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ASCOCHYTULA, ASCOCHYTELLA, ASCOCHYTA
AND RELATED FUNGI,
WITH SPECIAL REFERENCE TO
ASCOCHYTA PASPALI.

PETER KENNETH BUCHANAN

Thesis submitted for the degree of
Doctor of Philosophy in Botany,
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1982.
'Creator mundum ita instruxit, ut homo ubique
miracula illius manu facta adspiciat.'*

Linnaeus, 1752 (fide Kickx, 1867).

**'The Creator teaches mankind thus,
so that men can see everywhere the
miracles His hand has made.'
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ABSTRACT

Two Coelomycete genera, Ascochytaula Died. and Ascochyttella Tassi, were studied in order to determine their generic affinities, especially with Ascochyta. Ascochytaula obiones (Jaap) Died., the type species of Ascochytaula, is considered to be congeneric with Ascochyta pisi Lib., the type species of the earlier genus, Ascochyta Lib. Ascochytaula is thus reduced to synonymy with Ascochyta. Of the thirty-six species and two varieties named in, or directly associated with, Ascochytaula, twenty are herein described as species of Ascochyta and four are excluded from Ascochyta. The remaining species were either not examined, or are nomina dubia. The following names are proposed: Ascochyta asparagina (Petrak) comb. nov., A. deformis (P. Karsten) comb. nov., A. dorycnnii (Petrak) comb. nov., A. ludwigiana (Petrak) comb. nov., A. moravica (Petrak) comb. nov., A. obiones (Jaap) comb. nov., A. phlomidicola nom. nov., and A. ulicis (Grove) comb. nov.

Ascochytella Tassi, which has often been confused with Ascochytaula, is also synonymised with Ascochyta. The original thirteen species in Ascochytella were examined, and A. vicina (Sacc.) Tassi chosen as the lectotype species. Most of the thirteen species are regarded as being either misplaced in Ascochytella, or nomina dubia, and only four, including the lectotype, are accepted as species of Ascochyta. The name, Placodiplodia canthifolia (Cooke & Massee) comb. nov. is proposed.

The type species of Ascochyta, and of six related genera, Ascochytulina Petrak, Coniothyrium Corda, Diplodina Westend., Pseudodiplodia (P. Karsten) Sacc., Scolecosporiella Petrak, and Stagonospora (Sacc.) Sacc. were studied to determine the distinctions between these six genera and Ascochyta. Microdiplodida Allescher and Diplodia Fr. are also discussed, in relation to Ascochyta.
Ascochyta paspali (H. Sydow) Punith. (= Ascochyta paspali H. Sydow), which causes a leaf stripe disease of Paspalum dilatatum Poir., an important perennial grass of northern North Island pastures, was examined in detail. At some temperatures, under controlled climate conditions, the fungus significantly reduced the yield of P. dilatatum. A. paspali was found to grow systemically, as mycelium within the xylem vessels, and was able to infect all parts of the plant, including the roots and seeds. Green leaves sometimes became infected systemically without production of visual symptoms. Infected seed is suggested as a means for disease spread. No teleomorph for A. paspali was found, and the fungus is thought to overwinter in the dormant grass. The seasonal fluctuation in levels of P. dilatatum and of the disease was studied in two Northland pastures with paspalum as a component. One pasture was studied for fourteen months, and the other for four months. Disease levels, and paspalum levels, were determined by point quadrat analysis and by sorting of randomly cut samples. Levels of both the host and of the disease peaked in summer, while both were at low levels, or apparently absent, over the winter months.
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GLOSSARY

The glossary includes definitions of terms used in the text and descriptions. These terms relate either to mycology or grass morphology. Terminology of shape follows Ainsworth (1971, fig. 16), and is not repeated here.

acervular conidioma - an immersed conidioma consisting of a flat hymenial layer developing on a pseudoparenchymatic stroma and covered by host tissues. At maturity, the covering host tissues usually split to expose the hymenium, allowing release of the conidia.

acervulus - see acervular conidioma.

amerospore - a nonseptate spore with a length : width ratio not exceeding 15:1; if elongated, with only a single axis, and that axis not curved through more than 180°; any protuberances, other than setulae, not more than \( \frac{1}{4} \) the length of the spore body (Kendrick & Nag Raj, 1979).

anamorph - any form or state or organ ('morph') of asexual or somatic reproduction that has distinct morphology (De Vroey & Hennebert, in press).

annellide - a conidiogenous cell which produces its first conidium holoblastically, and subsequent conidia enteroblastically and basipetally. Through percurrent proliferation of the conidiogenous cell, each conidium secedes at a higher locus than the previous conidium, and leaves behind a ring-like scar, or annellation, at the point of secession.
basipetal - a succession of conidia in which the youngest conidium is closest to the conidiogenous locus.

blade - see leaf blade

channel - that region at the phialide apex surrounded by the periclinal thickening and collarette, through which conidia emerge.

clypeus - a pseudoparenchymatic fungal tissue surrounding the conidiomal apex, and often extending beyond the diameter of the conidioma.

coelemycete - an artificial grouping of fungi which produce conidia within acervular, pycnidial, pycnothryial, or stromatic conidiomata.

collarette - the outer, ruptured wall layer at the apex of a phialide, formed after secession of the first, holoblastic conidium. The collarette often encloses a periclinal thickening, and may extend beyond, or be of a similar length to this thickening, depending on the level at which the wall ruptures during secession of the first conidium.

confluent (conidiomata) - joined by hyphae, cells, or stromatic tissue (Sutton, 1980).

conidiogenesis - the process of development of conidia from conidiogenous cells.

conidiogenous cell - a fungal cell which produces a conidium.

conidiogenous locus - see locus

conidioma (pl. conidiomata) - a specialized, multi-hyphal, conidium-bearing structure (Kendrick & Nag Raj, 1979).

conidiophore - a specialized hypha or fungal cell(s) which supports a conidiogenous cell (Cole & Samson, 1979; Sutton, 1980).
conidium (pl. conidia) - a haploid spore produced from a conidiogenous cell by deuteromycetous (anamorphic) fungi.

culm - the stem of a grass, with long, usually hollow internodes and swollen, solid nodes; produced by elongation of the lower internodes of the axis, and bearing the inflorescence at its apex.

didymospore - a spore with one septum across the body; with a length:width ratio not exceeding 15:1; if elongated, with only a single axis, and that axis not curved through more than 180°; any protuberances, other than setulae, not more than ¼ the length of the spore body (Kendrick & Nag Raj, 1979).

discrete (conidiogenous cells) - in coelomycetous fungi, arising directly from cells of the conidiomatal wall and not supported by a conidiophore.

eccentric (septum) - displaced to one side, not median.

eguttulate - absence of oil droplets in the conidial cell(s); opposite of guttulate.

enteroblastic (conidiogenesis) - development of a conidium by the blowing out of the inner wall only of the conidiogenous cell prior to the formation of a septum delimiting the conidium.

eustroma - a mass of fungal cells or interwoven hyphae forming a structured tissue with one or more locules variously arranged, but excluding acervular and pycnidal conidiomata (Sutton, 1980).

flag leaf - the uppermost leaf on the culm of a grass, subtending the inflorescence.
holoblastic (conidiogenesis) - development of a conidium by the blowing out of all wall layers of the conidiogenous cell prior to the formation of a septum delimiting the conidium.

holomorph - the whole morphology shown by a fungus, including both the anamorph(s) and teleomorph (De Vroey & Hennebert, in press).

integrated (conidiogenous cell) - supported by a conidiophore (Sutton 1980).

lamina - see leaf blade.

leaf blade or lamina - the upper, expanded part of a grass leaf above the ligule.

leaf sheath - the lower, cylindrical part of a grass leaf below the ligule, arising from a node.

ligule - a thin, membranous outgrowth on the adaxial surface at the junction of the leaf blade and sheath of a grass.

locule (of a conidioma) - the cavity enclosed by fungal, host, or fungal/host tissue (Sutton, 1980).

(conidiogenous) locus - the specific area of a conidiogenous cell from which a conidium is produced. In a phialide, this locus is fixed; in an annellide, it advances with the proliferating apex of the conidiogenous cell.

longitudinal (conidioma) - longer than broad.

lumen - the cytoplasmic membrane and enclosed cytoplasm of a cell.

monophialide - a phialide with a single conidiogenous locus.

ostiole - a preformed, circular or oval pore at the apex of a pycnidial conidioma, through which conidia are discharged.

panicle - a type of grass flowerhead where the spikelets are borne on branches off the main axis (rachis).
pedicel-the stalk on which a grass spikelet is borne.

percurrent proliferation - growth of a conidiogenous cell, through its own apex, after secession of a conidium, as in annellides and proliferating phialides.

periclinal thickening - that region between the collarette and the channel of a phialide, composed of concentric rings of wall layers. The layers form from the outer wall of each seceding conidium, except the first conidium. This wall ruptures at the level of the septum and does not participate further in conidial production. Rupture of the outer wall layer of the first conidium forms the collarette.

phialide - a conidiogenous cell which produces its first conidium holoblastically and subsequent conidia enteroblastically and basipetally. Secession of the first conidium leaves a collarette at the phialide apex and, at least in Ascochyta-like fungi, subsequent conidia, developing from the same fixed conidiogenous locus, leave behind wall layers which form a periclinal thickening.

phragmospore - a spore subdivided by two or more septa, all transverse; with a length:width ratio not exceeding 15:1; if elongated, with only a single axis, and that axis not curved through more than 180°; any protuberances, other than setulae, not more than ¼ the length of the spore body (Kendrick & Nag Raj, 1979).

polyphialide - a phialide with more than one conidiogenous locus.

proliferating phialide - a phialide which, after production of conidia from a fixed conidiogenous locus, proliferates percurrently to form a new fixed locus at a higher level.
pseudoparenchyma - a tissue which appears similar to plant parenchyma, but is composed of fungal hyphae which have lost their individuality and appear as more or less isodiametric cells joined both terminally and laterally; includes textura globulosa and textura angularis.

pseudopycnidal (conidiomatal wall) - a delicate, thin, hyphal tissue surrounding a cavity, or part of a cavity formed after destruction of host cells by the fungus (Potebnia, 1910, p.65).

pseudostem - a hollow cylinder formed by the concentric leaf sheaths of a vegetative grass tiller.

pycnidal conidioma - a globose, flask-shaped, or longitudinal fructification with a wall of one to several layers of fungal cells, lined more or less entirely by a hymenium which produces conidia, and opening by an apical ostiole or sometimes by rupture.

pycnidium - see pycnidal conidioma.

pycnothyril conidioma - a superficial, flattened, shield-shaped, hemispherical conidioma consisting sometimes of an upper wall only, but sometimes with a basal wall as well (Sutton, 1980).

rachilla - a branch, from the rachis of a grass flowerhead, on which the spikelets are borne.

rachis - that part of the culm which acts as the main axis of the flowerhead.

sheath - see leaf sheath.

spikelet - the true inflorescence of a grass, containing 1-15 flowers.

stroma - see eustroma.
teleomorph - the sexually reproductive, morphologically (and/or karyologically) differentiated organ of a fungus; the 'perfect state' in the sense of the Code (Art. 59) (De Vroey & Hennebert, in press).

textura - tissue structure of an apothecial or conidiomatal wall (Korf, 1973, p.251, fig. 3).

textura angularis (conidiomatal wall) - tightly packed, isodiametric cells without intercellular spaces.

textura globulosa (conidiomatal wall) - globose cells with intercellular spaces.

textura intricata (conidiomatal wall) - interwoven hyphae.

textura prismatica (conidiomatal wall) - short-celled hyphae, with individual cells more or less brick-shaped.

tiller - the basic morphological unit of a grass plant; a branch originating from an axillary bud at the stem base, and characterised in the vegetative state by a contracted basal stem with short internodes. From the nodes arise adventitious roots and concentric leaf sheaths with expanded leaf blades. Further tillers develop in the axils of the leaf sheaths. A reproductive tiller produces, by internode elongation, a flowering stem, or culm, which bears the inflorescence.

verruculose - covered or marked with very small processes or warts.
PART ONE:

TAXONOMY OF ASCOCHYTULA, ASCOCHYTELLA,

ASCOCHYTA AND RELATED FUNGI.
CHAPTER ONE

INTRODUCTION TO COELOMYCETE SYSTEMATICS

1.1 HISTORY OF COELOMYCETE SYSTEMATICS

The Division Deuteromycotina, or Fungi Imperfecti, contains all anamorphic (asexually reproducing) fungi. Many of these fungi have a life cycle which involves a teleomorphic (sexually reproducing) stage in the Ascomycotina or Basidiomycotina, while for others, teleomorphs have not been discovered.

Saccardo (1880) divided the Deuteromycotina into three groups on the basis of conidiomatal type: Sphaeropsidaceae with pycnidial conidiomata, Melanconieae with acervular conidiomata, and Hyphomyceteae with exposed, superficial conidiophores. The first two groups, brought together under the collective term Coelomycetes (Grove, 1919), produce conidia within a cavity often surrounded by the host substrate, in contrast to the third group which produces conidia superficial to the substrate (Grove, 1935).

The Coelomycetes now include a diverse range of genera which bear conidia within pycnidial, acervular, pycnothyrial, and stromatic conidiomata (Sutton, 1977). The separation of pycnidial and acervular conidiomata from the sporodochial conidiomata of some Hyphomycetes cannot be clearly defined, but Coelomycetes and Hyphomycetes are retained as popular, convenient terms. There are over 1300 coelomycetous generic names in the literature, of which Sutton (1977) accepted 393 and rejected 720. Evaluation of the remaining names is apparently hindered by insufficient data. Ainsworth (1971) reported 7,000 coelomycetous species names.

Until recently, Deuteromycete systematics was based on the Saccardoan system of dividing genera according to conidial morphology, i.e. colour,
septation, shape and size. The host substrate was given importance in the delimitation of fungal species. This resulted in many narrowly defined and inadequately separated genera, with a proliferation of species names for the same organism growing on different hosts.

A new era in systematics began when Hughes (1953) proposed a revised classification of the Hyphomycetes, based on conidiogenesis - the process of development of conidia from conidiogenous cells. Conidiogenesis was given primary significance in delimiting genera, prompting numerous ultrastructural studies of Hyphomycetes, and much debate over the definitions and mechanisms of the different modes of conidium ontogeny (Kendrick, 1971). However, conidiogenesis has been shown to be less stable than first thought, and for some species may vary with mutation and environmental influences (Madelin, 1979). Conidiogenesis is now coming to be accepted as one character among several important characters in Hyphomycete taxonomy (Kendrick, 1980). The anatomico-ontogenetic system of Hyphomycete classification, adopted by Carmichael et al. (1980), equated conidiogenesis as one of the four most important taxonomic characters, along with the Saccardoan spore group, conidial colour, and the arrangement of conidia on the conidiogenous cell. This system is considered to be an improvement on the earlier anatomical arrangement (Nag Raj, 1981).

Coelomycete taxonomy has progressed more slowly than Hyphomycete taxonomy. It has been hindered by the smaller size of conidiogenous cells, compared with those of the Hyphomycetes, and by their frequent lack of differentiation from adjacent vegetative wall cells. Their location inside a conidioma has necessitated sectioning and prevented light microscope time-lapse studies of conidiogenesis. Nevertheless, a number of species have been examined in detail, establishing that the same basic modes of ontogeny found in the Hyphomycetes also characterise the Coelomycetes, although the range is more restricted.
It is important to ensure that the morphological basis of Coelomycete taxonomy does not become eclipsed by the ontogenetic approach, as happened with the Hyphomycetes. Sutton (1980) in a modern account of the Coelomycetes, proposed a scheme in which conidiogenesis was the principal character for separation of taxa at the level of order and genus. This emphasis on conidium ontogeny can make routine identification impracticable, especially if electron microscopy is needed to reveal the mode of conidiogenesis. Furthermore, there is the danger that taxa which are similar in other respects, may be widely separated on the basis of minor differences in conidiogenesis. A developmental-anatomic system of classification for the Coelomycetes, and for all other anamorph groups, is preferable (Nag Raj, 1981).

The fungi studied in this thesis produce pycnidial conidiomata. The characters relevant to the taxonomy of this group of Coelomycetes are discussed below.

1.2 CONIDIOMATA

The macroscopic characters of pycnidial conidiomata are usually not given high taxonomic importance, but are relevant for identification at the species level. Conidiomata are mostly brown to black and unilocular. They may be glabrous or setose, ostiolate or nonostiolute, and immersed, erumpent, or superficial in relation to the host surface. The dimensions and shape of the conidiomata are useful features, but they sometimes vary widely within a species. The distribution of conidiomata on the host and, where present, the nature of the lesions, provide further information.

The structure of the conidiomatal wall has recently assumed increasing importance (Hawksworth, 1981), and the terminology applied by Korf (1973)
to tissue structure of ascomycetous apothecia is now widely used to describe the walls of pycnidal conidiomata, viz textura angularis, textura globulosa, etc. Walls may be from one to several cells thick. The colour of the cells of the wall, and the thickness of their cell walls, often varies from the conidiomatal base to the apex. The darkest coloured cells, with thickened walls, tend to be outermost in the conidiomatal wall and towards the apex of the conidioma. Cell walls may be rough or smooth.

1.3 CONIDIogenous cells

The conidiogenous cells, from which conidia are produced, arise either from the specialized supporting cells of the conidiophore, or directly from cells of the conidiomatal wall. The size, shape, colour, and arrangement of these cells is diagnostic for a species. To identify the type of conidiogenesis, features at the apex of the conidiogenous cell are examined, and this may require use of the electron microscope. Although conidiogenesis should not be considered the most important taxonomic character, to the exclusion of all others, the changing definitions of the various processes of conidium ontogeny, over the past decade, warrant further discussion.

In all fungi examined in the present study, conidiogenesis was blastic, i.e. the conidium developed by the blowing out of part of the conidiogenous cell. Three types of blastic conidium ontogeny were encountered, viz holoblastic-solitary, phialidic, and annellidic. The characterization of, and distinctions between, these modes of conidiogenesis has been the subject of much debate.

The blastic mode is divided into two developmental categories (Kendrick, 1971), distinguished by the involvement in the formation of the conidial wall, of the outer layer(s) of the wall of the conidiogenous cell. In
holoblastic ontogeny, all wall layers of the conidiogenous cell contribute
to the conidial wall, whereas in enteroblastic ontogeny, only the inner
layer(s) and newly formed layer(s) are functional.

Phialidic and annellidic conidiogenesis were at first characterised
by enteroblastic and holoblastic ontogeny, respectively (Kendrick, 1971).
Both of these types of conidiogenesis give rise to a basipetal sequence
of conidia, but whereas the phialide produces conidia from a fixed
conidiogenous locus, the annellide produces single conidia from successively
higher loci, by the percurrent proliferation of the conidiogenous cell.
Under the light microscope, the phialide apex is seen to bear a collarette,
which consists of the wall layer left behind by the first-formed conidium,
while the annellide apex is usually elongated and bears a series of scars,
the annellations, representing the different levels of the advancing
conidiogenous locus.

Closer examination, under the electron microscope, has clouded these
concepts. Sutton (1971b) suggested that some conidiogenous cells, which
appear to be phialides by optical microscopy, may in fact be annellides in
which there is only a very short proliferation of the conidiogenous locus.
Hammill (1974) compared the two types of conidiogenesis and reported that
the second and subsequent conidia, from both the phialide and the annellide,
developed enteroblastically. It was later shown that the first-formed
conidium of the phialide, as well as of the annellide, developed holo-
blastically (Cole & Samson, 1979). Phialides and annellides, therefore,
both produce an initial holoblastic conidium, followed by subsequent
enteroblastic conidia, and thus appear to have more similarities than
differences (Hammill, 1981). The only real, consistently observable distinction
between them is that phialides have collarettes, and annellides have annellations.
The collarette signifies a fixed conidiogenous locus, whereas annellations
denote an advancing locus. Other less consistent differences noted between
the phialide and annellide include the presence of Woronin bodies as septal plugs between conidia and annellides, and their absence from most phialides (Cole & Samson, 1979). The collarette of a phialide is often longer than an annellation, since the outer wall layer of a phialide may rupture at any point at, or above, the level of the conidial-delimiting septum, whereas the wall of an annellide usually ruptures at the level of the septum.

Some phialides, like annellides, may also proliferate. The proliferating phialide extends through its collarette after the production, from a fixed locus, of several conidia, rather than after the production of only one conidium, in an annellide. Superficially, the proliferating phialide resembles the annellide, but can be distinguished, at least in the Hyphomycetes, by the use of time-lapse studies of living cells. These studies are not possible with Coelomycetes, since the conidiogenous cells are enclosed within the conidiomata. For the purposes of identification, Sutton (1980) referred to all percurrently proliferating conidiogenous cells of the Coelomycetes as annellides.

The phialide and the holoblastic-solitary conidiogenous cell can also be confused. During, or immediately after production of the first holoblastic conidium, a phialide may be indistinguishable from a holoblastic cell, especially when the phialide collarette is short. A phialidic conidiogenous cell may, therefore, appear to be holoblastic in an immature conidioma, but later develop a recognizable collarette and periclinal thickening.

In the present study, the phialide was the most frequently encountered conidiogenous cell. The production of the first four conidia from a typical coelomycetous phialide is illustrated diagrammatically in Fig. 1. The outer wall layer of the conidiogenous cell ruptures, to form a collarette, close to the level of the delimiting septum as the first conidium secedes.
Fig. 1

Diagrammatic interpretation of wall differentiation associated with phialidic conidiogenesis in Coelomycete fungi, eg. *Ascochyta* spp. The first-formed conidium is holoblastic (2), whereas the second and subsequent conidia are enteroblastic (4, 7, 8,). The outer conidiogenous cell wall layer involved in formation of the first conidium remains as the collarette (3), and outer wall layers involved in the formation of subsequent conidia contribute to the periclinal thickening (6-9) inside the collarette.
New wall layers, as well as the existing inner wall layer(s) of the conidiogenous cell, contribute to the wall of the next developing conidium. As each conidium secedes, an endogenous wall layer is left behind, inside the collarette, to form the periclinal thickening.

1.4 CONIDIA

Differences in the shape, septation, surface ornamentation, and colour of conidia may be important in the delimitation of genera, although small differences in pigmentation and/or number of septa should not be used to separate otherwise similar genera (Hawksworth, 1981). Such features, along with conidial size, can be used to separate species.

1.5 OTHER CHARACTERS

The cultural characters, such as colony appearance, colour, and growth rate under defined conditions, are useful additional characters in the description of a species. The in vitro morphological features may, however, differ markedly from those observed in vivo (Nag Raj, 1981). Conidial size, shape, and septation, as well as the form of the conidiomata and of conidiogenesis, may alter under artificial conditions.

The host range and geographical distribution of a species are important characters, but should be used with caution when separating otherwise similar taxa.

The teleomorphs of the Coelomycetes include members of the unitunicate and bitunicate Ascomycetes, as well as a few Basidiomycete species (Nag Raj, 1981). The finding of the teleomorph for a coelomycetous species is often difficult, because anamorphs and teleomorphs rarely develop simultaneously, and many teleomorphs form only occasionally in culture (Müller, 1981).
Proof of an anamorph-teleomorph connection requires cultural work, usually isolating an ascospore and inducing conidial formation. Many of the old coelomycetous species and genera are known only from herbarium specimens, and thus lack confirmed teleomorph connections.
CHAPTER TWO

METHODS

A list of species in Ascochyta Diedicke and in Ascochyta Libert subgenus Ascochyta (Died.) A. Trotter was compiled from Saccardo, Sylloge fungorum, Petrak (1930-1944), Petrak (1950), and Index of Fungi (1940-1981; including A Supplement to Petrak's Lists 1920-1939, 1969). The original description of each species and of its basionym was sighted, unless indicated otherwise.

Type specimens of species from Ascochytella Tassi, Ascochyta, Ascochyta, and related genera were studied wherever possible, along with other available collections. Material was examined from the following herbaria:

Botanischer Garten und Botanisches Museum Berlin-Dahlem, Berlin.
National Fungus Collections, Beltsville, Maryland.
Jardin Botanique National de Belgique, Brussels.
Cornell University, Ithaca, New York.
New South Wales Department of Agriculture, Rydalmere.
Herbarium Universitatis Florentinae, Florence.
Conservatoire et Jardin Botaniques, Geneva.
University of Helsinki.
Herbarium Hamburgense.
Institutul Agronomic, Iasi, Roumania.
Commonwealth Mycological Institute, England.
Herbarium Haussknecht, Jena, Germany.
Rijksherbarium, Leiden, The Netherlands (includes fungi from GRO).


Instituto de Botánica C. Spegazzina, La Plata, Argentina. LPS

Botanische Staatssammlung, Munich. M

Instituto 'Antonio José Cavanilles', Madrid. MA

National Museum of Wales, Cardiff. NMW

The New York Botanical Garden. NY

Università Degli Studi di Padova, Italy. PAD

Università Degli Studi di Parma, Italy. PARMA

Università di Pavia, Italy. PAV

Muséum National d'Histoire Naturelle, Paris. PC

Plant Diseases Division, D.S.I.R., Auckland. PDD

National Museum - Natural History Museum, Prague. PRM

Arthur Herbarium, Purdue University, Lafayette, Indiana. PUR

Città Universitaria, Rome. RO

University of Uppsala, Sweden. UPS

Museo Civico di Storia Naturale, Verona, Italy. VER

Department of Agriculture, Victoria, Burnley, Australia. VPRI

Naturhistorisches Museum, Vienna. W

University of Wisconsin, Madison. WIS

Herbarium names have been abbreviated according to Holmgren & Keuken (1974). An exclamation mark (!) following an herbarium name or specimen number indicates that the cited specimen has been examined; a question mark (?) means that the identity, or nomenclatural status, of the specimen is in doubt.

Relevant Articles (abbreviated, Art.) are cited by number, from the International Code of Botanical Nomenclature (hereafter called the Code)

In the text, authors' names for fungal species have generally been abbreviated according to Hawksworth (1980). Host plant names were checked for spelling, synonymy, and authorities in Bailey & Bailey (1976), and for the family in Rouleau (1970). Author abbreviations follow Allan (1961). Titles of periodicals conform to those used in Brown & Stratton (1963).

For routine examination, herbarium material was rehydrated in 3% potassium hydroxide for a few minutes, dipped in water, and mounted in lactic acid. Fresh material was mounted directly in lactic acid. Occasionally, material was stained with lactophenol cotton-blue (Anon., 1968) to improve observation of conidial septa. Slides were made permanent by sealing with Glyceel (Gurr, Biological Reagent 087700).

Sections for light microscopy were cut with a steel blade on an International Model CTD Microtome-Cryostat, operating at -20°C. Material to be sectioned was immersed in a drop of Cryoform (Damon/IEC Division) and orientated to the desired position in relation to the knife prior to freezing. Single conidiomata were more readily handled by supporting them in a block of agar, and then adding them to the Cryoform. The 6-8 μm thick sections were lifted from the knife using a fine paint-brush, floated onto water in a watchglass, and examined with a Watson Barnet dissecting microscope. Selected sections were transferred with a loop, made of nichrome fuse wire, into a drop of lactic acid on a microscope slide. A cover slip was gently lowered onto the drop. Sections were examined intact, or sometimes disrupted by applying gentle pressure on the coverslip, to more clearly reveal the conidiogenous cells.

An Olympus BHA microscope, equipped with 15x eye-pieces, 4x-100x objectives, and phase contrast optics, was used to examine the specimens. Drawings were made with the aid of an attached drawing tube. Illustrations
are annotated with details of the specimen from which they were drawn. Where more than one collection of a species was examined, the species description is derived from all such collections.

All measurements were made on specimens mounted in lactic acid, unless otherwise indicated. At least 40 conidia of each species were measured. Conidial measurements are expressed in the form (a-)b-c(-d) x (e-)f-g(-h) where a-d = range of length, e-h = range of width, b-c = mean length ± one standard deviation, f-g = mean width ± one standard deviation. Figures are rounded to the nearest 0.5 μm.

For a few selected species, the transmission electron microscope was used to examine herbarium and/or fresh material. Herbarium material required an extended period for infiltration during the preparation procedure. Best results for such specimens were achieved by first rehydrating in 3% potassium hydroxide, followed by washing in sterile distilled water, and embedding the material in agar. The specimens were then fixed in 3% glutaraldehyde in 0.1 M phosphate buffer (pH 7.2), washed in buffer, and postfixed overnight in 1% osmium tetroxide. After washing in sterile distilled water, they were passed through a graded ethanol dehydration series into propylene oxide (P.O.), and then into a graded P.O./Spurr's resin series. Overnight rotation in 30/70 P.O./Spurr's was followed by rotation in four changes of fresh Spurr's over a 2½ day period. The material was then orientated and embedded in silicone rubber flat moulds; the resin was polymerised for 2 days at 70°C before sectioning. Fresh material was fixed immediately in glutaraldehyde and the resin infiltration was shortened to 1½ days.

Sections were cut with a DuPont diamond knife on an LKB 8800 Ulrotome III ultramicrotome. They were then mounted onto formvar coated grids, stained with uranyl acetate and lead citrate, and examined on a Jeol JEM 100B microscope. Photographs were recorded on Kodak electron microscope film.
The full details of the preparation procedure and chemicals used are in the Appendix.

