cleistothecioid ascomata, small asci, light brown ascospores that are three septate when young but soon separate into 32 partspores in the ascus. The absence of gel coating and of germ slits or pores suggests a relationship to species of *Sporormia*, but no intermediate taxa are known and the two genera are separated by type of ascoma, asci and ascospores.

Phaeotrichum forms cleistothecioid ascomata that bear elongate, dark appendages. The ascospores are uniseptate, lack a gel coating and have a germ pore in each end. Because of the presence of germ pores rather than germ slits in particular, the family has been separated from the Sporormiaceae. But when no germ slits are present in species of *Sporormia, Pleophragmia* or *Westerdykella* this characteristic does not seem to be of overwhelming importance at the family level. The habit of species in *Phaeotrichum* is similar to those already mentioned; some species of *Preussia* s. lat. (i.e., *Sporormiella chaetomioides* [Griffiths] Ahmad & Cain, *S. pilosa* [Cain] Ahmad & Cain and *S. pilosella* [Cain] Ahmad & Cain) have appendaged ascomata; the ascospores in species of *Phaeotrichum* separate readily at the septum into partspores with a firm dark wall.

The species of *Trichodelitschia* were compared to those of *Phaeotrichum* (Cain 1956) and have been placed in the same family (Lundqvist 1964); they do show considerable similarity in appendaged ascomata and uniseptate ascospores with terminal germ pores. However, the perithecioid ascomata of *Trichodelitschia* bear setae over the apical region, the ostiole is lined with periphyses (not seen in taxa of the family elsewhere), the paraphyses are broad and cellular but branched and anastomosed above the asci, and, especially deviating from the family concept, the asci are cylindric, firm walled, and bear a minute refractive ring. Ascospore discharge is by breaking and wrinkling down of the ascus wall and the ascospores emerge in an adherent mass not surrounded by endotunica. Despite the detailed developmental studies that seem to show pleosporaceous structure in both *T. bisporula* (Crouan & Crouan) Munk in Müller & von Arx and *T. munkii* Lundqvist (Parguey-Leduc 1974), I have become convinced that the asci are unitunicate and that the genus belongs in Class Hymenoascomycetes. The primordium seems to be a small tight coil (oblique septa) rather than division of a single cell. The genus seems best assigned to the Trichosphaeriales, as von Höhnel (1920) had already surmised, although certainly not related to *Protoventuria*.

Key to Genera

1. Ascospores one septate, with terminal germ pores; ascomata cleistothecioid and appendaged.....*Phaeotrichum*
1. Ascospores more than one septate, though often separating into partspores, with germ slits or lacking both germ slits and germ pores.....2

2. Ascospores transversely septate, with germ slits, usually surrounded by gel coating; ascomata cleistothecioid or perithecioid.....*Preussia*
2. Ascospores without germ slits, walls light brown at least in part.....3
3. Ascospores three septate, soon separating into 32 partspores in the ascus, without gel coating; ascomata cleistothecioid.....*Westerdykella*
3. Ascospores more than three septate; ascomata perithecioid....4
4. Ascospores transversely septate, in a fascicle in the ascus, surrounded by a narrow gel coating.....*Sporormia*
4. Ascospores muriform, gel coating surrounding each ascospore.....*Pleophragmia*

Dacampiaceae Körber, Systema Lichenum Germaniae, 322. 1855.

Ascomata immersed becoming erumpent or superficial, small to medium sized, obpyriform, ovoid or globose; apex bluntly rounded or short papillate or elongate, with rounded pore, ostiole stuffed with tips of pseudoparaphyses or lined with periphyses, pallid or often reddened; surface smooth or roughened with protruding cells or short hyphal appendages, at times seated in subiculum of hyphae, heavily pigmented in erumpent-superficial taxa; peridium relatively wide, of three layers of different consistency, the outermost of small pseudoparenchymatous cells, often dark reddish brown, the middle of pallid cells, small and often thick walled, the innermost narrow, of compressed rows of pallid cells; in tall ascomata the inner layer most conspicuous toward apex, in globose ascomata most conspicuous at base and lower sides. Hamathecium of narrowly cellular, numerous or sparse pseudoparaphyses. Asci bitunicate, basal, oblong or cylindric. Ascospores hyaline or light clear brown, reddish brown or dark brown, ends paler at times, fusoid or ellipsoid or filiform, biconic at times, quite symmetric or asymmetric and more obovoid, one celled or one to several septate or muriform; wall smooth or verruculose, surrounded by gel coating in some; contents usually with single globule per cell or minutely guttulate; biseriate or uniseriate, when filiform in coiled fascicle in the ascus.

Anamorphs coelomycetous where known; conidia minute, one celled or one septate (described as *Chaetophoma, Coniothyrium, Pyrenochaeta*).

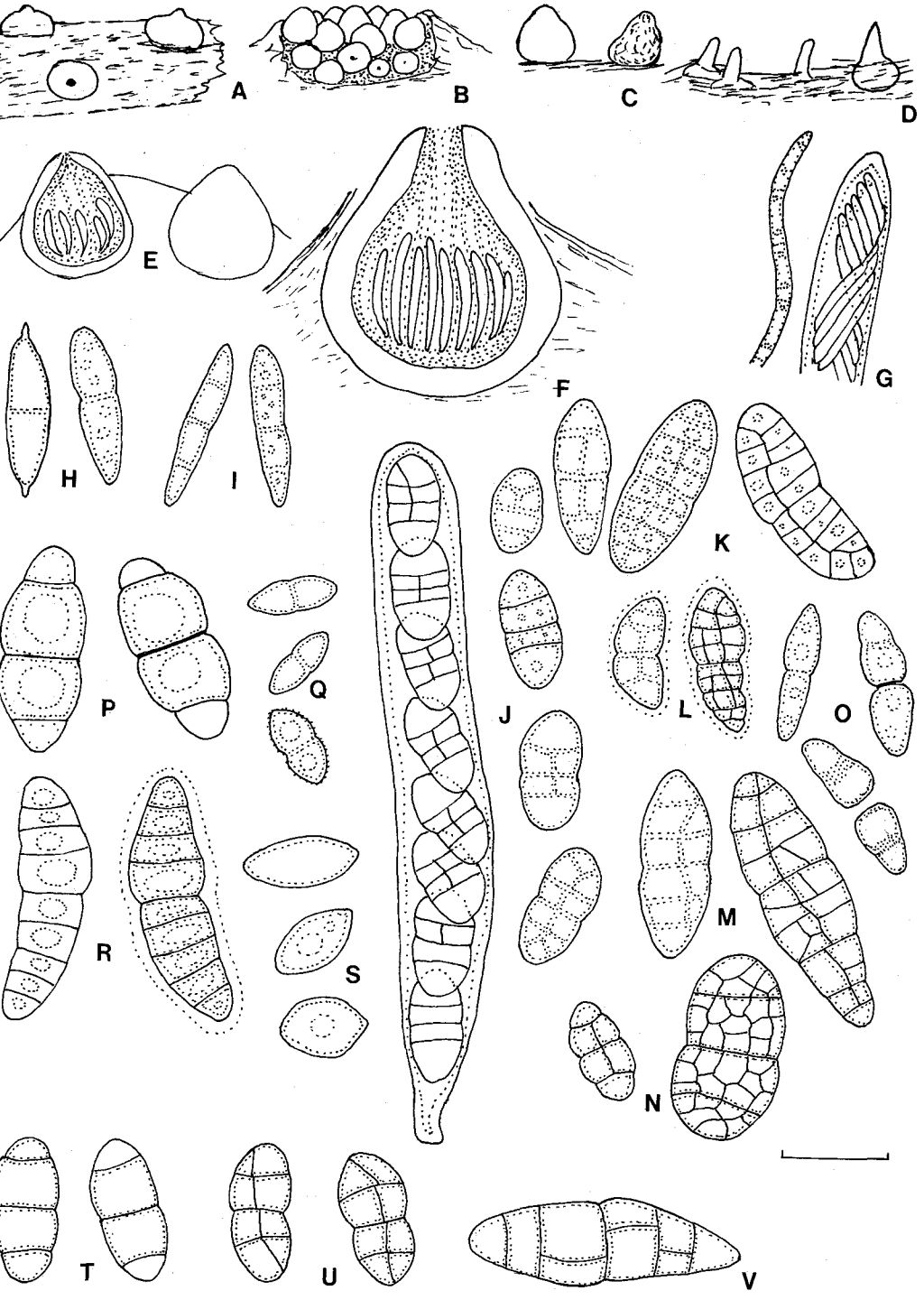
Saprobic or hypersaprobic, at times hemibiotrophic or biotrophic; in lichen thalli, rust pustules, old stromatic ascomycetes, woody branches, decorticated wood, roots, firm stalks of herbaceous plants, cosmopolitan.

This family has been assembled in manuscript as "Teichosporaceae" for some time. Its characteristics of more or less obpyriform or ovoid, medium to large-sized ascomata, three-layered peridium composed of small pseudoparenchymatous cells, of rather soft texture, basal usually cylindric asci in narrowly cellular pseudoparaphyses, and nearly symmetric ascospores, are shared by both *Dacampia* and *Pyrenidium*, the type genera of their

respective lichenicolous families. Hawksworth (1980) suggested a close relationship between *Dacampiosphaeria* (= *Pyrenidium*, Hawksworth 1983) and *Dacampia*, and I cannot see good evidence to separate two families. Dacampiaceae thus takes precedence as the family name for the group of taxa outlined above over Pyrenidiaceae Zahlbruckner in Engler & Prantl (Nat. Pflanzenfam. 1(1*): 76. 1903). Habit alone is not sufficient as a family character, although it is utilized as a generic one, and O. Eriksson and Hawksworth (1986) have already included in the Pyrenidiaceae the genus *Byssothecium*, which develops on basal parts of plants (Boise 1983). Here the concept of the family is extended to include not only *Byssothecium* but other related genera that utilize a wide range of substrates. Neither *Dacampia nor Pyrenidium* is known to me from North America; the illustrations are from European specimens.

Variations in shapes of ascomata are illustrated as are ascospore shapes and septation. *Eudarluca caricis* (Fr.) O. Eriksson is a cosmopolitan parasite in urediniosori (O. Eriksson 1966). *Bertiella rhodospila* (Berkeley & Curtis) Barr has red apices to the ascomata and forms erumpent-superficial crowds on old woody substrates. I cannot agree with O. Eriksson and Yue (1986) that *Bertiella macrospora* Sacc. belongs in *Massarina*; structure and position of the ascomata as well as ascospores without gel coating differ from those features of *Massarina*. Despite the formation of *Monodictys*-like conidia in one species (Samuels 1980), *Ohleria* is related to other taxa in the Dacampiaceae by the shape of ascomata and structure of the peridium. The ascospores are somewhat similar to those in *Bertiella* but are more pigmented and separate into partspores. *Leptospora rubella* (Pers.: Fr.) Rabenh. may be quite beaked and the apical tip is often reddened; the species is common in larger herbaceous stalks. *Loculohypoxylon grandineum* (Berkeley & Ravenel) Barr is unique in producing amerospores (Barr 1976b). *Immotthia* was erected for species that were originally described in *Otthia* or *Amphisphaeria*, with small phaeodidymospores but with quite different ascomata; *I. hypoxylon* (Ellis & Everh.) Barr

Plate 23. Features of Pleosporales. Dacampiaceae: A-D, habit sketches of A, *Teichospora megastega* Ellis & Everh.; B, *Immotthia hypoxylon*; C, *T. tuberculosa* Ellis & Everh.; D, *Leptospora rubella*. E, F, ascomata in vertical section of E, *Eudarluca caricis*; F, *Teichospora trabicola*. G, upper part of ascus and ascospores of *Leptospora rubella*. H-V, ascus and ascospores of H, *Eudarluca caricis*; I, *Bertiella rhodospila*; J, *Teichospora trabicola*; K, *T. megastega*; L, *T. aridophila* Peck; M, *T. clavispora* Ellis & Everh.; N, *T. tuberculata*; O, *Ohleriella modesta* Fuckel; P, *Byssothecium circinans*; Q, *Immotthia hypoxylon*; R, *Massariosphaeria phaeospora*; S, *Loculohypoxylon grandineum*; T, *Pyrenidium actinellum*; U, *Dacampia engeliana* (Saut.) Massal.; V, *D. hookeri* (Borr.) Massal. Standard line = 150 µm for E, F, 15 µm for G-V. Habits not to scale.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develops over old stromatic ascomycetes. *Byssothecium* was reinstated (Boise 1983) for *B. circinans* Fuckel on roots of alfalfa. Its ascospores are much like those of *Pyrenidium actinellum* Nyl. which is European as far as now known. *Massariosphaeria phaeospora* (Müller) Crivelli is also European but has related species in North America; it has reddish-brown constricted ascospores, surrounded by a gel coating. *Teichospora* includes numerous dictyosporous species. Fuckel (1870) designated *T. trabicola* Fuckel as the type species. This genus has been combined with *Strickeria* in the past, but the two are quite recognizable as different entities. Species of *Dacampia* are also dictyosporous, but ascomata are parasitic in lichen thalli.

Key to Genera

1. Ascospores hyaline or lightly pigmented, one or several septate.....2
1. Ascospores brown.....5
    2. Ascospores one to two septate; papilla pallid; often associated with rust sori.....*Eudarluca*
    2. Ascospores one to several septate; papilla frequently reddened; saprobic in woody or herbaceous substrates.....3
3. Ascospores elongate, scolecosporous, multiseptate...*Leptospora*
3. Ascospores fusoid, one to three septate.....4
    4. Ascospores separating at median septum into two partspores.....*Ohleria*
    4. Ascospores not separating into partspores.....*Bertiella*
5. Ascospores one celled.....*Loculohypoxylon*
5. Ascospores septate.....6
    6. Ascospores one septate.....*Immotthia*
    6. Ascospores several septate.....7
7. Ascospores transversely septate.....8
7. Ascospores muriform.....10
    8. Ascospores fusoid, quite asymmetric, multiseptate, usually surrounded by gel coating.....*Massariosphaeria*
    8. Ascospores ellipsoid, biconic, symmetric or asymmetric, three to five septate, not surrounded by gel coating.....9
9. Lichenicolous.....*Pyrenidium*
9. On herbaceous or woody plant parts.....*Byssothecium*
    10. Lichenicolous.....*Dacampia*
    10. On woody, rarely herbaceous plant parts.....*Teichospora*

Phaeosphaeriaceae Barr, Mycologia 71: 948. 1979.

Ascomata small to medium sized, immersed becoming erumpent, at times superficial in weathered substrates, separate, gregarious or occasionally forming locules in pseudostromatic tissues, sphaeroid or globose, rarely ovoid, at times elongate, collabent at times; apex rounded, short papillate, papilla well developed at times, pore rounded, rarely slitlike and opening by labiate cells, ostiole periphysate or not; surface glabrous or tomentose, at times hyphae forming darkened clypeus over

ascomata or hyphae connecting several ascomata in substrate; peridium rather soft, composed of small pseudoparenchymatous cells, inner rows of cells compressed, usually darkened and somewhat thickened in upper regions externally, thinner toward base. Hamathecium of narrowly cellular pseudoparaphyses, rather sparse. Asci bitunicate, basal to lateral, clavate, cylindric or oblong, with small ocular chamber. Ascospores hyaline, yellowish, dull yellowish brown, less often dark brown, ellipsoid, fusoid, oblong, cylindric or filiform, often inequilateral, compressed laterally at times, often with one cell enlarged, ends acute or obtuse, symmetric or asymmetric, one or several septate or muriform; wall thin or thickened, smooth or verruculose, at times surrrounded by gel coating or bearing terminal appendages; contents minutely guttulate or one or two globules per cell; overlapping uniseriate, biseriate or in fascicle in the ascus.

Anamorphs coelomycetous where known; conidiogenesis holoblastic or enteroblastic; conidia one celled or septate (described as *Ascochyta, Chaetodiplodia, Coniothyrium, Microdiplodia, Microsphaeropsis, Phoma, Scolecosporiella, Stagonospora, Sphaerellopsis*).

Biotrophic, hemibiotrophic or saprobic in other fungi, algae, vascular plants including equiseti, lycopods, ferns, herbaceous and woody dicots and monocots, cosmopolitan.

The removal of taxa such as *Teichospora* to the Dacampiaceae and *Kirschsteiniothelia (Microthelia p.p.)* to the Pleosporaceae, and the separation of the Leptosphaeriaceae makes the Phaeosphaeriaceae less heterogeneous than when it was described. The family still includes genera that vary in ascomata and ascospores in ways that indicate close relationships but that do pose problems for the systematist, as O. Eriksson (1981) remarked. The unifying features are relatively small sizes of immersed-erumpent ascomata, rather thin and soft peridium, rather sparse, narrowly cellular pseudoparaphyses.