Fungal cultures were grown in 9 cm disposable petri dishes on the following Difco Laboratories prepared media: oatmeal agar, cornmeal agar, malt extract agar, and potato dextrose agar. Streptomycin, at a concentration of 186 µg/ml, was incorporated with the potato dextrose agar, as the agar was dispensed into the petri dish. Cultures were incubated at 20-22°C under a 12 h darkness/12 h near-ultraviolet plus cool white fluorescent light regime.

Cultures were examined from the following culture collections:
Centraalbureau voor Schimmelcultures, Baarn, The Netherlands. CBS
Plantenziektenkundige Dienst, Wageningen, The Netherlands. PD
Plant Diseases Division, D.S.I.R., Auckland. PDDCC

The isolation of Ascochyta paspali (H. Sydow) Punith. from the host into pure culture was achieved by first dipping small pieces of infected host material into 70% ethanol, followed by immersion in a solution of 0.35% sodium hypochlorite for two minutes. The material was then plated directly onto prepared agar media.
CHAPTER THREE

ASCOCHYTA

3.1 INTRODUCTION TO THE GENUS ASCOCHYTA

Ascochyta was described by Libert (1830) for fourteen species of fungi with globose perithecia opening widely to liberate, in a gelatinous cirrus, asci containing globose spores. Conidia were misinterpreted as asci. A type species was not designated. The spelling of the generic name was changed by Link in 1833 from the Greek Ascoxyta to Ascochyta, as accepted today (Art. 73). The early history of Ascochyta is documented by Sprague & Johnson (1950), Mel'nik (1977), and Punithalingam (1979).

Saccardo (1878, 1884) significantly redefined the genus to include species which produce unisepitate, ovoid, or oblong, hyaline or greenish conidia from membranous, globose-lenticular, papillate, ostiolate conidiomata. Species were reported to grow on discoloured leaves and small branches. In 1878, he divided the genus into two main groups; one for species with hyaline conidia, the other for species with greenish or olivaceous conidia. Although Saccardo in 1884 failed to keep these groups separate, Saccardo & Saccardo (1906) reinstated them as subgenera: Eu-Ascochyta and Ascochyttella respectively. The generic description remained largely unchanged. Clements & Shear (1931) chose Ascochyta pisi Lib., one of the original fourteen species, as the lectotype species of Ascochyta.

Ascochyta is a parent genus, from which some authors have divided new genera and to which other authors have returned these same taxa (Fig. 2). Several authors have considered Saccardo's generic limits to be too broad, especially those limits pertaining to conidial colour (hyaline vs.
Diagrammatic representation of *Ascochyta* and related genera discussed in the present study, to show in particular the position of *Ascochyta* as a parent genus from which several genera have been segregated. Opinions differ as to whether these segregate genera should be recognized (arrows to outer rectangle) or synonymised with *Ascochyta* (arrows towards *Ascochyta*). Proposed recognition and synonymy of other related genera is indicated in a similar manner. The opinions of the following sixteen 20th century authors were considered, and the numbers on the arrows code for these authors; 'ALL' denotes agreement among the sixteen authors:

1. Allescher (1901, 1902)
2. von Arx (1970)
3. Boerema (1970b)
4. Clements & Shear (1931)
6. Diedicke (1912a,b)
7. Grove (1935, 1937)
8. von Höhnel (1923)
9. Mel'nik (1977)
11. Punithalingam (1979)
12. Saccardo & Saccardo (1906)
13. Sprague & Johnson (1950)
15. Tassi (1902)
pale coloured), position on the host (leaves vs. stems), conidial size, and conidial septation. Thus, Tassi (1902) and Diedicke (1912a) separated those species with pale coloured conidia from Ascochyta and related genera into the new genera, Ascochytella Tassi and Ascochytula Died. respectively. Diplodina Westend. (1857) was distinguished from Ascochyta by growing on stems and having larger hyaline conidia, more than 15 μm long (Tassi, 1902). For species on stems with hyaline conidia less than 15 μm in length, Tassi (1902) established the genus Diplodinula, and for those with larger, hyaline conidia over 40 x 10 μm, Petrak (1961) erected Macrodiplodina. Variation in conidial septation within Ascochyta led to the creation of two further genera, Stagonosporopsis Died. for species with uniseptate and 2- to 3-septate conidia, and Apiocarpella H. Sydow & Sydow for species with eccentrically uniseptate conidia. These genera are discussed later in more detail.

Sphaerellopsis Cooke (= Darluca Castagne) was considered by Saccardo (1884) to be synonymous with Ascochyta, but is now regarded as a distinct genus on account of its eustromatic, uredinicolous habit, presence of conidiophores, and 0-1 euseptate conidia with an apical gelatinous cap (Sutton, 1980).

As a consequence of these segregate genera, modern interpretation of the genus Ascochyta is divided. There is a general consensus that position on the host, conidial size, and number of septa are unimportant in defining Ascochyta. Opinions differ, however, as to the significance of conidial pigmentation and position of the septum. These two characters, as well as the nature of the conidiomatal wall, conidiogenesis, and teleomorph connections, are discussed separately below.
3.1.1 Conidial pigmentation

Strong division exists among taxonomists as to whether the genus should be confined to species with hyaline conidia or if it should also include species with pale coloured conidia. This issue is crucial to the fate of the genera Ascochyttella and Ascochytula, which were erected for species with pale coloured conidia (Tassi, 1902; Diedicke, 1912a). The following is a list of authors grouped according to their concept of Ascochyta, based on conidial colour.

<table>
<thead>
<tr>
<th>Ascochyta</th>
<th>Species with hyaline conidia only:</th>
<th>Species with hyaline or pale coloured conidia:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tassi (1902)</td>
<td></td>
<td>Saccardo (1878, 1884)</td>
</tr>
<tr>
<td>Potebnia (1907)</td>
<td></td>
<td>Allescher (1899)</td>
</tr>
<tr>
<td>Diedicke (1912a, b)</td>
<td></td>
<td>Lindau (1900)</td>
</tr>
<tr>
<td>Migula (1921)</td>
<td></td>
<td>Davis (1919a)</td>
</tr>
<tr>
<td>von Hühnel (1923)</td>
<td></td>
<td>Clements &amp; Shear (1931)</td>
</tr>
<tr>
<td>Petrak (1953)</td>
<td></td>
<td>Grove (1935)</td>
</tr>
<tr>
<td>Mel'nik (1977) ±</td>
<td></td>
<td>Sprague &amp; Johnson (1950)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Kohlmeyer &amp; Kohlmeyer (1979)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Punithalingam (1979)</td>
</tr>
</tbody>
</table>

I favour the practice adopted by Saccardo (1884) to include species with pale coloured conidia in Ascochyta. Libert (1830) did not mention conidial colour in her description of the genus. The much-studied lectotype species, A. pisi, has hyaline conidia as agreed by most authors (e.g. Mel'nik, 1977) and confirmed by my observations of isotype specimens. The fact that
the lectotype of the genus has hyaline conidia appears to be the only argument for restricting the genus to hyaline spored species. Arguments against this restriction are more convincing.

Saccardo (1884), in emending the genus to cover species with hyaline and greenish conidia, included species such as *A. passiflorae* Penzig & Sacc. and *A. calycanthi* Sacc. & Speg. with conidia described as pale brown, and hyaline or cloudy, respectively. This suggests that conidia of *A. calycanthi* may vary from hyaline to pale coloured. *A. salicorniae* Magnus has conidia described as hyaline to yellowish or light brown (Kohlmeyer & Kohlmeyer, 1979). Thus, conidial colour can vary within a species. Furthermore the differentiation of colour is subjective, despite standard colour charts. Colours may vary, for example, with the quality of microscope illumination and sometimes with age of a specimen. The transition from hyaline to pale coloured is a continuum and distinction between colourless and coloured becomes tenuous, as evidenced by terms such as subhyaline, almost colourless, cloudy.

While acknowledging the arbitrariness of separation by colour, Mel'nik (1977, p. 14) suggested that *Ascochyta* should include species with conidia which are either colourless or very slightly, almost imperceptibly, tinged and that analogous species with a more intense colouring of their conidia should be excluded. Such a system would appear to be unworkable. Conidial colour, as a single character, is not considered adequate for separation of anamorph genera, an opinion shared with Hawksworth (1981) and Nag Raj (1981). Species with pale coloured conidia should not therefore, on this basis alone, be excluded from *Ascochyta*.

The problem of conidial colour, however, still remains with *Ascochyta* and many other genera. Since colour is a continuum, there is an ill-defined point at which conidia must be judged brown instead of pale brown,
or dark instead of light. It is not my intention to extend *Ascochyta*

to include all species with didymosporous conidia irrespective of colour.

By confining the genus, somewhat arbitrarily, to species with hyaline to
pale brown conidia, there is, at the very least, the practical advantage
of simplifying Coelomycete taxonomy by transferring two genera, *Ascochytella*
Tassi and *Ascochytula* Died., and many species of a third, *Pseudodiplotidia*
(P. Karsten) Sacc. into synonymy with *Ascochyta*.

Conidial colouration is significant at the species level and is used
here to furnish practical, if not natural, infrageneric divisions. I
concur with Sprague & Johnson (1950) in their division of *Ascochyta* into
two sections, sect. *Ascochyta* [as *Eu-Ascochyta*] for species with hyaline
conidia and sect. *Ascochytella* (Tassi) Sprague & Johnson for species with
pale coloured conidial*.

3.1.2 *Conidial septation*

Conidia from isotype specimens of *Ascochyta pisi* are variable with
respect to septation. Most conidia are medianly uniseptate, but some
have a septum displaced towards one end of the conidium and others have
2 septa. In culture, conidia of *A. pisi* with 3(-4) septa were also
encountered in the present study. Other species, e.g. *A. lophanthi*
var. *osmophila* J. Davis, *A. avenae* (Petrak) Sprague & Johnson, and *A.*
paspali (H. Sydow) Punith., have conidia in which the position and/or

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* Saccardo & Saccardo (1906) were reported by Sprague & Johnson (1950)
and later authors to have first established these sections. However,
the earlier infrageneric taxa of *Ascochyta* were subgenera, not sections.
The index to Saccardo & Saccardo (1906) is entitled "Index Universalis -
Cohortium, Familia rum, Subfamilia rum, Genera rum, Subgenera m", and includes
*Ascochytella*; hence this name must hold the rank of subgenus. Saccardo
& Saccardo (1906) used 'section' incorrectly, at the level of subfamily
or tribe. I do not consider that a single character, such as conidial
colour, justifies the higher rank of subgenus.
number of septa is variable.

Stagonosporopsis Died., with sometimes multisepitate conidia, has thus been separated from Ascochyta by a character found to be variable within A. pisi and other Ascochyta species. Davis (1919a) listed the type of Stagonosporopsis, S. actaeae (Allescher) Died., as a synonym of Ascochyta actaeae (Bresad.) J. Davis. Synonymy of the genus with Ascochyta was supported by Clements & Shear (1931), Petrak (1925b, p. 5), Sprague & Johnson (1950), Mel'nik (1977), and by my examination of the holotype of S. actaeae. However, Grove (1935) and Sutton (1977) have maintained the genus.

Apiocarpella H. Sydow & Sydow, with eccentrically uniseptate conidia, was considered synonymous with Ascochyta by Clements & Shear (1931), Mel'nik (1971), and Punithalingam (1979), but regarded as distinct by Sprague & Johnson (1950) and Mel'nik (1977). Petrak (1952) favoured transferring the type species, Apiocarpella macrospora (Spec.) H. Sydow & Sydow, to either Diplodina or Stagonospora. Conidiogenesis of A. macrospora was described by Sutton (1980) as holoblastic, and by Punithalingam (1979), who examined the same specimens, as phialidic. While separation of Apiocarpella from Ascochyta purely on the basis of eccentrically septate conidia does not seem justified, especially since certain Ascochyta species have similar conidia, a difference in conidiogenesis between the two genera would add weight to an argument for retaining Apiocarpella. Ascochyta has phialidic conidiogenesis as discussed below. Re-examination of type material of Apiocarpella macrospora is required to accurately determine conidiogenesis and the fate of this genus. Unfortunately, the holotype of A. macrospora has been lost in the mail (Gamundi de Amos, LPS, pers. comm.). Punithalingam (1979) and Sutton (1980) cited the specimen IMI 109471 as having been taken from the holotype in LPS. In the absence of the holotype, IMI 109471
will serve as a lectotype. I did not examine material of *A. macrospora*.

Ascochyta is therefore considered to include species with predominantly medianly uniseptate, sometimes 2- or 3-septate, conidia. Division of Ascochyta into two subgenera based on presence or absence of 3-septate conidia (Mel'nik, 1977) is not followed.

The septation process in *A. pisi* was described by Brewer & Boerema (1965) and Boerema (1970a) as distoseptate, a term introduced by Luttrell (1963) and applied to conidia of certain Helminthosporium species which were clearly morphologically different under the light microscope, from species in most other genera. Such conidia lack true septa and the cells are surrounded by individual sac-like walls distinct from the outer conidial wall. True septa (eusepta) form by a process of inward extension of the 'single' lateral wall surrounding the conidium (Luttrell, 1963).

Application of the term, distoseptation, to conidia of *A. pisi* was challenged by Punithalingam (1979). Conidia of *A. pisi*, which I examined under the light microscope, have a septum of similar morphology to that seen in many other Coelomycetes, e.g. Coniothyrium, Diplodia, Diplodina, and Stagonospora, all of which are described as euseptate (Sutton, 1980). A visually quite different type of septation is apparent in *Coryneum Nees ex Schwein.* and *Massariothea H. Sydow.* The lumina of conidia of these fungi are reduced and almost spherical, as in *Helminthosporium,* and septation is described as distoseptate (Sutton, 1980). No Ascochyta species that I examined has this type of septation.

At the ultrastructural level, Boerema & Bollen (1975) argued that *A. pisi* was distoseptate by identifying a bilayered conidial wall. The inner wall of the conidium invaginated to produce a septum, distinct from the outer wall which enclosed the whole spore. Euseptate conidia have a single conidial wall according to Luttrell (1963). More recent studies by Mangenot & Reisinger (1976) and Cole & Samson (1979) have shown that
both euseptate and distoseptate conidia have walls of two or rarely three layers, although these may not be distinguishable at low magnification. The number of conidial wall layers therefore does not reflect the mode of septation.

Thin sections of conidia of *A. pisi* examined in the present study showed a 3-layered lateral conidial wall (Fig. 3). The outer two layers are thinner than the inner one, with the middle layer most electron dense. The inner layer is continuous at the septum, but also forms the septum. Thus, each cell of the conidium is not enclosed in a wall distinct from the lateral wall, a requirement for distoseptation.

Conidia of some distoseptate *Helminthosporium* species have a brittle outer wall which can be ruptured to liberate the spherical conidial cells still surrounded by their individual walls (Luttrell, 1963). Brewer & Boerema (1965) found a similar phenomenon with conidia of *A. pisi*. However, this feature is unlikely to be restricted to distoseptate conidia since euseptate conidia also have a bilayered or trilayered wall, the outer layer of which could conceivably rupture leaving the inner one intact.

To be of most use as a character, the type of septation should be recognizable at the light microscope level. The concept of euseptate and distoseptate conidia (Luttrell, 1963) is accepted in principle, but the use of number of wall layers (Boerema & Bollen, 1975) as a distinguishing feature is rejected. Also, the requirement of euseptate conidia to have the outer wall layer splitting at the septum, as suggested by Cole & Samson (1979), is not consistent with the morphology seen in *A. pisi*. The following definitions are proposed:

Euseptation - conidial septa formed from and remaining joined to the lateral conidial wall, forming divisions between lumina which are not reduced in size e.g. *Ascochyta* spp., *Diplodina* spp.
Distoseptation - conidial septa not formed from the lateral conidial wall; lumina are reduced and surrounded by a thickened wall distinct from the outer lateral wall. e.g. Coryneum spp., Massariothea spp., Helminthosporium spp.

Phoma Sacc. has predominantly aseptate conidia, but occasionally conidia become 2-celled, especially in vivo. Brewer & Boerema (1965) described Phoma as occasionally euseptate in contrast to distoseptate Ascochyta. Later, Boerema & Bollen (1975) withheld the term euseptate from Phoma pending further ultrastructural studies of septation in other genera. I have not examined any Phoma species in this study, but from published electron micrographs of Phoma (Boerema & Bollen, 1975; pl. 22 cf. pl. 27), I consider that Phoma is euseptate like Ascochyta. These authors maintained that Phoma can be distinguished from Ascochyta by differences in conidiogenesis and in septation. The former distinction is doubtful and is discussed later (p. 26). If the type of septation is the same for both genera, and all other characters are found to be uniform, a distinction between Phoma and Ascochyta based solely on number of septa in conidia is of doubtful taxonomic significance. Further comparative studies of Phoma and Ascochyta are required to determine if amalgamation of these two genera is justified.

3.1.3 Conidiomatal wall

Wall structure is considered a useful character to distinguish Ascochyta from other genera (Boerema & Dorenbosch, 1973), although descriptive terminology for wall characters needs refinement (Sutton, 1980). The conidiomatal wall of Ascochyta has been described as pseudopycnidial (Diedicke, 1912a) and pseudoparenchymatic (Boerema & Bollen, 1975; Mel'nik, 1977; Punithalingam, 1979). These are general
terms for a tissue of hyphal origin in which the hyphae have lost their individuality and the cells have become somewhat isodiametric. Pseudopycnidial particularly refers to a thin, delicate wall (Potebnia, 1910). Sutton (1980) and Hawksworth (1981) further defined the tissue as textura angularis, meaning, tightly-packed, isodiametric cells, lacking intercellular spaces (Korf, 1973).

Other characters of wall structure are not defined with precision. Wall thickness in Ascochyta has been variously described as thin (Grove, 1935; Boerema & Bollen, 1975; Sutton, 1980), thick (Sutton, 1973), thin or thick depending on substrate (Mel'nik, 1977), mostly 1-3 cells wide (Hawksworth, 1981), and one to several, mostly 2-5, cells wide (Punithalingam, 1979). Outer cells of the wall are often darker and thicker-walled than the inner hyaline cells (Boerema & Bollen, 1975), with pigmentation varying from pale to dark brown (Hawksworth, 1981).

3.1.4 Conidiogenesis

The mode of conidiogenesis in the type species, A. pisi, is phialidic as observed by the light microscope (Fig. 5B, E), with a collarette encircling the thickened periclinal wall of the conidiogenous cell (Punithalingam & Holliday, 1972; Sutton, 1980). The first detailed investigations of conidiogenesis in A. pisi were performed by Brewer & Boerema (1965), whose electron micrographs showed elongate, thin-walled conidial initials detached from conidiogenous cells by ingrowing transverse septa. A series of bands of successive scars or 'wall rests' (Brewer & Boerema, 1965) left behind by seceded conidia, were evident along the neck of the conidiogenous cells. Madelin (1966) and Sutton & Sandhu (1969) named such banded cells annellophores (= annellides) and suggested that delimitation of the conidium from the conidiogenous cell by a septum was an important characteristic of the annellide. A
discrepancy thus arose between light microscope and electron microscope observation of conidiogenesis in A. pisi.

Boerema & Bollen (1975) reported that the delimiting septum was not confined to Ascochyta 'annellides' but occurred also in the phialides of Phoma. They compared five Phoma species with three species of Ascochyta, A. pisi, A. pinodes, and A. fabae. In the three Ascochyta species, the first conidium from each conidiogenous cell was found to arise holo-blastically and to leave a scar (wall rest) or annellation on secession. The next conidium then developed by enteroblastic percurrent proliferation of the conidiogenous cell and seceded to leave a second annellation above the first. Secession occurred by means of a 3-layered septum. Each successive conidium could either develop at a higher level, or at about the same level to form in the latter case what Boerema & Bollen (1975) called an 'annellate collar', as in A. pinodes. In contrast, Phoma was described as phialidic, with a collarette formed when the first conidium seceded. This collarette was subsequently added to by mucilage from successive conidia arising from this fixed locus.

Although this work provided a possible means of separating the two genera, Ascochyta and Phoma, the approach is considered impracticable. Punithalingam (1979) and Sutton (1980) believed that since conidiogenous cells of Ascochyta and Phoma species are indistinguishable and appear as phialides under the light microscope, the genera should both be classified, for the purpose of practical taxonomy, as phialidic. Punithalingam (1979) extended the study of conidiogenous cells to those in immature pycnidia of Ascochyta species in culture and reported a different mode of ontogeny. During pycnidial cavity formation, conidiogenous cells were seen to produce a single conidium and to then be dislodged into the cavity. The next layer of conidiomatal wall cells lining the cavity then became conidiogenous cells, produced a conidium, were dislodged, and so on. These 'temporary'
conidiogenous cells were holoblastic. Permanent conidiogenous cells, which developed only at conidiomatal maturity, appeared phialidic by light microscopy. This phenomenon of dual conidiogenesis was reported by Punithalingam for most graminicolous Ascochyta species in culture, but was not investigated in the present study. The first conidium of a phialide develops holoblastically (Cole & Samson, 1979). The temporary holoblastic conidiogenous cells seen by Punithalingam (1979) could, therefore, be equally described as short-lived phialides which lack an obvious collarette, because only a single conidium is produced before they are dislodged.

The observations of Boerema & Bollen (1975) have been re-evaluated following a comparison of conidiogenous cells of A. pisi under the light and electron microscopes. A culture of A. pisi (PD 78/517) was received from Dr G.H. Boerema, and actively sporulating pycnidia were thin-sectioned for electron microscopy. The conidiogenous cells seen were unmistakably phialidic (Figs. 4A-C). Obvious short collarettes, formed by rupture of the phialide apex, surround a periclinal thickening of several wall layers. At least six wall layers can be distinguished at the phialide apex in Fig. 4C. No proliferation of conidiogenous cells was seen. The annellations illustrated by Boerema & Bollen (1975) cannot be reconciled with these results.

The annellate collar reported for A. pinodes by Boerema & Bollen (1975) deserves further discussion. The collar, composed of several wall layers, was acknowledged as arising from the secession of several conidia at 'approximately the same level'. This fixed conidiogenous locus fits the definition of a phialide (Cole & Samson, 1979). An annellide, on the other hand, produces a single conidium from one locus followed by percurrent proliferation to produce the next conidium at a new higher locus. The annellate collar, seen by Boerema & Bollen (1975), is identical to the
Ascochyta pisi:

A, B, thin longitudinal sections through mature conidia. The lateral conidial wall, composed of three layers, is continuous at the septum, but the inner layer also forms the septum.

A (x9,300), B (x10,600); A, B, culture PD 78/517.

Fig. 4

Ascochyta pisi:

A, B, thin sections through phialidic conidiogenous cells which have periclinal thickenings at their apices.

A (x10,000), B (x14,400); A, B, culture PD 78/517.

(overleaf)

C, thin section through a phialidic conidiogenous cell. There are at least six wall layers (arrowheads) in the periclinal thickening. (x19,600), culture PD 78/517.

D, E, thin sections through phialidic conidiogenous cells which have periclinal thickenings.

D (x16,500), E (x14,400); D, E, isotype of A. pisi (BR).
phialidic periclinal thickening, composed of concentric wall layers left after conidial secession. Conidiogenesis in *A. pinodes*, *A. pisi*, and *Phoma* spp. is therefore the same, namely phialidic.

To confirm the method of conidiogenesis in *A. pisi*, a few pycnidia from Libert's 1830 isotype specimen of *A. pisi* (BR) were thin-sectioned for examination under the electron microscope. Despite the age and poor condition of the material, conidiogenous cells were seen with collarettes and periclinal thickening, and conidiogenesis was confirmed to be phialidic (Figs 4D, E). This establishes beyond doubt that conidium ontogeny in the type species of *Ascochyta* is both functionally and ultrastructurally phialidic.

3.1.5 **Teleomorphs**

For teleomorphs, the classification adopted by Müller (1979) is followed. A single order, the Dothideales, covers all bitunicate Ascomycetes (von Arx & Müller, 1975). It contains several genera reported to have *Ascochyta* species as anamorphs. The best documented connections of *Ascochyta* are with *Didymella* Sacc. in the Mycosphaerellaceae (Müller, 1979; Punithalingam, 1979). Other connections have been reported by Kendrick & DiCosmo (1979) and Punithalingam (1979) with *Mycosphaerella* Johanson and *Microcyclus* Sacc., also in the Mycosphaerellaceae, and with *Gilletiella* Sacc. & Sydow, *Keissleriella Höhnel*, *Leptosphaeria* Ces. & de Not., *Trichometasphaeria* Munk, and *Didymosphaeria* Fuckel, all within the Pleosporaceae. Some of these connections are based only on circumstantial evidence, and are in need of confirmation. The teleomorph of *Ascochyta pisi* is unknown.

Teleomorph connections do not support separation of *Ascochyta* from *Phoma* (Müller, 1981). Species of *Phoma* are also connected with genera of the Mycosphaerellaceae (*Mycosphaerella* and *Didymella*) and with some genera
of the Pleosporaceae (e.g. Pleospora Rabenh. and Leptosphaeria) (Boerema, 1976; Müller, 1979).

The following generic description of Ascochyta is based on the characters discussed above.

ASCOCHYTA Libert, Plantae cryptogamicae quas in Arduenna collegit, fasc. 1: 8 (1830).

= Ascochyttella Tassi [as Aschochyttella], Bullettino del Laboratorio ed Orto Botanico, Siena 5: 27 (1902).
= Aschochyttula Diedicke [as (Potnia) Died.], Annales mycologici 10: 141 (1912).
= Stagonosporopsis Diedicke, Annales mycologici 10: 142 (1912).
For further synonymy, see Sutton (1980, p. 408).

Conidiomata: pycnidial, mostly solitary, scattered or aggregated, nonstromatic, unilocular, immersed or erumpent, pale brown to black, globose or flattened globose, sometimes longitudinal, rarely irregular, papillate or nonpapillate, glabrous, usually ostiolate, ostiole ± circular.

Conidiomatal wall: in vertical section textura angularis, usually 1-4 cells wide, cells mostly smooth-walled, outermost cells sometimes with thickened, pale brown to brown walls, innermost cells thin-walled and hyaline; wall sometimes wider and darker towards the ostiole.

Conidiophores: absent.

Conidiogenous cells: monophialidic, lining the cavity, discrete, arising directly from cells of the wall, hyaline, smooth-walled, ampulliform, conic, or lageniform, usually not proliferating.

Conidia: (0-) 1 (-3) euseptate, when unisepatate septum ± median, rarely eccentric, arising singly, not in chains, hyaline or pale yellow to light
brown, elliptical, oblong, cylindrical or fusiform, rarely irregular, base rounded or truncate, apex rounded or rarely acute, mostly straight, smooth-walled.

Teleomorphs: Didymella Sacc. and other genera of the Mycosphaerellaceae and Pleosporaceae.

Number of species: Several hundred names in Ascochyta exist in the literature. Mel'nik (1977), in the only modern treatment of the whole genus, accepted 328 species, excluded 414, was unable to examine 59, and listed 29 names as invalidly published. Allowing for synonymy, there are well in excess of 850 species names in Ascochyta.

Recent major works: Mel'nik (1977) monographed the genus; Punithalingam (1979) treated the graminicolous Ascochyta species.

Infrageneric taxa:

Section Ascochyta - conidia hyaline; Type species - A. pisi Lib.
Section Ascochyttella (Tassi) Sprague & Johnson (1950)
- conidia pale coloured; Type species - A. vicina Sacc.

Six species including A. pisi were studied from section Ascochyta.
Many species from the genera Ascochyttella Tassi and Ascochyttula Died. belong in Ascochyta section Ascochyttella.

3.2 ASCOCHYTA, SECTION ASCOCHYTA

Six species from this section were examined: A. pisi, the type species; A. sesleriae and A. actaeae, the type species of Macrodiplodina and Stagonosporopsis respectively, two genera which are considered to be synonyms of Ascochyta; two varieties of A. lophanthi, previously accommodated by Trotter (1931) in the subgenus Ascochyttula; and Ascochyta aquilegiae, one of the original thirteen species of Ascochyttella.
ASCOCYTA PISI Libert, Plantae cryptogamicae quas in Arduenna collegit, Fasc. 1: no. 59 (1830).

=Gloeosporium pisi (Lib.) Oudemans, Archives néerlandaises des sciences exactes et naturelles 11: 359, 373 (1876).


= Ascochyta pisicola (Berk.) Saccardo, Sylloge fungorum 3: 397 (1884).

Additional synonyms in Mel'nik (1977, p. 72).

Fig. 5.

Lesions: on leaves and pods, light greyish brown to brown, circular with a raised, dark brown margin, 2-7.5 mm diam., sometimes irregular when adjacent lesions coalesce.

Conidiomata: pycnidial, gregarious, ± concentric in lesions, nonstromatic, subepidermal, erumpent, light yellow-brown to brown, subglobose, 100-180 (-250) μm diam., nonpapillate, ostiolate, glabrous; ostiole circular with a brown to dark brown border, 25-40 (-60) μm wide; conidial ooze pink.

Conidiomatal wall: in vertical section textura angularis, (1-) 2 (-3) cells wide, 8-13 μm; cells smooth-walled, hyaline, 4-8 μm high x 6-10 μm wide, outermost cells somewhat thicker walled; towards the ostiole, wall sometimes wider, cells pale brown, sometimes compressed.

Conidiogenous cells: phialidic, lining the cavity, discrete, arising directly from cells of the wall, hyaline, ampulliform to lageniform,
Ascochyta pisi:

A, conidia
B, conidiogenous cells
C, median vertical section of conidioma
   A, B, C, isotype of A. pisi (BR)

(overleaf)
D, conidia
E, conidiogenous cells
F, median vertical section of conidioma
   D, E, F, culture PD 78/517
collarette small but obvious and rarely flaring, periclinal wall thickened, not proliferating or rarely with a single percurrent pro-
lieration, (6-)8.5(-10) μm high x (4.5-)6.5(-10) μm wide.

Conidia: (0-)1(-2) septate, usually medianly but sometimes unequally
septate, hyaline, cylindrical or occasionally irregular, mostly not or
only slightly constricted, base broadly rounded or somewhat truncate,
apex broadly rounded, straight or sometimes slightly curved, smooth-
walled, eguttulate, 0-septate 7-15 x 2.5-4.5 μm; 1-septate (8-)11.5-
14.5(-18.5) x (2.7-)3-4(-4.5) μm; 2-septate 13-19 x 3.5-6 μm.

Habitat: on leaves and pods of Lathyrus L., Lupinus L., Phaseolus L.,
Pisum L., and Vicia L. (Fabaceae).

Distribution: Europe (Wales, England, France, Belgium, Poland, Sweden,
Germany, Austria, Romania, Italy); Middle East (Israel); North America
(Canada, U.S.A.); Australasia (Australia, New Zealand).

Additional records in Sutton (1980, p. 410) and in C.M.I. Distribution
Maps of Plant Diseases no. 273, ed. 3 (1971).

Isotype: In leguminibus Pisi sativi, Autumnno, Libert, Plantae cryptogamicae
quas in Arduenna collegit, Leodii, Fasc. 1: no. 59 (1830)(BR! K!)

Specimens examined:

Ascochyta pisi:

Wales - on Pisum sativum, Coed Coch, Denbighshire, Oct 1877, M.J.
Berkeley (K).

France - in leguminibus Pisi sativi, Autumnno, M.A. Libert, Plantae
cryptogamicae quas in Arduenna collegit, Fasc. 1: no. 59 (1830)
(BR - 2 specimens, K) [as Ascoxyta pisi; isotype of Ascochyta pisi
Lib.].

Austria - on Pisum sativum, Wien, Deutsch-Wagram, Jul 1939, F. Petrak,
Reliquiae Petrykianae no. 313 (PDD 39648).
- on *Pisum* sp., ... im Pressbaum, Wien, Wald, Jul 1914, F. Theissen, no. 2197 (FH) [incorrectly labelled as type].

Sweden - in foliis et leguminibus *Viciae villosae*, Bjers par.

Vesterhejde, 10 Jul 1898, J.T.C. Westergren, Micromycetes rariores selecti no. 1537b (K.)*

New Zealand - on *Pisum sativum*, Weraroa, Wellington, 6 Jun 1919, G.H. Cunningham (PDD 1523).*

- on *Pisum sativum*, Mt Albert, Auckland, 23 Dec 1979, P. Johnston (PDD 40299).

*Gloeosporium pisi:*

Italy - ad *Pisi sativi* Lin. legumina immatura, quae tandem penetrat et semina attingit, Romagna: Bologna, 1876, G. Passerini, de Thuemen Mycotheca universalis no. 589 (K).

*Septoria leguminum* var. *pisorum:*

Belgium - on *Pisum* sp., Belgique, Westendorp, Herb. Westendorp (BR).

*Sphaeria (Depazea) concava:*

England (?) - in *Pisum*, Gard. Chronicle, 1855, Ex Herb. Berk (K)*

[as *Depazea concava*].

*Depazea piscicola:*

England - on *Pisum sativum*, King's Cliffe, Norths., M.J. Berkeley, Ex Herb. Berk. (K)* [as *Sphaeria (Depazea) piscicola*].

*Characteristics in culture:*

Colonies: on oatmeal agar at ca. 20°C, under 12 h near-ultraviolet plus cool white fluorescent light/12 h darkness. In 12 days, ca. 7 cm diam; aerial mycelium sparse, white, cottony, submerged mycelium sparse, margin entire but faint, pigment lacking in agar.

* Specimens with conidia of greater width than those of *Ascochyta pisi*; see Notes, p.38.
Conidiomata: pycnidial, abundant, forming in concentric rings, erumpent or sometimes submerged and multi-beaked or arising from aerial mycelium, brown to dark brown, globose, 120-190(-270) \( \mu \)m diam., ostiolate, glabrous; conidial ooze pink.

Conidiomatal wall: in vertical section textura angularis, 1-4 cells wide, outermost cells thicker walled and very pale brown, innermost cells hyaline; towards the ostiole, wall sometimes wider and outer cells light brown.

Conidiogenous cells: phialidic, 6-12 \( \mu \)m high x 5-9 \( \mu \)m wide.

Conidia: (0-)1(-4) septate, usually medianly septate, hyaline, sometimes constricted at septum, guttulate or with granulated cytoplasm at base and apex, 1-septate (9.5-)10-13(-17.5) x (2-)2.5-3(-3.5) \( \mu \)m.

Cultures examined:

Ascochyta pisi:

Netherlands - on pea, f. G.H. Boerema, PD 78/517 (PDDCC 6893).

New Zealand - on Pisum sativum, Mt Albert, Auckland, 23 Dec 1979, P. Johnston (PDDCC 6892).

Notes: Conidial dimensions for Ascochyta pisi were given by both Saccardo (1884, p. 398) and Grove (1935, p. 310) as 14-16 x 4-6 \( \mu \)m, although recent authors including Punithalingam & Holliday (1972), Boerema & Dorenbosch (1973), Mel'nik (1977), and Sutton (1980) have described narrower conidia, ca. 10-18 x 3-4.5 \( \mu \)m. Uniseptate conidia from the three isotype and six of the other ten specimens examined in this study measured (8-)11.5-14.5 (-18.5) x (2.5-)3-4(-4.5) \( \mu \)m, confirming the narrower width as being characteristic of A. pisi.

Four of the collections (marked with an asterisk) contain wider conidia, mostly 10-18 x 4-5.5 \( \mu \)m, within otherwise similar conidiomata.
These collections are considered to be outside the species limits of A. pisi. The names of two of these, Depazea concava and D. pisicola, were considered by Linford & Sprague (1927), Grove (1935), and Boerema & Dorenbosch (1973) to be synonyms of A. pisi. This synonymy is in doubt until all relevant type specimens can be examined.

Zythia rabiei Pass. (= Phyllosticta rabiei (Pass.) Trotter) was listed as a synonym of Ascochyta pisi by Saccardo (1884). In studies comparing the two fungi, Sprague (1930) and Sattar (1934) recognized both species separately. I examined type specimens of Z. rabiei on Cicer arietinum, Parma, Italy, 1866 (K, FH). They contained pycnidia with mostly non-septate, hyaline conidia, 9.5-13.5 x 3.5-5.5 μm, clearly different from A. pisi.

A teleomorph for A. pisi is unknown.

Stone (1912), supported by Melhus (1913) and Vaughan (1913), claimed that A. pisi was the anamorph of Mycosphaerella pinodes (Berk. & Bloxam) Vestergren. Jones (1927) and Linford & Sprague (1927) however found that the anamorph, previously understood as A. pisi, represented two distinct species, with M. pinodes the teleomorph of the second species, Ascochyta pinodes Jones.

Additional literature and illustrations: Saccardo (1884, p. 397-8); Stone (1912, p. 564-92, pl. 19-20); Brooks & Searle (1921, p. 183, 187); Linford & Sprague (1927, p. 381-97, pl. 16, 17); Sprague (1929, p. 917-32, pl. 34-6); Sattar (1934); Grove (1935, p. 309-10); Wollenweber & Hochapfel (1936, p. 605); Punithalingam & Holliday (1972); Boerema & Dorenbosch (1973, p. 39, fig. 1); Mel'nik (1977, p. 72); Sutton (1980, p. 408-10, fig. 244).
ASCOCHYTA SESLERIAE and MACRODIPLODINA

Petrak (1961) considered Ascochyta sesleriæ C. Massal. to be distinct from Ascochyta and Diplodina because of its larger conidia. A. sesleriæ became the type species of a new genus, Macrodiplodina Petrak, characterised by ostiolate, papillate, erumpent pycnidia on leaves, with thickly pseudoparenchymatic, dark walls and oblong-fusoid, 40 x 10 μm, unisepate conidia, formed from conidiogenous cells lining the cavity. Mel'nik (1977) and Punithalingam (1979) did not accept the separation of Macrodiplodina from Ascochyta solely on the basis of conidial size, and the species was returned to Ascochyta, an opinion I agree with.

ASCOCHYTA SESLERIAE C. Massalongo, Atti del Reale Istituto veneto di scienze, lettere ed arti 74(2): 251 (1914); non Baudys & Picbauer (1924).


Fig. 6.

Lesions: not obvious.

Conidiomata: pycnidial, solitary or rarely in pairs, scattered, amphigenous, interveinal, subepidermal, somewhat erumpent, black, globose but often laterally compressed when fully developed, (120-)200-250(-290) x 120-150 (-200) μm, papillate, ostiolate, glabrous; ostiole circular or oval with thickened border, 15-25 μm wide.

Conidiomatal wall: in vertical section textura angularis, 3 cells wide, 16-25 μm; cells smooth-walled, outermost cells oval or sometimes elongate, 10-21 x 5-12 μm with thick, 1-3 μm wide, brown to dark brown walls, innermost cells hyaline, smaller and thinner walled; towards the apex, wall up
Ascochyta sesleriae:

A, conidia (drawn at 2 different scales)
B, conidiogenous cells
C, median vertical section of conidioma

A, B, C, holotype (VER).
to 30 μm wide and darker.

Conidiogenous cells: phialidic (?), discrete, arising directly from cells of the wall, hyaline, broadly ampulliform, 5-9 μm high x 11-17 μm wide.

Conidia: medianly 1-septate, very rarely 2-septate, septa thin, 0.5 μm wide, subhyaline to very pale greenish, fusiform, slightly constricted at septum, base rounded or sometimes truncate, apex rounded, straight, smooth-walled, wall thin, 0.5 μm wide, guttulate with 2-3 large guttules or remnants of these, 1-septate (35.5-)39-44(-45.5) x (8-)9.5-10.5(-11) μm; 2-septate ca. 50 x 11 μm.

Habitat: on leaves of Sesleria caerulea (L.) Ard., Sesleria sp. (Poaceae).

Distribution: Europe (Italy).

Additional records in Mel'nik (1977, p. 116); Punithalingam (1979, p. 141).

Holotype: In folliis emortuis Sesleriae! coeruleae? e mt. Turcato ad originem vallis Tregnago, Jun 1907 (VER!).

Specimen examined:

Ascochytta sesleriiae:

Italy - on Sesleria sp., Giugno 907 (VER) [holotype of A. sesleriiae].

Notes: Conidiomata of A. sesleriiae were overmature, and conidiogenous cells rare and mostly disintegrated in the holotype. Thus, the mode of conidiogenesis could not be accurately determined, although the wall of the conidium initial was thicker than that of the conidiogenous cell, suggesting phialidic development. Punithalingam (1979) described conidium ontogeny as phialidic.

The specimen from VER is believed to be the holotype. Handwritten
collection details on the specimen label are illegible, except for the host and date which both agree with the protologue. The handwritten description on the packet corresponds to that in the protologue of *A. sesleriae*.

A later homonym, *Ascochyta sesleriae* Baudys & Picbauer was considered by Petrák (1947, p. 140) to be a different species since it was reported to have pale brownish conidia. The species was recombined as *Ascochyttella sesleriae* (Baudys & Picbauer) Petrák, but must be cited as a new name *Ascochyttella sesleriae* Petrák (Art. 72).

Additional illustration: Punithalingam (1979, fig. 83).

**ASCOCHYTAA ACTEAEAE and STAGONOSPOROPSIS**

The genus was described for species of *Ascochyta*, *Diplodina*, and *Actinonema* Fr. with pseudopycnidial conidiomata and hyaline or faintly coloured conidia which sometimes develop an additional septum to become 3-celled. Eight species from the above genera were referred to *Stagonosporopsis* by Diedicke (1912a, p. 142) but only one new combination was validly published. The other seven combinations were not validly published (Art. 33) until Diedicke (1912b, p. 397-401)*. Clements & Shear (1931) selected a lectotype species, *Stagonosporopsis boltshaueri* (Sacc.) Died., since no type species had been designated. However, the single valid combination, *S. actaeae* (Allescher) Died., made by Diedicke (1912a, p. 144), is accepted as the type species (Trotter, 1931; Sutton, 1977), since it predates all other combinations.

*Stagonosporopsis* was recognized by Migula (1921), von Höhnel (1923),

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*Diedicke (1912a, p. 142) was dated Apr 1912; Diedicke (1912b, p. 397-401) was dated 22 Nov 1912.*
Trotter (1931), Grove (1935) and Sutton (1977). *S. actaeae* was considered to be an *Ascochyta* species by Davis (1919a), and Petrak (1925b, p. 5) proposed that *Stagonosporopsis* be included in *Ascochyta*. This move was supported by Clements & Shear (1931), Sprague & Johnson (1950), and Mel'nik (1977). Petrak (1943) later regarded the genus as a transitional form between *Ascochyta* and *Stagonospora*, with a closer affinity to the latter.

*S. actaeae* was compared with *A. pisi* in the present study, and the two species found to be congeneric. *Stagonosporopsis* is therefore considered to be a synonym of *Ascochyta*.

**ASCOCYHTA ACTAEAE** (Bresad.) J. Davis, [as Ascobhyta], Transactions of the Wisconsin Academy of Sciences, Arts, and Letters 19: 656 (1919).


≡ *Marssonina actaeae* (Bresad.) Magnus, Hedwigia 45: 90 (1906).

= *Actinonema actaeae* Allescher, Bericht der Bayerischen botanischen Gesellschaft zur Erforschung der heimischen Flora 5: 19 (1897).


Fig. 7.

**Lesions:** irregularly shaped, dark.

**Conidiomata:** pycnidial, solitary, gregarious in or adjacent to lesions, amphigenous, nonstromatic, subepidermal, erumpent, yellow-brown, globose to flattened globose, 100-170 μm diam., somewhat papillate, ostiolate, glabrous; ostiole circular, 20-30 μm wide, surrounded by a dark border.

**Conidiomatal wall:** in vertical section textura angularis, 1-3 cells wide, 8-13 μm; cells thin-walled, hyaline, smooth, up to 12 x 6.5 μm but variable; towards the ostiole, cells smaller and hyaline.
Fig. 7

Ascochyta actaeae:

A, conidia

B, conidiogenous cells
   A, holotype of Actinonema actaeae (M)
   B, Actinonema actaeae, Jul 1896 (M)

(overleaf)

C, conidiogenous cells

D, median vertical section of conidioma
   C,D, Actinonema actaeae, Jul 1896 (M).

Fig. 8 (overleaf)

Ascochyta aquilegiae:

conidia, ex Herb. v. Hännel no. 2191a (FH).
Conidiogenous cells: phialidic, lining the cavity, discrete, arising directly from cells of the wall, hyaline, irregularly ampulliform to flattened conic, collarette short, periclinal wall only slightly thickened, sometimes proliferating, 3-7 μm high x 6.5-11.5 μm wide.

Conidia: 0-1(-3) septate, when uniseptate septum sometimes eccentric, hyaline, cylindrical, not constricted at septa, base rounded or somewhat truncate, apex rounded, straight or sometimes slightly curved, smooth- and thin-walled, with irregular, small cell inclusions, 0-septate (15.5-)21.5-26.5(-35.5) x (5-)5.5-6.5(-7) μm; 1-septate (16.5-)22-28.5(-33) x (5-)5.5-6.5(-7.5) μm; 2- and 3-septate 29.5-37 x 6-7.5 μm.

Habitat: on leaves of Actaea spicata L. (Dilleniaceae).

Additional hosts in Davis (1919a) and Mel'nik (1977).

Distribution: Europe (Germany).

Holotype: in foliis exsiccatis Actaeae spicatae "Nossen" Saxoniae (not seen).

Specimens examined:

Actinonema actaeae:

Germany - an noch lebenden Blättern von Actaea spicata, Oberammergau:
  Graswangthal, Jul 1896, Allescher, Pilzherbar A. Allescher (M).
  - an noch lebenden und welkenden Blättern von Actaea spicata,
    Oberammergau: Graswangthal, Aug 1896, Allescher, Pilzherbar A.
    Allescher (M) [holotype of Actinonema actaeae].

Notes: Stagonosporopsis actaeae is accepted as a facultative synonym of Ascochyta actaeae although specimens of the latter were not examined. Allescher (1897) in describing Actinonema actaeae, noted its similarity to Marssonia actaeae, but considered it to be distinct, since M. actaeae
had been described as densely aggregated and not growing in lesions. Diedicke (1915, p. 825) suggested that *M. actaeae* should be compared with *Stagonosporopsis actaeae*. Subsequent comparison by Davis (1919a) led to the synonymy accepted above. I concur that *Ascochyta* is the correct genus for this fungus, because of the thin-walled, pycnidial conidiomata, phialidic conidiogenesis, and hyaline, 0-1(-3) septate conidia.

Allescher (1897) and Grove (1937) emphasized the presence of delicate, branched, whitish fibrils on the leaves bearing *Actinonema actaeae*, and regarded them as an important character of *Actinonema*. Diedicke (1912a) examined cross-sections of infected leaves and interpreted the 'fibrils' as foldings of the host cuticle. Fibrils on specimens from *M* were seen in the present study, but not examined in detail. They appeared to be of hyphal origin, and confined to the lesions. Since conidiomata of *A. actaeae* are sometimes outside the lesions, it would suggest that the fibrils are not directly associated with the conidiomata but may arise from the fungus following extensive colonization of host tissue and lesion formation.

Additional illustrations: Diedicke (1912b, p. 350, fig. 14); Migula (1921, taf. 37, fig. 12, 13).

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**ASCOCYHTA AQUILEGIAE** (Roum. & Pat.) Saccardo, Sylloge fungorum 3: 396 (1884); non (Rabenh.) Hönnel (1905).

≡ *Phyllosticta aquilegiae* Roumeguère & Patouillard, Revue mycologique 5: 28, tab. 36, fig. 3 (1883).


≡ *Actinonema aquilegiae* (Roum. & Pat.) Grove, Journal of Botany, British and Foreign 56: 343, pl. 550, fig. 18 (1918).
= Ascochyta aquilegiae (Rabenh.) Höhnel, Annales mycologici 3: 406 (1905); non (Roum. & Pat.) Sacc. (1884).
= Depazea aquilegiae Rabenhorst, Klotzschii Herbarium vivum mycologicum ... no. 1651 (1852), fide Mel'nik (1977).
Additional synonyms in Grove (1937, p. 269); Mel'nik (1977, p. 77).
Fig. 8.

Lesions: usually marginal, grey to brown, border dark brown; white mycelial fibrils radiating from centre of lesion to border.
Conidiomata: pycnidial, solitary, gregarious, amphigenous, nonstromatic, subepidermal, erumpent, pale brown to brown, subglobose, 80-170 μm diam., ostiolate, glabrous; ostiole circular, up to 30 μm wide.
Conidia: medianly or occasionally eccentrically uniseptate, sometimes nonseptate, occasionally 2-septate, hyaline, cylindrical to fusiform or somewhat irregular, usually not constricted at septum, base and apex broadly rounded, smooth-walled, guttulate or eguttulate, 10-20(-25) x 3-5.5 μm.

Habitat: on leaves of Aquilegia vulgaris L., Aquilegia sp., and Delphinium sp. (Ranunculaceae).
Distribution: Europe (Belgium, Germany, Austria, Czechoslovakia, Yugoslavia); Australasia (New Zealand); North America (Wyoming, U.S.A.).
Isotype: sur les feuilles de l'Ancolie des jardins. (Aquilegia vulgaris L.), Environs de Malmedy, Reliq. Libertianae, C. Roumeguère Fungi gallici exsiccati 2489 (NY!).
Specimens examined:

Actinonema aquilegiae:


Ascochyta aquilegiae (Roum. & Pat.) Sacc.:

Germany - auf Aquilegia vulgaris, Berlin bot. Garten, Aug 1888, P. Sydow, Sydow Mycotheca marchica 2274 (K).

Ascochyta aquilegiae (Rabenh.) Höhnel:

Czechoslovakia - auf noch lebenden und absterbenden Blättern von Kultivirten Aquilegiaarten in Pflanzenschulen in Turnau, Böhmen, 26 Sep 1908, 26 Sep 1910, Kabát, Kabát & Bubák Fungi imperfecti exsiccati 811 (K).
Yugoslavia - auf Aquilegia spec., Bosnien, ..., 30 Oct 1918, F. Petrak, Petrak Fungi albanici et bosniaci exsiccati Nr. 3 (K).

Phyllosticta aquilegiae Roum. & Pat.:

Belgium - sur les feuilles de l'Ancolie des jardins (Aquilegia vulgaris L.), Environ de Malmedy, Reliq. Libertianae, C. Roumeguère Fungi Gallici Exsiccati 2489 (NY) [Isotype of Ascochyta aquilegiae (Roum. & Pat.) Sacc.].

Phyllosticta aquilegiae (Rabenh.) Bresad. [nom. inval.]:

Germany - auf Aquilegia vulgaris L. in Garten; verbreitet, a.
Königstein, b. Nossen u. Freiberg, Jul & Aug 1890, 91, 94, 95,
W. Krieger, Krieger Fungi saxonici 1186 (NY).

Notes: Phyllosticta aquilegiae Roum. & Pat., the basionym of Ascochyta aquilegiae (Roum. & Pat.) Sacc., was based on part of the type specimen of Depazea aquilegiae Rabenh. P. aquilegiae and A. aquilegiae were both described in their protologues as having brown, eccentrically uniseptate conidia, whereas examination of an isotype has shown the conidia to be hyaline. It was this reference to pigmented conidia that probably led Tassi (1902) to include this fungus among the thirteen original species in Ascochyttella Tassi. As reported by von Höhnel (1905), Diedicke (1912b), and Grove (1918), however, A. aquilegiae has hyaline conidia. The fungus was therefore not congeneric with Ascochyttella.

Von Höhnel (1905) discussed the several published names for this fungus, favouring the new combination Ascochyta aquilegiae (Rabenh.) Höhnel, because he regarded the description of A. aquilegiae (Roum. & Pat.) Sacc. given by Saccardo (1884) to be incorrect. As a later homonym of Saccardo's name however, von Höhnel's combination is illegitimate (Art. 64). Mel'nik (1977) mistakenly recognized A. aquilegiae (Rabenh.) Höhnel, and excluded A. aquilegiae (Roum. & Pat.) Sacc. from Ascochyta because of its reported brown conidia.

Grove (1918) considered the conidiomata of this fungus to be acervular, and emphasised the white fibrils that radiated from the centre of the lesions. He emended the genus, Actinonema Fries, to include the latter character, and recombined the fungus as Actinonema aquilegiae (Roum. & Pat.) Grove. On the specimens examined above, the conidiomata were seen to be pycnidial, and the superficial, flattened fibrils appeared to be of hyphal origin, branching frequently towards the border of the lesion. Although easily overlooked on dried material, fibrils were present on most lesions. They provide a useful character at the species, rather than the
generic level.

Conidial septation and length is variable in Ascochyta aquilegiae. In most collections, the majority of conidia were uniseptate; less often, nonseptate conidia predominated. Conidiogenous cells were rare and seen from only one specimen. They appeared to be holoblastic but no definite conclusion was reached on the mode of conidiogenesis.

Another fungus, Phyllosticta aquilegicola Brunaud on Aquilegia was examined (NY) and found to have smaller, nonseptate conidia, 6.5-10 x 2-3 μm. It is here considered to be distinct from A. aquilegiae. Petrak (1925a, p. 298) reported that this fungus was a juvenile form of A. aquilegiae, and von Höhnel (1905) and Grove (1918) listed the two as synonyms.

Additional literature and illustrations: Allescher (1899, p. 630); Saccardo & Trotter (1913, p. 1013); Migula (1921, p. 265); Petrak (1922a, p. 11); Grove (1937, p. 269, fig. 105a); Moore (1959, p. 51); Dingley (1969, p. 97).


Fig. 9.

Lesions: brown to dark brown, margin irregular.

Conidiomata: pycnidial, solitary, sparse, nonstromatic, subepidermal, erumpent, pale brown, globose to subglobose, 80-120 μm diam, nonpapillate, ostiolate, glabrous; ostiole circular, 20-25 μm wide, with dark border, sometimes not obvious.

Conidiomatal wall: in vertical section textura angularis, 1-2 cells wide, 6.5-10 μm; cells hyaline, thin-walled, 6-10 x 2.5-6.5 μm; towards the ostiole, wall wider, of 3-4 layers of smaller, thicker walled, pale yellow-
Ascochyta lophanthi var. osmophila:

A, conidia
B, conidiogenous cells
C, median vertical section of conidioma
A, B, C, holotype (WIS).
brown cells.

Conidiogenous cells: phialidic, lining the cavity, discrete, arising directly from cells of the wall, hyaline, ampulliform, channel wide, collarette and periclinal thickening minute, not proliferating, 3-7.5 μm high x 4.5-8 μm wide.

Conidia: (0-)1-septate, septum thin, median or sometimes eccentric; hyaline to very pale greenish, cylindrical, not constricted at septum, base somewhat truncate or rounded, apex rounded, straight or sometimes variously curved, smooth-walled, sometimes guttulate with 1 or 2 large guttules per cell, nonseptate (15-)17-22(-25.5) x (4-)4.5-5.5(-6) μm; uniseptate (14.5-)16.5-21.5(-25.5) x (3.5-)4.5-5.5(-6) μm.

Habitat: on leaves of Agastache foeniculum (Pursh) Kuntze (Lamiaceae).

Distribution: North America (Wisconsin, United States).

Holotype: on Agastache foeniculum, Danbury (WIS!)

Specimen examined:

Ascochyta lopanthi var. osmophila.

United States - on Agastache foeniculum, Danbury, Wis., 30 Aug 1916,
J.J. Davis s.n., Part of type of Ascochyta compositarum sic. var.
osmophila n. var. Davis (WIS) [holotype of A. lopanthi var. osmophila].

Notes: Trotter (1931) included this variety in Ascochyta subgenus Ascochyta. Mel'nik (1977), however, found that the conidia were hyaline. From my observations of the holotype, the conidia are hyaline or faintly greenish, the green colour resulting from guttules and other cell contents rather than from a pigmented conidial wall. This variety is herein accommodated in Ascochyta section Ascochyta. The type variety, A. lopanthi var. lopanthi, which was not seen, was earlier listed by Saccardo & Saccardo.
(1906) in the subgenus Eu-Ascochyta.

Mel'nik (1977) cited A. lophanthi var. osmophila as a synonym of A. lagochili Byzova; I have not examined specimens of this fungus.

The holotype specimen was incorrectly labelled as A. compositarum var. osmophila but was later annotated, possibly by Davis himself, as A. lophanthi var. osmophila. A. compositarum was described as a new species, on members of the Asteraceae, on the same page as the descriptions of A. lophanthi var. osmophila and var. lycopina. This may explain the mistake. A. compositarum var. osmophila was not published.


Fig. 10.

Lesions: brown.

Conidiomata: pycnidial, solitary, sparse, on adaxial surface, immersed, erumpent, light brown, globose, ca. 110-120 μm diam., ostiolate, glabrous; ostiole circular, ca. 20 μm diam., with a dark border.

Conidia: (0-)1-septate with septum median or eccentric, hyaline, cylindrical to elliptical, not or only slightly constricted at septum, base and apex broadly rounded, mostly straight, smooth-walled, sometimes guttulate, 20-25 x 8-10 μm.

Habitat: on leaves of Lycopus uniflorus (Lamiaceae).

Distribution: North America (Wisconsin, United States).

Holotype: on Lycopus uniflorus, Shiocton, Wisconsin, August (WIS!).
Fig. 10

Ascochyta lophanthi var. lycopina:
conidia, holotype (WIS).

Fig. 11

Ascochyta cocoina:
A, conidia
B, conidiogenous cells
A,B, holotype (MA).
Specimen examined:
Ascochyta lophanthi var. lycopina:

United States - on Lycopus uniflorus, Shiocton, Wis., 17 Aug 1917,
J.J. Davis, s.n. (WIS) [part of holotype of A. lophanthi var. lycopina].