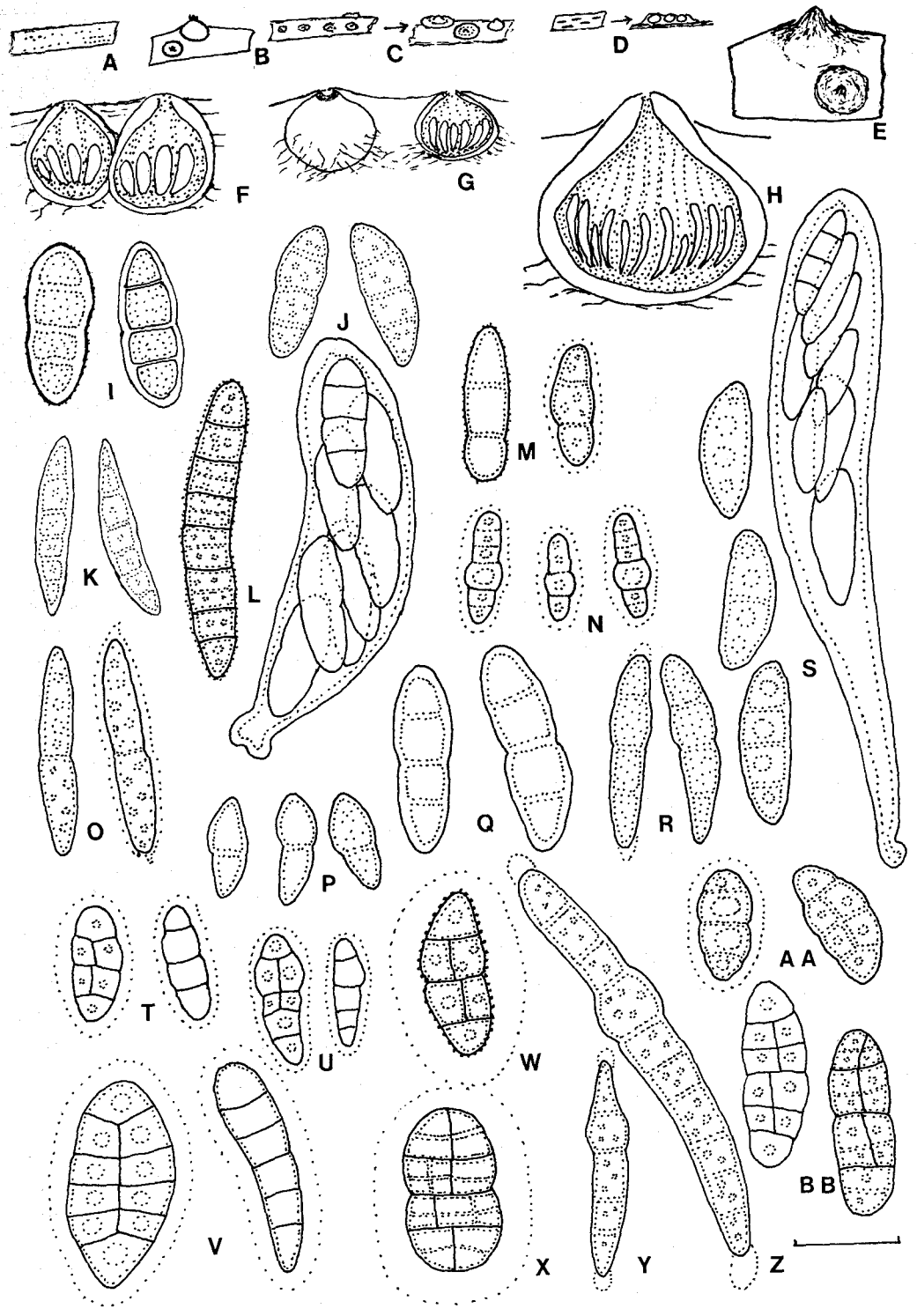
After Holm (1957) recognized the validity of *Phaeosphaeria*, studies by O. Eriksson (1967), Hedjaroude (1969) and Leuchtmann (1985) have established a number of variations that occur in this genus. *Nodulosphaeria* too was reinstated by Holm (1957) and was studied in detail by Shoemaker (1984b) and Leuchtmann (1985). *Paraphaeosphaeria* was erected by O. Eriksson (1967) and further addressed by Hedjaroude (1969), Shoemaker and Babcock (1985) and Leuchtmann (1985). *Montagnula* was regarded as part of *Pleospora* (Wehmeyer 1961) but was reestablished as a genus by Crivelli (1983). *Ophiosphaerella* was clarified by Walker (1980) and *Didymella* first by Corbaz (1957) and more recently by Corlett (1981). *Rhopographus* (Obrist 1959), *Lautitia* (Schatz 1984) and *Bricookea* (Barr 1982a) are monotypic genera. *Graphyllium* is the earliest name for species formerly in *Platyspora* (Wehmeyer 1961) or in *Comoclathris* (Harr 1972). *Chaetoplea* is based upon *C. calvescens* (Fr. ex Desm.) Clements (Shoemaker 1968) and is enlarged by the addition of several species that are found on woody substrates but are morphologically similar to *C. calvescens*

for example, *C. pusilla* (Karsten & Malbranch) Barr (Barr 1981) and *C. oblongispora* (Ellis & Everh.) Barr. *Kalmusia* is utilized for fungi like *K. ebuli* Niessl and includes the entity described as *Diapleella clivensis* (Berkeley & Broome) Munk. Extralimital genera that could be referred to the Phaeosphaeriaceae include *Bimuria* (Hawksworth et al. 1979), *Shiraia* P. Hennings (Amano 1980), *Amarenomyces* (O. Eriksson 1981), and perhaps *Entodesmium* (Shoemaker 1984b).

Key to Genera

1. Ascospores one septate.....2
1. Ascospores more than one septate.....3
2. Ascospores narrowly oblong; parasitic in *Chondrus*.....*Lautitia*
2. Ascospores fusoid or ellipsoid; in vascular plants.....*Didymella*
3. Ascospores elongate, scolecosporous.....*Ophiosphaerella*
3. Ascospores short to elongate but not truly scolecosporous....4
4. Ascospores hyaline, three septate; ascomata gregarious, opening by a slit.....*Bricookea*
4. Ascospores pigmented slightly or strongly.....5
5. Ascospores transversely septate.....6
5. Ascospores muriform.....10
6. Ascomata forming locules in stroma; on fern rachises.....*Rhopographus*
6. Ascomata separate or connected by hyphae.....7
7. Ascomata with short setae forming or covering apical papilla; ascospores with supramedian cell enlarged, often bearing terminal appendages.....*Nodulosphaeria*
7. Ascomata without apical setae; ascospores not as above.....8

Plate 24. Features of Pleosporales. Phaeosphaeriaceae: A-E, habit sketches of A, *Phaeosphaeria microscopica* (Karsten) O. Eriksson; B, *Nodulosphaeria epilobii* (Müller) Holm; C, *Didymella exigua* (Niessl) Sacc.; D, *Rhopographus filicinus* (Fr.) Nitschke in Fuckel; E, *Montagnula infernalis* (Niessl) Berlese. F-H, ascomata in vertical section of F, *Phaeosphaeria typharum* (Desm.) Holm; G, *P. microscopica*; H, *Kalmusia clivensis* (Berkeley & Broome) Barr. I-BB, asci and ascospores of I, *Phaeosphaeria typharum*; J, *P. microscopica*; K, *P. associata* (Rehm) O. Eriksson; L, *P. berlesei* (Larsen & Munk) Hedjaroude; M, *Paraphaeosphaeria michotii* (West.) O. Eriksson; N, *P. obtusispora* (Speg.) O. Eriksson; O, *Lautitia danica* (Berlese) Schatz; P, *Didymella exigua*; Q, *Bricookea sepalorum* (Vleugel) Barr; R, *Rhopographus filicinus*; S, *Kalmusia clivensis*; T, *Graphyllium hysterioides* (Ellis & Everh.) Barr; U, *G. ipomoeae* (Clements) Barr; V, *G. planispora* (Ellis) Barr; W, *Montagnula infernalis*; X, *M. phragmospora* (Dur. & Mont.) Crivelli; Y, *Nodulosphaeria modesta* (Desm.) Munk; Z, *N. epilobii*; AA, *Chaetoplea calvescens*; BB, *C. oblongispora*. Standard line = 150 µm for F-H, 15 µm for I-BB. Habits not to scale.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8. Ascospores oblong, primary (A1) septum and enlarged cell submedian.....*Paraphaeosphaeria*

8. Ascospores fusoid or ellipsoid, primary (A1) septum and enlarged cells median or supramedian.....9

9. Ascomata typically thin walled, in monocots; ascospores usually yellowish brown.....*Phaeosphaeria*

9. Ascomata typically thicker walled, in dicots; ascospores usually reddish brown or dark brown.....*Kalmusia*

10. Ascospores laterally compressed, muriform in face view only.....*Graphyllium*

10. Ascospores not laterally compressed, muriform in both face and side views.....11

11. Ascospores yellowish brown or dark brown, wall smooth or finely verruculose; in dicots, often woody substrates..*Chaetoplea*

11. Ascospores dark reddish brown, wall coarsely verruculose; in large monocots.....*Montagnula*

Lophiostomataceae Nitschke, Verh. Naturhist. Vereines Preuss. Rheinl. Westphalens 26. Corr.-Bl. 2: 74. 1869.

Massarinaceae Munk, Friesia 5: 305. 1956.

Ascomata immersed, erumpent or becoming superficial, separate or gregarious, substrate reddened at times; sphaeroid or globose, small to medium sized; apex varied: rounded, short papillate or with well-developed rounded or compressed papilla, caplike in some, or with short setae forming papilla; pore rounded or slitlike, periphysate or stuffed with small cells; surface dark, smooth or roughened with protruding hyphae, occasionally setose, in subiculum at times; peridium firm, composed of small pseudoparepchymatous cells, somewhat compressed at times, often thin at base and thickened above, clypeate at times. Hamathecium of narrowly cellular pseudoparaphyses, numerous, in matrix, often forming sheetlike layer above asci. Asci bitunicate, basal to lateral, clavate and stipitate or oblong to nearly cylindric, with small ocular chamber. Ascospores hyaline, becoming light yellowish brown, dull brown, vinaceous brown or dark brown, ellipsoid or fusoid, ends acute or obtuse, symmetric or asymmetric, often inequilateral or slightly curved, primary (A1) septum median or supramedian, often constricted, often constricted in each hemispore, slowly becoming several septate, muriform at times; wall often surrounded by gel coating or ends appendaged, smooth or verruculose or longitudinally striate in age; contents usually with one globule in each cell or potential cell; overlapping biseriate or uniseriate in the ascus.

Anamorphs coelomycetous where known; conidiogenesis phialidic; conidia one celled or one septate (described as *Ceratophoma, Coniothyrium, Dendrophoma, Microsphaeropsis, Pyrenochaeta*). Several species described in *Massarina* have hyphomycetous anamorphs (Webster and Descals 1979); I am not certain of their true disposition.

Saprobic or hemibiotrophic on fern rachises, herbaceous monocots and dicots, woody substrates, cosmopolitan.

Recognition of the Lophiostomataceae as a family of the Pleosporales must necessarily follow lectotypification of *Lophiostoma macrostomum* (Tode: Fr.) Ces. & de Not. (Holm in litt. 1987) by the fungus also known as *L. crenatum* (Pers.: Fr.) Fuckel or *L. angustilabrum* (Berkeley & Broome) Cooke. The rearrangement of taxa once grouped in the family by e.g., Chesters and Bell (1970) separates such species as the "*pachythele* group," *L. pileatum, Platystomum* species, into the Melanommatales. As a consequence, the conspicuous, short or elongate, compressed apical papilla is now of generic or sometimes only of specific importance. Other taxa included in the Lophiostomataceae may have a conspicuous but rounded apical papilla, or a short papilla, sometimes composed of grouped setae, or a caplike apex, or the apex of ascoma may be rounded and open by a small pore or a slit.

The Massarinaceae does not seem separable from the Lophiostomataceae by any combination of characters. Munk (1956) emphasized the thin basal peridium and dark, small-celled apical papilla when describing the Massarinaceae. In 1957 he included with *Massarina, Trichometasphaeria* bearing apical setae, "*Metasphaeria*" *coccodes* having a well-developed apical papilla, *Keissleriella* and *Pseudotrichia*. The latter two I separate because of melanommataceous centra in the type species of each genus. *Herpotrichia* in the narrow sense was added to the Massarinaceae by Barr (1984). O. Eriksson and Hawksworth (1985, 1986) included *Massariosphaeria*, which seems better disposed in the Dacampiaceae. *Dangeardiella* is included in the key, but is not yet known from North America (Obrist 1959). Several species of *Massarina* were described and illustrated by Bose (1961), who at the same time reported on *Herpotrichia* in the broad sense and *Keissleriella* in which he included *Trichometasphaeria*. Species of *Herpotrichia* in the broad sense were reviewed and illustrated by Sivanesan (1972) and in the narrow sense by Barr (1984). *Cilioplea* was reinstated and enlarged by Crivelli (1983).

Features that are typical of the family are the peridium of rows of small pseudoparenchymatous cells, thin toward the base and often thickened and more heavily pigmented toward the apex, at times extending as a clypeus; pseudoparaphyses that are numerous, narrowly cellular and often occupy a disproportionately large area of the centrum as a sheetlike layer above the asci; ascospores that tend to be fusoid, with the A1 septum constricted and a constriction in each hemispore, but with additional septa and pigmentation slow to develop. Each of these features may vary among the genera and some of the variations are expressed in the following key.

Key to Genera

1. Ascospores relatively symmetric, A1 septum median and hemispores equal.....2
1. Ascospores asymmetric, A1 septum supramedian, hemispores unequal, often with one enlarged cell; ascomata with setae usually forming or covering short papilla.....6

2. Ascomata elongate, opening by long cristate slit; ascospores hyaline, several septate; on fern rachises.....*Dangeardiella*

2. Ascomata rounded, opening by rounded or compressed pore in apex.....3

3. Ascomata tomentose, seated in well-developed subiculum, apex rounded or with blunt caplike papilla; ascospores becoming brown.....*Herpotrichia*

3. Ascomata with sparse hyphae, often forming shallow clypeus above ascoma.....4

4. Ascomata with rounded apex or low papilla; ascospores hyaline, becoming light brown in age.....*Massarina*

4. Ascomata with well-developed usually compressed papilla.5

5. Ascospores one or several transversely septate.....*Lophiostoma*

5. Ascospores muriform.....*Lophidiopsis*

6. Ascospores transversely septate.....*Trichometasphaeria*

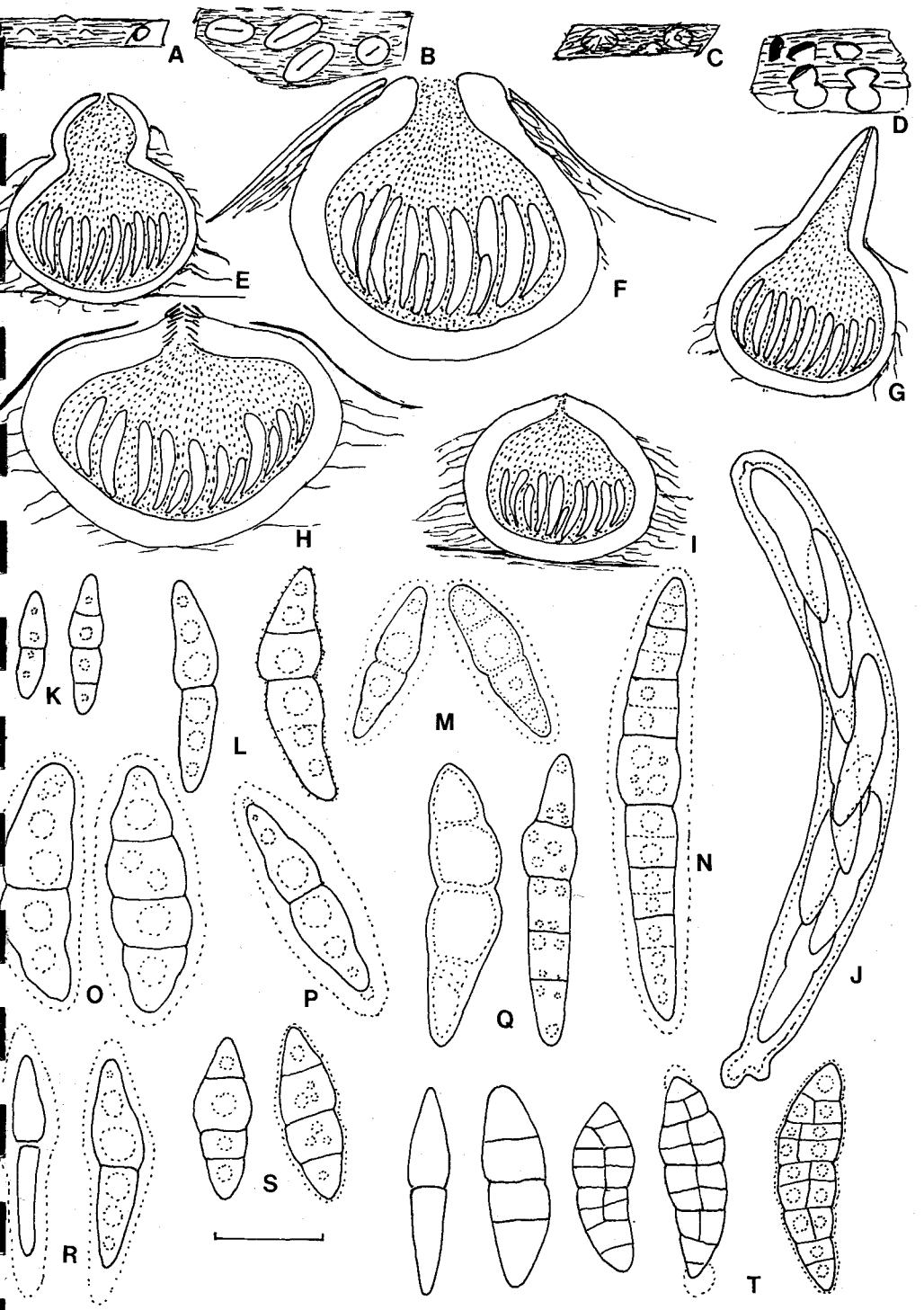
6. Ascospores muriform.....*Cilioplea*

Arthopyreniaceae W. Watson, New Phytol. 28: 107. 1929.

Ascomata slightly immersed in uppermost layers of periderm, becoming erumpent superficial, dimidiate or sphaeroid, small to medium sized; apex short papillate or plane, finally opening by a broadly eroded pore; peridium narrow, thickened above with clypeal tissues, usually shining black, composed of small pseudoparenchymatous cells, clypeal tissues closely attached to peridium. Hamathecium of narrowly cellular pseudoparaphyses, not numerous, in gel matrix, some conspicuously cellular. Asci bitunicate, basal, clavate, oblong or saccate, thickened above. Ascospores hyaline or shades of brown, asymmetric or nearly symmetric, obovoid, fusoid or elongate, one or several septate or muriform; wall thin, verruculose at times, often surrounded by gel coating; contents granular or guttulate; biseriate or partially uniseriate or crowded in the ascus.

Anamorphs coelomycetous where known; producing small rodlike microconidia.

Plate 25. Features of Pleosporales. Lophiostomataceae: A-D, habit sketches of A, *Massarina eburnea* (Tul. & Tul.) Sacc.; B, *Lophiostoma hysterioides* (Schwein.) Sacc.; C, *Herpotrichia herpotrichoides* (Fuckel) Cannon; D, *Lophiostoma macrostomum* (Tode: Fr.) Ces. & de Not. E-I, ascomata in vertical section of E, *Herpotrichia macrotricha* (Berkeley & Broome) Sacc.; F, *Massarina eburnea*; G, *Lophiostoma macrostomum*; H, *Cilioplea coronata* (Niessl) Munk; I, *Herpotrichia juniperi* (Duby) Petrak. J-T, ascus and ascospores of J, *Lophiostoma macrostomum*; K, *L. hysterioides*; L, *L. macrostomum*; M, *L. nucula* (Fr.) de Not.; N, *L. spiraeae* Peck; O, *Massarina eburnea*; P, *M. corticola* (Fuckel) Sacc.; Q, *Trichometasphaeria gloeospora* (Berkeley & Curtis) Holm; R, *Herpotrichia macrotricha*; S, *H. juniperi*; T, *Cilioplea coronata*, sequence in formation of septa. Standard line = 150 µm for E-I, 15 µm for J-T. Habits not to scale.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Saprobic or lichenized, in thin thallus, on woody substrates, widespread.

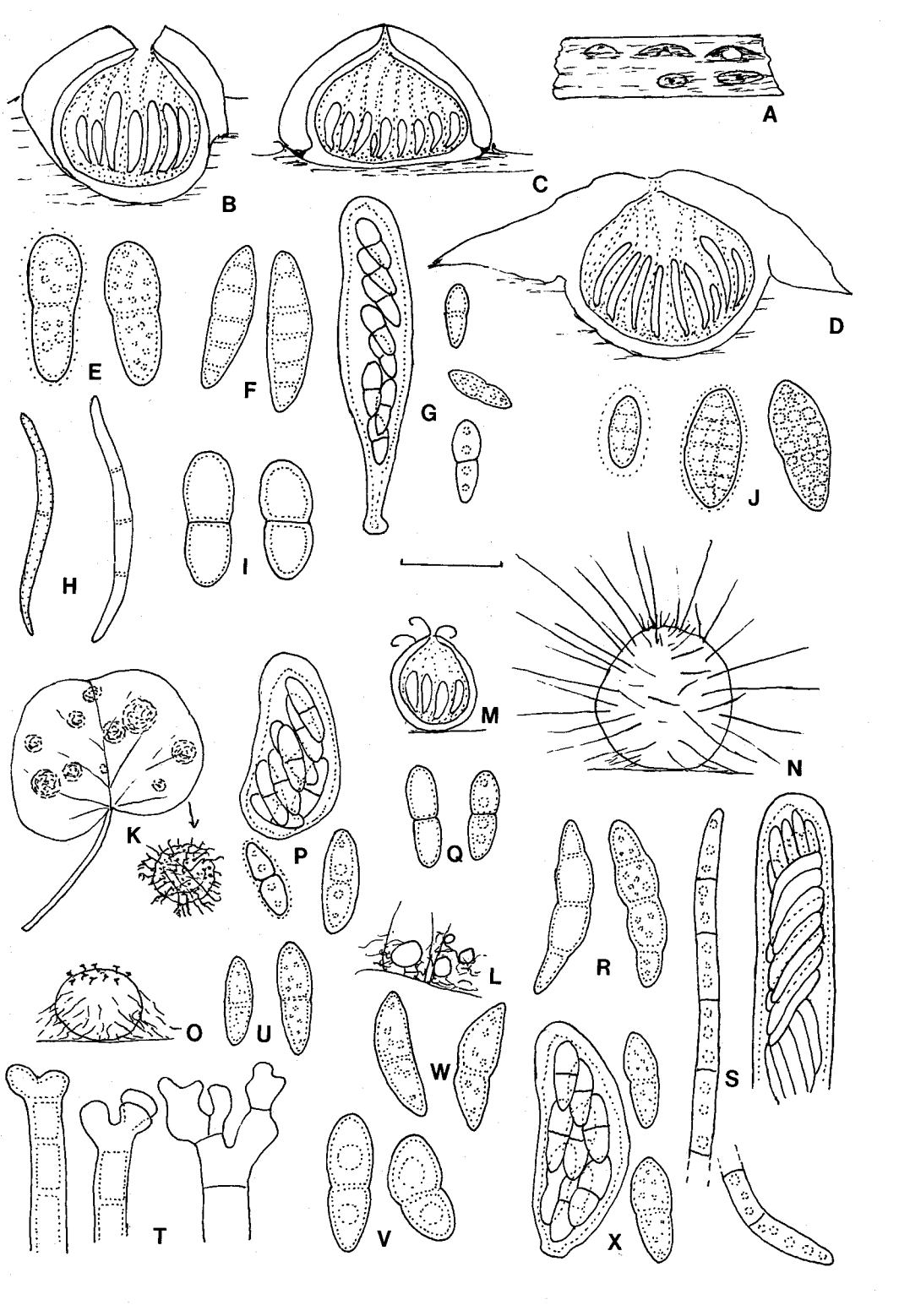
This family is restricted to taxa with characteristics described above, similar to Vêzda's (1968) and O. Eriksson and Hawksworth's (1985, 1986) interpretations. It excludes a number of genera that were embraced in the concept of Mycoporaceae, which included the Arthopyreniaceae, in the sense of Riedl (1962) or von Arx and Müller (1975). Several genera, e.g., *Tomasellia*, *Sporoschizon*, *Naetrocymbe*, are as yet too little known to me for inclusion in the key. *Julella* is the earlier name for species of both *Peltosphaeria* and *Polyblastiopsis* (Barr 1986). Several species of *Mycomicrothelia* were described and illustrated by Hawksworth (1985c). Harris (1973) provided information on *Arthopyrenia* and *Leptorhaphis* as did Riedl (1962). Harris (pers. comm.) has additional refinements on the classification of *Arthopyrenia* and its relatives in preparation so that this interpretation will be updated.

The taxa of this family differ from those of the Lophiostomataceae especially in the position of ascomata in relation to substrate as well as in the fewer pseudoparaphyses above the asci.

Key to Genera

1. Ascospores brown, one septate.....*Mycomicrothelia*
1. Ascospores hyaline or yellowish.....2
    2. Ascospores muriform.....*Julella*
    2. Ascospores transversely septate, occasionally with a longitudinal septum in one or two cells.....3
3. Ascospores cylindric fusoid or acicular.....*Leptorhaphis*
3. Ascospores oblong, fusoid or obovoid.....*Arthopyrenia*

Plate 26. Features of Pleosporales. A-J. Arthopyreniaceae: A, habit of *Julella vitrispora* (Cooke & Harkness) Barr. B-D, ascomata in vertical section of B, *Arthopyrenia halodytes* (Nyl.) Arnold; C, *A. punctiformis* Ach.; D, *Julella vitrispora*. E-J, ascus and ascospores of E, *A. halodytes*; F, *A. submuriformis* Harris; G, *A. punctiformis*; H, *Leptorhaphis parameca* (Massal.) Körber; I, *Mycomicrothelia macularis* (Massal.) Keissler; J, *Julella vitrispora*. K-X. Dimeriaceae: K, L, habit sketches of K, *Dimerium langloisii* (Ellis & G. Martin) Sacc. & D. Sacc. over *Asterina* hyphae; L, *Eudimeriolum plantaginis* (Tehon & Daniels) Barr. M-O, ascomata in side view or vertical section of M, *Phaeodimeriella guarapiense* (Speg.) Theissen; N, *Acanthophiobolus helicosporus* (Berkeley & Broome) Walker; O, *Lasiostemma fimbriatum* (Dearness & House) Barr. P-S, U-X, asci and ascospores of P, *Dimerium langloisii*; Q, *Phaeodimeriella guarapiense*; R, *Nematostoma occidentale* (Ellis & Everh.) Barr; S, *Acanthophiobolus helicosporus*; U, *Lasiostemma fimbriatum*; V, *L. erysipheoides* (Ellis & Everh.) Farr; W, *Eudimeriolum plantaginis*; X, *Eumela dodonaeae* (F. L. Stevens) Farr, Schoknecht & Crane. T, setae of *Lasiostemma fimbriatum*. Standard line = 150 μm for B-D, M-O, 15 μm for E-J, P-X. Habits not to scale.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Dimeriaceae Müller & von Arx in von Arx & Müller, Stud. Mycol. Baarn 9: 104. 1975.

Ascomata superficial, usually gregarious, minute to small, rarely medium sized, globose or sphaeroid; apex rounded or short papillate, opening by rounded pore; surface glabrous or bearing simple or septate, pointed or blunt and lobed setae; peridium narrow, one or few rows of compressed pseudoparenchymatous cells; with superficial hyphae often forming colony on substrate, hyphae entirely superficial or in trichomes or as delicate layer in or beneath cuticle, or penetrating epidermal cells or deep within tissues. Hamathecium of narrowly cellular pseudoparaphyses, often deliquescent at maturity. Asci bitunicate, basal, oblong or saccate. Ascospores hyaline to yellow, olivaceous or brown, obovoid, fusoid, ellipsoid, clavate or filiform, one or several transversely septate; wall smooth; contents minutely guttulate or homogeneous; overlapping biseriate or crowded or in fascicle in the ascus.

Anamorphic states coelomycetous where known; pycnidia small; conidia hyaline or brown, one celled.

Saprobic or biotropic on leaves and branches of vascular plants or hyperbiotrophic on mycelium of other fungi.

O. Eriksson (1981) pointed out that the earliest valid name for the family is Pseudoperisporiaceae Toro in Seaver & Chardon (Sci. Surv. Porto Rico & Virgin Islands 8: 40. 1926). *Pseudoperisporium erigeronicola* (Stevens) Toro is a synonym of *Lasiostemma melioloides* (Berkeley & Curtis) Theissen & H. Sydow, the latter the type species of *Lasiostemma*, the earlier generic name. The family name was not accepted by Müller and von Arx (1962) when they first used the Dimeriaceae, nor by von Arx and Müller (1975) when they validated that family name. M. L. Farr (pers. comm.) prefers Dimeriaceae also and states that Toro himself did not utilize Pseudoperisporiaceae in his later studies. Epipolaeaceae Theissen & H. Sydow (Ann. Mycol. 16: 7. 1918; nom. inval., ICBN, Arts 32, 34) is another family name for this group of taxa.

Dimeriaceous fungi pose special problems because of small sizes of ascomata and few sparse collections. Some species of the Venturiaceae, especially of *Protoventuria*, present a similar appearance and could be confused. Several genera included in the Dimeriaceae by von Arx and Müller (1975) are removed to other families in this study, e.g., the Parodiellaceae (*Lizonia, Pododimeria*) or by other authors, e.g., the Tubeufiaceae (*Philonectria*: Rossman 1987) of the Pleosporales, or to the Dothideales (*Dimeriella*: Farr 1979), or to Class Hymenoascomycetes (*Nematothecium*: Pirozynski 1976). My concept of the family follows the studies of Farr (1966, 1979, 1984) who regards ascospore pigmentation as often varying with state of maturity, and for most taxa the presence or absence of setae or hyphal appendages to be of subgeneric or specific rather than generic value. One point of difference lies in the position of the taxa on leaves of Pinaceae (Farr 1963, 1984; Shoemaker 1965). These taxa do have dothideaceous centra and I prefer to arrange them

in the family Euantennariaceae of the Capnodiales.

Three groups, each composed of a few genera, seem recognizable. One such is separated by stressing the habit of ascomata on hyphae of other fungi. In another, the species are entirely superficial, often developing hyphae in trichomes of leaves or stems, scattered or forming effuse colonies. Many of the taxa bear pointed setae on the upper surfaces but others are glabrous or bear hyphal appendages; *Eudimeriolum* is separated into two subgenera on these features (Farr 1979). The third includes taxa that form intramatrical as well as superficial hyphae. Observations on the presence of such hyphae and their positions do present problems, as Farr (1979) observed. The ascomata of taxa in *Lasiostemma* tend to be grouped in conspicuous colonies, although some colonies are effuse or slight with scattered ascomata; the hyphae penetrate into or beneath the cuticle as a narrow layer. Glabrous ascomata or the presence of hyphal appendages separate subgenus *Lasiostemma* from subgenus *Setostemma*, where setae are blunt and lobed at the tips. In species of *Eumela*, hyphae penetrate epidermal cells, whereas in species of *Episphaerella* hyphae ramify through leaf tissues.

Key to Genera

1. Hyperbiotrophic on mycelium of other fungi.....2
1. Saprobic or biotrophic on vascular plants.....3
    2. Ascomata glabrous or with mycelial appendages....*Dimerium*
    2. Ascomata setose.....*Phaeodimeriella*
3. Hyphae entirely superficial or penetrating trichomes.....4
3. Hyphae forming layer in or under cuticle or penetrating epidermal cells or throughout leaf tissues.....6
    4. Ascospores one septate.....*Eudimeriolum*
    4. Ascospores several septate.....5
5. Ascospores fusoid or somewhat obovoid, three to five septate.. .....*Nematostoma*
5. Ascospores elongate filiform, multiseptate....*Acanthophiobolus*
    6. Hyphae forming layer in or under cuticle.....*Lasiostemma*
    6. Hyphae penetrating deeper than cuticle.....7
7. Hyphae penetrating epidermal cells.....*Eumela*
7. Hyphae throughout leaf tissues.....*Episphaerella*

Polystomellaceae Theissen & H. Sydow, Ann. Mycol. 13: 158. 1915.

Ascomata multiloculate in flattened, subcuticular or superficial stroma, when superficial with thin subcuticular layer and hyphae penetrating substrate tissues, or uniloculate ascomata; locules low sphaeroid or dimidiate; apex rounded; peridium surface usually shining black, cells irregular and forming textura epidermoidea, in side view pseudoparenchymatous, darkened above locules, pallid beneath. Hamathecium of narrowly cellular pseudoparaphyses, often deliquescent at maturity. Asci bitunicate, basal, oblong clavate or ovoid. Ascospores hyaline, yellowish, greenish or olive brown, obovoid or oblong, one celled or septate; wall smooth or verruculose; contents guttulate;

crowded in the ascus.