Notes: Conidiomata were rare and overmature on the type material studied
and were not able to be fully described. The few conidia seen, from only
a single pycnidium, were similar to those described in the protologue of
A. lophanthi var. lycopina: 'sporules hyaline or smoky tinged, cylindrical
with rounded ends, uniseptate, 16-24 x 7-8 µm'. The hyaline conidia justify
the inclusion of this fungus in Ascochyta section Ascochyta rather than in
subgenus Ascochytula, as listed by Trotter (1931). Mel'nik (1977) reported
that he examined the holotype from UC and found pigmented conidia. The
holotype, however, is not held in UC (I. Tavares, UC, pers. comm.). I do
not concur with Mel'nik's observation of conidial colour.

The name, Ascochyta thaspii Ell. & Ev. var lycopina is cited in Davis
(1919c, p. 707) with a description identical to that given for A. lophanthi
var. lycopina, except for conidial width (7-9 µm vs. 7-8 µm), and with
details of an additional collection from Two Rivers, Jul 1917. The
editor's footnote reads: 'Duplication of v. 700'. It would appear that
Davis described A. lophanthi var. lycopina a second time, with a different
specific epithet. In later publications, such as Davis (1922, p. 403),
the name A. lophanthi var. lycopina was continued, and recorded on a
second host, Lycopus virginicus L.
3.3 ASCOCHYTA, SECTION ASCOCHYTELLA. THE GENERA ASCOCHYTELLA AND ASCOCHYTULA


≡ Ascochyta Tassi [as Ascochyttella], Bulletino del Laboratorio ed Orto Botanico, Siena 5: 27 (1902).
≡ Ascochyta Lib. subgenus Ascochyttella (Tassi) Saccardo & D. Saccardo, Sylloge fungorum 18: 347 (1906).
≡ Ascochyttula Diedicke [as (Potebnia) Died.], Annales mycologici 10: 141 (1912).
≡ Ascochyta Lib. subgenus Ascochyttula (Died.) Trotter [as (Potebnia) Died.], Sylloge fungorum 25: 345 (1931).

Ascochyttella was established by Tassi (1902) to accommodate species of Diplodida, Ascochyta, and Phyllosticta with the following characters: conidiomata subepidermal, lenticular to subglobose, and membranous, with a protruding pore, inhabiting discoloured areas on leaves or rarely on branches, and producing conidia which are ovoid to oblong, small, coloured, and uniseptate. Thirteen species were originally listed, all new combinations of species from the above three genera. A type species was not designated.

The name Ascochyttula was first used for a proposed subgenus of Ascochyta. Potebnia (1907) favoured the uniting of Ascochyta and Diplodina and the addition, to this single, enlarged genus, of species of Diplodina-like fungi with pale coloured conidia. He cited three Diplodina-like species which would fit this concept: Microdipodina pterophila (Fautrey) Allescher, M. ascochyttula (Sacc.) Allescher, and Diplodina deflectens P. Karsten. Potebnia then suggested that these species could, perhaps, be separated in a subgenus of Ascochyta which he called Ascochyttula. However, new combinations of Ascochyta-Ascochyttula were not made, nor was a type species
indicated. Later in the same paper, Potebnia again listed the three species, under the same generic names as above. I therefore consider that the subgenus was not formally established.

Diedicke (1912a) recognized the subgenus Ascochytyula and elevated the name to generic rank as Ascochytyula (Potebnia) Died. He redefined Ascochyttella to distinguish it from Ascochytyula on the basis of conidial wall structure and conidial shape. Three further species, Diplodina obionis Jaap, D. ouedmansii Allescher, and D. plana P. Karsten, plus the three species of Potebnia (1907), were accepted in Ascochytyula, again without any new combinations.

The first formalized names in Ascochytyula (Diedicke, 1912b) were the three species of Diedicke (1912a) and two additional species, Ascochytyula atriplicis Died. and A. symphoricarpī (Pass.) Died. The three species originally mentioned by Potebnia (1907) were not included in Ascochytyula. Microdiploodia ascochytyula, the only one of Potebnia's three species treated in Diedicke (1912b), was listed under Microdiploodia. However, Ascochytyula still lacked a type species.

3.3.1 Citation and lectotypification

(a) Ascochytyella: Diedicke (1912a, b) emended Ascochytyella and cited the name as Ascochytyella (Tassi) Died. Since he accepted all of Tassi's original species (Diedicke 1912b, p. 401), the correct citation must be Ascochytyella Tassi emend. Died. or more simply Ascochytyella Tassi (Art. 47). A lectotype species has not been chosen from among the original thirteen species. Clements & Shear (1931) chose a later species, Ascochytyella deformis (P. Karsten) Died. as lectotype, but this cannot stand as it is not one of the original species of Ascochytyella (Art. 7).

In the present study, an attempt was made to examine all of the original species of Ascochytyella, so that a lectotype species could be chosen
for the genus. Of the thirteen species, four are considered to be **nomina dubia**, four are transferred to **Ascochyta**, four are transferred to other genera, and one species was not examined. **Ascochyrtella vicina** (Sacc.) Tassi is herein designated as the lectotype species for the genus. This species conforms to the original concept of **Ascochyrtella** (Tassi, 1902), having small, pale coloured, uniseptate conidia. These are also features included in the earlier genus, **Ascochyta**. **Ascochyrtella** Tassi, along with its lectotype species, can now be validly transferred to synonymy with **Ascochyta**.

(b) **Ascochyrtula**: Although Diedicke (1912a) and later authors have accepted that Potebnia (1907) described a new subgenus, **Ascochyta-Ascochyrtula**, close examination of the text of Potebnia shows that the name was not validly published and is a **nomen provisorum** (Art. 34). Three species were tentatively assigned to a subgenus name, but their respective generic names were retained. The subgenus was conceived by Potebnia as a means of possibly separating within **Ascochyta** those *Diplodia*-like species with pale coloured conidia. The genus name **Ascochyrtula** must, therefore, be cited as a new name credited solely to Diedicke (1912a), i.e. as **Ascochyrtula** Potebnia ex Died. (Art. 46), or more simply **Ascochyrtula** Died.

Clements & Shear (1931) chose **Ascochyrtula obiones** as the lectotype species. Since this was one of the original five species of Diedicke (1912b) and conforms to the generic description, it must be accepted.

### 3.3.2 Generic affinities of **Ascochyrtella** and **Ascochyrtula**

**Ascochyrtella**, as described by Tassi (1902), encompassed all **Ascochyta**-like fungi with small, uniseptate, pale coloured conidia, including those later named under **Ascochyrtula**. Diedicke (1912a), however, emended **Ascochyrtella** so as to separate it from **Ascochyrtula**, principally on the basis of conidiomatal wall structure. **Ascochyrtella** was restricted to species
with a pseudopycnidial wall, whereas Ascochytula contained species with a thicker, parenchymatic, Phoma-like wall with brown cells outermost and hyaline cells innermost. A further distinction between the two genera was spore shape, although Diedicke (1912a, b) indicated that this character was somewhat tentative, applicable to those species which he had examined, but not known to be consistent overall. Ascochytella was characterised by narrowly fusiform conidia, Ascochytula by oblong or cylindrical conidia with rounded ends.

Few authors, apart from Migula (1921) and von Hohnel (1923), accepted Diedicke's criteria for distinguishing Ascochytella from Ascochytula. Petrak (1921b, 1923, 1925b) questioned the validity of the generic separation and later Petrak (1953) brought Ascochytella, and some species of Ascochytula, into synonymy with Pseudodiplodia (P. Karsten) Sacc.. This was supported by Ruprecht (1959), Mel'nik (1977), and Sutton (1977). Other authors have favoured synonymy of Ascochytella and Ascochytula with Ascochyta (Clements & Shear, 1931; Sprague & Johnson, 1950). Saccardo & Saccardo (1906) relegated Ascochytella to subgeneric rank in Ascochyta, and Trotter (1931) did likewise with Ascochytula. Grove (1935) believed that the species of Ascochytella and Ascochytula deserved to be in a single, separate genus. The earlier name, Ascochytella, should have been adopted by Grove. However, by incorrectly citing the author and date for each genus, as Ascochytella Died. (1912) and Ascochytula Potebnia (1907), he mistakenly chose Ascochytula.

Zambettakis (1954) listed Ascochytella as a synonym of Ascochytulina Petrak, but the presence of a clypeus in Ascochytulina clearly distinguishes the two genera. Ascochytula was retained by Dickinson & Morgan-Jones (1966) because of a reported difference in conidiomatal wall structure from that of Ascochyta. This is further discussed under Ascochyta obiones (p. 83).

The various treatments of Ascochytella and Ascochytula have often
reflected the authors' opinions concerning the generic limits of Ascochyta. Those authors who considered that Ascochyta should be confined to species with hyaline conidia have recommended synonymy of Ascochyttella and Ascochyttula with Pseudodiplodia, or their union into a single genus. Those who have included species with pale coloured conidia in Ascochyta have advocated synonymy of Ascochyttella and Ascochyttula with Ascochyta.

3.3.3 A revised view of Ascochyttella and Ascochyttula.

I consider that these two genera cannot be distinguished. Diedicke (1912a, b) characterised Ascochyttella as having a pseudopycnidial wall, but this was not consistent with his acceptance of Tassi's 13 original species. For example, Ascochyttella unedenis (Sacc.) Tassi and A. canthifolia (Cooke & Massee) Tassi both have pseudoparenchymatic walls of textura angularis, 3 and 3-10 cells wide respectively. Several species of Ascochyttula have a similar wall structure of textura angularis, 2-4 cells wide e.g. Ascochyttula obiones (Jaap) Died. Wall structure, therefore, does not justify separation of the two genera (Petrak, 1921b, 1923). Conidial shape cannot serve as a distinguishing character either. At least five of Tassi's original Ascochyttella species have broad conidia with rounded ends, not fusiform with pointed ends as described for the genus by Diedicke (1912a, b). Other characters such as conidiomatal form, conidiogenesis, and conidial septation and pigmentation are similar for both genera. To my knowledge, teleomorph connections have not been proven for any species in these genera, although unconfirmed links have been reported with Leptostphaeria and Pleospora. (Potebnie, 1907; Petrak, 1924; Grove, 1935).

I concur with Clements & Shear (1931) that Ascochyttella and
Ascochytula should be listed as synonyms of Ascochyta, after I found that the type species of the three genera are congeneric. The genus Ascochyta, as discussed earlier (p. 31), includes species with hyaline to light brown, 1(-3) septate conidia, produced on phialides in simple, ostiolar, pycnidial conidiomata. Many Ascochyttella and Ascochytula species, which I examined, conform to this description, and are considered to belong in Ascochyta in the section Ascochyttella (Tassi) Sprague & Johnson. This section accommodates species with pale coloured conidia, and is a practical rather than a natural grouping, which should aid species identification within the large genus, Ascochyta. The type species of this section is A. vicina Sacc., the lectotype species of Ascochyttella Tassi.

Synonymy of Ascochyttella and Ascochytula with Pseudodiplodia, as proposed by Petrak (1953), is not supported. Pseudodiplodia ligniaria, the type species, differs in having annellidic conidiogenous cells, darker, brown conidia, and lacking a preformed conidiomatal ostiole.

To date, over 120 species of Ascochyttella have been described. Only the original thirteen species of Tassi (1902) are treated here. From Ascochytula, at generic or infrageneric rank, thirty-six species and two varieties are discussed. These represent all species names in Ascochytula Died., the three species listed by Potebnia (1907) in his provisional subgenus, and three names in Ascochyta subgenus Ascochytula (Died.) Trotter.

In the following treatment, the species are grouped in alphabetical order within each host family. The host families are also arranged alphabetically.
3.3.4 Species of Ascochyttella and Ascochyttula in Ascochyta section Ascochyttella

Areceaceae

**ASCOCYHTA COCOCINA** González Fragoso, Boletín de la R. Sociedad española de historia natural 17: 308 (1917).

**Fig. 11.**

**Lesions:** absent

**Conidiomata:** pycnidial, solitary, immersed, slightly erumpent, black, flattened globose, ca. 130 μm diam., ostiolate, glabrous; ostiole circular ca. 12 μm wide.

**Conidiogenous cells:** phialidic, hyaline, ampulliform to subglobose, collarette minute, ca. 3.5-4.5 μm high x 4 μm wide.

**Conidia:** medianly uniseptate, pale brown, elliptical to fusiform, usually not constricted at septum, base somewhat truncate, apex rounded, straight, smooth-walled, eguttulate,(5.5-)7-8.5(-9) x 2.5-3.5(-4) μm.

**Habitat:** on bark of *Cocos nucifera* L. (Areceaceae).

**Distribution:** Europe (Spain).

**Holotype:** In cortice *Cocoes nuciferae* prope El Palo (Málaga) cult.; leg. C. Bolivar, 9 Jan 1917 (MA!).

**Specimen examined:**

**Ascochyta cocoina:**

Spain - holotype of *A. cocoina* (MA).

**Notes:** This species was reported in the protologue to be similar to *Ascochyttella*, and was listed by Trotter (1931) in *Ascochyta* subgenus *Ascochyttula*. Mel'nik (1977) considered that it should be excluded from
Ascochyta because of its pale coloured conidia.

The holotype specimen which I examined consisted of a very small piece of wood on which were found Phoma spp. and a Pleospora-like fungus but only one pycnidium of A. cocaina. This pycnidium was observed in a squash mount, so conidiomatal wall characters were not determined. Only three conidiogenous cells were seen. The fungus is accepted in Ascochyta on the basis of the characters examined.

Asparagaceae

ASCOCHYTA ASPARAGINA (Petrak) comb. nov.


Fig. 12.

Lesions: absent.

Conidiomata: pycnidial, solitary, gregarious, sometimes closely aggregated in pairs or small groups, nonstromatic, immersed, slightly erumpent, dark brown to black, subglobose, (100-)130-170(-200) μm diam., papillate, ostiolate, glabrous; ostiole circular or oval, with a thickened border, 16-22 x 9-17 μm, projecting slightly above host surface.

Conidiomatal wall: in vertical section textura angularis, 3-4 cells wide, 13-17 μm; outermost 2-3 layers of cells yellow-brown, darkest towards the outside, with thickened walls, up to 8 x 5 μm, innermost cells hyaline, thin-walled, smaller, more isodiametric; towards the ostiole, wall sometimes wider, cellular detail somewhat obscured, cells darker brown, thick-walled, and compressed.
Ascochyta asparagina:

A, conidia
B, conidiogenous cells
C, median vertical section of conidioma
   A,B,C, holotype (W.12647)

D, conidia of another fungus on Asparagus
   (W 12205) - see text.
Conidiogenous cells: phialidic, lining the cavity, discrete, arising directly from cells of the wall or occasionally from an existing phialide, hyaline, ampulliform to conic, collarette small, periclinal wall thickened, rarely proliferating, rarely polyphialidic, 4-5.5 μm high x 3.5-6.5 μm wide.

Conidia: medianly 1-septate, rarely 2-septate, light yellow-brown, oval or elliptical, usually not constricted at septum, base rounded or somewhat truncate, apex rounded, straight, smooth-walled, eguttulate, occasional conidium more rounded and constricted at septum, uniseptate (5.5-)7-9(-10.5) x (2-)2.5-3(-3.5) μm.

Habitat: on stems of Asparagus officinalis (Asparagaceae).

Distribution: Europe (Czechoslovakia).

Holotype: Auf dürren Stengeln von Asparagus officinalis in einem Garten in Mähr.-Weisskirchen, 25 Jul 1916, Petrak (W!).

Specimen examined:

Ascochyttella asparagina:


Notes: The above is an emended description since the protologue of Ascochyttula asparagina appears to have been based on two collections bearing different fungi. Two specimens labelled, 'TYPUS: Ascochyttella asparagina' were received from W (No. 12647 and 12205). Both had similar collection details except for the date, 12647: 25 Jul 1916, 12205: Jul 1916. The fungi present on the two collections differed, most noticeably in conidiomatal wall structure and conidial size and shape. W12647 had a conidiomatal wall with definite cellular detail, except towards the
ostiole, and larger cells than that of W12205. W12205 had somewhat shorter, narrower conidia than those of W12647, as well as a second type of conidium, which was longer, wider, and strongly constricted (Fig. 12D). Each fungus was somewhat at variance with the published description of Ascochyta asparagina. The description is emended to apply only to the species on W12647, since the date on this specimen is more precise and is the same as that given by Petrak (1921b).

The use of the name Ascochyttella on the herbarium specimens and Ascochyta in publication perhaps reflects Petrak's opinion of these two genera. Petrak (1921b, p. 283) suggested that the separation of these genera based on pseudopycnidial versus parenchymatic conidiomatal wall structure was not absolute, since Ascochyta asparagina was parenchymatic only at its apex, and therefore could equally be considered an Ascochyttella species.

Ascochyta asparagina has smaller conidia than those reported for two other species, Ascochyta asparagi Sandu-Ville and Ascochyttella asparagi Ahmad, described on asparagus, although neither of these species was examined.

Asteraceae

**ASCOCYHTA MORAVICA** (Petrak) comb. nov.


Fig. 13.

Lesions: absent.

Conidiomata: pycnidial, solitary, gregarious, usually in irregular rows parallel to veins of stem, nonstromatic, subepidermal, somewhat erumpent,
Ascochyta moravica:

A, conidia
B, conidiogenous cells
C, median vertical section of conidioma

A, B, C, holotype (W 12262).
black, subglobose to flattened globose or sometimes laterally compressed, 220-440 μm long x 160-300 μm wide, slightly papillate, ostiolate, glabrous; ostiole ± circular, to 20 μm wide.

**Conidiomatal wall:** in vertical section textura angularis, 4-6 cells wide, 20-30 μm; cells smooth-walled, outer cells slightly thicker-walled and larger (up to 11 μm long) than the inner cells; on the sides, outermost layer of cells brown; towards the ostiole cells brown and thick-walled, otherwise wall hyaline.

**Conidiogenous cells:** phialidic, lining the cavity, discrete, arising directly from cells of the wall, hyaline, ampulliform to conic, channel moderately wide, collarette prominent and sometimes flaring, 3.5-5.5 μm high x 3.5-6.5 μm wide.

**Conidia:** medianly 1-septate, brown, elliptical to oval, not constricted at septum, basal cell tapering with end acutely rounded, apex rounded, straight, smooth-walled, guttulate, 1(-2) guttules per cell, 0-septate 7.8-8.5 x 3-3.5 μm; 1-septate (7.5-)8-9(-10.5) x (3-)3.5-4(-4.5) μm.

**Habitat:** on dead stems of *Centaurea scabiosa* L. (Asteraceae).

**Distribution:** Europe (Czechoslovakia).

**Holotype:** Auf dürren Stengeln von *Centaurea scabiosa* auf den Abhängen des "Swrčow" bei Mahr.-Weisskirchen, 20 Dec 1918, F. Petrak (W!).

**Specimen examined:**

**Ascochyta moravica:**

Czechoslovakia - on stem of *Centaurea scabiosa*, Felsige Hänge, Srčov, Mährisch-Weisskirchen, 20 Dec 1918, F. Petrak (W 12262) [holotype of *Ascochyta moravica*].

**Notes:** This species is herein transferred to *Ascochyta*, as the most suitable genus available, although the conidia are a darker brown, and
the conidiomatal wall somewhat thicker, than that found in other species of Ascochyta section Ascochytella. Other characters, however, such as conidiomatal form, conidiogenesis, and conidial shape and septation lie within the generic limits of Ascochyta.

Petrak (1921b, 1923, 1924) described seven species of Ascochytula but, without explanation, Petrak (1953) transferred only five of these to Pseudodiplodia, leaving A. moravica and A. asparagina in Ascochytula.

Additional literature: Trotter (1972, p. 1049).

Caprifoliaceae


≡ Diplodina symphoricarpi (Pass.) Allescher, Rabenhorst


≡ Ascochytula symphoricarpi (Pass.) Diedicke, Kryptogamen-


?≡ Diplodina deformis (P. Karsten) Saccardo f. symphoricarpi Fautrey

in Roumeguère, Revue Mycologique 12: 165 (1890).

Fig. 14.

Lesions: absent.

Conidiomata: pycnidial, solitary, scattered or aggregated, nonstromatic, subepidermal, somewhat erumpent, dark brown to black, globose to conic, 80-170 μm diam., sometimes laterally compressed, to 230 μm long, papillate, ostiolate, glabrous; ostiole circular, 10-20 μm wide.
Ascochyta symphoricarpi:

A-D, conidia
E, conidiogenous cells
F, median vertical section of conidioma

A, holotype of A. symphoricarpi (PARMA)
B, E, F, Sydow Mycotheca germanica no. 2390 (K)
C, Sydow Mycotheca germanica no. 2561 (K)
D, ex Herb. W.B. Grove (K).
Conidiomatal wall: in vertical section textura angularis, 2-4 cells wide, 7.5-12 μm; outermost cells larger with thicker, sometimes roughened, brown walls, paler at the conidiomatal base, innermost cells smaller with thin, hyaline, smooth walls; towards the ostiole, wall thicker, up to 5 cells wide, 18 μm, with 2-3 outer layers of thickened, rough, brown-walled cells.

Conidiogenous cells: phialidic, lining the cavity, discrete, arising directly from cells of the wall, hyaline, ampulliform to conic, collarette and periclinal thickening small but obvious, not proliferating, 3.5-5 μm high x 3-4.5 μm wide.

Conidia: medianly 1-septate, sometimes 2- or 3-septate, pale olivaceous brown, elliptical to fusiform, mostly not constricted at septa, base rounded or somewhat truncate, apex rounded, mostly straight or occasionally slightly curved, usually smooth-walled, eguttulate, (6.5-)8-12(-13) x (2-)2.5-3(-4) μm.

Habitat: on branches of Symphoricarpos albus (L.) S.F. Blake (= S. racemosus Michx.) (Caprifoliaceae).

Distribution: Europe (Ireland, England, France, Germany, Italy).

Holotype: Nei ramicelli vivi di Symphoricarpos racemosus Mchx., Parma (PARMA?).

Specimens examined:

Ascochyta symphoricarpi:

Italy - in ramulis Symphoricarpis racemosi, Parma, 0.B.(?) '87 (PARMA)

[?holotype of Ascochyta symphoricarpi].

Ascochyttula symphoricarpi:

Germany - auf Ästen von Symphoricarpis racemosa, in Gessellschaft von Phomopsis ryckholtii (Nke) Hoehn und Hendersonia fiedleri
West. var. symphoricarpi Cke., Brandenburg: Baumschulen zu Tamsel, 5 May 1927, P. Vogel, Sydow Mycotheca germanica no. 2390 (K).
- auf Ästen von Sympchorcarpus racemosa, Brandenburg: Potsdam, 13 Jun 1931, H. Sydow, Sydow Mycotheca germanica no. 2561 (K).
Ireland - on Symphoricarpus racemosus, Kilmashogue, Co. Dublin, 5 Apr 1936, ex Herb. W.B. Grove (K).

Diplodina deformis f. symphoricarpi:

France - sur rameaux verts du Symphoricarpus racemosa, dans un jardin à Noidan (Côte-d'Or), Mar 1890, F. Fautrey, C. Roumanguère
Fungi selecti exsiccati no. 5458 (K) [isotype of D. deformis f. symphoricarpi. Fungus not found on this specimen].

Notes: The wide morphological variability of this fungus which is evident from published descriptions, was confirmed in the specimens examined. The fungus often grows amongst other similar Coelomycetes which leads to confusion in positive identification. Conidial length, for example, was given by Passerini (1889) as 12 μm, Diedicke (1912b) as 10-15 μm, and Grove (1935) as 8-11 μm. In the specimens examined, mean length varied from 8 μm in Sydow Mycotheca germanica no. 2390, to 11 μm in the PARMA collection (Fig. 14 A-D). Conidia with 2-3 septa were common only in the Parma specimen. A few conidia from the Grove specimen had roughened walls (Fig. 14D).

The conidia were consistently pale coloured, not hyaline as originally described by Passerini. This distinguishes A. symphoricarpi from the hyaline Ascochyta species on Symphoricarpus viz., Ascochyta symphoricarpophila Fairman, A. symphoriae Briard & Hariot, and A. symphoriae Kabát & Bubák (a later homonym).

Ascochyta symphoricarpi is morphologically very close to Diplodina deformis (P. Karsten) Sacc. on Sambucus nigra L. (Sambucaceae).
D. deformis has somewhat larger conidiomata which lack an ostiole, and has a thicker conidiomatal wall. D. deformis f. symphoricarpi Fautrey is possibly a synonym of Ascochyta symphoricarpi, but the isotype specimen (K) did not bear the fungus.

The specimen of Ascochyta symphoricarpi examined is apparently the only specimen under this name in Passerini's herbarium at PARMA; I therefore presume that it is the holotype. Positive determination is hampered by the lack of collection details in Passerini's protologue to the species.

Additional literature: Saccardo (1892, p. 296); Grove (1935, p. 331); Mel'nik (1977, p. 196).

Celastraceae

ASCOCHYTA EUONYMELLA (Sacc.) Allescher, Rabenhorst Kryptogamen-Flora von Deutschland, Oesterreich, und der Schweiz. Die Pilze, Abt. 6: 642 (1899).


≡ Ascochytula euonymella (Sacc.) Grove, British Stem-and Leaf-Fungi (Coelomycetes) 1: 329 (1935).

Fig. 15.

Lesions: absent.

Conidiomata: pycnidial, solitary, gregarious, nonstromatic, immersed, erumpent, dark-brown to black, globose to flattened globose, 120-200 \( \mu \text{m} \) diam., papillate, ostiolate, glabrous; ostiole circular, ca. 15 \( \mu \text{m} \) wide. Conidiomatal wall: in vertical section textura angularis, 2-4 cells wide, 8-15 \( \mu \text{m} \); outermost layer of cells pale brown with slightly thickened,
Fig. 15

Ascochyta euonymella:
A. conidia
B. conidiogenous cells
C. median vertical section of conidioma
rough walls, innermost cells hyaline, thin-walled; towards the ostiole, wall 4-6 cells wide, 20-25 μm, outermost cells with thicker, rough, brown walls.

Conidiogenous cells: phialidic, lining the cavity, discrete, arising directly from cells of the wall or occasionally with a single supporting cell, hyaline, ampulliform to conic, collarette not flaring, periclinal wall thickened, not proliferating, 3.5-5.5 μm high x 2.5-4.5 μm wide.

Conidia: medianly 1-septate, rarely 2-septate, pale olivaceous, fusiform or sometimes elliptical, not constricted at septum, base usually truncate, apex rounded, mostly straight or sometimes slightly curved, smooth-walled, eguttulate, 1-septate (8.5-)9-11(-12.5) x 2-2.5(-3.0) μm; 2-septate 11-14.5 x 2-3 μm.

Habitat: on capsules and twigs of Euonymus europaea L. (Celastraceae).
Distribution: Europe (England, France).

Holotype: In capsulis Euonymi europaei, territorium Quevillense (prope Rouen), Letendre (PAD?).

Specimens examined:

Ascochyta vicina:
- on Euonymus europaeus, no. 796 (PAD) [holotype of A. vicina var. euonymella].

Ascochyta euonymella:

Notes: The specimen examined from PAD was the only collection available from Saccardo's herbarium under the name Ascochyta vicina on Euonymus. Gola (1930) reported that there were three specimens, including the type,
in PAD labelled *A. vicina*, with collection locations of Itb.(?) [= Northern Italy] and Amb. [= North America]; neither of these corresponds to the location in the protologue of *A. euonymella*. Since the specimen which I examined lacks collection details, it cannot be positively identified as the holotype.

Allescher (1899) raised the fungus from variety to species rank because he considered that *A. vicina* Sacc. var. *vicina*, which grows on stems, should be transferred to *Diplodina*.

From published descriptions, *A. euonymella* appears to be distinguishable, by its pigmented conidia, from the several hyaline-spored *Ascochyta* species recorded on *Euonymus*, including *A. euonymi* Pass., *A. oudemansii* Sacc. & Sydow (= *A. euonymi* Oudem.), and *A. euonymicola* Allescher. The pigmented species, *Microdiplodia euonymella* Petrak and *M. euonymi* Politis are reported to have wider and shorter conidia respectively than *A. euonymella*, while *A. kabati-bubaki* Savul. & Sandu-Ville (= *A. euonymi* Kabát & Bubák) is considered by Mel'nik (1977) to be a *Phyllosticta* species.

**Chenopodiaceae**

**ASCOCHYTA OBIONES** (Jaap) comb. nov.

≡ *Diplodina obionis* Jaap, Verhandlungen des Botanischen Vereins der Provinz Brandenburg 47: 96 (1905).


**Fig. 16.**
Lesions: absent.

Conidiomata: pycnidial, solitary or sometimes confluent, scattered or aggregated, nonstromatic, subepidermal, erumpent, dark brown to black, globose to flattened-globose or elliptical, 100-250 \( \mu m \) diam., papillate, ostiolate, glabrous; ostiole circular with a dark border, 20-50 \( \mu m \) wide.

Conidiomatal wall: in vertical section textura angularis, 3-4 cells wide, 13-21 \( \mu m \); cells smooth-walled, outermost 2 layers consisting of flattened cells measuring 6-11 x 4-6 \( \mu m \) with thickened pale brown, or occasionally brown, walls, inner layers of more isodiametric, thin-walled, hyaline cells; towards the ostiole, wall only sometimes wider, outermost cells darker with thickened brown walls.