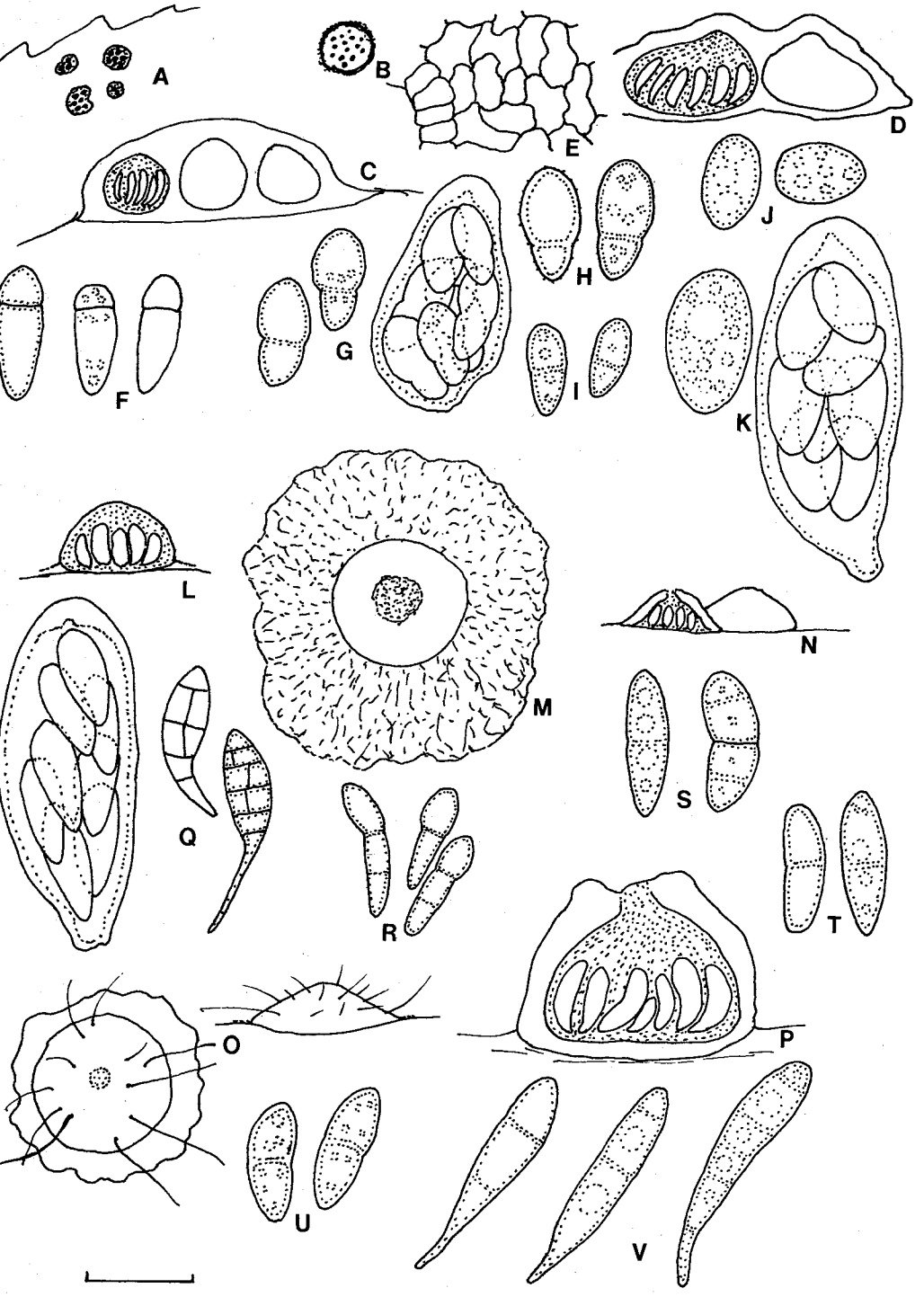
Anamorphs coelomycetous where known; acervular; conidiogenesis holoblastic (described as *Didymochora*).

Biotrophic, developing in or on living leaves and stems, maturing during growing season or after overwintering, widespread.

Other names utilized for this family include: Stigmateaceae Theissen (Ann. Mycol. 14: 426. 1916); Stigmateaceae subfamily Munkielleae Theissen & H. Sydow (Ann. Mycol. 15: 400. 1917); Munkiellaceae (Theissen & H. Sydow) Luttrell (The Fungi IVA: 154. 1973). The Polystomellaceae, which included taxa with superficial ascomata, and the Munkiellaceae, which included taxa with subcuticular ascomata, were combined by O. Eriksson (1981). The Munkiellaceae was meant to replace the Stigmateaceae (Luttrell 1973), with *Stigmatea robertiani* Fr. the original species. B. Eriksson (1974) pointed out some of the problems involved in typifying *Stigmatea*, and concluded that the name could not be utilized for *S. robertiani*. *Hormotheca* accommodates species related to *S. robertiani* (Corlett and Barr 1986), separated from *Coleroa* in the Venturiaceae where it was once incorporated (Müller and von Arx 1962; Barr 1968). In addition to *H. robertiani* (Fr.) von Höhnel, *H. rubicola* (Ellis & Everh.) Corlett & Barr and *H. plantaginis* (Ellis) Corlett & Barr are known from temperate North America; other taxa are found in subtropical and tropical regions. *Atopospora betulina* (Fr.) Petrak with obapiospores develops in leaves of *Betula*, and was also once placed in the Venturiaceae. The amerosporous *Ellisiodothis inquinans* (Ellis & Everh.) Theissen and *E. smilacis* (de Not.) von Arx & Müller have both been described in some detail by Luttrell (1944, 1948).

Dothidella (synonym *Polystomella*) with ascospores having a median septum and *Munkiella* with apiospores are two of the tropical representatives of the family. Several other genera with amerospores and two with phragmospores have been included in the Munkiellaceae (Luttrell 1973). *Trabutia* was supposed to

Plate 27. Features of Pleosporales. A-K. Polystomellaceae: A, B, habit sketches of A, *Atopospora betulina*; B, *Hormotheca rubicola*. C, D, ascomata in vertical section of C, *A. betulina*; D, *Ellisiodothis smilacis*. E, surface of peridium in *H. plantaginis*. F-K, asci and ascospores of F, *A. betulina*; G, *H. rubicola*; H, *H. robertiani*; I, *H. plantaginis*; J, *Ellisiodothis smilacis*; K, *E. inquinans*. L-V. Micropeltidaceae: L-P, ascomata in face view or vertical section of L, *Mycoglaena acuminans* (Nyl.) Vainio; M, *Dictyothyrium subcyaneum* (Ellis & G. Martin) Theissen; N, *Stomiopeltis borealis* Munk; O, *Chaetothyrina asterinoides* (Ellis & G. Martin) Barr; P, *Micropeltis* sp. Q-V, ascus and ascospores of Q, *Mycoglaena acuminans*; R, *Dictyothyrium subcyaneum*; S, *Stomiopeltis* sp. on *Ilex*; T, *S. borealis*; U, *Chaetothyrina asterinoides*; V, *Micropeltis* sp. Standard line = 150 μm for C, D, L-P, 15 μm for E-K, Q-V. Habits not to scale.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belong in the family too, but the specimens that I have studied have all been unitunicate, and I believe that *Trabutia* should be assigned to the Phyllachorales (Barr 1987a). *Gilletiella* apparently belongs to the Polystomellaceae, according to the description and illustrations by Farr (1977). It seems possible too that *Trichodothis comata* (Berkeley & Ravenel) Theissen & H. Sydow is better disposed here than in the Venturiaceae. The superficial scutate stromata are borne on a small hypostroma. From the stroma surface, coarse, dark, cylindric hyphae radiate out for some 200 µm.

Luttrell (1973) also included *Vizella* and *Entopeltis* in the Munkiellaceae. The family Vizellaceae (Swart 1971) consists of parasites on species of Proteaceae in the southern hemisphere. The ascomata are subcuticular or intracuticular, the flattened hyphae have thin walls but dark septa, the ascospores are brown with a transverse hyaline band. The features of hyphae and ascospores seem quite unique and serve to separate the family from all others in the Pleosporales.

Key to Genera

1. Ascospores one celled.....*Ellisiodothis*
1. Ascospores septate.....2
    2. Ascospores with supramedian septum.....*Atopospora*
    2. Ascospores with median or submedian septum.....*Hormotheca*

Micropeltidaceae Clements & Shear, The Genera of Fungi, 100. 1931.

Ascomata dimidiate scutate, separate or occasionally laterally coalesced and polyloculate, superficial on cuticle, seated on and surrounded by small, often delicate, radiating weft of hyphae, bluish, greenish or brown; apex rounded, apical pore opening widely at maturity, often irregular; peridium of one to few rows of pseudoparenchymatous cells, basal layers thin and pallid, with delicate subcuticular hyphae, surface of peridium of "meandering" cells, somewhat textura epidermoidea. Hamathecium of narrowly cellular pseudoparaphyses, deliquescent at maturity. Asci bitunicate, basal, oblong, clavate, saccate or approaching broadly cylindric. Ascospores hyaline or light brown, asymmetric, one or several septate or muriform, basal cell elongated as appendage-like structure in some; wall smooth; contents with one or more globules; overlapping biseriate or crowded or occasionally uniseriate in the ascus.

Anamorphs scarcely known, pycnothyriaceous taxa associated with species of *Stomiopeltis* (Farr 1987).

Saprobic, epiphytic, on leaves, cone scales, branches of gymnosperms and angiosperms, widespread.

The taxa of this family resemble those of Microthyriaceae in several respects, but are most readily separated by the structure of the peridium. That in the Micropeltidaceae is composed in surface view of "meandering" cells, often appearing as textura epidermoidea, whereas that in the Microthyriaceae is composed

of radiating rows of cells, the cells isodiametric or elongate. The pseudoparaphyses in species of Micropeltidaceae are narrowly cellular and those in species of Microthyriaceae are trabeculate; in taxa of both families the pseudoparaphyses tend to deliquesce and thus are not always available as distinguishing characters.

Luttrell (1946) delimited the species of *Stomiopeltis*. Since that time, additional species have been described or transferred to the genus; the study by P. Ellis (1977c) is the most recent one. *Mycoglaena* species were described by Harris (1973). Many of the genera included in the monograph by Batista (1959) require re-evaluation. Some obviously belong elsewhere, but it is evident from the literature that members of the family are more common in tropical than in temperate regions. *Dictyothyrium subcyaneum* and *Chaetothyrina asterinoides* are two examples from subtropical Florida, and many more undoubtedly exist. A species tentatively assigned to *Micropeltis*, occurring on *Betula*, has phragmospores comparable to the dictyospores of *Mycoglaena*, but a more substantial ascoma.

Key to Genera

1. Ascospores one septate (at times additional septa formed by maturity).....2
1. Ascospores several septate or muriform, often tapered toward base; peridium and mycelial weft usually bluish or greenish tinged.....4
    2. Superficial mycelium surrounding ascomata delicate, hyaline or tinged bluish.....*Dictyothyrium*
    2. Superficial mycelium surrounding ascomata sometimes well developed, grayish or brown.....3
3. Ascomata bearing dark setae.....*Chaetothyrina*
3. Ascomata not bearing setae.....*Stomiopeltis*
    4. Ascospores transversely septate.....*Micropeltis*
    4. Ascospores muriform.....*Mycoglaena*

MELANOMMATALES

Barr, Mycologia 75: 11. 1983.

Ascomata perithecioid, cleistothecioid or hysterothecioid, immersed, erumpent or superficial, globose, sphaeroid, turbinate, ovoid, obpyriform, conoid, dimidiate, conchate or dolabrate, (small) medium to large sized; apex with short or conspicuous papilla, at times composed of short setae, rounded or compressed, pore rounded or compressed, ostiole often periphysate; surface smooth or roughened, glabrous or bearing hyphal appendages; peridium of small, thick-walled cells or compressed cells, at times cells cuboid and in radiating rows, sometimes forming cephalothecoid plates; pseudostromatic tissues, subiculum or clypeal tissues present at times. Hamathecium of narrow, trabeculate, branched and anastomosing or unbranched pseudoparaphyses, usually in gel matrix, at times inspersed. Asci bitunicate, peripheral or sometimes basal in position, cylindric, clavate or oblong. Ascospores variable in pigmentation, shape and septation

usually with bipolar symmetry but at times becoming asymmetric.

Anamorphs coelomycetous where known, rarely hyphomycetous.

Saprobic, hypersaprobic, epiphytic, lichenized or hemibiotrophic.

This order includes part of the Pyrenulales according to O. Eriksson and Hawksworth (1986) and several other families, in other words, it is not restricted to lichenized taxa or to those with distoseptate ascospores. The family Trichotheliaceae (syn. Porinaceae) is excluded as belonging to Class Hymenoascomycetes as far as I can determine from study of species of *Porina*. Santesson (1952) was of this opinion, although he included the family under the Strigulaceae at that time. Henssen and Jahns (1974) remarked that the Porinaceae was the only lichenized group that belonged with certainty to the Sphaeriales.

Basically, the order is separated from the Pleosporales, with which it has been for many years combined, by the presence of trabeculate or narrow unbranched pseudoparaphyses and peripherally arranged asci in the centrum, by small-celled or compressed-celled peridium, and by ascospores that exhibit bipolar symmetry. Any one of these features may deviate in a particular taxon in both orders. Ascospores showing bipolar symmetry or peridium of small or compressed cells are known in taxa of the Pleosporales. The arrangement of asci in a peripheral layer does occur, but only infrequently, in the Pleosporales, whereas it is common in the Melanommatales, even though several taxa within this order have asci in a basal layer.

The families and arrangement of genera differ in some respects from my earlier arrangement (Barr 1979b), as additional data provide better understanding of the entities and their relationships. The members of the Strigulaceae in the narrow sense, notably *Strigula elegans* (Fée) Müll. Arg., have short periphysoids in the upper region of the centrum, and the family is reassigned to the Chaetothyriales. The Microglaenaceae, suggested to belong in the Pyrenulaceae by Harris (1975), has been examined in some detail by O. Eriksson (1981). He recognized, as did Harris, and Vězda (1968), that *Microglaena* contained diverse elements; the type species *M. wallrothiana* Körber = *Thelenella modesta* [Nyl.] Nyl.) belongs in the Pertusariaceae. In addition Körber's 1855 name was predated by *Microglena* Ehrenb. 1831, Chlorophyta. The Sporormiaceae when examined more closely is found to be partly pleosporaceous and partly melanommataceous. Several *Sporormiella*-like taxa with trabeculate pseudoparaphyses are arranged under the Fenestellaceae in *Ohleriella*, whereas *Sporormiella* itself belongs in the Didymosphaeriaceae. The Melanommataceae is restricted in components, and the Massariaceae includes the Zopfiaceae in part. For lophiostomataceous taxa that are not pleosporaceous the family Platystomaceae is utilized; it is not restricted to taxa with compressed apical papilla and a number of species with rounded apical papillae are included in several genera. The Testudinaceae is not included in the key because these apparently reduced, cleistothecioid organisms should be inserted in other

families as their affinities become known. Only *Zopfia* and *Neotestudina* of the cleistothecioid genera are assigned at present, to the Massariaceae and Didymosphaeriaceae respectively.