Conidiogenous cells: phialidic, lining the cavity, discrete, arising directly from cells of the wall, hyaline, ampulliform, channel wide, collarette obvious and sometimes flaring, periclinal wall thickened, not proliferating, (4-)6(-8) \( \mu m \) high x (3-)5(-7) \( \mu m \) wide.

Conidia: medianly 1-septate, rarely 2- or 3-septate, pale brown, elliptical or oblong to cylindrical, often weakly constricted at septum, septum brown and at its circumference thickened and sometimes protruding, base broadly rounded or somewhat truncate, apex broadly rounded, straight or sometimes slightly curved, smooth-walled, sometimes guttulate when young, 1-septate (8-)9-12(-14) x (3-)3.5-4.5(-6) \( \mu m \); 2- and 3-septate 11.5-16 x 3.5-4.5 \( \mu m \).

Habitat: on leaves and stems of Halimione portulacoides (L.) Aellen (= Obione portulacoides (L.) Moq.) (Chenopodiaceae).

Distribution: Europe (England, Germany).

Isotype: Auf dürren Zweigen von Obione portulacoides, Strandwiesen bei Wittdün auf der Insel Amrum, Schleswig-Holstein, Otto Jaap Fungi selecti exsiccati no. 98 (BPI!, HBG!, K!).
Ascochyta obiones:

A, conidia

B, conidiogenous cells

C, median vertical section of conidioma

A, isotype (K)

B, culture CBS 786.68

C, isotype (HBG).

(overleaf)

D, thin section through conidia (x10,000).

E, thin section through the apex of a phialidic conidiogenous cell to show the collarette and several wall layers (between arrowheads) in the periclinal thickening (x20,000).

F, thin section through a phialide, with a developing conidial initial and pronounced periclinal thickening (x19,500).

D,E,F, culture CBS 786.68.
Specimens examined:

Ascochyta obionis:

England - on *Obione portulacoides*, Sandplace (2), Cornwall, 23 Jul 1929, P.G.M. Rhodes no. 4203 & F. Rilstone (K).
- on *Obione portulacoides*, Sandplace, E. Cornwall, 19 Sep 1932, P.G.M. Rhodes no. 5167 (K).
- on *Obione portulacoides*, Gibraltar Point, Lincolnshire, Jan 1962, G. Morgan-Jones (IMI 107966 - slide only).

Germany - auf *Obione portulacoides*, Steenodde auf Amrum, 28 Jul 1904, O. Jaap (FH, HBG - 2 specimens).

*Diplodina obionis*:

Germany - auf dürren Zweigen von *Obione portulacoides* Moquin-Tandon, Strandwiesen bei Wittdün auf der Insel Amrum, Schleswig-Holstein, 29 Jul 1904, O. Jaap, Otto Jaap Fungi selecti exsiccati no. 98 (BPI, HBG - 2 specimens, K) [isotypes of *Diplodina obionis*].

Characteristics in culture:

Colonies on oatmeal agar at ca. 20°C, under 12 h darkness/12 h near-ultraviolet plus cool white fluorescent light. In 18 days, 3.5-4 cm diam.; colony flat, aerial mycelium cottony, low, grey olivaceous* towards the centre of the colony, white to pale rosy vinaceous towards the diffuse, irregular margin, colony reverse pale ochreous; conidiomata immersed, or on surface of agar, occasionally on aerial mycelium, often aggregated in groups, hairy, pale brown becoming darker with age; conidial slime brown.

On malt extract agar, aerial mycelium absent, colony greenish glaucous, colony reverse concolourous; conidiomata abundant.

On potato dextrose agar, aerial mycelium white, bearing a few conidiomata, with sectors of dense conidiomatal production lacking aerial mycelium, margin diffuse and irregular, colony reverse pale saffron and dark grey olivaceous.

Culture examined:
Ascochytula obiones:
- on Halimione portulacoides (CBS 786.68).

Notes: Ascochytula obiones was chosen as the lectotype species for Ascochytula by Clements & Shear (1931), although the genus was listed by these authors as a synonym of Ascochyta. However, Grove (1935) recognized Ascochytula and Ascochytula obiones. Dickinson & Morgan-Jones (1966), in an extensive study of A. obiones, concluded that the species should not be transferred to Ascochyta. While acknowledging that the conidia were similar to those of Ascochyta, they considered that the different structure of the conidiomatal walls of A. obiones and Ascochyta pisi, the type species of Ascochyta, justified separation of Ascochytula and Ascochyta.

The conidiomatal wall of A. obiones has been variously described as pale parenchymatic (Jaap, 1905), thick-walled parenchymatic (Diedicke, 1912b; Migula, 1921), and truly parenchymatic, rather thin, pale fuscous, much darker round the ostiole (Grove, 1935). Dickinson & Morgan-Jones (1966) reported that the wall of A. obiones had a bilayered structure, consisting of an outer layer of thick-walled, dark cells and an inner one of small, hyaline cells. By contrast, they described Ascochyta pisi as having a thin, undifferentiated, light brown conidiomatal wall.

My examination of A. obiones confirms that the wall, 3-4 cells wide of textura angularis, is differentiated into two layers, but pigmentation of the outer cells is variable, from pale brown (in type collections and
in culture), to brown (in Rhodes no. 4203, K). Cells at the ostiole are brown. *A. pisi* has a thinner, usually hyaline, conidiomatal wall of textura angularis, (1-)2(-3) cells wide, but not entirely lacking a bilayered appearance. The outermost cells have a somewhat thickened wall and cells at the ostiole are pale brown. A bilayered wall structure is more evident in cultures of *A. pisi*, where the wall, 1-4 cells wide, has an outermost layer of cells with very pale brown, thickened walls, and an inner layer of hyaline cells.

I consider that the differences in wall pigmentation and thickness between *A. obiones* and *A. pisi* are too minor to justify separation of *Ascochyta obiones* from *Ascochyta*, and I therefore propose the new combination, *Ascochyta obiones*.

Both *A. obiones* and *A. pisi* have phialidic conidiogenesis (Figs. 16 and 4, 5). Dickinson & Morgan-Jones (1966) suspected that conidiogenesis in *A. obiones* was annellidic, but could not verify this. The conidiogenous cells of *A. obiones* which I examined were definitely phialidic, with a collarette enclosing a multilayered periclinal thickening. The number of wall layers in this thickening represents the number of conidia which have seceded. In Fig. 16E, 7-9 layers can be distinguished.

Although the conidia of *A. obiones* are pale brown and those of *A. pisi* are hyaline, *Ascochyta* is herein accepted as including species with pale coloured conidia (see p. 18). Conidia of *A. obiones* were described by Dickinson & Morgan-Jones (1966) as having an apical cell larger than the basal cell. From my observations, this character is variable, and is not diagnostic for this species. The degree of constriction at the septa is also variable; those conidia in Jaap's two Jul 28, 1904 collections (HBG) were more strongly constricted than in others.

There are no confirmed teleomorph connections for either *A. obiones* or *A. pisi*, although Grove (1935) reported that *Leptosphaeria obiones*
(Crouan & Crouan) Sacc. grew with A. obiones and Coniothyrium obiones Jaap.

The specific epithet of A. obiones, originally spelt obionis, was changed by Grove (1935) to obiones. Dr G. Kuschel (pers. comm.) advised that the epithet should be kept as obiones. The usual Latin genitive case of Obione, a Greek word, is obionae but obiones is also acceptable. Obionae could be confusing by implying a host name, Obiona.

Additional literature: Migula (1921, p.305, taf. 37, fig. 1-5); Grove (1935, p. 329); Dickinson & Pugh (1965a & b); Dickinson & Morgan-Jones (1966, p. 47-50, fig. 1-2); Kohlmeyer & Kohlmeyer (1979, p. 90, 516-7).

Ericaceae

ASCOCYHTA UNEDonis Saccardo [as unedinis], Michelia 1: 530 (1879).

≡ Ascochyrtella unedonis (Sacc.) Tassi, Bulletino del Laboratorio ed Orto Botanico, Siena 5: 28 (1902).

Fig. 17.

Lesions: on leaves, variable in shape, paler coloured than surrounding leaf surface, bounded by a raised, dark red-brown margin, up to 9 x 5 mm. Conidiomata: pycnidial, solitary, sparse, epiphyllous, nonstromatic, immersed, barely showing at leaf surface, black, globose or subglobose, 130-210 μm diam., nonpapillate, lacking a preformed ostiole, glabrous. Conidiomatal wall: in vertical section textura angularis, mostly 3 cells wide, 12-16 μm; cells smooth-walled, 3-8 μm long x 2-4 μm wide, outermost cells rectangular with slightly thickened, pale brown walls, innermost cells subglobose, hyaline, thin-walled; towards the conidiomatal apex, cells somewhat compressed, brown, thick-walled.
Ascochyta unedonis:

A, conidia
B, conidiogenous cells
C, median vertical section of conidioma
A,B,C, holotyple (PAD).
Conidiogenous cells: phialidic, lining the lower half of the cavity, discrete, arising directly from cells of the wall, hyaline, subglobose to conic, collarette sometimes flaring, periclinal wall thickened, not proliferating, 3-4.5 μm high x 4-5 μm wide.

Conidia: medianly uniseptate, pale yellow-brown, fusiform to oblong, not or only weakly constricted at septum, base truncate or broadly rounded, apex rounded, straight or occasionally slightly curved, smooth-walled, eguttulate, (6-)7.5-10(-12) x (2-)2.5-3 μm.

Habitat: on leaves of Arbutus unedo L. (Ericaceae).

Distribution: Europe (France).

Holotype: in foliis Arbuti unedinis, Saintes, P. Brunaud (PAD!).

Specimen examined:

Ascochyta unedonis:
- collection details lacking, spores and pycnidium sketched on packet (PAD) [holotype of A. unedonis].

Notes: Gola (1930) reported that two collections of this fungus were deposited in PAD, and that one or both were type specimens. The specimen which I examined was the only collection available from PAD and is probably the holotype. The herbarium packet bears the name, Ascochyta unedonis n.s., with the numeral, I. There are also drawings and measurements of conidia and a pycnidium. These correspond to the measurements given by Saccardo (1879) in the protologue to A. unedonis. The fungus is rare on this specimen. An unidentified sporodochial Hyphomycete is common in the same lesions.

Allescher (1899) stated that A. unedonis differed significantly from typical Ascochyta species in having coloured conidia. For this reason, Tassi
(1902) listed it among the thirteen original species of Ascochyttella Tassi. Likewise, Mel'nik (1977) did not accept A. unedonis in Ascochyta, because of its pigmented conidia.

Fabaceae

ASCOCHYTA DORYCNII (Petrak) comb. nov.


Fig. 18.

Lesions: absent.
Conidiomata: pycnidial, usually solitary, scattered, nonstromatic, subepidermal, erumpent, black, subglobose, 100-180 μm diam., papillate, ostiolate, glabrous; ostiole circular with a slightly thickened border, ca. 20 μm wide.
Conidiomatal wall: in vertical section textura angularis, 2-3 cells wide, 7-14 μm; cells smooth-walled, outermost cells thick-walled, light brown fading to very pale brown at the conidiomatal base, cells up to 8.5 μm across, innermost cells smaller, hyaline, thin-walled; towards the ostiole, wall thicker, up to 18 μm wide, cells thick-walled, brown.
Conidiogenous cells: phialidic, lining the cavity, usually discrete, arising directly from cells of the wall, hyaline, ampulliform to conic, channel wide, collarette and periclinal thickening minute, not proliferating, 2.5-4.5 μm high x 3-5 μm wide.
Conidia: medianly 1-septate, occasionally 2- or 3-septate, pale yellowish to olivaceous brown, light brown in mass, cylindrical, oblong, or elliptical, not or only weakly constricted at septa, base often truncate, apex broadly
Ascochyta dorycni:

A, conidia
B, conidiogenous cells
C, median vertical section of conidioma
A,B,C, holotype (W 12665).
rounded, mostly straight, smooth-walled, eguttulate, 1-septate (6.5-)
8-10.5(-12.5) x 2.5-3.5(-4) μm; 2- and 3-septate 10-12.5 x 3-4 μm.

Habitat: on thin, dead branches of Dorycnium herbaceum Vill. (Fabaceae).
Distribution: Europe (Czechoslovakia).
Holotype: auf dürren, dünnen Ästchen von Dorycnium herbaceum - Auspitz
in Mähren; Feldweg von Poppitz nach Steirowitz, Jul 1923, leg. Dr. J.
Hruby (W!).

Specimen examined:
Ascochyta dorycni:
Czechoslovakia - Holotype of A. dorycni with collection data as above
(W 12665).

Notes: In the type specimen, A. dorycni is associated with a number of
other fungi; including two Pleospora spp. and a Leptosphaeria sp. As
reported by Petrak (1924), these three species are poorly developed and
sparse on the type material, but may include the teleomorph of A. dorycni.

A different host, Dorycnium suffruticosi auct. (=D. gracile Jord.)
was reported for A. dorycni in Index of Fungi 3: 310. This was probably
a mistake, rather than a reidentification of the host, or a new host record.

ASCOCHYTA LUDWIGIANA (Petrak) comb. nov.

Fig. 19.
Lesions: absent.

Conidiomata: pycnidial, solitary, gregarious, sometimes 2 or 3 closely grouped, nonstromatic, subepidermal, erumpent, black, flattened globose or often broadly ellipsoidal, 140-250 \( \mu m \) long x 140-180 \( \mu m \) wide, papillate, ostiolate, glabrous; ostiole circular with a black border, 15-25 \( \mu m \) wide.

Conidiomatal wall: in vertical section textura angularis, 2-3 cells wide, 10-16.5 \( \mu m \); cells smooth-walled, outermost 1-2 layers of cells 6.5-13 \( \mu m \) across, with brown walls thickened up to 1.5 \( \mu m \), innermost layer(s) of cells with hyaline thinner walls; towards the ostiole, wall composed of 3-5 layers of smaller, thick-walled, brown cells.

Conidiogenous cells: phialidic, lining the cavity, discrete, arising directly from cells of the wall, hyaline, ampulliform to conic, channel wide, collarette and periclinal thickening prominent, not proliferating, 5.5-8 \( \mu m \) high x 9-15 \( \mu m \) wide.

Conidia: ± medianly 1-septate, rarely 2- or 3-septate, light brown, broadly ellipsoidal, oval, or subglobose, not or only weakly constricted at septa, base and apex broadly rounded, straight, smooth-walled, usually with one guttule in each cell, 1-septate (7.5-)9.5-13(-16) x (5.5-)6-7.5 (-8) \( \mu m \); 2- and 3-septate ca. 12.5-13.5 x 7-7.5 \( \mu m \).

Habitat: on dead stems of *Onobrychis sativa* Lam. = *O. viciifolia* Scop. (Fabaceae).

Distribution: Europe (France).

Holotype: Auf dürren Stengeln von *Onobrychis sativa* bei Forbach in Lothringen (= Lorraine), 11 Apr 1914, leg. A. Ludwig (M!).

Specimen examined:

Pseudodiplodia ludwigiana:

France - on *Onobrychis sativa*, Forbach: Thedinger Blog (?), 11 Apr 1914,
Fig. 19

Ascochyta ludwigiana:

A, conidia
B, conidiogenous cells
C, median vertical section of conidioma

A, B, C, holotype (W 10929).
A. Ludwig, Herbarium Dr A. Ludwig, Flora von Lothringen (W 10929) [holotype of A. ludwigiana].

Notes: Due to the overmaturity of this specimen, Petrak (1923) did not see conidiogenous cells and they were infrequent in the pycnidia which I examined. As well as the unusually large collarettes and periclinal thickening, the conidiogenous cells are distinctive in that the cytoplasm of some has shrunk back to lie well below the cell apex.

Petrak reported a Plenodomus or Sclerophomella-type fungus growing with A. ludwigiana. Also seen on the holotype was a Phoma species and another Ascochyta species with pigmented conidia, 8-12 x 2-3 μm.

Several Ascochyta species and varieties have been recorded on Onobrychis sativa, including: Ascochyta orobi Sacc. (= A. pisi Lib. fide Mel'nik, 1977); A. orobi Sacc. var. onobrychidis Prillieux & Delacroix; A. onobrychidis V. Bondarzeva-Monteverde (= A. boltshauersi Sacc. fide Mel'nik, 1977); and A. pisi Lib. var. onobrychidis Sacc. & Trotter. The first three would appear to be readily distinguishable from A. ludwigiana by their reportedly longer, hyaline conidia. A. pisi var. onobrychidis was described with longer, wider, pale greenish conidia. Specimens of these fungi were not examined.


≡ Diplodia maculicola Winter, Hedwigia 24: 259 (1885).

Fig. 20.
Lesions: on adaxial leaf surface, yellow-brown to yellow against dark brown leaf, irregularly shaped, margin diffuse, 0.4-1.0 mm across.

Conidiomata: pycnidial, solitary or in pairs, scattered, nonstromatic subepidermal, somewhat erumpent, dark brown, conic to pulvinate, conidiomatal base flat, 120-320 µm diam., nonpapillate, nonostiolate, glabrous; dehiscence by rupture at conidiomatal apex.

Conidiomatal wall: reduced, in vertical section textura angularis, 0-1 cell wide, cells hyaline, smooth, thin-walled, 4-6.5 µm wide; towards the conidiomatal apex, wall 3-5 cells wide, cells thicker-walled, hyaline except for occasional pale brown cell, 2.5-5 µm wide.

Conidiogenous cells: phialidic, lining the cavity, discrete, arising directly from cells of the wall or sometimes supporting wall cell not obvious, hyaline, ampulliform, collarette distinct enclosing thickened periclinal wall, sometimes proliferating, 4-7.5 µm high x 4.5-8 µm wide.

Conidia: medianly uniseptate, light brown, oval to elliptical, not constricted at septum, base often truncate rarely with remnants of a frill, apex broadly rounded, mostly straight or slightly curved, smooth-walled, guttulate with numerous small cell inclusions, (10.5-)13-15.5 (-18) x (4.5-)5-6(-6.5) µm.

Habitat: on living leaves of ?Andira Juss. (Fabaceae).

Distribution: South America (Brazil).

Isotype: Ad folia viva Leguminosae adhuc indeterminatae, Brasilia: Prope São Francisco, leg. E. Ule, Rabenhorstii Fungi europaei et extraeuropaei 3298 (JE!).

Specimens examined:

Diplodia maculicola:

Brazil - ad folia viva Leguminosae adhuc indeterminatae, prope São
Fig. 20

*Ascochyta maculicola:*

A, conidia
B, conidiogenous cells
C, median vertical section of conidioma

A, B, C, ex herb. Ule (HBG).
Francisco, Oct 1884, E. Ule, Rabenhorst-Winter Fungi europaei 3298 (JE) [isotype of D. maculicola].
- Andira auf Papilionaceae, pr. St Catharina, São Francisco, Oct 1884, ex herb. Ule (HBG).

Notes: The reduced conidiomatal wall, flattened conidiomatal base, and lack of a preformed ostiole is not typical of most Ascochyta species, but the conidiogenesis and conidia conform to the generic concept of Ascochyta. Tassi (1902) reported that this species showed similarities to Ascochyta.

The host of D. maculicola was described in the protologue as an unidentified member of the Leguminosae. On the label of the HBG collection, the host is named as 'Andira auf Papilionaceae'. It is uncertain whether this was a later identification of the host, or an earlier identification found to be incorrect and thus omitted from the protologue. The name does not appear on the isotype, Fungi europaei 3298.

Ascochyttella winteri Tassi was one of the thirteen original species of Ascochyttella, although somewhat atypical of the genus. The name was not valid as a new species, since Tassi (1902) indicated that it was based on Diplodia maculicola Winter. A new combination of the epithet maculicola should have been made in Ascochyttella, there being no existing combination to prevent it.

Microdiplodia andirae Batista & Maia, also recorded on Andira from Brazil, would appear to be distinct from A. maculicola as it was described with smaller, thick-walled conidiomata and shorter conidia. I did not examine this fungus. Zambettakis (1954) considered D. maculicola to be a synonym of Diplodia microsporella Sacc, along with other fungi including Microdiplodia henningsii Staritz. These two species were not examined, but the description of M. henningsii, as having an ostiolate pycnidial conidiomata and shorter conidia (Webster & Lucas, 1959), would suggest that D. maculicola
is different from *M. henningsii*.

Additional literature: Saccardo (1892, p. 276).

**ASCOCHYTA ULICIS** (Grove) comb. nov.

≡ *Ascochytula ulicis* Grove, British Stem- and Leaf-Fungi (Coelomycetes) 1: 457, 331 (1935).

Fig. 21.

Lesions: absent.

Conidiomata: pycnidial, solitary, gregarious, nonstromatic, subepidermal, erumpent, becoming exposed when overlying host tissue cracks and flakes, black, globose, 150-220 μm diam., somewhat papillate, ostiulate, glabrous. Conidiomatal wall: in vertical section textura angularis, 5-7 cells wide, 20-28 μm; cells smooth-walled, outermost 3-4 layers of cells pale brown and thicker-walled than the inner hyaline cells; towards the ostiole, cells darker brown.

Conidiogenous cells: phialidic, lining the cavity, discrete, arising directly from cells of the wall, hyaline, broadly ampulliform, collarette often flaring, enclosing thickened periclinal wall, septum delimiting conidium often forms above collarette, cells 4-6 μm wide.

Conidia: medianly 1-septate, rarely 2-septate, very pale brown, elliptical to fusiform, not constricted at septum, base bluntly round or truncate, apex rounded, straight, smooth-walled, microguttulate, (7.5-)8-10(-13.5) x 2-2.5(-3.0) μm.

Habitat: on dead stems of *Ulex europaeus* L. (Fabaceae).

Distribution: Europe (England).

Holotype: on dead stems of *Ulex europaeus*, Powick, near Worcester, May (Rhodes) (K!).
Ascochyta ulicis:

A, conidia

B, conidiogenous cells

A, B, holotype (K).
Specimens examined:
Ascochyta ulicis:

England - on Ulex europaeus, Old Hills, Powick, near Worcester, 26 May 1931, P.G.M. Rhodes, no. 4778c (K) [holotype of A. ulicis].
- on Ulex europaeus, Slapton Ley, S. Devon, 9 Jun 1972, D.L. Hawksworth (IMI 166798b) [Fungus not found on this specimen].

Notes: Conidiogenous cells of A. ulicis were sometimes seen with the septum, which separates the developing conidium, forming above the level of the collarette. This may suggest proliferation of the conidiogenous locus. Otherwise, the wall layers of the conidiogenous cell may shrink back, after each conidial secession, to the level of the periclinal thickening within the collarette. The conidial initial would then be produced at a fixed locus but secede at a second, higher locus. Cultural examination of the fungus is needed to study this phenomenon.

Other fungi on the holotype with similar dark, pycnidal conidiomata included Phoma spp. and Diplodia ulicis Sacc. & Speg.

Grossulariaceae

ASCOCYHTA GROSSULARIAE Oudemans, Nederlandsch Kruidkundig archief, ser. 3, 1: 498 (1898); non Libert (1834).

≡ Ascochyta grossulariae (Oudem.) Diedicke, Kryptogamen-Flora der Mark Brandenburg, Pilze VII, 9(2): 410 (1912)

Lesions: absent.

Conidiomata: pycnidial, solitary or occasionally clustered in pairs or small groups, scattered or aggregated, nonstromatic, subepidermal, erumpent, dark brown to black, subglobose, flattened globose, or irregularly lobed, 80-200 μm diam., mostly nonpapillate, ostiolate, glabrous; ostiole ± circular, central or eccentric, with a dark brown border, 5-12 μm wide.

Conidiomatal wall: in vertical section textura angularis, 2-3 cells wide, 8-12 μm; cells hyaline with smooth, thin walls, outermost cells usually larger and slightly thicker walled; towards the ostiole, wall 4 cells wide, 13-16 μm, composed of thick walled, dark brown cells.

Conidiogenous cells: holoblastic, rarely with a single proliferation or collarette, lining the cavity, discrete, arising directly from cells of the wall, hyaline, subglobose, ampulliform, or conic, 3-6 μm high x 3-6 μm wide, otherwise obclavate or lageniform, 7-9 μm high x 2.5-4 μm wide.

Conidia: medianly 1-septate, rarely 2-septate, pale olivaceous, narrowly cylindrical to oblong or elliptical, not constricted at septum, apex rounded, base sometimes truncate or bluntly rounded, straight or sometimes slightly curved, smooth walled, eguttulate, 1-septate (7-)8-11.5(-16) x (1.5-)2.0-2.5(-3) μm 2-septate 12-14.5 x 2.5-3 μm.
Ascochyta grossulariae:

A,B,C, conidia
D,E, conidiogenous cells
A,D, neotype (L88)
B,E, Flora moravica, May 1936 (K)
C, ex Herb. W.B. Grove, Apr 1933 (K).

(overleaf)
F,G, surface view of conidioma to show irregular, lobed shape and eccentric ostiole.
H, median vertical section of conidioma.
F,H, Flora moravica, May 1936 (K)
G, ex Herb. W.B.Grove, Apr 1928 (K).

Distribution: Europe (England, Scotland, Netherlands, Germany, Czechoslovakia).

Holotype: Sur les rameaux du Ribes grossularia, Wassenaar, 1894; Destée.

Specimens examined:

Ascochyta grossulariae:

Netherlands - [host not named], Princepeel bij Mil, N. Brabant, 17 Mar 1899, J. Ritzema-Bos (L88) [Neotype].

Ascochyttella grossulariae:

England - on gooseberry, Lambourne Hill, West Cornwall, 17 Apr 1933, F. Rilstone, Ex Herb. W.B. Grove (K).

Scotland - on tip of wild gooseberry between Greenlaw and Hume, Berwickshire, 7 May 1944, R.W.G. Dennis (K) [Fungus not found on this specimen].

Czechoslovakia - auf Ribes grossularia, Sternberg, Mähren, May 1936, L.J. Piskor, Flora moravica (K).

Diplodina (Ascochyttella) grossulariae:

England - on Ribes grossularia, Ockeridge (with Coniothyrium ribicolum), 25 Apr 1928, Ex Herb. W.B. Grove (K).

Diplodina oudemansii:

Germany - auf lebenden, einjährigen Zweigen von Ribes grossularia L., Triglitz in der Prignitz, Prov. Brandenburg, 1 Apr 1907, Otto Jaap, Otto Jaap Fungi selecti exsiccati no. 288 (K).
Notes: The name *Ascochyta grossulariae* Oudem. is used here in a provisional sense only. *Ascochyta* species are phialidic, whereas conidiogenous cells in *A. grossulariae* are holoblastic, except for a few with what appears to be either a single, very short proliferation or a minute collarette. There is no genus in Sutton (1980) to accommodate pycnidial fungi with holoblastic, unisepitate, non-appendaged, pale brown conidia. Furthermore, *A. grossulariae* Oudem. is a later homonym of *Ascochyta grossulariae* Lib. [= *Septoria grossulariae* (Lib.) Westend. *fide* Saccardo, 1884; Mel'nik, 1977], and is therefore an illegitimate name. Since *Ascochyta* is only a temporary generic name for this fungus, a new epithet has not been chosen.

The holotype of *Ascochyta grossulariae* Oudem. cannot be traced in Oudemans's herbarium (L). In the absence of the holotype and any known isotype, the specimen (L88), collected in 1899 by Ritzema Bos, a co-worker of Oudemans's, is designated the neotype. Although the host name is not written on the specimen packet, the material is identifiable as branches of *Ribes grossularia*.

Although type material was not examined, *Diplodina grossulariae* Sacc. & Briard appears, from its description, to be synonymous with *Ascochyta grossulariae* Oudem. Both fungi were described on *Ribes grossularia*. Grove (1935) suggested that the two species were the same, and should examination of type specimens confirm synonymy, the earlier epithet will be *grossulariae* of Saccardo & Briard.

The conidiomata of *A. grossulariae* are distinctive with their often irregularly lobed shape and sometimes eccentric ostiole (Fig. 22 F,G). Conidia and conidiogenous cells, from different collections, are somewhat variable in size and shape (Fig. 22 A-E). *A. grossulariae* grows in a mixed population including *Hendersonia*, *Phoma*, and *Coniothyrium* species. Grove (1937, p. 8 and 83) considered *Hendersonia grossulariae* Oudem. and *Coniothyrium ribis* Brunaud to be part of the same life cycle with *A. grossulariae*. 
Additional illustrations: Diedicke (1912b, p. 30, fig. 19); Migula (1921, taf. 37, fig. 10, 11).

Lamiaceae

ASCOCYHTA PHLOMIDICOLA nom. nov.

≡ Ascochyta phlomidis Grove, British Stem- and Leaf-Fungi (Coelomycetes) 1: 457, 329 (1935); non Jaap (1916).

Fig. 23.

Lesions: absent.

Conidiomata: pycnidial, solitary, gregarious, nonstromatic, subepidermal, erumpent, black, globose to flattened globose, 80-140 μm diam., somewhat papillate, ostiolate, glabrous; ostiole circular, surrounded by a rim of dark brown cells, narrow, 4-10 μm wide.