Key to Families

1. Ascomata dimidiate to scutate or conchate to dolabrate, superficial, saprobic or epiphytic; peridium composed of compressed layers of cells or of cephalothecoid plates.....2
1. Ascomata differing in shape from above, immersed, erumpent or superficial.....3
    2. Ascomata dimidiate or scutate, apex opening by rounded pore.....Microthyriaceae
    2. Ascomata conchate to dolabrate, usually hysterothecioid, apex opening by elongate usually cristate slit.....Mytilinidiaceae
3. Ascomata obpyriform or ovoid, at times in valsoid configuration in pseudostroma; peridium three layered, two layers of small-celled pseudoparenchyma, innermost layer of compressed cells; ascus apex with relatively large ocular chamber often containing rodlike structures.....Fenestellaceae
3. Ascomata basically globose, ovoid or sphaeroid; peridium two layered.....4
    4. Pseudoparaphyses simple or rarely branched, matrix often inspersed in upper regions; ascospores frequently distoseptate.....5
    4. Pseudoparaphyses branched and anastomosed, matrix not inspersed; ascospores euseptate or distoseptate.....6
5. Lichenized; ascomata often surmounted by clypeal tissues; asci with small ocular chamber.....Pyrenulaceae
5. Saprobic; ascomata without clypeal tissues, apical papilla conspicuous; asci with large, differentially staining ocular chamber.....Requienellaceae
    6. Ascospores distoseptate or with thickened walls at maturity; saprobic or lichenized.....7
    6. Ascospores euseptate, walls thin or thickened; saprobic.9
7. Saprobic; asci with large ocular chamber, usually surrounded by refractive ring; ascospores or contents brown.....Massariaceae
7. Lichenized; asci without refractive ring; ascospores hyaline, rarely browning in age.....8
    8. Ascomata clypeate; asci cylindric with large ocular chamber.....Acrocordiaceae
    8. Ascomata within pseudostroma; asci oblong with small ocular chamber.....Trypetheliaceae
9. Ascomata typically sphaeroid and immersed beneath clypeus or in subiculum; ascospores rather small, shades of brown, ellipsoid or oblong.....Didymosphaeriaceae
9. Ascomata globose, turbinate or ovoid, immersed erumpent or superficial with bases embedded in substrate; subiculum present in some; ascospores hyaline or shades of brown, ellipsoid or fusoid.....10

10. Ascomata with abrupt, short rounded, compressed or setose papilla; peridium of small pseudoparenchymatous cells, often heavily pigmented and sclerotial.....Melanommataceae

10. Ascomata with well-developed, rounded or compressed papilla or short beak; peridium of rows of compressed cells, pigment often in patches.....Platystomaceae

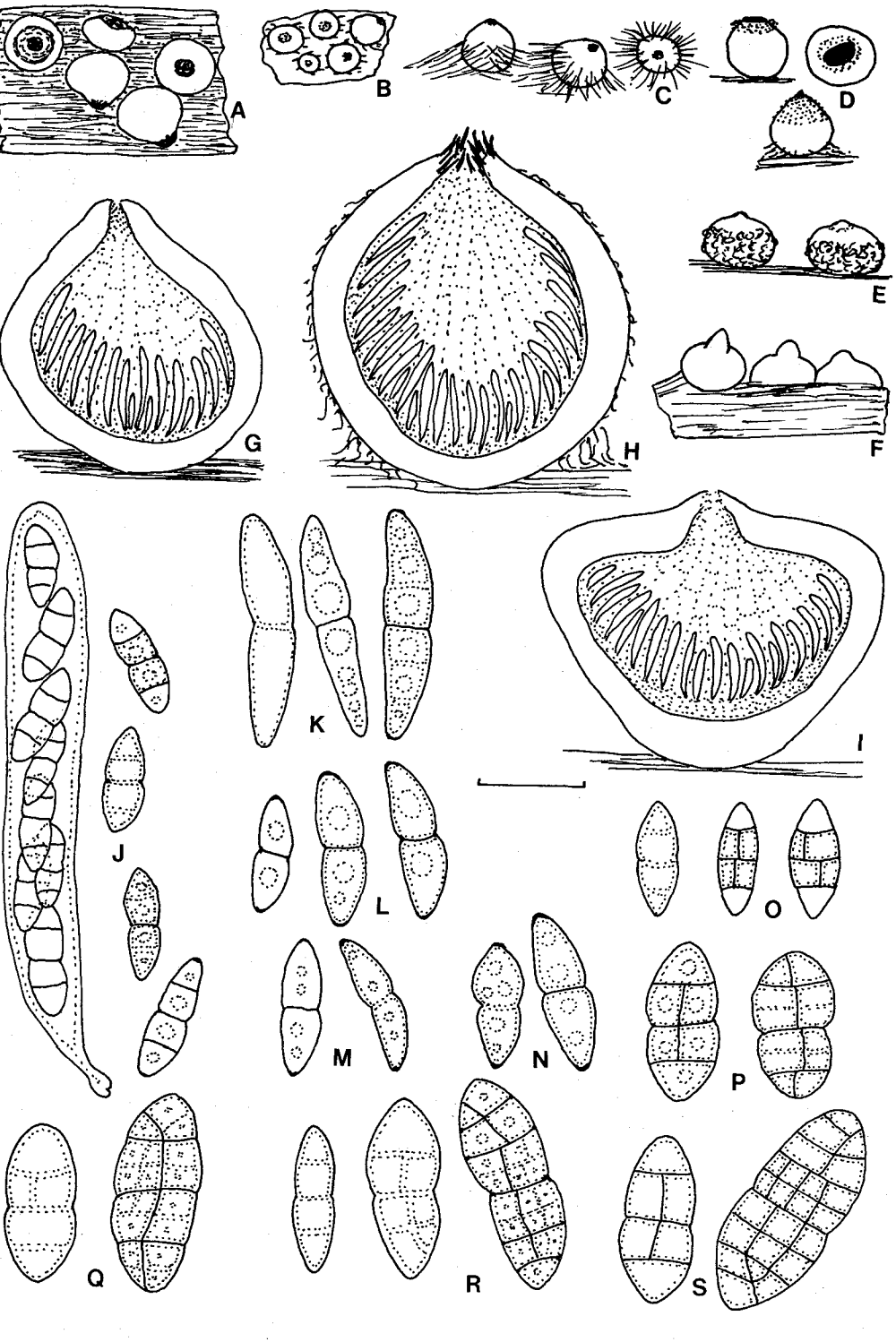
Melanommataceae Winter in Rabenhorst, Kryptogamen-Flora 1(2): 220. 1885.

Ascomata immersed becoming widely erumpent and appearing superficial with bases attached to substrate, separate or gregarious or grouped on basal stromatic tissues or in subiculum or over other fungi, (small) medium to large sized, globose or ovoid or turbinate, collabent at times; apex abruptly short papillate, rounded or compressed, papilla at times composed of short dark setae, pore rounded or slitlike; surface glabrous or roughened by protruding cells, short hyphae or elongate hyphae that merge with and form subiculum; peridium firm, composed of small thick-walled, pseudoparenchymatous cells, usually blackened and crustose externally, often reddish or yellowish brown internally. Hamathecium of trabeculate pseudoparaphyses, branched and anastomosing in gel matrix. Asci bitunicate, peripheral, cylindric or clavate, with small ocular chamber. Ascospores hyaline, light brown, reddish brown, dull brown or dark brown, fusoid, ellipsoid or oblong, symmetric, straight or inequilateral, one or several septate or muriform, usually constricted at median primary septum; wall thin with septa darker than wall or contents or wall thickened, surrounded by gel coating or bearing terminal appendages at times, smooth or verruculose; contents usually with one rhomboid globule in each cell; uniseriate or partially biseriate in the ascus.

Anamorphs coelomycetous where known; conidiogenesis phialidic; conidia hyaline, one celled (described as *Aposphaeria, Dendrophoma, Pyrenochaeta*).

Saprobic especially on woody substrates, occasionally hyperparasitic on other ascomycetes, cosmopolitan.

Plate 28. Features of Melanommatales. Melanommataceae: A=F, habit sketches of A, *Melanomma pulvis-pyrius*; B, *Byssosphaeria schiedermayeriana* (Fuckel) Barr; C, *B. xestothele* (Berkeley & Curtis) Barr; D, *Ostropella albocincta*; E, *Strickeria insecura* (Ellis) Kuntze; F, *S. mammoides* (Ellis & Everh.) Kuntze. G-I, ascomata in vertical section of G, *Melanomma pulvis-pyrius*; H, *Keissleriella sambucina*; I, *Strickeria kochii*. J-S, ascus and ascospores of J, *Melanomma pulvis-pyrius; K. Byssosphaeria schiedermayeriana*; L, *B. diffusa*; M, *Keissleriella sambucina*; N, *Ostropella albocincta*; O, *Strickeria kochii*; P, *S. insecura*; Q, *S. mammoides*; R, *S. symphoricarpi* Tracy & Earle; S, *S. kelseyi* (Ellis & Everh.) Barr. Standard line = 150 µm for G-I, 15 µm for J-S. Habits not to scale.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A number of taxa in this family have gregarious, widely erumpent ascomata, some seated in a well-developed subiculum, others in a thin, blackened coating on the substrate surface. The apical papilla, whether rounded or compressed, is abrupt, sometimes conspicuous although short. The peridium is composed of small, thick-walled cells. Several species have remarkably similar ascospores, one septate and pallid with the septum and tips darkened; they are arranged in genera whose apical papillae differ: *Ostropella albocincta* (Berkeley & Curtis) von Höhnel with low compressed crest on globose ascomata, *Keissleriella sambucina* (Rehm) von Höhnel with apex composed of short setae on globose ascomata, and *Byssosphaeria diffusa* (Schwein.) Cooke with rounded papillate apex on turbinate or ovoid ascomata. Other species of *Byssosphaeria* develop three or more septa in the more elongate and more pigmented ascospores (Barr 1984). *Melanomma pulvis-pyrius* (Pers.: Fr.) Fuckel with three transverse septa and *Strickeria kochii* Körber with longitudinal septa in the mid cells are the type species of their respective genera; they have globose ascomata with short rounded papillae, ascospores with dark septa, similar in shape to those noted above. Other species in both *Melanomma* and *Strickeria* vary in ascoma shape to ovoid or turbinate and in size, shape and septation and deeper pigmentation of ascospores.

Key to Genera

1. Apical papilla abruptly compressed and conspicuous, ascomata seated in subiculum.....*Ostropella*
1. Apical papilla not abruptly compressed, short papillate.....2
    2. Apical papilla composed of short dark setae.....*Keissleriella*
    2. Apical papilla not composed of short dark setae.....3
3. Ascospores muriform.....*Strickeria*
3. Ascospores transversely septate.....4
    4. Ascomata seated in subiculum; ascospores one to several septate.....*Byssosphaeria*
    4. Ascomata seated on blackened crust on wood or over other ascomycetes; ascospores three septate.....*Melanomma*

Platystomaceae Schröter in Cohn, Kryptogamen-Fl. Schlesiens 2: 323. 1894.

Ascomata immersed with apices erumpent, or erumpent superficial with bases immersed, at times in subiculum, separate or gregarious or in valsoid groups, globose or conoid and applanate with flattened bases, (small) medium to large sized; apex well developed, papillate or short beaked, rounded or compressed or angular, at times pore area red, orange or yellow with pigment encrusting tips of pseudoparaphyses; surface smooth or tomentose, tomentum and/or subiculum brown or brightly pigmented (yellowish, greenish, ochraceous, ferruginous, orange, vinaceous), sometimes as disc over papillate ascomata; peridium firm, composed of several rows of small compressed cells,

reddish brown. Hamathecium of trabeculate pseudoparaphyses, branched and anastomosing in gel matrix. Asci bitunicate, peripheral or basal in tall narrow ascomata, clavate or cylindric, with small ocular chamber. Ascospores hyaline, light clear brown, reddish brown or dark brown, ends pale at times, ellipsoid or fusoid, ends obtuse or acute, several septate, some muriform, constricted at median septum; wall smooth or verruculose or longitudinally striate, occasionally surrounded by gel coating; contents with large globule per cell; overlapping uniseriate or biseriate in the ascus.

Anamorphs coelomycetous where known; conidiogenesis phialidic; conidia light brown, one celled (described as *Cyclothyrium*).

Saprobic, usually on woody substrates or hypersaprobic over other ascomycetes, cosmopolitan.

The Platystomaceae contains some fungi traditionally assigned to the Lophiostomataceae, that is with compressed papillae, as in species of *Platystomum*, and others whose papillae are rounded. The majority of taxa included in the Lophiostomataceae must be removed to the Pleosporales when *Lophiostoma macrostomum* (Tode: Fr.) Ces. & de Not. is lectotypified by a Friesian specimen (Holm in litt.) corresponding to *L. crenatum* or *L. angustilabrum* of Chesters and Bell (1970). On the other hand, *Platystomum compressum* (Pers.: Fr.) Trev. and some relatives are melanommataceous in centrum, with rather distant trabeculate pseudoparaphyses. The Platystomaceae is recognizable by the well-developed apical papilla, either compressed or rounded, or by conoid shape that extends in some taxa as a tall narrow cone, and by the peridium of rows of compressed cells. The ascospores are typically fusoid or ellipsoid, several septate, and range from hyaline through shades of brown often with reddish tinges.

The low conoid form of ascomata in some species of *Astrosphaeriella* suggests the Microthyriaceae, whose members originate superficially on the substrate. At the other extreme, the tall conoid species of this genus, with supporting vertically oriented rows of peridium, hint at the Mytilinidiaceae. The distribution of *Astrosphaeriella* is tropical for the most part (Hawksworth 1981, Hawksworth and Boise 1986), but at least one species has been collected in northern Florida. *Thyridaria* was monographed by Wehmeyer (1941), *Pseudotrichia* by Barr (1984), and *Trematosphaeria* by Boise (1985).

Key to Genera

1. Ascomata conoid with applanate base; ascospores narrowly fusoid and elongate, pallid; on stout monocots, tropical or subtropical.....*Astrosphaeriella*
1. Ascomata globose or somewhat conoid; ascospores fusoid or ellipsoid, if elongate ascomata not conoid; on various substrates, temperate or tropical.....2

2. Ascomata surrounded by abundant hyphal tomentum, often extended as subiculum or forming stromatic disc over tips of papillae.....3

2. Ascomata without abundant hyphal tomentum, subiculum or stromatic disc; ascospores reddish brown to dark brown.....4

3. Ascomata gregarious in subiculum; ascospores hyaline or light brown, fusoid to elongate, three to multiseptate....*Pseudotrichia*

3. Ascomata usually in valsoid groups and often beneath disc of hyphae but separate at times; ascospores reddish brown or dark brown, ellipsoid or fusoid, three to five septate.....*Thyridaria*

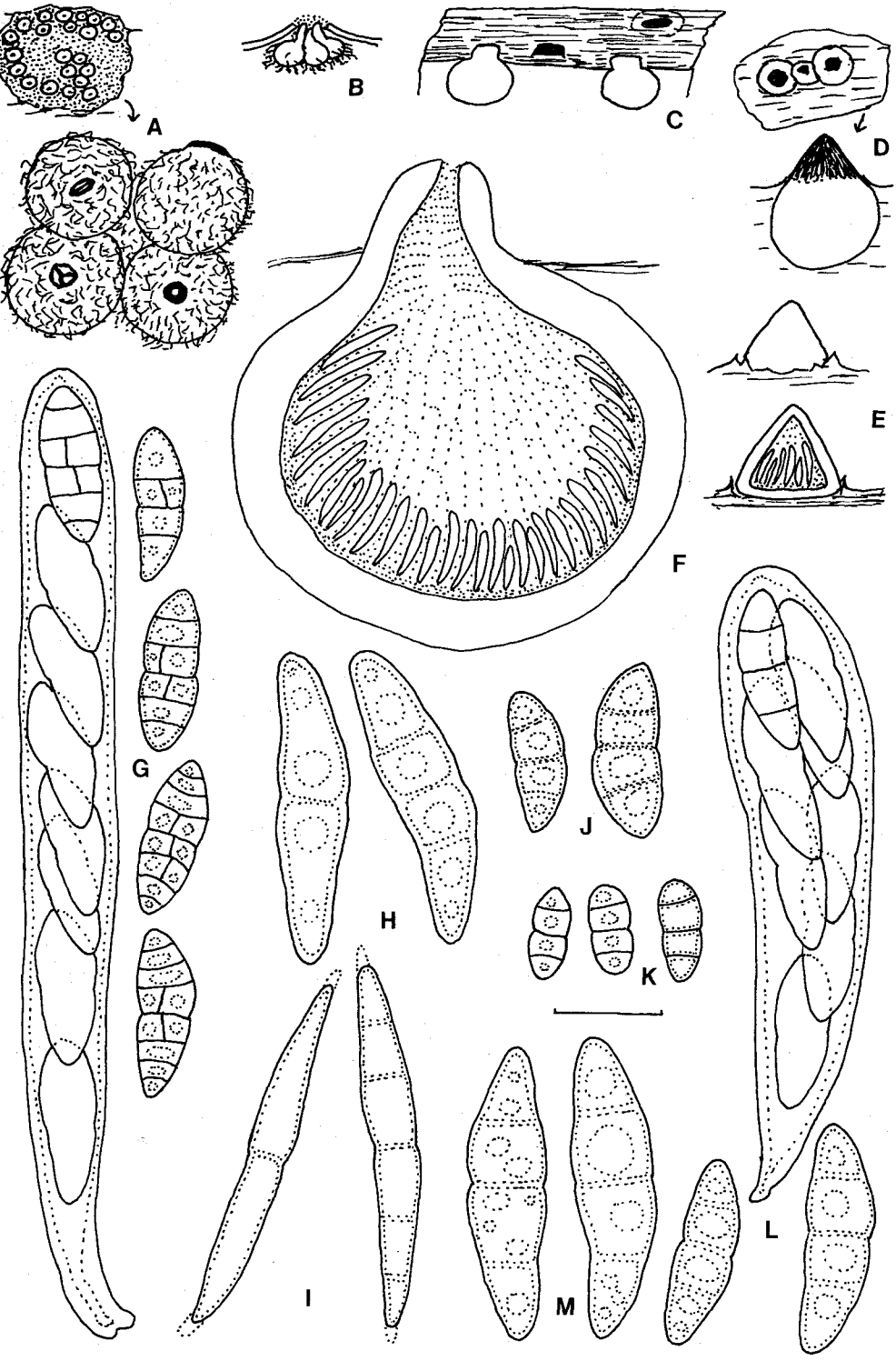
4. Ascospores transversely septate.....*Trematosphaeria*

4. Ascospores muriform or at least with longitudinal septum in one or two cells.....*Platystomum*

Didymosphaeriaceae Munk, Dansk Bot. Ark. 15(2): 128. 1953.