Conidiomatal wall: in vertical section textura angularis, 2-4 cells wide, 6-13 μm; outermost 1-2(-3) layers of cells brown, sometimes paler towards the conidiomatal base, rough-walled, more elongate, and thicker-walled than the hyaline, smooth, thin-walled innermost cells; towards the ostiole, wall wider, up to 20 μm, of smaller cells with thicker, brown, rough walls and a single layer of small hyaline innermost cells.

Conidiogenous cells: phialidic, lining the cavity, usually discrete but occasionally 2 or 3 closely grouped, mostly arising directly from cells of the wall, hyaline, conic to ampulliform, collarette small, not proliferating, 3-5.5 μm high x 3.5-7 μm wide.

Conidia: medianly 1-septate, rarely 2- or 3-septate, light olivaceous-brown, cylindrical, elliptical, or fusiform, not constricted at septum, base somewhat truncate or bluntly rounded, apex rounded, straight or
Fig. 23

Ascochyta phlomidicola:

A, conidia
B, conidiogenous cells
C, median vertical section of conidioma

A,B,C, holotype (K).
sometimes slightly curved, smooth-walled, eguttulate, 1-septate (7-)8.5-10.5(-11.5) x 2-2.5(-3) µm; 2- and 3-septate 11-14 x 2.5-3 µm.

Habitat: on dead stems of Phlomis fruticosa L. (Lamiaceae).

Distribution: Europe (England).

Holotype: on dead stems of Phlomis fruticosa, in a garden at Polperro, Cornwall, April (K!).

Specimen examined:

Ascochyta phlomidis:

   England - holotype, as above, no date (K).

Notes: The basionym is a later homonym of Ascochyta phlomidis Jaap (1916) (= Ascochyta jaapii Sacc.) and therefore must be rejected (Art. 64). Published descriptions suggest that the two names might stand for the same fungus. Specimens of Ascochyta phlomidis Jaap, however, were not present amongst Jaap's collections at HBG, nor at B, E, FH, H, or JE. In the absence of confirmed synonymy, and of any other legitimate epithet for Grove's fungus, a new name Ascochyta phlomidicola is here presented (Art. 72). The epithet, phlomidis, could not be used for this fungus in Ascochyta, because of the earlier name, Ascochyta phlomidis Bubák & Wróblewski in Bubák (1916a). The latter fungus, examined from FH, was found to be distinct from A. phlomidicola. A. phlomidis has light brown pycnidial conidiomata formed within leaf lesions, and subhyaline, wider conidia. Mel'nik (1977) listed this fungus as a synonym of Ascochyta lamiorum Sacc.
Oleaceae

ASCOCHYTA PTEROPHILA (Fautrey) Keissler, Annalen des Naturhistorischen Museums in Wien 35: 18 (1922).

≡ Diplodia pterophila Fautrey in Roumeguère, Revue mycologique 12: 124 (1890).

≡ Microdiploodia pterophila (Fautrey) Allescher, Rabenhorst Kryptogamen-Flora von Deutschland, Oesterreich, und der Schweiz. Die Pilze, Abt. 7: 86 (1901).


≡ Ascochyta syringae Jaap, Annales mycologici 12: 26 (1914).

≡ Ascochyta syringae (Jaap) Trotter, Sylloge fungorum 25: 346 (1931); non Bresadola (1894).

Fig. 24.

Lesions: absent.

Conidiomata: pycnidial, solitary, or occasionally adjacent conidiomata confluent, scattered or gregarious, sparse, nonstromatic, subepidermal, erumpent, black, globose to flattened globose, 80-160(-200) μm diam., not or sometimes weakly papillate, ostiolate, glabrous; ostiole circular, 10-25 μm wide.

Conidiomatal wall: in vertical section textura angularis, 2-3(-4) cells wide, 8-16 μm; outermost cells up to 11.5 x 5 μm with slightly thickened, slightly roughened walls, pale brown fading to subhyaline at conidiomatal base, innermost cells smaller, thin-walled, hyaline; towards the ostiole, wall wider, up to 25 μm, outermost cells with thickened, slightly roughened, light brown to brown walls, innermost cells hyaline.
Ascochyta pterophila:

A-D, conidia

E,F, conidiogenous cells

G, median vertical section of conidioma

A, isotype (UPS)

B,E,G, isotype (NY)

C, F.Ludwig, Apr 1908 (PC)

D,F, ?holotype of A. syringae (HBG).
Conidiogenous cells: phialidic, lining the cavity, discrete, arising directly from cells of the wall, hyaline, ampulliform, collarette sometimes weakly flaring, not or rarely proliferating, 3-5 μm high x 3.5-6 μm wide.

Conidia: medianly 1-septate, sometimes 2- or 3-septate, pale olivaceous brown, light yellow brown in mass, elliptical or fusiform, not constricted at septum except in some multiseptate conidia, base mostly truncate, apex rounded, mostly straight, smooth-walled, eguttulate, 1-septate (6.5-)8.5-11 (-13.5) x (2-)2.5-3(-3.5) μm; 2- and 3-septate 10-14 x 2.5-3.5 μm.

Habitat: on samaras of Fraxinus excelsior L., and on capsules of Syringa vulgaris L. (Oleaceae).

Distribution: Europe (France, Germany).

Isotype: Sur les samares du Fraxinus excelsior en communauté avec Phoma samarorum et Ph. pterophila, Nôidán (Côte-d'Or), Février, 1890, F. Fautrey, Roumequère Fungi selecti exsiccati 5379 (NY!, UPS!)

Specimens examined:

Diplodia pterophila:

France - isotype of A. pterophila, as above (NY, UPS).
- sur samares de frêne, avec Phoma pterophila (les plus gros perithèces)..., F. Fautrey, Herbier Cryptogamique de la Côte-D'or no. 1306 (PC). [Fungus not found on this specimen.]
- sur samares de frêne, Parc de Saint-Cloud, Apr 1908, F. Ludwig (PC).

Ascochyta syringae:

Germany - auf Syringa vulgaris, mit Phoma depressa (Lév.) Sacc., Hessen: Bad Nauheim, 21 May 1898, O. Jaap (HBG) [holotype of A. syringae].
Notes: Microdiplodia pterophila (Fautrey) Allescher was proposed by Poteblia (1907) as one of three species for his subgenus, Ascochytia subgenus Ascochytula, and was accepted by Diedicke (1912a) in Ascochytula Died. A combination in Ascochytula, however, has never been made.

Allescher (1901) suggested that the species might be better placed in Ascochyta Lib. The ostiolate conidiomata with textura angularis walls, and pale coloured, uniseptate conidia produced from phialides, are all features of Ascochyta, and support acceptance of the name, Ascochyta pterophila (Fautrey) Keissler.

Conidiomata of A. pterophila were not plentiful on the specimens examined, often growing in a mixed population with the morphologically similar pycnidia of several Phoma species. The Ascochyta conidia, although somewhat variable between collections (Fig. 24 A-D), were usually shorter and wider than measurements given by Fautrey for the type, (10-)12(-16) x 2 μm.

Ascochytula syringae Jaap is considered to be conspecific with A. pterophila. The specimen examined was the only one available from Jaap's herbarium at HBG. It is thought to be the holotype since it corresponds with the protologue in all respects except the date, (21 May 1898 vs. 26 May 1898). The conidiomata examined were larger than those described by Jaap, 50-100 μm diam. Phoma sp. and a Libertella-like fungus were common on the specimen.

The combination Ascochytula syringae (Jaap) Trotter is a later homonym of A. syringae Bresadola. Several specimens of the latter fungus were examined (FH, HBG, PDD). It is distinct from Ascochytula syringae, possessing light yellow-brown conidiomata and hyaline conidia.

An earlier epithet, in Ascochyta, may exist for A. pterophila although relevant specimens have not been examined. The fungus, Ascochyta fraxini Oudem., recorded on branches of Fraxinus excelsior, was described as having small, ostiolate pycnidia, up to 250 μm diam., with uniseptate, sometimes
2-septate, pale greenish conidia, fusoid to fusoid-clavate, measuring 11-14 x 2 1/3 μm (Oudemans, 1889). Subsequent authors have recombined the name in various genera: Diplodina fraxini (Oudem.) Allescher, Stagonosporopsis fraxini (Oudem.) Died., Ascochyttella fraxini (Oudem.) Petrak, and Pseudodiplodia fraxini (Oudem.) Petrak. Petrak in Sydow (1924) described Ascochyttella fraxini from samaras, as a poorer form of Oudemans's fungus on branches, noting that it had smaller pycnidia and shorter conidia measuring 7-10 x 2-2.5 μm. This description agrees closely with Ascochyta pterophila from samaras.

The descriptions of Diplodina syringae Hollós and Microdiploodia syringae Allescher, both occurring on Syringa vulgaris, suggest that these names may be further synonyms of A. pterophila; specimens were not examined.

Poaceae

ASCOCYSTA AGROPYRINA (Fairman) Trotter, Saccardo's Syllogoe fungorum 25: 345 (1931).

≡ Ascochyta agopyrina Fairman, Mycologia 10: 258 (1918).

Fig. 25.

Lesions: absent.

Conidiomata: pycnidial, solitary, somewhat gregarious, nonstromatic, subepidermal, erumpent, black, mostly elliptical, 120-250 μm long x 100-110 μm wide, nonpapillate, ostiolate, glabrous; ostiole circular, ca. 10 μm wide.

Conidiomatal wall: in vertical section textura angularis, 2-3 cells wide, 12-15 μm; cells smooth-walled, outermost cells large, up to 13 x 7.5 μm, with thick, 0.5-1.0 μm wide brown walls, innermost cells smaller, hyaline, thinner-walled, somewhat flattened; towards the ostiole, wall of smaller
Fig. 25

Ascochyta agropyrina:
A, conidia
B, conidiogenous cell
C, median vertical section of conidioma, cut width-wise.
A,B,C, holotype (CUP-F 14330a).
cells, the outermost 2 layers brown and thick-walled.

Conidiogenous cells: phialidic, discrete, arising directly from cells of the wall, collarette minute, ca. 3 μm high x 11 μm wide.

Conidia: medianly 1-septate, light brown with brown walls, elliptical to oblong, slightly constricted at the septum, base rounded or somewhat truncate, apex rounded, straight, sometimes guttulate, wall ca. 0.5 μm wide, verruculose, 14-20(-24) x 5-6(-7.5) μm.

Habitat: on leaves of Agropyron bakeri E. Nels. (Poaceae).

Distribution: North America (New Mexico, U.S.A.).

Additional records in Punithalingam (1979, p. 38) and Sprague & Johnson (1950, p. 544).

Holotype: on old leaves of Agropyron bakeri E. Nels. (14330a, p.p.) (CUP-F!).

Specimen examined:

Ascochytula agropyrina:

U.S.A. - on old leaves of Agropyron bakeri E. Nels., Baldy Peak, Colfax County, New Mexico, above timber line, altitude about 3600 m, 4 Sep 1916, P.C. Standley, Plants of New Mexico (CUP-F 14330 a) [holotype of A. agropyrina].

Notes: Examination of this fungus was confined to one conidioma, along with a prepared slide enclosed with the holotype. At most, only five conidiomata now remain on the type specimen. The conidiomata differ somewhat from those described by Fairman (1918) and Punithalingam (1979) in being elliptical and having a conspicuous outermost wall layer of thick-walled, large, brown cells. Only a single phialide was seen, suggesting that the conidioma examined was overmature. Conidiogenesis for
this species was identified by Punithalingam (1979) as phialidic.

Trotter (1931) transferred the fungus to section Ascochyta of Ascochyta, on account of its pale brown conidia. Punithalingam (1979) described pale straw yellow to straw yellow conidia; those I examined agreed with Sprague & Johnson's (1950) description of light brown conidia at maturity. The verruculose conidial wall is diagnostic for this species.

Additional illustrations: Sprague & Johnson (1950, p. 543, fig. 2B-2E); Punithalingam (1979, fig. 3).


Fig. 26.

Lesions: absent.

Conidiomata: pycnidial, solitary, scattered on outer and inner surfaces of the culm, nonstromatic, brown to dark brown, subepidermal; on outer surface of culm becoming erumpent by longitudinal fissures in host tissue, broadly elliptical, 100-280(-380) μm long x 100-160 μm wide; on inner surface of culm, more strongly erumpent without fissures, globose, 100-240 μm diam.; somewhat papillate, ostiolate, glabrous; ostiole circular, surrounded by a dark border, 10-20 μm wide.

Conidiomatal wall: in vertical section textura angularis, 3-4 cells wide, 13-20 μm; cells smooth-walled, outermost 1-2 layers of cells pale brown, larger, and thicker-walled than the hyaline inner cells; towards the ostiole, cells thicker-walled and brown.

Conidiogenous cells: phialidic, lining the cavity, discrete, arising
Ascochyta culmicola:

A, conidia
B, conidiogenous cells
C, median vertical section of a conidioma from inner surface of culm.

A, B, C, holotype (IMI 137042).
directly from cells of the wall, hyaline, ampulliform to conic, channel wide, collarette and periclinal thickening minute, not proliferating, 4-5.5 μm high x 4.5-7.5 μm wide.

Conidia: medianly 1-septate, sometimes nonseptate, rarely 2- or 3-septate, pale yellow-brown, cylindrical to elliptical, not constricted at the septum, base somewhat truncate, apex rounded, mostly straight, smooth-walled, eguttulate, 0-septate 6-11.5 x 2.5-4 μm; 1-septate (7.5-)9.5-11.5(-14) x (2.5-)3-3.5(-4) μm.

Habitat: on culms of *Erianthus ravennae* (L.) Beauv. (Poaceae).

Distribution: Asia (Pakistan).

Holotype: on culms of *Erianthus ravennae*, Lahore, 26 Feb 1967, no. 19768 (IMI 137042').

Specimen examined:

Ascochyta culmicola:

Pakistan - on *Erianthus ravennae*, 1967, S. Ahmad, 19768 (IMI 137042')

[ex holotype of *A. culmicola*].

Additional illustration: Punithalingam (1979, fig. 26).


Fig. 27.
Lesions: amphigenous, elongate, extending from the tip of the blade down
the lamina, sometimes covering the full length of the blade and occasionally
part of the sheath, light brown to brown, becoming grey-brown with age,
margin indistinct or narrow, not raised, purplish brown.
Conidiomata: pycnidial, numerous, amphigenous, solitary or sometimes in
pairs, mostly interveinal in irregular rows, nonstromatic, subepidermal,
eruptent, initially pale brown, becoming dark brown to black with age,
subglobose to flattened globose or sometimes laterally compressed and
elliptical, 100-200 µm diam., slightly papillate, ostiolate, glabrous;
ostiole circular with a dark brown border, 10-18 µm wide.
Conidiomatal wall: in vertical section textura angularis, 2-4(-6) cells
wide, 10-20 µm; outermost cells with thicker, pale to light brown, smooth
walls, innermost cells thin-walled and hyaline; towards the ostiole wall
thicker, 4-7 cells wide, 15-30 µm, cells smaller with thickened darker
brown walls.
Conidiogenous cells: phialidic, lining the cavity, discrete, arising
directly from cells of the wall, hyaline, ampulliform, channel wide,
collarette obvious in mature cells but lacking in young conidiogenous cells
which appear holoblastic, rarely proliferating, 4-9.5 µm high x 4-9.5 µm
wide.
Conidia: ± medianly uniseptate, sometimes 0, 2, or 3-septate, pale brown,
naviculare, oblclavate, or elliptical, not or only slightly constricted at
septum, base truncate or broadly rounded, apical cell tapering, apex often
attenuate and acutely rounded, straight or sometimes slightly curved,
rarely weakly sigmoid or irregular, smooth-walled, sometimes guttulate
especially when immature, 0-septate 13-23 x 4-6 µm; 1-septate (14-)17.5-
21.5(-30.5) x (4-)5-6(-7.5) µm; 2-septate (17-)19.5-23.5(-26) x (4.5-)
5-6.5(-7) µm; 3-septate (19-)20-25(-33) x (4.5-)5-6.5(-7.5) µm.
Ascochyta paspali:

A, conidia (macroconidia)
B, microconidia
C, D, conidiogenous cells
A, neotype (K)
B, culture PDDCC 6264
C, La Plata, Feb 1978 (LPS 26319)
D, ex VPRI 10662 (DAR 35401)

(overleaf: E, F)
Ascochyta paspali:

E (i-v), conidia (macroconidia) drawn from 5 collections from Australasia.

(i) New South Wales, Australia (DAR 32158)
(ii) Victoria, Australia (DAR 35406)
(iii) Auckland, New Zealand (PDD 41459)
(iv) Northland, New Zealand (PDD 41688)
(v) Tonga (PDD 39595)

(overleaf)

F (i-v), conidia (macroconidia) drawn from 5 collections from North and South America.

(i) Texas, U.S.A. (IMI 176770)
(ii) North Carolina, U.S.A. (IMI 176771)
(iii) North Carolina, U.S.A. host: Paspalum floridanum var. glabratum (IMI 176768)
(iv) neotype, Buenos Aires, Argentina (K)
(v) Buenos Aires, Argentina (LPS 26319)
Ascochyta paspali:

G, median vertical section of conidioma.
H, thick median vertical section through conidioma (x600).
I, thick section to show conidiogenous cells (phialides)
    with prominent apical periclinal thickenings (x2,700).
    G, neotype (K)
    H,I, La Plata, Feb 1978 (LPS 26319).

(overleaf)
J,K, thin sections through holoblastic conidiogenous cells;
J (x12,000), K (x13,200).
L, thin section through an old, apparently phialidic
    conidiogenous cell, with degenerating periclinal
    thickening (x15,000).
    J,K,L, ex fresh material.
Habitat: on leaves and sheaths of *Paspalum dilatatum* Poir. and *Paspalum floridanum* Michx var. *glabratum* Engelm. ex Vasey (Poaceae).

Distribution: Oceania (Australia, New Zealand, Tonga); North America (southeastern U.S.A.); South America (Argentina).

Holotype: in foliis subvivis usque fere emortuis Paspali dilatati, La Plata, Argentina, Jun 1935 (leg. Lindquist no. 1629) [lost from LPS].

Neotype: on leaves of *Paspalum dilatatum*, Eva Perón (= La Plata), Buenos Aires, Argentina, J.C. Lindquist, 30 Mar 1955, ex LPS 26319 (K!).

Specimens examined:

**Ascochyta paspali:**

New Zealand* - on *Paspalum dilatatum*, Spraggs Bush, Waitakere Ranges, Auckland, 29 Dec 1971, J.M. Dingley (PDD 29792); Waitangi, Northland, 19 Feb 1972, J.M. Dingley (PDD 29791); Mititai Flats, Dargaville, Northland, 12 Apr 1976, A. Richardson (PDD 35458); D.S.I.R. Grasslands Division grounds, Kaikohe, Northland, 5 May 1976, E.H.C. McKenzie (PDD 34844); Kaitaia, Northland, 30 Nov 1976, E.H.C. McKenzie (PDD 35759); Ruawai, Northland, 12 Oct 1979 (PDD 40128); Motuihe Island, Auckland, 1 Dec 1979 (PDD 40156); Middlemore Hospital grounds, Auckland, 9 Dec 1979, Y.D. Joe (PDD 40159); Tumu Rd, Te Puke, Bay of Plenty, 10 Dec 1979 (PDD 41662); Angle Rd, Whakatane, Bay of Plenty, 11 Dec 1979 (PDD 40157); Kohi Point Lookout, Whakatane, Bay of Plenty, 11 Dec 1979 (PDD 40158); Ruawai, Northland, 18 Jan 1980 (PDD 40249); Ministry of Agriculture and Fisheries Field Trial Block, Rakauwhia Rd, Kaikohe, Northland, 31 Jan 1980 (PDD 40246); Waipoua River bridge, Waipoua Forest, Northland, 31 Jan 1980 (PDD 40247); Omahuta Kauri Reserve, Omahuta Forest, Northland, 31 Jan 1980 (PDD 40248); Ministry of Agriculture

*Collector is the author unless otherwise indicated.*
and Fisheries grounds, Dargaville, Northland, 23 Jan 1981 (PDD 41685); Morrison Rd, Arapohue, Northland, 23 Jan 1981 (PDD 41688); Ruawai, Northland, 23 Jan 1981 (PDD 41689); Maungaturoto, Northland, 23 Jan 1981 (PDD 41686); Warkworth, Auckland, 23 Jan 1981 (PDD 41687); Mt Albert Research Centre grounds, Auckland, 20 Feb 1981 (PDD 41459); Waiuku State Forest, Auckland, 17 Apr 1981 (PDD 40817); Waitoa, Waikato, 11 Jan 1982, R.A. Underwood (PDD 41963).

Tonga - on Paspalum dilatatum, Airport grounds, Tongatapu, 21 May 1979, E.H.C. McKenzie (PDD 39595); Experimental Farm, Tongatapu, 22 May 1979, E.H.C. McKenzie (PDD 39594).

Argentina - on Paspalum dilatatum, Eva Perón (= La Plata), Buenos Aires, 30 Mar 1955, J.C. Lindquist, ex LPS 26319 (K) [neotype of A. paspali]; Facultad de Agronomía, La Plata, Buenos Aires, 20 Feb 1978, J.C. Lindquist (LPS 26319).

Scolecosporiella spraguei:

Australia - on Paspalum dilatatum, Lismore, R.D. 58, New South Wales, 5 Nov 1978, A. Beck & R. Fitzell 78/120 (DAR 32158); Strathmerton, R.D. 88, Victoria, 20 Dec 1978, J. Cornish, ex VPRI 10662 (DAR 35401); Blighty, near Finley, R.D. 74, New South Wales, 12 Mar 1979, J. Lacy (DAR 33271); Myrtle Park, near Finley, R.D. 74, New South Wales, 6 Nov 1979, J. Lacy (DAR 34371); Strathmerton, R.D. 88, Victoria, 15 Nov 1979, R. Clarke, ex VPRI 10912 (DAR 35406).

U.S.A. - on Paspalum dilatatum, Lufkin, Texas, 25 May 1939, C.L. Lefebvre, ex WSP 11639 (IMI 176770 - slide only); greenhouse, Raleigh, North Carolina, 3 Jun 1940, C.L. Lefebvre, ex WSP 11640 (IMI 176771 - slide only); Tifton, Georgia, 24 Jul 1940, C.L. Lefebvre, ex WSP 11641 (IMI 176772 - slide only - dehydrated).

- on Paspalum floridanum var. glabratum, roadside, Clayton, North Carolina, 30 Jun 1940, C.L. Lefebvre, ex WSP 11643 (IMI 176768 -
slide only) [holotype of *S. spraguei*].

**Characteristics in Culture:** (see Fig. 29A)

Colonies on oatmeal agar at ca. 20°C, under 12 h darkness/12 h near-ultraviolet plus cool white fluorescent light. In 6 weeks, 4-5 cm diam.; colony raised, surface crustose, sometimes becoming radially convoluted; aerial mycelium felt-like, restricted, smoke grey* to pale olivaceous grey, with irregular concentric rings of increased conidiomatal production; margin distinct and lobed; cinnamon coloured pigment extending into the agar; colony reverse umber brown; conidiomata numerous, aggregated in stromatic groups, often individually indistinct, partially to fully immersed in surface crust, black, sporulating profusely to produce microconidia in a white or pink, watery slime, or less often macroconidia in a dark brown slime; the conidial masses darken and harden with age.

In darkness, colony flatter and sometimes grey with a rosy buff tinge, margin more diffuse and sometimes pale cinnamon; conidiomata usually producing more macroconidia than microconidia.

**Cultures examined:**

*Ascochyta paspali:*

New Zealand - on *Paspalum dilatatum*, Auckland, 1978 (PDDCC 6264, 6265); No. 5 Dairy, Ruakura, Hamilton, 29 Dec 1978 (PDDCC 7737);

Mt Albert Research Centre, Auckland, 1981 (PDDCC 7739, 7740, 7741).

Tonga - ex PDD 39595 (PDDCC 7760).

Argentina - ex LPS 26319, 20 Feb 1978 (PDDCC 6266).

Notes:
(a) Taxonomy: The holotype of Ascochyta paspali, deposited by H. Sydow in LPS, has been lost (Gamundi de Amos, pers. comm.). Enquiries to numerous herbaria including B, BPI, DAR, FH, HBG, K, LPS, M, NY, S, and UPS, have failed to locate any collections that could serve as lectotype or isotype, and the neotype collection, ex LPS 26319 (K), designated by Punithalingam (1979), must be accepted. Both the holotype and the neotype were collected by J.C. Lindquist at La Plata, Argentina.

In describing Scolecosporiella spraguei, Sutton & Alcorn (1974) examined four specimens from WSP. Three of these were on Paspalum dilatatum, whilst the fourth, on P. floridanum var. glabratum, was designated the holotype. A microscopic preparation made from each collection was deposited at IMI. Unfortunately, the specimens from WSP, examined by Dr Sutton in 1973, cannot be located at WSP and are presumed lost (R. Chacko, pers. comm.). However, the four slides at IMI were examined. The fungus on the three collections on P. dilatatum has pale brown, navicular, 1(-3) septate conidia, 14.5-23 x 4-6 μm (Figs 27F (i) & (ii)), and is clearly conspecific with Ascochyta paspali. Conidia from the collection on P. floridanum var. glabratum, however, are (1-)3 septate and longer, (21.5-)26.5(-33) x (4.5-)5(-6) μm (Fig. 27F (iii)). These differences led Punithalingam (1979) to suggest that this fungus is different from the neotype of Ascochyta paspali.

There is a considerable variation in the proportion of 3-septate conidia between conidiomata of A. paspali on P. dilatatum. Up to 30% of the conidia within a conidioma may be 3-septate, although the percentage is usually lower. The predominance of 3-septate conidia in the single conidioma examined on IMI 176768 is but an extension of this variability. In size and shape, these conidia are similar to the 3-septate conidia found in other collections of A. paspali (Figs 27E, F). Thus, Scolecosporiella
spraguei is considered to be conspecific with A. paspali, and the name is reduced to synonymy.

Conidiogenesis in A. paspali has been reported to be holoblastic (Sutton & Alcorn, 1974), and phialidic (Punithalingam, 1979), and thus the species was placed in different genera by these authors. Sections of conidiomata taken from herbarium specimens, fresh material from the field, and from cultures, were viewed in the present study by optical and electron microscopy. Conidiogenous cells within the same conidiomata were sometimes of two types, holoblastic (Figs 27D, J, K) and phialidic (Figs 27C, I, L). This suggests that either the fungus produces conidia by two different modes of ontogeny or, more likely, that the two types of cells represent different stages of the same mode of conidiogenesis. A phialide produces its first conidium holoblastically (Cole & Samson, 1979), and at that stage is, therefore, indistinguishable from a holoblastic-solitary conidiogenous cell (see p. 7). The most frequent mode of conidiogenesis in A. paspali may involve production of a single holoblastic conidium from most of the conidiogenous cells, followed by disintegration of the cell. Some cells, however, may produce additional conidia by an enteroblastic process, and thus develop a collarette and periclinal thickening at their apex. Such cells would then be identifiable as phialides. Although the phialides represented a minority of the conidiogenous cells seen, the fully mature conidiogenous cell of A. paspali is considered to be a phialide. This agrees with Punithalingam (1979) and with the type of conidiogenesis in Ascochyta.

The basionym, Ascochyta paspali was incorrectly cited in 'Petrak's Lists' (Petrak, 1950) as Ascochyta paspali Sydow. Punithalingam (1979) suggested that, for this reason, the name was not transferred to Pseudodiplodia when Petrak (1953) 'transferred all Ascochyta species to Pseudodiplodia.' In fact, Petrak (1953) transferred only five of the thirty species names
then in Ascochyta. Mel'nik (1977) also cited the species as Ascochyta paspali Sydow, and excluded it from Ascochyta on the basis of its spore pigmentation.

*Stagonospora paspali* Atkinson has been confused, in the past, with *A. paspali*. The four specimens of *Scolecosporiella spraguei* from WSP were incorrectly labelled *Stagonospora paspali*, and the description of *S. paspali* given by Sprague (1950) is almost certainly a composite description of both *A. paspali* and *S. paspali*. Castellani & Germano (1977) described *S. paspali*, based on an examination of three of the WSP specimens shown above to be conspecific with *A. paspali*. Their illustration is of conidia of *A. paspali*.

(b) **Cultural Features:** *A. paspali* grows most rapidly on either oatmeal agar or cornmeal agar, but it has denser growth and more sporulation on oatmeal agar. On potato-dextrose agar and malt agar, colony growth is severely restricted.