Ascomata perithecioid or occasionally cleistothecioid, immersed in substrate, becoming erumpent and appearing superficial when periderm eroded, separate or gregarious, sphaeroid or globose, small to medium sized, rarely large; apex rounded with short or broad blunt papilla, pore rounded; surface surrounded by sparse or well-developed hyphal tomentum, expanded as clypeus that sometimes covers several ascomata, or as subiculum; peridium narrow at base, composed of rows of small, compressed, prosenchymatous cells, usually broadest in upper regions, in some cells dark and dense in upper centrum as internal clypeus, in cleistothecioid forms composed of cephalothecoid plates. Hamathecium of trabeculate pseudoparaphyses, branched and anastomosing in gel matrix. Asci bitunicate, peripheral, cylindric or clavate, with small ocular chamber. Ascospores light brown, clear brown, reddish brown, vinaceous brown or dark brown, ellipsoid or oblong, biconic at times, ends obtuse or acute, symmetric, straight or inequilateral, one or several septate or some muriform, often constricted slightly at septa; wall smooth or foveolate or verruculose, at times with germ slit in each cell or minute pores at ends, surrounded by gel coating at times; contents with one rhomboid or rounded globule per cell or homogeneous; uniseriate or partially biseriate in the ascus.

Plate 29. Features of Melanommatales. Platystomaceae: A-E, habit sketches of A, *Pseudotrichia mutabilis* (Pers.: Fr.) Wehmeyer; B, *Thyridaria broussonetiae* (Sacc.) Traverso; C, *Platystomum compressum*; D, *Trematosphaeria confusa* (Garov.) Boise & Hawksworth; E, *Astrosphaeriella trochus* (Penzig & Sacc.) Hawksworth. F, ascoma in vertical section of *Platystomum compressum*. G-M, asci and ascospores of G, *P. compressum*; H, *Pseudotrichia mutabilis*; I, *Astrosphaeriella trochus*; J, *Thyridaria broussonetiae*; K, *T. minima* (Ellis & Everh.) Wehmeyer; L, *Trematosphaeria pertusa* (Pers.: Fr.) Fuckel; M, *T. confusa*. Standard line = 150 µm for F, 15 µm for G-M. Habits not to scale.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Anamorphs coelomycetous where known; conidiogenesis phialidic; conidia brown, one celled or one septate (described as *Dendrophoma*, *Microdiplodia*).

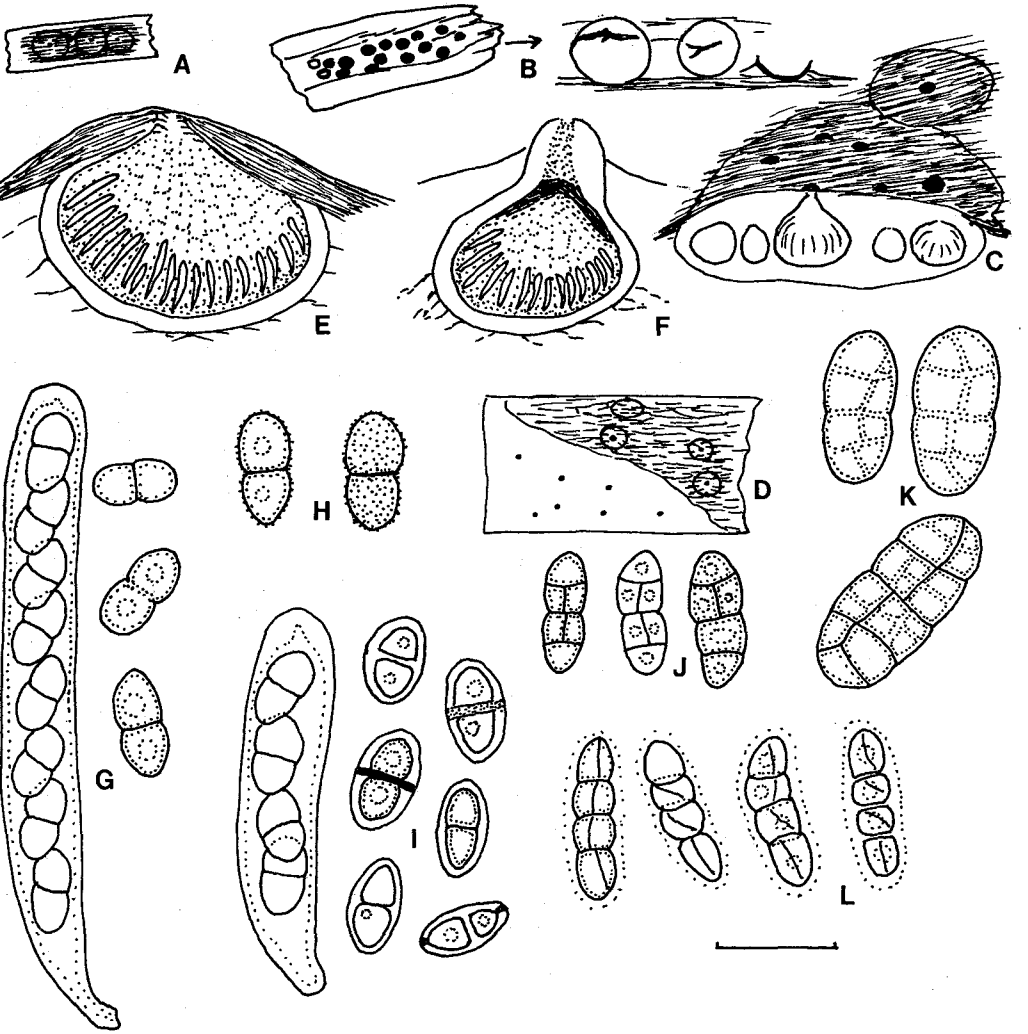
Saprobic in woody branches, herbaceous stems or leaves, in animal dung, or hypersaprobic in other ascomycetes, cosmopolitan.

The taxa of this family typically develop sphaeroid ascomata in the substrate beneath a clypeus that may be small over a single ascoma or may extend over several adjacent ascomata, or the ascomata may be surrounded by a hyphal subiculum. The small to medium-sized ascospores have a firm wall and septa, the pigment often appearing concentrated in the "corner" between septum and wall.

The ascomata in species of *Didymosphaeria* vary in a pattern that is repeated in other members of the family. *Didymosphaeria futilis* (Berkeley & Broome) Rehm typically forms a shallow or well-developed clypeus over an individual ascoma, whereas *D. oblitescens* (Berkeley & Broome) Fuckel is a more robust species whose ascomata are usually invested in subiculum hyphae and occasionally contain a blackened internal clypeus. In *Neotestudina diplodioides* Barr (Barr 1987b) the ascoma is cleistothecioid and the narrow peridium is composed of cephalothecoid plates; ascospores are much as in species of *Didymosphaeria*. *Sporormiella nigropurpurea* Ellis & Everh. forms ascomata beneath a clypeus, and the transversely septate ascospores have a germ slit in each cell. Several of the species placed in this genus (Ahmad and Cain 1972) differ in important features (see discussion under Phaeotrichaceae, Pleosporales) and re-evaluation of the species is needed. The species of *Karstenula*, typified by *K. rhodostoma* (Albertini & Schwein.: Fr.) Speg., range in ascomata and the presence of clypeus or subiculum much as those of *Didymosphaeria*, and are set apart by somewhat larger and muriform ascospores.

The genus *Xylobotryon*, with *X. andinum* Pat., seems best accommodated in the Didymosphaeriaceae; asci and one-septate ascospores are similar to those of *Didymosphaeria*. Rossman (1976) recognized that it was a member of the Loculoascomycetes and illustrated the type species. The presence of a stipitate stroma (?hypostroma) is unique and does lend some doubt to this tentative disposition.

Plate 30. Features of Melanommatales. Didymosphaeriaceae: A-D, habit sketches of A, *Didymosphaeria futilis*; B, *Neotestudina diplodioides*; C, *Karstenula rousseliana* (Sacc. & Speg.) Barr; D, *K. rhodostoma*. E, F, ascomata in vertical section of E, *Didymosphaeria futilis*; F, *D. oblitescens*. G-L, asci and ascospores of G, *D. futilis*; H, *D. oblitescens*; I, *Neotestudina diplodioides*; J, *Karstenula rhodostoma*; K, *K. rousseliana*; L, *Sporormiella nigropurpurea*. Standard line = 150 μm for E, F, 15 μm for G-L. Habits not to scale.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Key to Genera

1. Ascospores one septate (or rarely one celled).....2
1. Ascospores more than one septate.....3
2. Ascomata perithecioid; peridium composed of numerous rows of cells.....*Didymosphaeria*
2. Ascomata cleistothecioid; peridium composed of cephalothecoid plates.....*Neotestudina*
3. Ascospores transversely septate, with elongate germ slit in each cell.....*Sporormiella*
3. Ascospores muriform, without germ slit.....*Karstenula*

Fenestellaceae Barr, Mycologia 71: 952. 1979.

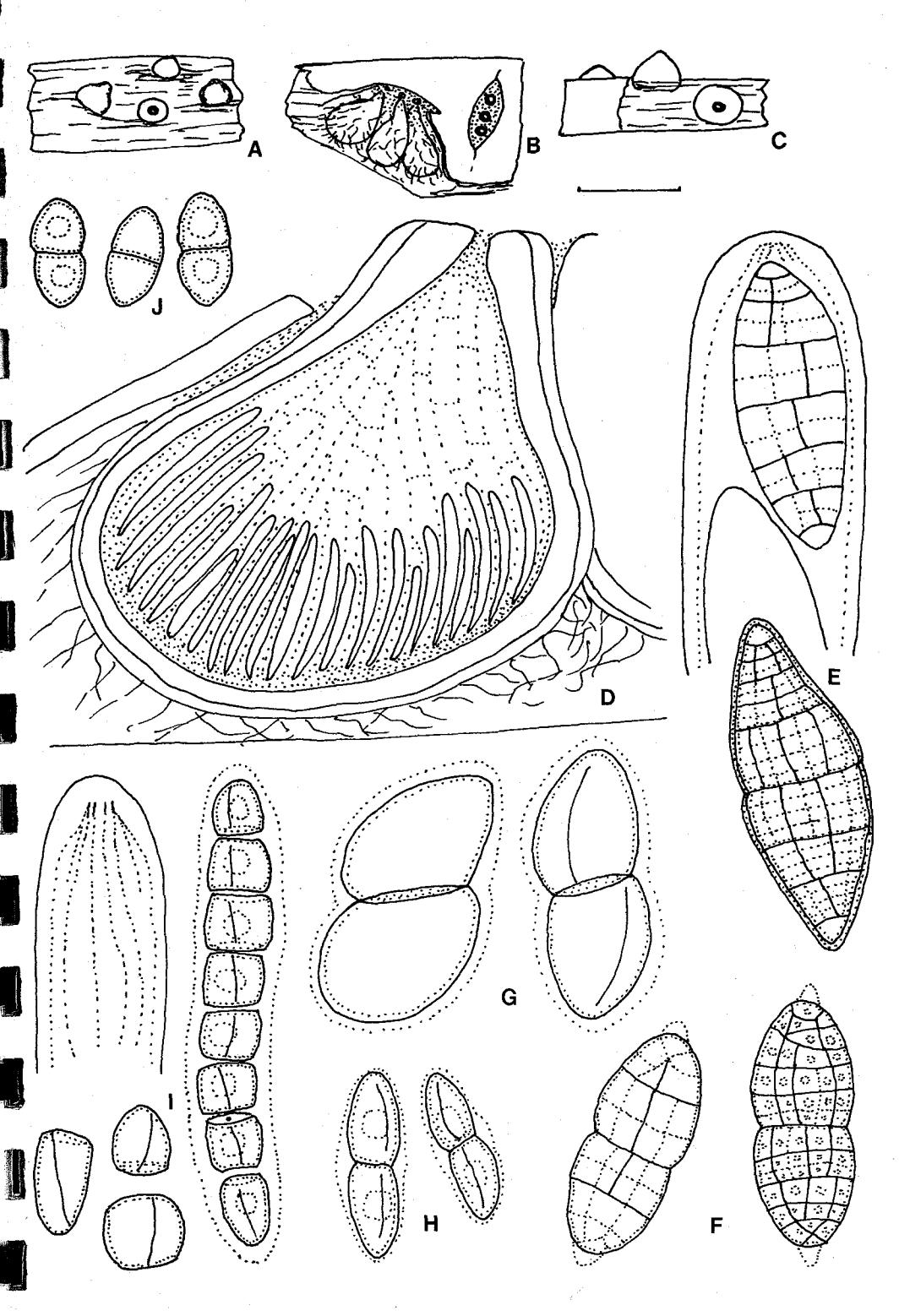
Ascomata immersed, becoming erumpent or superficial when periderm is eroded, separate or gregarious or in valsoid groups, medium to large sized, obpyriform or ovoid; apex tapered to broad blunt papilla, pore rounded; surface smooth or roughened by protruding cells or short hyphae, or hyphae aggregated as pseudostroma surrounding and/or forming disc above papillae; peridium three layered, composed of two outer layers of small pseudoparenchymatous cells, darkest externally, surrounding thin inner layer of compressed cells. Hamathecium of trabeculate pseudoparaphyses in gel matrix. Asci bitunicate, peripheral or basal, cylindric or clavate, with wide ocular chamber often containing distinct rods. Ascospores reddish brown, becoming dark brown, end cells pallid at times, ellipsoid or fusoid, symmetric, straight or inequilateral, one or several septate or muriform, constricted at one or all septa, separating into partspores at times; wall smooth or verruculose or longitudinally striate, with germ slit in each cell at times, surrounded by gel coating at times; contents with one large globule in each cell; uniseriate or biseriate in the ascus.

Anamorphs scarcely known.

Saprobic or hemibiotrophic in woody substrates, animal dung, or hypersaprobic over other ascomycetes, cosmopolitan.

The members of the Fenestellaceae have obpyriform or ovoid ascomata whose peridium is broad and obviously two layered, at least in the upper regions. The species of *Fenestella* usually are grouped in valsoid configuration and at times develop beneath a disc of hyphae. Other genera that I had assigned earlier (Barr 1979b) to the family are relocated. In addition to the dictyosporous *Fenestella, Lojkania* with didymospores (Barr 1984)

Plate 31. Features of Melanommatales. Fenestellaceae: A-C, habit sketches of A, *Lojkania nuda* (Ellis & Everh.) Barr; B, *Fenestella princeps* Tul. & Tul.; C, *Ohleriella neomexicana* Earle. D, ascoma in vertical section of *Fenestella princeps*. E-J, asci and ascospores of E, *F. princeps*; F, *F. media* Tul. & Tul.; G, *Delitschia didyma* Auerswald; H, *D. timagamensis* Cain; I, *Ohleriella neomexicana*, young ascus apex, ascospore, partspores; J, *Lojkania nuda*. Standard line = 150 μm for D, 15 μm for E-J. Habits not to scale.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and *Ohleriella* with phragmospores make a compact grouping. *Ohleriella* was consigned as a synonym of *Sporormiella* (Ahmad and Cain 1972) but the type species *O. neomexicana* and a few additional species differ from *Sporormiella* in several respects and fit well in the Fenestellaceae. The few species of *Delitschia* (Luck-Allen and Cain 1975) that I have studied also belong in the Fenestellaceae. By extrapolation, *Semidelitschia* (Cain and Luck-Allen 1969) probably belongs in this family also.

Key to Genera

1. Ascomata frequently grouped in valsoid configuration over other ascomycetes; ascospores muriform.....*Fenestella*
1. Ascomata usually separate, gregarious, not in valsoid configuration; ascospores transversely septate.....2
    2. Ascospores several septate, with germ slit in cell wall.....*Ohleriella*
    2. Ascospores one septate.....3
3. Ascospores with germ slit in cell wall; coprophilous.....*Delitschia*
3. Ascospores without germ slit in cell wall; lignicolous.....*Lojkania*

Massariaceae Nitschke, Verh. Naturhist. Preuss. Rheinl. 26. Corr.-Bl. 2: 73. 1869.

Zopfiaceae Arnaud ex Malloch & Cain, Canad. J. Bot. 50: 67. 1972.

Zopfiaceae Arnaud, Bull. Soc. Mycol. France 29: 259. 1913, nom. inval., ICBN, Art. 36.

Ascomata immersed becoming erumpent to superficial with bases remaining immersed, separate, gregarious or grouped in pseudostromatic tissues or beneath clypeus, medium to large sized, globose, apex stout papillate or short beaked, rounded or compressed, pore rounded or slitlike, apex surmounted at times by peaks of stromatic tissue that form a coarsely sulcate surface, or ascomata cleistothecioid without papilla or pore; surface smooth or bearing hyphae; peridium relatively wide, composed of numerous rows of small cells or narrow and composed of cephalothecoid plates. Hamathecium of trabeculate pseudoparaphyses in gel matrix. Asci bitunicate, basal or peripheral, broadly oblong or cylindric, with low wide ocular chamber, at times containing rods, often surrounded by refractive ring. Ascospores hyaline or light to dark brown, ellipsoid, oblong or fusoid, biconic at times, symmetric, straight or inequilateral, one or several septate, some muriform, often distoseptate, constricted at median septum or not constricted; wall thick, smooth or foveolate, verruculose or longitudinally striate, often surrounded by gel coating; contents homogeneous or granular in lenticular cells or with globule in each cell; biseriate or uniseriate in the ascus.

Anamorphs scarcely known.