Two types of conidia are produced in culture. The conidia typically present in conidiomata formed on the host (e.g. Fig. 27A) occur in larger numbers in cultures kept in the dark, rather than in the light. They are here called macroconidia, to distinguish them from the smaller microconidia. Microconidia are produced only *in vitro* and more are produced in cultures kept in a light/dark regime, than in continuous darkness. The microconidia (Fig. 27B) are nonseptate, hyaline, bacilliform to ± allantoid, 3-6 x 0.5-2 μm, and are liberated in a watery slime from irregular, convoluted locules, which develop either directly in the crustose colony surface, or within old macroconidial conidiomata. Occasional microconidia were seen to germinate, and single microconidia gave rise to a normal colony, from which both macro- and microconidia were produced. The function of microconidia in the life cycle of *A. paspali* is unknown.
A temperature trial was conducted with six isolates of *A. paspali*. Five of the isolates arose from single macroconidia, and one, PDDCC 7740 arose from a microconidium. The fungi were grown in 9 cm plastic petri dishes containing 15 ml of fresh cornmeal agar (pH 6.0). A 4 mm diam. mycelial plug, taken from the growing edge of the colony, was placed with the mycelial surface downward in the centre of each petri dish. Five replicates were incubated in the dark at each of six temperatures between 10 and 35°C. After 48 days, two diameters, perpendicular to each other, were measured. The mean diameter for each isolate at each temperature was calculated (Table 1), and the overall mean diameter at each temperature was plotted (Fig. 28).

Maximum growth was recorded at 25°C. At 10°C, growth was minimal, while at 35°C, the fungus died. The growth rate of each isolate was similar at all temperatures, except at 25°C. At 25°C, the growth of two of the isolates, PDDCC 7737 and 7760, was markedly reduced, and their diameters lay between the measurements recorded at 20 and 30°C (Table 1).

During the temperature trial, some colonies from four isolates, PDDCC 7738, 7739, 7740, and 7741, produced a second form of hyphal growth. This was most commonly produced at 25°C. From one, or a few locations towards the periphery of a colony, fast-growing, non-sporulating, white, submerged mycelium grew out in a diffuse fan shape (Fig. 29B). The growth of the original mycelium slowed after the appearance of the fast-growing mycelium. When portions of this fast-growing mycelium were transferred to fresh agar plates, normal parent-type colonies, with macro- and microconidia, were usually produced. Occasionally, a further aberrant colony, composed entirely of fast-growing mycelium, was produced.

A similar phenomenon, but involving surface mycelium, has been reported by Coggins et al. (1980) for *Serpula lacrymans* (Wulfen ex Fr.) Schröter, both in culture and also on building materials infected by this
TABLE 1. Mean colony diameter (mm) of each of six isolates of Ascochyta paspali, after 48 days growth on cornmeal agar at six temperatures.

Fig. 28

Mean colony diameter (mm) of Ascochyta paspali after 48 days growth on cornmeal agar at six temperatures (from data in Table 1). 

=mean ± 1 standard deviation.
TABLE 1.

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<th>10</th>
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<th>20</th>
<th>25</th>
<th>30</th>
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<td>11.2</td>
<td>29.1</td>
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<td>35.9</td>
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<td>59.0</td>
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<td>5.6</td>
<td>10.2</td>
<td>23.6</td>
<td>44.9</td>
<td>34.6</td>
<td>&quot;</td>
</tr>
</tbody>
</table>
Fig. 29

Ascochyta paspali:

A, six-week-old colonies on oatmeal agar, grown at ca. 20° under 12h darkness / 12h near-ultraviolet plus cool white fluorescent light.

B, colonies on cornmeal agar grown at 25° in darkness. Plate on left is a typical colony; other four plates show 'point growth' with fast growing, sparse, white mycelium extending beyond the parent colony.
fungus. Called 'point growth' by these authors, it is unlikely to involve genetic change, and has been interpreted as a mechanism by which the fungus can grow from a site of depleted nutrients to a new nutrient source. The 'point growth' observed in *A. paspali* is not known to occur outside of cultures, but may, perhaps, correlate with the mycelium which rapidly grows through the vascular tissue of an infected paspalum plant.

Additional literature: Sprague (1950, p.279, fig.58A); Sutton & Alcorn (1974, p. 521, 528-9, fig. 6); Mel'nik (1977, p.190); Castellani & Germano (1977, p. 76-7, tav. 1, fig. D); Punithalingam (1979, p. 125-6, fig. 70).

**Polygonaceae**

**ASCOCHYTA VICINA** Saccardo, [as *Ascochyta vicina* f. *rumicina*], *Michelia* 2: 109 (1880).


**Fig. 30.**

**Lesions:** absent.

**Conidiomata:** pycnidial, solitary or sometimes conidiomata confluent in pairs, gregarious, ± in rows parallel to the veins of the stem, nonstromatic, subepidermal, somewhat erumpent, black, flattened longitudinal, elongated parallel to the veins, 150-260 μm long x 80-120 μm wide, nonpapillate, ostiolate, glabrous; ostiole inconspicuous, circular, 15-20 μm wide.

**Conidiomatal wall:** in vertical section textura angularis, 2-3 cells wide, 6-10 μm, cells mostly 3.5-5.5 x 2-4 μm; outermost cells at the base hyaline to pale yellow, at the sides yellow brown and slightly roughened with cell walls somewhat thickened, innermost cells hyaline and thin walled; towards the ostiole, wall 3-5 cells wide, 10-20 μm, outermost 1-3 cells with brown, thickened, and rough walls, sometimes with cell
Ascochyta vicina:

A, photograph of the holotype specimen (PAD)
B, conidia
C, conidiogenous cells
D, median, vertical, length-wise section of conidioma.
A-D, holotype (PAD).
Phano hystrix

A: Image of a specimen with labels and measurements.

B: Diagram of elongated structures.

C: Diagram of clustered structures.

D: Diagram of a broader structure with detailed features.

10 µm

50 µm
detail obscure, innermost cells hyaline and thin-walled.

Conidiogenous cells: phialidic, lining the cavity, discrete, arising directly from cells of the wall, hyaline, ampulliform, collarette and periclinal thickening minute, 3-5 μm high x 3-5.5 μm wide.

Conidia: medianly 1-septate, pale yellow-brown, elliptical to fusiform, not or only slightly constricted at septum, base somewhat truncate or rounded, apex rounded, usually straight or sometimes slightly curved, smooth-walled, eguttulate, (7-)8-9.5(-11.5) x (2-)2.5-3(-3.5) μm.

Habitat: on stems of Rumex sp. (Polygonaceae).

Distribution: Europe (France).

Holotype: in caule Rumicis, prope Rouen, Letendre (PAD!)

Specimen examined:

Ascochyta vicina f. rumicina:

- on stems of Rumex, no. 788 (PAD) [holotype of A. vicina].

Notes: A. vicina is the type species of Ascochyta section Ascochyttella, and is the lectotype species of Ascochyttella Tassi. The fungus was originally named Ascochyta vicina f. rumicina, and was described together with A. vicina var. euonymella. The latter fungus was on capsules of Euonymus europaea L., and was distinguished from A. vicina f. rumicina by the size of the conidiomata. However, the publication of A. vicina var. euonymella automatically established the name A. vicina var. vicina (Art. 26), which is of higher rank than A. vicina f. rumicina (Art. 4), and which thus became the correct name for the fungus on Rumex. Saccardo (1884, p. 404) republished the original description of A. vicina but included a second host, Salvia officinalis L., in addition to Rumex.

Typification of A. vicina has been confused. Saccardo (1882) cited
A. vicina (as A. sycina) with the exsiccata, Mycotheca Veneta 1571. However, M.V. 1571 is also listed beside Epicoccum neglectum Desm. Oudemans (1923, p. 595), under Ascochyta vicina, referred to the exsiccata, M.V. 1521, and this is likely to have been the number intended by Saccardo, since M.V. 1521 is not cited for any fungus name in Saccardo (1882). Mel'nik (1977) examined two collections of M.V. 1521 (K, LEP) and considered them to be isotypes of A. vicina var. vicina. However, M.V. 1521, examined in the present study (BPI, NY), cannot be the isotype of A. vicina, because the host is Salvia, a member of the Lamiaceae. Furthermore, the exsiccata specimens are labelled Ascochyta vicina f. salviae. The type collection of A. vicina var. vicina must agree with the protologue, and be on Rumex. An examination of M.V. 1521 indicated that A. vicina f. salviae was similar to A. vicina var. vicina, except for the smaller, 80-180 μm diam., flattened-globose conidiomata, and the occasionally 2-septate conidia.

The specimen here designated as the holotype of A. vicina was located at PAD. This specimen is not a member of an exsiccata set, and is mounted on a label which bears the names of two fungi, Phoma hysteriola (?) and Ascochyta vicina f. rumicina, on Rumex (Fig. 30A). Only the latter fungus was seen on the specimen. The conidiomata were longitudinal, rather than hemispherical as reported by Saccardo, and were longer than the published diameter of 110-120 μm. The conidia were slightly wider than the reported measurements of 8-10 x 2-2½ μm. Although there is no indication of the date, location of the collection, or the collector on the specimen label, the accompanying sketches and dimensions of conidia and conidiomata correspond exactly with those in the protologue to A. vicina, and thus identify the specimen as the holotype.
ASCOCYHTA SP.

Fig. 31.

Lesions: absent.

Conidiomata: pycnidal, solitary or occasionally in pairs, gregarious, nonstromatic, subepidermal, erumpent, black, flattened globose, 160-240 μm diam., nonpapillate, ostiolate, glabrous; ostiole up to 20 μm wide, with a somewhat thickened, dark border.

Conidiomatal wall: in vertical section of textura angularis, 3-5 cells wide, 13-20 μm; cells smooth-walled, outermost cells hyaline, up to 10 μm across, more elongate and slightly thicker walled than the smaller, hyaline, innermost cells; towards the ostiole, cell walls thicker and brown, with loss of cellular detail.

Conidiogenous cells: phialidic, lining the cavity, discrete, arising directly from cells of the wall, hyaline, ampulliform to conic, collarette and periclinal thickening minute, 4.5-6 μm high x 3.5-5(-7) μm wide.

Conidia: medianly 1-septate, occasionally 2(-3) septate, pale brown, cylindrical, not constricted at septum, base somewhat truncate, apex rounded, usually straight, smooth-walled, eguttulate, 1-septate (6-)8-11(-13) x 2-2.5 μm; 2 and 3-septate 10.5-16 x 2-2.5 μm.

Habitat: on branches of Polygonum lapathifolium L. (Polygonaceae).

Distribution: Europe (Czechoslovakia).

Specimen examined:

Ascochyta polygonicola:

Fig. 31

Ascochyta sp. on Polygonum lapathifolium:

A, conidia
B, conidiogenous cells
C, median vertical section of conidioma

A, B, C, W 12254
Notes: Based on the above specimen, Petrak (1923, p. 212) described *Ascochyta polygonicola* (Kabát & Bubák) Petrak (≡ *Ascochyta polygonicola* Kabát & Bubák). He later transferred the name to *Pseudodiplodia* (Petrak, 1953). The holotype specimen of *Ascochyta polygonicola*, described by Bubák & Kabát (1907) on leaves of *Polygonum lapathifolium* (BPI), bore a fungus which was obviously not the same as that on Petrak's specimen of *Ascochyta polygonicola*. It had pycnidial conidiomata 80-150 μm diam., producing elliptical, hyaline, 0-1 septate conidia, 6.5-13 x 2.5-4.5 μm. *Ascochyta polygonicola* was thus misapplied by Petrak, and the name becomes a synonym of *Ascochyta polygonicola* (≡ *A. volubilis* Sacc. & Malbr. fide Mel'nik, 1977), leaving Petrak's specimen, W 12254, without a suitable, published name. Although the fungus on W 12254 clearly belongs to *Ascochyta* section *Ascochytella*, I do not feel justified in describing it as a new species based on a single herbarium specimen.

**Sambucaceae**

**ASCOCHYTA DEFORMIS** (P. Karsten) comb. nov.

≡ *Diplodia deformis* P. Karsten, Meddelanden af Societas pro fauna et flora fennica 11: 156 (1884).

≡ *Diplodina deformis* (P. Karsten) Saccardo, Sylloge fungorum 3: 413 (1884).

≡ *Diplodinula deformis* (P. Karsten) Tassi, Bullettino del Laboratorio ed Orto Botanico, Siena 5: 45 (1902).


Fig. 32.

Lesions: absent.

Conidiomata: pycnidial, solitary or sometimes in small groups of two or more confluent pycnidia, nonstromatic, subepidermal, erumpent, dark brown to black, subglobose to oval or somewhat irregular, 100-300 μm diam., nonpapillate, lacking a preformed ostiole, glabrous; pore developing later at apex, circular, 8-20 μm wide, or oval, 18-35 x 10-25 μm.

Conidiomatal wall: in vertical section textura angularis, 3-6 cells wide, 10-28 μm; cells smooth-walled, outermost cells up to 6.5 μm wide, hyaline and thin-walled or otherwise brown and thicker-walled, innermost cells hyaline, thin-walled; towards the apex, wall sometimes wider, cells thicker-walled and brown.

Conidiogenous cells: phialidic, lining the cavity, discrete, arising directly from cells of the wall, hyaline, ampulliform to conic, collarette small and sometimes flared, periclinal wall slightly thickened, not proliferating, 3-6.5 μm high x 3-5 μm wide.

Conidia: medianly 1-septate, sometimes 2- or 3-septate, pale brown, elliptical to fusiform, not constricted at septum except when multisepitate, apex rounded, base truncate, mostly straight, smooth-walled, sometimes with one small guttule per cell, 1-septate (8-)9.5-12(-14) x (2-)2.5-3.5(-4) μm; 2- and 3-septate (10-)11-14.5(-18) x 2.5-3.5(-4) μm.

Habitat: on dead twigs of Sambucus nigra L. and S. racemosa L. (Sambucaceae).

Distribution: Europe (England, Finland).

Holotype: In ramulis emortuis Sambuci racemosae ad Helsingforsiam, m. Martio 1859 (H!).
Ascochyta deformis:
A, conidia
B, conidiogenous cells
C, vertical section through two confluent conidiomata
A, B, C, holotype (H).
Specimens examined:

**Ascochyttella deformis:**

- on *S. niger*, East Knoyles, South Wilts., 5 May 1931, P.G.M. Rhodes 4735, Ex Herb. W.B. Grove (K).

**Ascochyttula deformis:**

- England - on *S. nigra*, Wheatfen Broad, E. Norfolk, 19 Mar 1936, E.A. Ellis 1118, Ex Herb. W.B. Grove (K) [Fungus not found on this specimen].

**Diplodia deformis:**

- Finland - on *Sambucus*, Helsingfors, Nylandia, 29 Mar 1859, P.A. Karsten 602, Herb. Petter Adolf Karsten (H) [Holotype of *D. deformis*].

**Diplodina deformis:**

- England - on twigs of *S. nigra*, Kew Gardens, Apr 1885, Fungi exsiccati selecti, Ex Herb. M.C. Cooke (K).

**Notes:** This morphologically variable species, with combinations in seven different genera, illustrates the confusion between these genera. Saccardo (1884), in recognition of the pale coloured conidia of this fungus, transferred it from the brown spored genus, *Diplodia*, to *Diplodina*. Diedicke (1912b) limited *Diplodina* to species with hyaline conidia only, and removed it to the pale brown spored genus, *Ascochyttella*. *Ascochyttula* was mistakenly adopted by Grove (1935) as the earlier name for all species of *Ascochyttella*. Ruprecht (1959) considered *Ascochyttella* to be a synonym of *Pseudodiplodia*. Each transfer of this fungus was justified principally on the basis of conidial colour. The fungus is here recombined in *Ascochyta* because of its 1(-3)-septate, pale brown conidia, borne on phialides within
a simple, though variable, pycnidial conidioma. **Diplodia**, with holoblastic conidiogenesis and brown conidia, is not a suitable genus for this fungus.

Variability of *A. deformis* was evident between different collections. The holotype specimen on *Sambucus racemosa* differed in certain characters from the other collections, on *S. nigra*. Conidiomata on *S. racemosa* were often aggregated in small groups, confluent, and strongly erumpent, with walls hyaline except at the apex, whereas those on *S. nigra* were solitary, less strongly erumpent, and with outermost cells of the conidiomatal wall brown. As reported by Karsten (1884b), all conidiomata lacked preformed ostioles, but pores developed at maturity (Grove, 1935). The pores were variable in size and often difficult to see on conidiomata in situ. Up to 30% of conidia were multiseptate in Rhodes' collection, no. 4735 (K) - 16% were 2-septate and 14% 3-septate; the percentage of multiseptate conidia in other collections was lower.

Several species of *Ascochyta*, *Diplodina*, and *Diplodia*, with similar sized conidia, have been recorded on *Sambucus*. *Ascochyta wisconsinensis* J. Davis, *A. sambucella* Pass., and *A. sambucella* Bubák & Krieger all differ from *A. deformis* in having hyaline conidia (Melnik, 1977). *A. sambuci* Sacc. has pale coloured, but somewhat larger, conidia, 15-18 x 3-3.5 μm. *A. sambuci* Pandotra & Sastry is a *Septoria* sp. (Melnik, 1977). *Diplodia sambucicola* Fautrey may be a synonym of *A. deformis*, but the type of *D. sambucicola* has not been examined. *Diplodina plana* Karsten, listed by Rupprecht (1959) as a synonym of *A. deformis*, could not be found on the holotype, and must be considered a nom. dub.
3.3.5 Species of Ascochyttella and Ascochyttula not examined

Specimens of the species listed in this section were either not seen or, if seen, the named fungus was not present. Therefore, the status of these species cannot be determined.

Ascochyta populina Saccardo, Michelia 1: 168 (1878).
≡ Ascochyttula populina (Sacc.) Servazzi [as Ascoscytula],
Bollettino del Laboratorio sperimentale e Osservatorio di fitopatologia 18: 93. 1939 (1940).

This species was described as: 'Maculis variis, angulosis, arescendo candidis, atrocinctis; peritheciis punctiformibus, sparsis; spermatiis cylindraceo – fusoideis, 10-11 x 1.5-2, rectis, 1-septatis, non v. vix constrictis, e hyalino olivaceis. Hab. in pag. sup. foliorum Populi nigrae a Selva, Sept. 1874.'

Material of this fungus was not located at PAD, and the species was not listed by Gola (1930) as being in Saccardo's herbarium. Servazzi recombined the name in Ascochyttula because of the pigmented conidia. However, the conidia illustrated by Servazzi, appear to be considerably wider than the 1.5-2 μm described for A. populina in the protologue, suggesting a possible misidentification. Mel'nik (1977, p. 191) excluded the species from Ascochyta, but did not examine specimens.

Ascochyta sambuci Saccardo, Michelia 1: 168 (1878).
≡ Ascochyttella sambuci (Sacc.) Tassi, Bullettino del Laboratorio ed Orto Botanico, Siena 5: 28 (1902).

This fungus was described as: 'Maculis vagis arescendo candidcantibus; peritheciiis parcis, punctiformibus, pertusis; spermatiis fusoideis,
15-18 x 3-3.5, 1-septatis, non constrictis, olivaceis. Hab. in pag. sup. foliorum Sambuci nigrae a Selva, Sept. 1876.'

A single specimen labelled Ascochyta sambuci, no. 477, fol. Sambucus nigra, which according to Gola (1930) is the type and only specimen in Saccardo's herbarium (PAD), was examined. No fungus conforming to the above description was found, but another Coelomycete with 1-3 septate, pale yellow-brown conidia was seen. This was probably Hendersonia sambuci Müller in Saccardo.

Isotype specimens of Ascochyta sambuci (Mycetheca Veneta no. 986) were not examined. Mel'nik (1977, p. 194) reported the fungus on M.V. 986 (K). Ascochyttella sambuci was one of the original thirteen species listed by Tassi (1902) in Ascochyttella. Boerema & Dorenbosch (1973) considered A. sambuci to be a synonym of Stagonospora samarorum (Desm.) Boerema.

Additional literature: Allescher (1899, p. 663); Migula (1921, p. 287).

Ascochyttula anthemidis Sandu-Ville & Mititiuc [as Ascochyttula], Microbiologia (Societatea de Stiinte Biologice din Republica Socialista Romania) 2: 104 (1971).

This species was described as: 'Maculis nullis; pycnidis laxe dispersis, primo immersis, dein superficialibus, sphaericis, lenter depressis: 75-150 μm diametro, contextu ex cellus parenchymaticis, fuligineis, poro cca 10-14 μm lato apertis; sporidiis bicellularibus, medio constrictis, utrinque rotundatis, bruneoflavidis, rectis hinc inde leniter curvatis ex cellulis leniter inaequalibus, 10-14 x 4-6 μm. Hab. in caulibus emortuis Anthemidis tinctoriae L. prope Ponoare, distr. Suceava ubi 7 Aug 1964 Mititiuc legit Socio cum Phoma herbarum.'
The authors stated that material had been deposited in the mycological herbarium at Institutul Agronomic 'Ion Ionescu de la Brad' Iaşi (IASI). No specimens under this name are present in IASI (M. Hatman, pers. comm.) nor were any available from BUCM.


This species was described as: 'Pycnidiiis laxe dispersis, immersis, epidermidem lacerantibus et dein superficialibus, in subiculum ex hyphis crassis, nigris dispositis: 100-220 μ diametro, poro circulare cca 15-20 μ lato praeditis; contextu tenuis et fusco. Sporidiis castaneo-brunneis, sed isolatis fere flavidis vel fere hyalinis, cylindraceo-ellipsoideis, utrinque leniter attenuatis et rotundatis, non constrictis: 7.5-12 x 5-6 μm, hinc inde fere inequilateralibus, hinc inde cellulis inaequalibus Hab. in caulibus emortuis Asparagus officinale L. prope Iaşi, distr. Iaşi, ubi 3 May 1967 legimus.'

Material of this fungus was not available from the Mycological Herbarium 'C. Sandu-Ville' at IASI, nor from BUCM.

From the description, the species appears to have wider conidia than either Ascochyta asparagina Petrak or Ascochyttella asparagi Ahmad, two similar fungi recorded on Asparagus.

≡ Ascochyta atriplicis (Died.) Trotter, Sylloge fungorum 25: 321 (1931); non Lasch (1846) (nom. nud. fide Mel'nik, 1977), non Died. (1904), non Beeli (1924).

This fungus was described as: 'Fruchtgehäuse in kleinen Gruppen beisammenstehend, nach Verwesung der Epidermis fast oberflächlich, von erst hell-, dann fast schwarzbraunem parenchymatischem Gewebe, dünnwandig, mit kleinem Porus, 90-150 µm im Durchmesser. Sporen länglich, beidendig abgerundet, mit einer Querwand, sehr selten etwas eingeschnürt, in jeder Zelle mit einem Öltröpfchen, 7-9 µ lang, 3.5-4 µm breit. Auf alten vorjährigen Stengeln von Atriplex hastatum und laciniatum. Auf den Inseln Amrum und Sylt (0. Jaap, Juli 1904). Exsicc.: Jaap, Fung. sel. exsicc. 172 sub Diplodina atriplicis Vestergr.'

The following three herbarium specimens, and one culture, were examined but no fungus corresponding to the above description could be found.

Ascochyta atriplicis - on Atriplex hastata. Culture CBS 787.68.
Diplodina atriplicis - auf alten, vorjährigen Stengeln von Atriplex hastatum L. ... Insel Sylt, 21 Jul 1904, leg. O. Jaap, Otto Jaap Fungi selecti exsiccati 172 (B, JE).

Ascochyta-like fungi with pale brown, and larger conidia than those described for Ascochyta atriplicis, were present on all three herbarium specimens. The fungus on the IASI specimen had conidia 16.5-25.5 x 5-6 µm, while Jaap's collections, from B and JE, bore conidia 8-15 x 3-5(-6) µm, too small to be those of Diplodina atriplicis. The fungus on Jaap's specimens matches the description of Microdipodia henningsii Staritz (Webster & Lucas, 1959). Pleospora calvescens (Fr.) Tulasne, the teleomorph
of *M. henningsii*, was also present on Jaap's two collections.

The culture, labelled *Ascochyta atriplicis* CBS 787.68, was identical to cultures of *Ascochyta caulina* (Karsten) van der Aa & van Kesteren (CBS 343.78, 246.79) examined, and is considered to have been mislabelled.

The holotype of *A. atriplicis* is part of the particular specimen of *Diplodina atriplicis* (Jaap, Fung. sel. exsicc. 172) which Diedicke (1912b) examined. This specimen is presumably other than the two collections which I examined from B and JE.

*A. atriplicis* was listed by van der Aa & van Kesteren (1979) as one of several synonyms of *Ascochyta caulina*, a fungus found on *Atriplex* and *Chenopodium*. Other synonyms included *Diplodina atriplicis* and *Microdiploodia henningsii*. However, they described *A. caulina* as having setose conidiomata both on stems and in culture, with 1(-3) septate, subhyaline to brownish conidia, 12-27 x 3.5-7.5 μm in vitro, and smaller in vivo. On the basis of the protologue of *Ascochyta atriplicis*, it is unlikely that this species is conspecific with *Ascochyta caulina*.

*Ascochyta buettneriae* V. Bondarzeva- Monteverde, Notulæ systematicæ e Sectione cryptogamica Institutī botanici nomine V.L. Komarov Academiae scientiarum U.R.S.S. 4(10-12): 42 (1938) [not seen].

This species was described as follows (Mel'nik, pers. comm.): 'Pycnidiiis solitarii, paucis, atris, hemisphaericis, 185-225 μm diam., poro rotundato circa 40 μm diam. praeditis, contextu brunneo, parenchymatico grosse celluloso; conidiis cylindraceis, utrinque rotundatis, medio unisepitatis, non constictis, 8-12 x 4 μm, flavidulis, in massula fuliginosis. Hab. In fructibus *Buettneriae 'urticifoliae'* (Sterculiaceae) ex Italia acceptis, 8 Apr 1933.'

Specimens of this fungus were not available from LE.

This species was described as: 'Fruchtgehäuse meist in kleinen, der Länge nach gestreckten, meist sehr lockerem Herden, seltener etwas weitläufiger locker zerstreut, unter der meist weisslichgrau verfärbten Epidermis sich entwickelnd, nicht selten zu 2-3 ziemlich dichtgedrängt beisammenstehend und dann oft etwas verwachsen, niedergedrückt rundlich, sehr verschieden gross, 65-180 µm, meist ca. 150 µm im Durchmesser, nur mit dem gestutzt kegel-oder papillen-förmigen, von einem rundlichen, ca. 15-20 µm weiten Porus durchbohrten Ostiolum hervorbrechend. Pyknidemembran ziemlich weichhäutig, ca. 10 µm dick, aus wenigen, meist ca. 3 Lagen von ziemlich stark zusammengepressten, unregelmässig rundlich eckigen, bald ziemlich hell durchscheinend gelblichbraunen, bald dunkel olivenbraunen, ziemlich dünnwandigen, meist ca. 5-7 µm grossen Zellen bestehend, aussen mehr oder weniger mit hell gelblichbraunen oder honiggelben, reich verzweigten, im Substrat weit hinkriechenden, meist ziemlich kurzgliedrigen, ca. 5 µm, seltener bis 7 µm breiten Hyphen besetzt. Konidien den ganzen Pyknidenhohlbauem sehr dicht ausfüllend, schmal zylindrisch spindelförmig, beidendig, unten oft etwas stärker verjüngt, stumpf abgerundet, gerade, selten etwas ungleichseitig oder schwach gekrümmt, ungefähr in der Mitte mit einer, sehr selten mit 2-3 Querwänden, nicht oder nur sehr schwach eingeschnürt, sehr hell gelbgrünlich, in grösseren Mengen gelblichbraun, ohne erkennbaren Inhalt, 8-14 x 2-2 µm, auf den rundlichen, oft etwas papillen-förmig vorspringenden, hyalinen Zellen der inneren Wandfläche entstehend.

Auf dürren Stengeln von Echium vulgare bei der Station Czernotin-Keltsch nächst Mähr.-Weisskirchen, 6 Jun 1923.'
No material of this fungus is located in Petrak's Pilzherbarium, W (U. Passauer, pers. comm.), or at ZT.

Ascochyta psephelii Woronich, Travaux du Musée botanique de l'Académie des sciences de Russie 21: 177 (1927) [not seen].

This species was described as follows (Mel'nik, pers. comm.):
'Maculis rotundatis vel subirregularibus, brunneis, non limitatis, dein griseis, tenuitum, brunneo-marginatis, 0.5-1.5 mm diam., copiosis. Pycnidii globosis, epiphyllis, usque 100 µm diam. contextu brunneo, parenchymatico. Sporulis cylindraceis, apicibus rotundatis, dilute brunneolo-olivaceis, 1-septatis, 6.6 x 3.3 µm. Hab. In fol. viv. Psephelli sp., Caucasus, guv. Tersk, distr., Pjatigorsk, prope p. Nikolajevskaja, 23 Jul 1925, ipse legi.'

Specimens were not available from LE.

Diplodia ascochyta Saccardo, Michelia 2: 349 (1881).

≡ Microdiploodia ascochyta (Sacc.) Allescher, Rabenhorst Kryptogamen-Flora von Deutschland, Oesterreich, und der Schweiz I. Die Pilze, Abt. 7: 88 (1901).

≡ Microdiploodia ascochyta (Sacc.) Tassi, Bullettino del Laboratorio ed Orto Botanico, Siena 5: 31 (1902).