Saprobic or hemibiotrophic in wood, branches, periderm, nut pericarps, stony endocarps, roots, cosmopolitan.

The complex of genera grouped into the Massariaceae presents some problems. Species of *Massaria* and *Aglaospora* have distoseptate ascospores and their asci usually show a refractive ring around the wide ocular chamber. Species of *Navicella* differ by the presence of a compressed papilla and the formation of more than three distosepta in the ascospores. The species of *Decaisnella* (Barr 1986, formerly arranged under *Titanella*, Barr 1979a) also show distosepta in immature ascospores, but these may not be evident after additional transverse and longitudinal septa are produced. *Massaria*, including *Aglaospora*, and *Decaisnella* are the genera that O. Eriksson and Hawksworth (1986) accept in the Massariaceae which they submerge under the Trypetheliaceae. Harris (1986) differs in opinion and suggests that the Massariaceae presently includes only remnants of the group of fungi that gave rise to both the Pyrenulaceae and the Trypetheliaceae.

Two other genera placed in the Massariaceae, *Caryospora* and *Zopfia*, could be separated as the Zopfiaceae in the strict sense. Immature ascospores do have a distoseptate appearance, although it is not evident in mature ones, and the apices of immature asci have a wide ocular chamber with a suggestion of refractive ring; for these reasons I do not remove these two genera from the Massariaceae. *Dothivalsaria megalospora* (Auerswald) Petrak poses additional problems. Only old specimens (100 years or more) have been available for study; the ascus apex sometimes shows a refractive ring around the ocular chamber and the immature ascospores are suggestive of those of *Caryospora* in contents if not in shape. The configuration of ascomata and presence of coarse stromatic sulcations above the papillae is suggestive of those features in *Aglaospora profusa* (Fr.) de Not.

Two genera described recently from mangrove wood seem likely to belong in the Massariaceae also: *Aigialus* (Kohlmeyer and Schatz 1985) with dictyospores, and *Biatriospora* (Hyde and Borse 1986) with phragmospores. Large ascomata, asci with a refractive apical ring, trabeculate pseudoparaphyses, and large ascospores all point to this family.

Key to Genera

1. Apices of ascomata surmounted by sulcate peaks of stromatic tissue above substrate.....2
1. Apices of ascomata without sulcate peaks of stromatic tissue, papilla rounded or compressed, or ascomata cleistothecioid.....3
    2. Ascospores conspicuously distoseptate, hyaline with brown cell contents.....*Aglaospora*
    2. Ascospores not obviously distoseptate, one septate, brown .....*Dothivalsaria*
3. Ascospores conspicuously distoseptate at maturity.....4
3. Ascospores not obviously distoseptate at maturity.....5
    4. Ascomata with rounded papilla; ascospores three septate.. .....*Massaria*
    4. Ascomata with compressed papilla; ascospores five to eleven septate.....*Navicella*

5. Ascospores muriform; ascomata with rounded or compressed papillae.....*Decaisnella*
5. Ascospores one to three septate; ascomata with rounded papilla or ascomata cleistothecioid.....6
    6. Ascomata perithecioid; peridium wide, composed of several rows of cells.....*Caryospora*
    6. Ascomata cleistothecioid; peridium narrow, composed of cephalothecoid plates.....*Zopfia*

Pyrenulaceae Rabenhorst, Kryptogamen-Flora von Sachsen, 42. 1870.

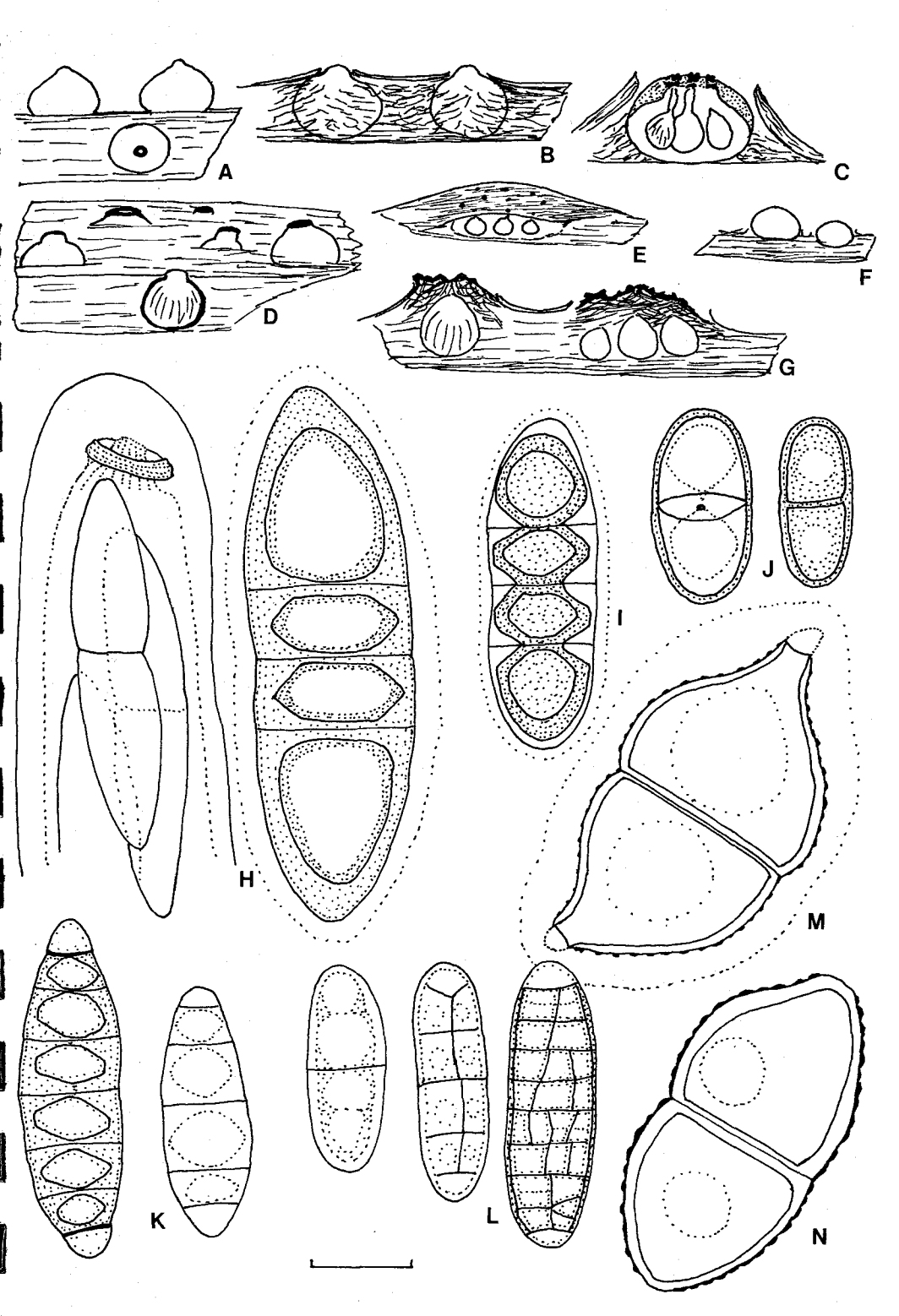
Ascomata immersed in endophloeodal thallus, separate, gregarious or in valsoid configuration, sphaeroid, medium to large sized, upright or horizontal; apex papillate, central, eccentric or lateral, pore rounded; surface smooth; peridium narrow toward base, composed of small pseudoparenchymatous cells, wide above with clypeal tissues. Hamathecium of unbranched or sparsely branched pseudoparaphyses in gel matrix, faintly blue green becoming pinkish orange in IKI, often inspersed with granules. Asci bitunicate, basal, cylindric or clavate, with narrow ocular chamber. Ascospores brown or occasionally remaining hyaline, ellipsoid or oblong, symmetric, straight or inequilateral, one or several septate or at times muriform, usually distoseptate; wall thickened, smooth; contents with large lenticular globule and cells mostly lenticular; uniseriate or biseriate in the ascus.

Anamorphs coelomycetes where known; microconidia filiform.

Lichenized, usually corticolous, cosmopolitan.

The concept of the Pyrenulaceae derived from Harris (1975) includes the families Paratheliaceae, Gleophragmiaceae, and Gloenodictyaceae. Unbranched pseudoparaphyses, often inspersed, aid in separating the Pyrenulaceae from the Massariaceae. Many of the taxa are tropical, but representatives of several genera do occur in temperate North America and are keyed below as well as being utilized to illustrate some of the characteristics of the family.

Plate 32. Features of Melanommatales. Massariaceae: A-G, habit sketches of A, *Caryospora langloisii* Ellis & Everh.; B, *Massaria pyri* Otth; C, *Aglaospora profusa*; D, *Navicella julii* Fabre; E, *Decaisnella spectabilis* Fabre; F, *Zopfia rhizophila* Rabenh.; G, *Dothivalsaria megalospora*. H-N, ascus apex and ascospores of H, *Massaria inquinans* (Tode: Fr.) Ces. & de Not.; I, *Aglaospora profusa*; J, *Dothivalsaria megalospora*; K, *Navicella pileata* (Tode: Fr.) Fabre; L, *Decaisnella spectabilis*; M, *Caryospora putaminum* (Schwein.: Fr.) de Not.; N, *Zopfia rhizophila*. Standard line = 15 μm for H-N. Habits not to scale.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Key to Genera

1. Ascomata separate or gregarious, upright.....2
1. Ascomata separate and horizontal or grouped in valsoid configuration.....4
2. Ascospores transversely euseptate.....*Eopyrenula*
2. Ascospores distoseptate.....3
3. Ascospores transversely septate (at times with longitudinal septum in one or two cells).....*Pyrenula*
3. Ascospores muriform.....*Anthracothecium*
4. Ascomata separate and horizontal with eccentric or lateral ostiole; ascospores transversely euseptate.....*Plagiocarpa*
4. Ascomata grouped in valosid configuration; ascospores distoseptate.....5
5. Ostioles of grouped ascomata separate; ascospores transversely septate.....*Melanotheca*
5. Ostioles of grouped ascomata united into a single chamber; ascospores muriform.....*Parmentaria*

Acrocordiaceae Oxner ex Barr, Mycotaxon 29: 505. 1987.

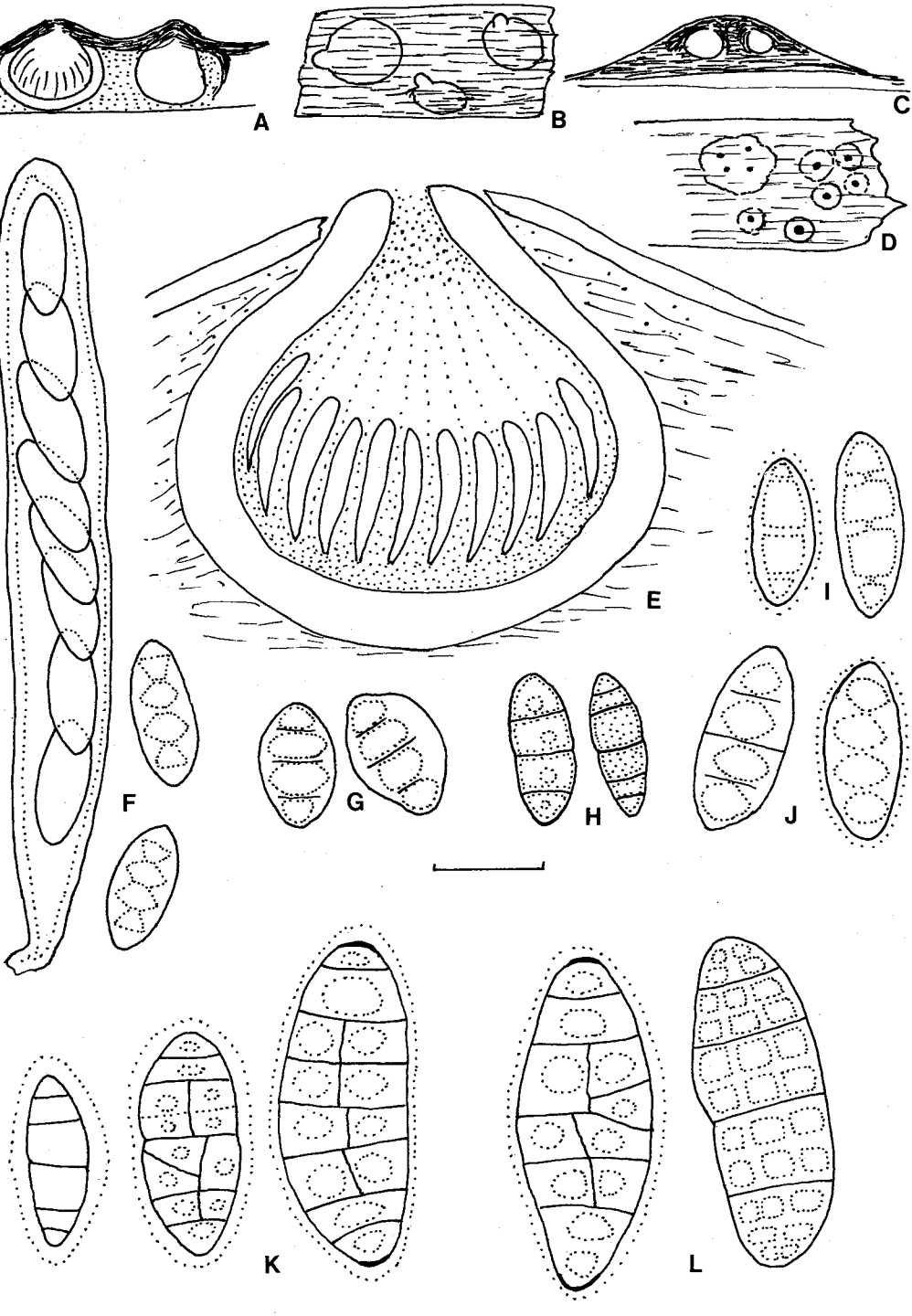
Acrocordiaceae Oxner, Flora Lyšajnykĭo Ukrainy, 144. 1956; nom. inval., ICBN, Art. 36.

Ascomata immersed in endophloeodal thallus or thin crustose thallus, separate or gregarious, medium to large sized, sphaeroid; apex papillate, pore rounded; surface smooth; peridium narrow toward base, composed of small-celled pseudoparenchyma, usually wide above and merged with clypeus. Hamathecium of trabeculate pseudoparaphyses, branched and anastomosing in gel matrix. Asci bitunicate, basal, cylindric or clavate, with wide ocular chamber. Ascospores hyaline, slightly pigmented in age, ellipsoid or obovoid, symmetric or asymmetric, straight or inequilateral, one or more transversely septate; wall thickened, often finely verruculose; contents globular; uniseriate or biseriate in the ascus.

Lichenized, corticolous or saxicolous, cosmopolitan.

The genera included here in the Acrocordiaceae formed part of the family Strigulaceae (Harris 1975), but with the discovery of apical periphysoids in *Strigula*, that family in a restricted sense is transferred to the Chaetothyriales. Two closely related genera are known to me in temperate North America, both with

Plate 33. Features of Melanommatales. Pyrenulaceae: A-D, habit sketches of A, *Pyrenula neglecta* Harris; B, *Plagiocarpa hyalospora* (Nyl.) Harris; C, *Melanotheca cruenta* (Mont.) Müll. Arg.; D, *Anthracothecium leucostomum* (Ach.) Malme. E, ascoma in vertical section of *A. leucostomum*. F-L, ascus and ascospores of F, *Pyrenula mamillana* (Ach.) Trev.; G, *P. neglecta*; H, *Eopyrenula leucoplaca* (Wallr.) Harris; I, *Plagiocarpa hyalospora*; J, *Melanotheca cruenta*; K, *Anthracothecium leucostomum*; L, *Parmentaria astroidea* Fée. Standard line = 150 µm for E, 15 µm for F-L. Habits not to scale.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basically one-septate ascospores. *Acrocordia* has symmetric, ellipsoid ascospores in cylindric asci, whereas *Anisomeridium* has somewhat asymmetric ascospores with the lower cell usually shorter than the upper, borne in broad, more clavate asci. Harris (pers. comm.) has in preparation a revised classification of these and related taxa.

O. Eriksson and Hawksworth (1985, 1986) included *Acrocordia* among the Pyrenulaceae, but the branched pseudoparaphyses in gel matrix that neither changes color in IKI nor is inspersed serve to separate the Acrocordiaceae from the Pyrenulaceae. From the Didymosphaeriaceae the Acrocordiaceae are separated by peridium structure and the wide ocular chamber in the ascus apex. I had originally allied *Acrocordia* and *Anisomeridium* with *Pleurotrema*, but Harris (1986) includes that genus and the Pleurotremataceae under the Trypetheliaceae.

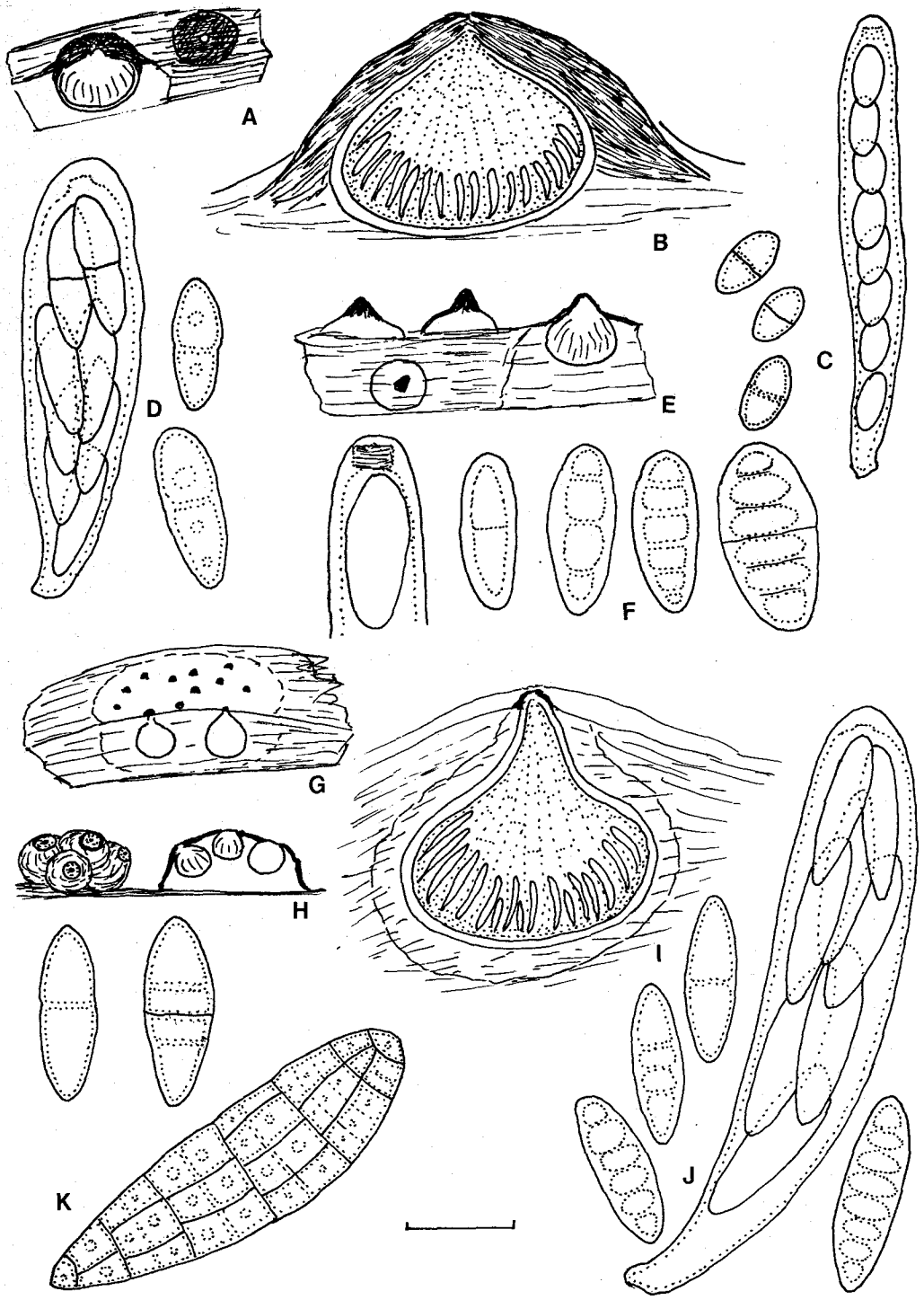
Requienellaceae Boise, Mycologia 78: 37. 1986.

Ascomata immersed erumpent, separate or gregarious, medium to large sized, globose; apex broadly papillate, conspicuously shining in contrast to sides, rounded, pore rounded; surface below papilla roughened with short hyphae; peridium relatively wide, composed of small pseudoparenchymatous cells, at times thickened and clypeal in upper regions. Hamathecium of narrow, not or scarcely branched pseudoparaphyses, matrix inspersed at times. Asci bitunicate, basal and lateral, cylindric clavate, ocular chamber wide and staining differentially. Ascospores brown, ellipsoid fusoid, symmetric, straight or inequilateral, transversely distoseptate; wall thick, smooth; contents with large globule in each cell; uniseriate in the ascus.

Saprobic in wood or periderm, widespread.

Some aspects -- the narrow and scarcely branched pseudoparaphyses and the distoseptate ascospores -- suggest the Pyrenulaceae, but the ascus apex differs from that found in the Pyrenulaceae, and the habit is saprobic. *Requienella* is the sole genus at present in the family. The type species, *R. seminuda* (Pers.: Fr.) Boise, is known from North America as well as from Europe (Boise 1986).

Plate 34. Features of Melanommatales. A-D. Acrocordiaceae: A, habit sketch, B, ascoma in vertical section, C, ascus and ascospores of *Acrocordia cavata* (Ach.) Harris. D, ascus and ascospores of *Anisomeridium subprostans* (Nyl.) Harris. E, F. Requienellaceae: E, habit sketch, F, apex of ascus and ascospores of *Requienella seminuda*. G-K. Trypetheliaceae: G, H, habit sketches of G, *Trypethelium virens* Tuckerman; H, *Laurera madreporiformis* (Eschw.) Riddle. I, ascoma in section of *T. virens*. J, K, ascus and ascospores of J, *T. virens*; K, *L. madreporiformis*. Standard line = 150 µm for B, I, 15 µm for C, D, F, J, K. Habits not to scale.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Trypetheliaceae Eschweiler, Syst. Lich. 17. 1824.

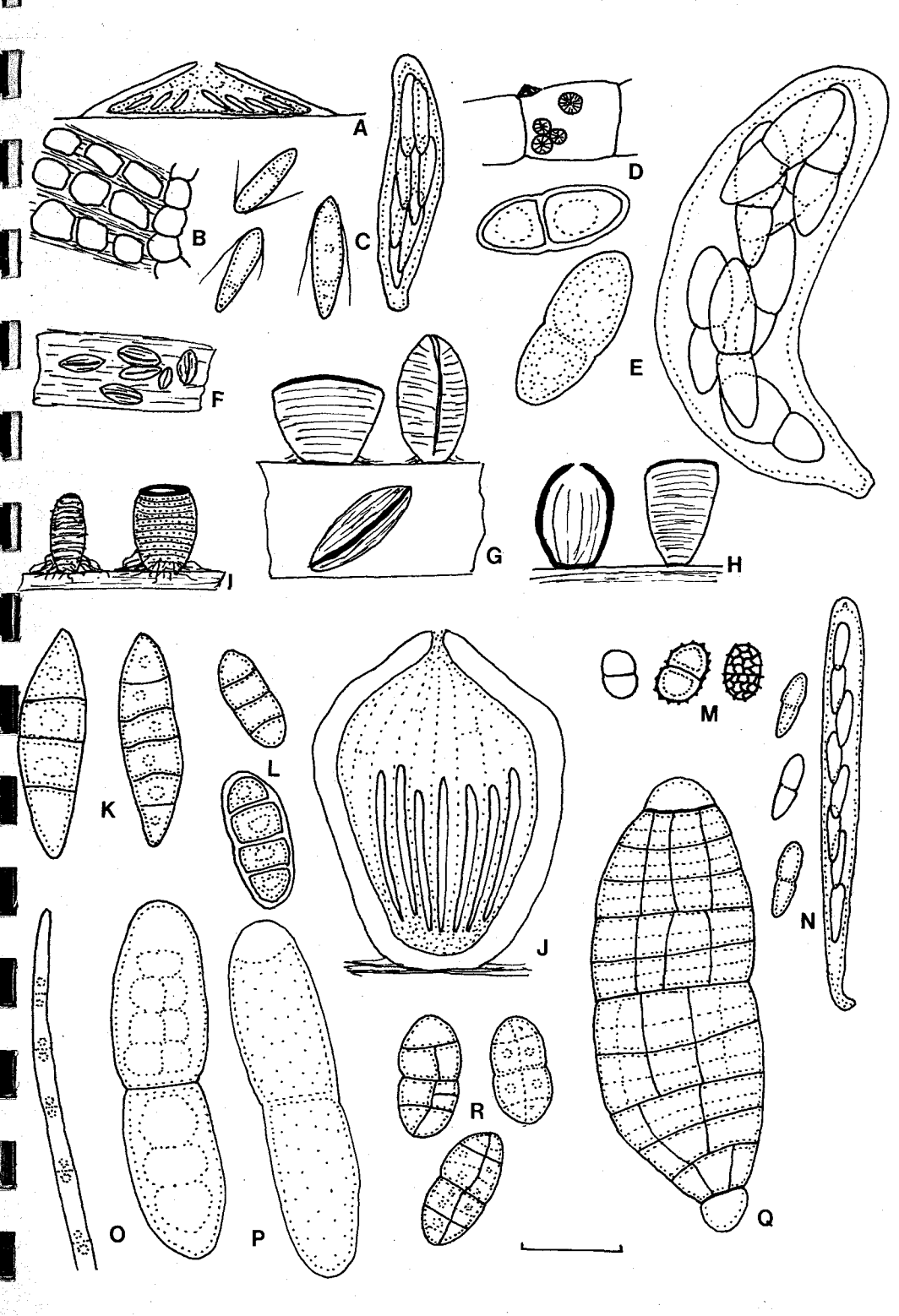
Ascomata immersed in pseudostroma in endophloeodal thallus or crustose thallus, globose, medium to large sized, often brightly colored, immersed in pseudostromatic tissues and gregarious; apex short and broadly papillate, central to lateral, pore rounded; peridium narrow, composed of small compressed cells, usually pallid within stromatic tissues. Hamathecium of trabeculate pseudoparaphyses, branched and anastomosing in gel matrix, often inspersed with oily granules. Asci bitunicate, basal, cylindric or clavate, with wide shallow ocular chamber. Ascospores hyaline, rarely becoming brown, ellipsoid or ovoid or fusoid, symmetric, straight or inequilateral, several transversely septate or at times muriform, usually distoseptate or euseptate with thickened wall; wall smooth, surrounded by gel coating; contents with large lenticular globule; uniseriate or biseriate in the ascus.

Anamorphs coelomycetous where known; microconidia rod shaped.

Lichenized, corticolous, cosmopolitan.

This concept of the family, modelled after that of Harris (1986), includes the families Astrotheliaceae, Cryptotheliaceae, Hyalophragmiaceae, Laureraceae, Melanothecomycetaceae and Pleurotrematomycetaceae. Most of the genera are tropical in distribution and the reader is referred to Harris (1986) for an enlightening discourse on the taxa and on postulated relationships among the Trypetheliaceae, Pyrenulaceae and Massariaceae. I am aware of representatives of two genera in temperate or subtropical North America, *Trypethelium* and *Laurera*, the former with transversely septate ascospores and the latter with muriform ascospores. The Massariaceae, included under the Trypetheliaceae by O. Eriksson and Hawksworth (1986) is retained as a separate family.

Plate 35. Features of Melanommatales. A-E. Microthyriaceae: A, ascoma in vertical section, B, portion of surface showing arrangement of cells, C, ascus and ascospores of *Microthyrium cf. harrimanii* Sacc. D, Habit sketch, E, ascus and ascospores of *Seynesiella sequoiae* (Cooke & Harkness) Müller. F-R. Mytilinidiaceae: F-I, habit sketches of F, *Mytilinidion thujarum* (Cooke & Peck) Lohman; G, *Lophium mytilinum* Pers.: Fr.; H, *Ostreichnion sassafras* (Schwein.) Barr; I, *Glyphium elatum* (Grev.) Zogg. J, ascoma in vertical section of *Mytilinidion thujarum*. K-R, ascus and ascospores of K, *M. thujarum*; L, *M. acicola* Winter; M, *Quasiconcha reticulata* Barr & Blackwell; N, *Actinidium nitidum* (Ellis) Zogg; O, *Lophium mytilinum* (portion only); P, *Ostreichnion curtisii* (Duby) Barr; Q, *O. sassafras*; R, *Ostreola formosa* (Cooke) Barr. Standard line = 150 μm for A, J, 15 μm for B, C, E, K-R. Habits not to scale.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Microthyriaceae Saccardo, Syll. Fung. 2: 658. 1883.

Ascomata superficial, dimidiate or scutate, base applanate, small to medium sized; pore rounded, surrounded by rings of usually dark cells; peridium composed of radiating rows of cells in surface view, cells either isodiametric or elongate, often extending out at margin as delicate radiating hyphae, in side view composed of few rows of compressed cells, base thin and pallid; delicate haustorial hyphae subcuticular. Hamathecium of trabeculate, deliquescing pseudoparaphyses. Asci bitunicate, basal or from lower corners, pointing toward pore, oblong or saccate, with narrow ocular chamber. Ascospores hyaline or brown, fusoid or ellipsoid, somewhat asymmetric, one septate in temperate-zone species; wall smooth, at times bearing two to four cilia from apex, side or septum; contents with one or two globules per cell; overlapping biseriate or crowded in the ascus.

Saprobic on dead leaves, stems, cone scales, occasionally on living tissues then apparently more epiphytic than biotrophic, widespread.

In this family numerous taxa have been described from warmer regions, and they exhibit considerable diversity in ascospore shape and septation. In temperate North America, I am confident of only two genera, both with one-septate ascospores. *Microthyrium* produces hyaline ascospores that may bear cilia, and *Seynesiella* produces brown ascospores. The restricted sense of the family excludes some taxa that are better accommodated in the Polystomellaceae of the Pleosporales or the Trichopeltidaceae of the Chaetothyriales. J. P. Ellis (1977a) has described and illustrated the British species of *Microthyrium*.

Mytilinidiaceae Kirschstein, Verh. Bot.Verein. Prov. Brandenb. 66: 28. 1924 (as Mytilidiaceae).

Lophiaceae Zogg ex von Arx & Müller, Stud. Mycol. Baarn 9: 69. 1975.

Ascomata superficial or with bases immersed in substrate, conchate or dolabrate, somewhat elongate, sometimes depressed shield shaped but ellipsoid from above, medium to large sized; apex typically cristate, opening by longitudinal slit; peridium carbonaceous, brittle, prosenchymatous, at times composed of cephalothecoid plates. Hamathecium of sparse trabeculate pseudoparaphyses, at times lacking at maturity. Asci bitunicate, basal, cylindric or clavate, with narrow ocular chamber. Ascospores hyaline soon yellowish to light or dark brown, broadly or narrowly ellipsoid, fusoid, or elongate and cylindric or filiform, one or several transversely septate, muriform in some; wall smooth or ornamented; contents usually with one globule in each cell; overlapping uniseriate, biseriate or in one or two fascicles in the ascus.

Anamorphs coelomycetous where known (described as *Aposphaeria, Pyrenochaeta, Sclerochaeta*) or infrequently hyphomycetous (described as *Chalara-like, Peyronelia, Septonema*).

Saprobic, occasionally hemibiotrophic, on leaves, branches, cones of gymnosperms, some on woody angiosperms, cosmopolitan.

The conchate or dolabrate ascomata with thin brittle peridium and crested apices are representative of the family, segregated from the Hysteriaceae as the Lophiaceae by Zogg (1962), who described and illustrated many of the taxa. Lohman (1932, 1933) described several species of *Mytilinidion* and other taxa. Darker (1963) described *Ostreola*, which now contains *O. formosa*, a common species in western North America. *Glyphium* was monographed by Goree (1974); Sutton (1970) described its hyphomycetous anamorphs. Barr (1975) enlarged *Ostreichnion* and separated three species. Barr and Blackwell (1980) erected the genus *Quasiconcha* for a fungus found on *Juniperus* seeds in dung; *Q. reticulata* is now known to occur on conifer roots (Blackwell and Gilbertson 1985). Considerable variability is evident in size, shape and septation of ascospores within the family, characteristics that permit separation of genera in the following key.

Key to Genera

1. Ascospores one septate, small (less than 30 µm long).....2
1. Ascospores one septate and larger than 30 µm or several septate.....3
    2. Ascospores broad, reticulate.....*Quasiconcha*
    2. Ascospores narrow, smooth or finely longitudinally striate.....*Actidium*
3. Ascospores filiform, multiseptate, about equal in length to that of the ascus.....4
3. Ascospores ellipsoid, fusoid, cylindric, not equal in length to that of the ascus.....5
    4. Ascomata conchate.....*Lophium*
    4. Ascomata dolabrate.....*Glyphium*
5. Ascospores transversely septate (if more than 50 µm long only 2-4 µm wide).....*Mytilinidion*
5. Ascospores muriform (or large and remaining one septate).....6
    6. Ascomata conchate; ascospores ellipsoid, not over 30 x 10 µm, with single longitudinal septum in mid cells....*Ostreola*
    6. Ascomata conchate or approaching dolabrate; ascospores ellipsoid or cylindric, more than 30 µm long, with several longitudinal septa in cells or large and remaining one septate.....*Ostreichnion*

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