This species was described as: 'Perithecii gregarii et inde in cespitulos aggregatis, subsuperficialibus globulosolenticularibus, 80 micr.d. pertusi; stylosporis breve fusoides, 8-9 x 2½-3, utrinque obtusiusculis, olivaceis - in sarmentis decorticatis et saepius infuscatis Lonicerae pericymeni [Caprifoliaceae] Mb. (167). Habitus Diplodiæae, sed characteres potius Ascochytae.'
No material of this species was available from Saccardo's herbarium, PAD, although Gola (1930) reported that a single type specimen was located there. The epithet and comment following the protologue indicated Saccardo's uncertainty as to whether the fungus should belong in Diplodia or Ascochyta. Likewise, Allescher (1901) and Zambettakis (1954) were uncertain of its disposition.

Potebnia (1907) redescribed the species with larger conidiomata, 170-200 x 140-160 μm, and larger, sometimes 2-septate conidia, 9-12 x 2.5-3.5 μm. M. ascochytula was one of three species that Potebnia suggested might belong in a subgenus of Ascochyta which he proposed to call Ascochytula. A combination in Ascochyta or the genus Ascochytula has never been made.

Illustrations: Potebnia (1907, p. 17, tab. III, fig. 31); Diedicke (1912b, p. 552, fig. 30).


For additional synonyms, see Hawksworth & Dyko (1979).

Hawksworth & Dyko (1979) fully described and illustrated this lichenicolous fungus, and established it as the type species of the new genus, Lichenodiplis Dyko & Hawksworth. Type material (ANGUC) of this fungus was not examined.

3.3.6 Doubtful species of Ascochytella and Ascochytula

The species of Ascochytella and Ascochytula in this section could not be satisfactorily typified, and are declared to be nomina dubia. The type specimens of these species are either presumed lost or, where present, lack the described fungus.

Ascochytula camelliae Passerini in Brunaud, Champ. Saint. 5: 6, fide Saccardo (1892, p. 298) nom. dub.


Ascochytula camelliae was described in Saccardo (1892, p. 298) as: 'Maculis oblongis vel irregularibus, latissimis, griseo-albidis; peritheciis membranaceis, contextu brunneo-parenchymatico; sporulis olivaceis, 1-septatis, 5-7.5 x 2.5-3. Hab. in foliis Camelliae japonicae, Rochefort Galliae.'

Material of this fungus was not available from FH, FI, PARMA, PAD, PAV, PI, or RO. Mel'nik (1977) cited the species, but did not examine specimens. Tassi (1902) recombined the species in Ascochytella as one of the thirteen original species because of its pigmented conidia.

Ascochytula jaapii Saccardo in Trotter [as jaapi], Saccardo's Sylloge fungorum 25: 346 (1931) nom. dub.

≡ Ascochytula phlomidis Jaap, Annales mycologici 14: 35 (1916); non Grove (1935).

Jaap (1916) described this fungus as: 'Fruchtkörper gesellig, zuerst von der Oberhaut bedeckt, dann diese mit der Mündung durchbrechend, kugelförmig, etwa 100 μ breit, aus gelbbraunem, parenchymatischem Gewebe; Sporen ellipsoidisch, länglich oder kurz zylindrisch, an den Enden breit
abgerundet, gelblich graugrün, 5-9 μ lang und 3-4 μ dick, 2 zellig, nicht eingeschnürt, meist mit 2 polaren Ölkörpern.

An dürren Stengeln von Phlomis fruticosa L. [Lamiaceae] bei Ragusa, 15 Mar 1914.'

Specimens were not available from Jaap's herbarium at HBG, nor from B, E, FH, H, or JE.

Saccardo in Trotter (1931) could not use the combination Ascochyta phlomidis, because of the earlier A. phlomidis Bubák & Wróblewski in Bubák (1916a) (Art. 55). A specimen of the latter fungus on Phlomis alpina (FH) was examined. It had hyaline to subhyaline, (0-)1-septate conidia, 7-11.5 x 2.5-3.5 μm. Ascochyta phlomidis is therefore considered to be distinct from A. jaapii (see also under Ascochyta phlomidicola). Trotter (1931) listed A. jaapii in Ascochyta subgenus Ascochyttula, but the species was excluded from Ascochyta by Mel'nik (1977), because of its reportedly pale coloured conidia. Mel'nik did not examine material of this species.

Ascochyta ligustrina Passerini in Passerini, Thümen, & Brunaud, Revue mycologique 7: 154 (Jul 1, 1885); and in Passerini, Thümen & Brunaud, Journal d'Histoire Naturelle de Bordeaux et du Sud-Ouest n. 4: 55 (1885) nom. dub.


Ascochyta ligustrina was described as: 'Maculis versiformibus, subocraceis, brunneo-marginatis; peritheciis paucis, sparsis, atris, acutiusculis; spermatiis lanceolatis, 1-septatis, ad septum leniter constrictis, olivaceis, 5-7 mik. long.; 2½ crass. - In foliis Ligustri vulgaris. - Saintes. (P. Brunaud.)'.
Specimens of this fungus were not available from FI, FH, PAD, PARMA, or PI, nor were any examined by Mel'nik (1977, p. 188).

*A. ligustrina* was published in two almost identical papers in different journals dated 1885. Both papers were entitled 'Fungi gallici novi- Series II', and the species was cited as 'Ascochyta ligustrina Passer in litt.' and '..... in litt. ad Paul Brunaud'. Descriptions were the same. The precise date of the paper in Revue mycologique is known, but that of the other paper is not.

From the description, *A. ligustrina* would appear to have smaller conidia than *A. pterophila* (Fautrey) Keissler (= Ascochyta syringae Jaap), another Ascochyta species with pigmented conidia, on the Oleaceae. *A. ligustrina* was one of the thirteen original species in *Ascochyttella* Tassi.

*Ascochyttella cardui* Sandu-Ville in Sandu-Ville, Iacob, & Gutu, Lucrările științifice. Institutul agronomic 'Professor Ion Ionescu de la Brad', Iași, Ser. 1: 327 (1968) nom. inval.


Lesions: absent.

Conidiomata: pycnidal, scattered, mixed with other Coelomycetes, nonstromatic, somewhat erumpent, black, subglobose, 120-180 μm diam., ostiolate, glabrous; ostiole ca. 20 μm wide.

Conidiogenous cells: phialidic, solitary, arising directly from cells of the wall, hyaline, ampulliform, 4.5-5.5 μm high x 4.5-5 μm wide.

Conidia: medianly 1-septate, sometimes 2- or 3-septate, pale yellow-brown, elongate-elliptical to fusiform, not constricted at septum, base often somewhat truncate, apex rounded, straight, smooth-walled, eguttulate; 1-septate
(7.5-)8.5-10.5(-13) x (2-)2.5(-3) μm, 2- and 3-septate 11-13.5 x 2.5-3 μm.

Habitat: on dead stems of Carduus sp. and Carduus nutans L. (Asteraceae).

Distribution: Europe (Romania).


Specimens examined:

Ascochyttella cardui:

Romania - on Carduus sp., Toplet, județul Caraș-Severin, 28 May 1967, C. Sandu-Ville (IASI) [? type of Ascochyttella cardui].

Ascochyttula cardui:

Romania - auf totem Stengel von Carduus nutans L., Svinița, județul Caraș-Severin, 26 May 1967, C. Sandu-Ville (IASI) [? type of Ascochyttula cardui].

Notes: The same fungus was found on both specimens examined, although only rarely on the one labelled Ascochyttula cardui. This fungus was similar to the published descriptions of both Ascochyttula cardui and Ascochyttella cardui, but not in exact agreement with either. It was not possible to judge which of the two descriptions was closer.

Ascochyttella cardui and Ascochyttula cardui were both described as new species by Sandu-Ville. The descriptions were similar, differing mainly in the diameter of conidiomata and the width of conidia. Neither name was accompanied by a Latin description, and hence both were invalidly published (Art. 36).

The genus name, Ascochyttula, is a mis-spelling, but the intended name is uncertain. Ascochyttula could equally apply to Ascochyttula, as interpreted
by Index of Fungi 4(4): 91 (1972), or to Ascochytella, in which case the name would be a homonym. Ascochytula is probably the intended name, since the collection details of host and location in the protologue of Ascochytula cardui agree with those on a specimen in IASI labelled Ascochytula cardui. However, the published date of collection of Ascochytula cardui, 26 May 1927 differs from the date on the specimen, 26 May 1967.

The collection details on the specimen labelled Ascochytella cardui (IASI) also differ from those given in the protologue to this species. There is a discrepancy both in the date of collection, 28 May 1967 vs 30 May 1967, and in the collection location, Toplet vs Cornea.

No further collections under either name, were available from the Mycological Herbarium 'C. Sandu-Ville' at IASI.


This fungus was validly published and described as: 'Pycnidia gregarious, dark-brown to black, ostiolated with thick wall, 122-258 μm in diam.; conidia numerous, oblong-fusoid, broadest at the septa, septum thick, obtuse at both ends, bicelled, brownish, 8-14 x 5-7 μm. On dead leaves and twigs of Sapindus trifoliatum L., [Pushkar, Ajmer, Rajasthan. Dec 1970.] Specimen deposited with CMI, Kew, No. IMI 155809. Coll. No. J.U.M.L. 48.'

The holotype specimen, IMI 155809, was found to have collection details entirely different from those in the protologue. The specimen label read: 'Ascochytula sp. on Livistona sp., Jodhpur, India, 12 Mar 1971, K.S. Panwar. Ju/Bot/48.' Livistona is a member of the Arecaceae, whereas Sapindus is in the Sapindaceae. The host material in IMI 155809 was identified as belonging to a palm (Arecaceae). The specimen bore
several fungi, including Phoma sp, Myrothecium sp, and two Ascochyta-like species, both of which had smaller conidiomata and distinctly narrower conidia than those described for A. sapindi. No fungus corresponding to the description of A. sapindi was present.

There are no specimens of Ascochyta sapindi on Sapindus trifoliatum in IMI (B.C. Sutton, pers. comm.).

**Diplodia destruens** McAlpine, Fungus Diseases of Citrus Trees in Australia p. 98 (1899) nom. dub.

≡ Ascochyttella destruens (McAlp.) Tassi, Bullettino del Laboratorio ed Orto Botanico, Siena 5: 28 (1902).

≡ Ascochyta destruens (McAlp.) Saccardo & D. Saccardo, Sylloge fungorum 18: 347 (1906).

*Diplodia destruens* was described as: 'Minute, black, punctiform pustules, on scabby portions of leaves, or on dirty-grey patches, with ruddy-brown margin, at first running in irregular lines, ultimately expanding, and decayed tissue falling out. Perithecia somewhat gregarious, immersed, dark-brown, by transmitted light, depressed globose or elliptical, with minute apical pore, 150-170 μm diam. Sporules yellowish-brown to smoky-brown in mass, pale and transparent individually, elliptical, 1-septate, not constricted at septa, straight, average 10 x 4 μm


Specimens examined:

*Diplodia destruens*:

Australia - from orange lvs, Burnley, 19 Sep 1892 (VPRI 1390) [syntype of *D. destruens*; fungus not found on specimen].
- [slide only] from orange leaf, Mt Remarkable, S.A., 22 Jun 1895, A. Moleneaux (VPRI) [ex syntype of D. destruens; fungus not found on slide].
- on Citrus limonis, dead twigs, Burramine South, 5 Jan 1900, John Lawless (VPRI 1389).
- [slide only] on orange, 5 Jan 1900 (VPRI).
- [slide only] on orange twig, Burramine, 5 Jan 1900, Lawless (VPRI).

**Hendersonia socia:**

Australia - on Lisbon lemon leaves, with Fusarium roseum, Diplodia destruens, Coniothyrium cervinum, Royal Horticultural Gardens, Burnley, 1 May 1899, McAlpine (VPRI 1459) [probable syntype of H. socia; fungus not found on this specimen].

**Notes:** Of the three syntypes of *D. destruens* mentioned in the protologue, only the 1892 specimen (VPRI 1390) and a slide made from the 1895 collection (VPRI) are now available (I. Pascoe, pers. comm.). *D. destruens* could not be found on either this specimen or the slide. It was likewise not found on VPRI 1459, labelled as *Hendersonia socia* with *D. destruens* also present.

Other, later, specimens from VPRI bear a fungus corresponding in part to the description of *D. destruens*. Uniseptate conidia from these collections are of similar size and shape to those reported, but the conidiomata contain varying proportions, up to 60%, of 2- or 3-septate conidia. This suggests that *D. destruens* may be an immature 'Hendersonia' sp.

Zambettakis (1954) listed *D. destruens* as a synonym of *Microdiplodia perpusila* (Desm.) Allescher, along with *Microdiplodia palmarum* (Corda) Died. [as (Cooke) Died.] and *Diplodia passeriniana* Thümen. The latter two species, discussed below under *Coniothyrium* Corda, are distinct from *D. destruens* in having verruculose conidia. *Microdiplodia perpusila* was not examined.
Diplodia phyllostictae Cooke, Grevillea 5: 147 (1877) nom. dub.


≡ Ascochyta phyllostictae (Cooke) Saccardo & D. Saccardo, Sylloge fungorum 18: 347 (1906).

This species was described by Cooke as: 'Macula pallida, brunneo cincta. Perithecii semi-immersis, atris, gregariis; sporis ellipticis, unisepaltatis, parvulis. On leaves of forest trees. Mysore. [India]. Spores .016 x .008 mm., but slightly coloured brown.'

The holotype specimen, examined from K, did not bear a fungus corresponding to the above description.

Ascochyttella cookei Tassi was one of the original thirteen species in Ascochyttella Tassi, but it was not valid as a new species. The name was based on D. phyllostictae Cooke, and therefore Tassi (1902) should have made a new combination of the epithet, phyllostictae, in Ascochyttella. Zambettakis (1954, p. 300) cited D. phyllostictae as a synonym of Metadiplodia coryphae (Cooke) Zambettakis.


≡ Ascochytula amplexidis (Hollós) Sarejanni & Démétriadés, Annales de l'Institut phytopathologique Benaki 5: 8 (1951).

This species was described by Hollós as: 'Pycnidiiis erumpentibus, dense gregariis, confluentibus, depresso-globosis, fuscis, poro pertusis, 160-210 μm diam., contextu parenchymatico; sporulis oblongo-ellipsoideis vel cylindraceis, utrinque attenuatis et rotundatis, medio 1-septatis, non constrictis, dilute flavidulis, 8-13 x 3-4 μm. Hab. in ramulis emortuis Ampelopsis quinquefoliae, Kecskemét Hungariae. ... május hóban szedtem [= collected in May].'
Much of Hollós's herbarium, including material of this fungus, was destroyed in the Second World War (J. Gönczöl, BP, pers. comm.). Specimens were also not located at B, G, PREM, or W.

Diplodina plana P. Karsten, Meddelanden af Societas pro fauna et flora fennica 14: 150 (1887) nom. dub.


Diplodina plana was described as: 'Pyrenia sparsa, epidermide tecta, plana, orbicularia, atra, poro pertusa, diam. 0.1-0.2 mm. Sporae oblongatae, utrinque obtusae, rectae, 1-septatae, chlorino-hyalinae, longit. 6-10 mm., crassit. 2 mm.

In ramis emortuis Sambuci racemosae in horto Mustialensi, m. Aprili 1872.'

No fungus corresponding to this description could be found on the holotype specimen examined from Herb. P.A. Karsten (H).

Rupprecht (1959) listed this name in synonymy with Pseudodiplodia deformis (P. Karsten) Sacc. (≡ Diplodia deformis P. Karsten), also on S. racemosae. Comparison of the protologue of these two species however, does not support synonymy. D. plana was reported to have smaller conidiomata, each with a protruding ostiole, and smaller conidia than those of Diplodia deformis; conidiomata of D. deformis develop a pore only at maturity.
3.3.7 Species of Ascochyttella and Ascochyttula excluded from Ascochyta

Seven species of Ascochyttella and Ascochyttula are excluded from Ascochyta. Three species are described below, and four are described under the appropriate genera in Chapter 4:

- Ascochyttella depazeoides (Durieu & Mont.) Tassi (p.176)
- Ascochyttella passeriniana (Thümen) Tassi (p.176)
- Ascochyttella pinnarum (Pass.) Tarsi (p.176)
- Ascochyttula lonicerae (Höhnel) Höhnel (p.169)

**PLACODIPLODIA CANTHIFOLIA** (Cooke & Massee) comb. nov.

≡ Diplodia canthifolia Cooke & Massee, Grevillea 20: 36 (1891).
≡ Ascochyttella canthifolia (Cooke & Massee) Tassi, Bullettino del Laboratorio ed Orto Botanico, Siena 5: 27 (1902).
≡ Ascochyta canthifolia (Cooke & Massee) Saccardo & D. Saccardo, Sylloge fungorum 18: 347 (1906).

Additional synonyms in Zambettakis (1954, p. 300).

**Fig. 33.**

**Lesions:** absent.

**Conidiomata:** eustromatic, solitary, scattered, subepidermal, erumpent, black, subglobose or variable, 200-300(-350) μm diam., nonpapillate, nonostiolate, glabrous; dehiscence by rupture at conidiomatal apex.

**Conidiomatal wall:** in vertical section textura angularis, irregular and convoluted, 3-10 cells wide, 25-70 μm; outermost cells at conidiomatal base thin-walled and pale brown, at sides thicker-walled and slightly
**Fig. 33**

*Placodiplodia canthinafolia:*

A, conidia

B, conidiogenous cells

C, median vertical section of conidioma

\(A, B, C\), holotype (K).
darker brown, innermost cells thin-walled, hyaline.

Conidiogenous cells: phialidic, discrete, arising directly from cells of the wall, hyaline, ampulliform, collarette somewhat flaring, periclinal wall thickened, not proliferating, 7-10 μm high x 7-12 μm wide.

Conidia: 0-1-septate, light brown to brown, oval, elliptical, limoniform, or somewhat irregular, mostly not constricted at septum, septum usually medianly but sometimes markedly eccentric, with a central septal pore, wall thick about 1.5 μm wide, base and apex rounded, straight or sometimes curved, smooth-walled, eguttulate, 0-septate (8.5-)9-11(-12) x (5-)5.5-6.5(-7) μm; 1-septate (9-)10.5-12.5(-14) x 5.5-7(-9) μm.

Habitat: on leaves of Canthium latifolium FvM. ex Benth. (Rubiaceae).

Distribution: Australasia (Queensland, Australia).

Holotype: on leaves of Canthium latifolium, Tempe Downs (Mueller) (K!).

Specimen examined:

Diplodia canthifolia:

Australia - on leaves of Canthium latifolium, Tempe Downs, 1891, R.F. Thornton, Ex Phytologic Mus. of Melbourne, Baron Ferd. von Mueller (K) [holotype of P. canthifolia].

Notes: The monotypic genus Placodiopodia Bubák, with type species P. copelandii Bubák, has been described and illustrated by Sutton (1980) in the Phialostromatineae. The genus description is somewhat uncertain, since the holotype, and only specimen, of P. copelandii examined by Sutton (1980) was found to be overmature. Only one conidiogenous cell, identifiable as a phialide, was found. Apart from a thicker, and darker, conidiomatal wall, Placodiopodia shows similarity to Pseudodiopodia (P. Karsten) Sacc. sensu Sutton (1980).
Placodiplodia canthīfolia is considered to be congeneric with *P. copelandii* as described by Sutton, although it differs in having a paler coloured upper conidiomatal wall, and by having approximately equal numbers of non-septate and unisepitate conidia. The conidia of *P. copelandii* are medianly unisepitate.

The convoluted, stromatic conidiomatal wall and darker brown conidia separate this fungus from *Ascochyta*. The combination *Metadiplodia canthīfolia* (Cooke & Massee) Zambettakis is not accepted, since the genus *Metadiplodia* may be a later synonym of *Diplodia* (Sutton, 1977).

Additional literature: Saccardo (1892, p. 283), Bubák (1916b, p. 304-5).


Fig. 34.

Lesions: absent.

Conidiomata: pycnidial, solitary, in pairs, or closely aggregated in small groups, numerous, nonstromatic, subepidermal, erumpent, black, flattened globose, 120-260 μm diam., nonpapillate, ostiolate, glabrous; ostiole circular or oval, 20-40 μm wide.

Conidiogenous cells: holoblastic or phialidic, hyaline, collarette where present minute, channel wide.

Conidia: nonseptate, rarely 1-septate with septum variously positioned, pale brown, ends of conidia refractive and darker brown, cylindrical, oblong, or elliptical, sometimes slightly constricted about the middle, base somewhat truncate, apex bluntly rounded, mostly straight or slightly curved, smooth-walled, usually eguttulate, (10-)11.5-14.5(-19) x (4-)4.5-5.5(-6) μm.
Habitat: on dead stems of *Aconitum wilsonii* Stapf ex Mottet = *A. carmichaelii* Debeaux. (Ranunculaceae).

Distribution: Europe (W. Ukraine - USSR).

Holotype: Auf dürren Stengeln von *Aconitum wilsoni* im Schlossparke von Podhorce bei Stryj in Südostgalizien, 27 Mar 1918 (W!).

Specimen examined:

*Ascochytula aconiticola:*

USSR - holotype of *A. aconiticola* with collection details as above (W 12290).

Notes: This species is considered distinct from other *Ascochyta* species in that its conidia are predominantly nonseptate. Furthermore, conidiogenous cells are variable with respect to the presence or absence of a collarette; Petrak (1924) described them as 'höchst untypisch' (extremely atypical) and densely lining the cavity. The conidiomatal wall was described as several layers of brown cells, 18-25 μm wide.

These characters suggest that the fungus might belong to *Sphaeropsis* Sacc. Sutton (1980) listed this genus in the section Blastopycnidiineae Anellidic, despite its holoblastic ontogeny. The single percurrent proliferation of the conidiogenous cells, mentioned by Sutton, could conceivably be interpreted as a phialidic collarette (see Sutton, 1980, fig.57C).

A name for this fungus may exist in *Macrophoma* (Sacc.) Berl. & Vogl. regarded by Sutton (1980) as a synonym of *Sphaeropsis*. *Macrophoma grossetexta* Bubák on *Aconitum pantocsekianum* appears, from its description, to be similar to *A. aconiticola*, except for its reportedly hyaline conidia. Type specimens should be compared to determine whether these two fungi are conspecific.

Lesions: absent.

Conidiomata: pycnidal, solitary or sometimes in small groups, scattered, immersed, erumpent, brown to black, flattened globose or somewhat irregular, 100-150 μm diam., ostiolate, glabrous; ostiole 12-20 μm wide.

Conidia: nonseptate, sometimes medianly uniseptate, pale yellow brown, oblong to elongate elliptical, not constricted, base rounded or somewhat truncate, apex rounded, straight, smooth-walled, 0-septate (5.5-)6-7.5(-9) x (2.0-)2.5-3(-3.5) μm; 1-septate 7.5-8.5(-9.5) x 2.5-3.0(-3.5) μm.

Habitat: on winged pods of Tipuana tipu (Benth.) O. Kuntze (Fabaceae).

Distribution: Europe (Portugal, ?U.S.S.R.); South America (Uruguay).

Holotype: in alulis leguminum Tipuanae speciosae Benth. (Leguminosae) socia Septoriae tipuanae ex Lusitania acceptis, 15 Mar 1934 [T. speciosa is an illegitimate name for Machaerium tipu Benth., the basionym of T. tipu].

Specimens examined:

Ascochyta tipuanae:


U.S.S.R.? - on Tipuana tipu, ... [illegible], 1965 (LE) [A. tipuanae not found on this specimen].

Notes: The holotype of A. tipuanae was not examined, although the Uruguayan specimen (LE) had been incorrectly annotated by Mel'nik as the holotype. The fungus present on this specimen corresponded adequately to
the protologue description of *A. tipuanae*, but is considered not to belong in *Ascochyta*, since approximately only 20% of the conidia were septate. The fungus might better belong in *Microsphaeropsis* Höhnel. However, since the holotype was not seen, and details of conidiomatal wall structure and conidiogenesis were not elucidated, no new combination is proposed for this fungus.

The 1965 specimen from LE contains an *Ascochyta*-like fungus with 0-1(-2) septate conidia, larger than the measurements of 4-9 × 3 μm reported for *A. tipuana*. Nonseptate conidia from this collection measured (6-7)0-10(-13) x (2.5-)3.0-3.5(-4.0) μm, unisepatate conidia (7.5-)8.5-10.5(-15) x (3.0-)3.5-4.0(-4.5) μm. The fungus was not conspecific with *A. tipuana*.
CHAPTER FOUR

RELATED GENERA

In this chapter, eight genera related to Ascochyta are discussed. Most of these genera include species that were either previously accommodated in Ascochyttella or Ascochyttula, or were synonyms of such species. With the exception of Diplodia and Microdiploidia, the type species of each genus is described and illustrated. Ascochyttulina, Coniothyrium, Diplodia, Diplodina, Microdiploidia, and Pseudodiploidia have, in common with Ascochyta, didymosporous, nonappendaged conidia. They are distinguished from Ascochyta principally by the nature of the conidiomata, mode of conidiogenesis, or conidial colour, or by a combination of these characters. Scolecosporiella and Stagonospora have phragmosporous conidia, produced within conidiomata similar to those of Ascochyta.


This monotypic genus, described for Diplodia deflectens P. Karsten, was characterised by rather thick-walled, clypeate conidiomata, at first closed, then widely opening (Petrak, 1922b). The conidia were described as rather large, uniseptate, and pale coloured, and the conidiogenous cells as absent or very short. Sutton (1980) added that the conidiomata were ostiolate, conidiogenous cells phialidic, and conidia verruculose. My examination of A. deflectens agrees with the generic description given by Sutton (1980).

The presence of a clypeus separates Ascochyttulina from other genera. Sutton (1980) suggested that apart from the clypeus and verruculose conidia,
the genus was very similar to *Pseudodiplodia* (P. Karsten) Sacc. Zambettakis (1954) considered *Pseudodiplodia* to be a synonym of *Ascochytyulina*. However, from my observations, *P. ligniaria*, the type species of *Pseudodiplodia*, has annellides and lacks a preformed ostiole. These features, plus the absence of a clypeus, clearly distinguish *Pseudodiplodia* from *Ascochytyulina*.

Clements & Shear (1931) listed *Clypeodiplodia* F. Stev. as a synonym of *Ascochytyulina*, although Sutton (1977) stated that the thick-walled, nonostiolate conidiomata, and larger conidia of *Clypeodiplodia* do not support this synonymy. The type species, *C. baccharidis* F. Stev. was not examined in this study.


≡ *Diplodia deflectens* P. Karsten, Meddelanden af Societas pro fauna et flora fennica 11: 12 (2 Feb, 1884); Hedwigia 23: 18 (1884).


Additional synonym, *Phoma sempervirentis* Oudem., fide Sutton (1980, p.430). Fig. 35.

Lesions: absent.

Conidiomata: pycnidal, solitary, gregarious, nonstromatic, subepidermal, erumpent, dark brown to black, globose to flattened globose, 110-260 μm diam., nonpapillate, ostiolate, glabrous, clypeate; ostiole circular, 15-30 μm wide, sometimes with a thickened border.
Ascochyta aconiticola:
conidia, holotype (W 12290)

Ascochytilina deflectens:
A, conidia
B, conidiogenous cells
(overleaf)
C, conidiogenous cells
D, median vertical section of conidioma
A,D, holotype of Diplodia deflectens (H)
B,C, holotype of Pseudodiplodia lonicerae (FH).
Conidiomatal wall: in vertical section textura angularis, 2-4 cells wide, 13-20 μm; cells smooth-walled, outermost cells thicker-walled and subhyaline, innermost cells thin-walled and hyaline; towards the ostiole, wall wider with outermost cells brown, smaller, and thick-walled.

Clypeus: from above, light brown, somewhat filamentous, radiating to extend varying distances beyond the conidioma, not obvious on all conidiomata; in vertical section loose textura intricata, 16-33 μm thick, light brown, merging with the conidiomatal wall at the apex.

Conidiogenous cells: phialidic, lining the cavity, discrete, arising directly from cells of the wall, hyaline, ampulliform or conic, channel wide, collarette obvious but not flared, periclinal wall variably thickened, not proliferating, 6-12.5 μm high x 6.5-11.5 μm wide.

Conidia: medianly 1-septate, rarely 2- or 3-septate, pale brown, elliptical, sometimes weakly constricted at septum, base somewhat truncate, apex rounded, straight, finely verruculose, eguttulate, 1-septate (13.5-)16-19.5(-23.5) x (6-)6.5-7.5(-8) μm; 2- and 3-septate 19-23.5 x 6.5-8.5 μm.

Habitat: on dead branches of *Lonicera tatarica* L. (Caprifoliaceae).

Distribution: Europe (Finland, Austria).


Holotype: in ramulis emortuis *Lonicerae* prope Vasam, fine m. Aprilis 1865 (H!).

Specimens examined:

**Diplodia deflectens:**


P.A. Karsten no. 1486 (H) [Holotype of *D. deflectens*].

**Pseudodiplodia lonicerae:**

Austria - auf Zweigen v. *Lonicera tatarica*, Prater, Vindobona
[= Vienna], 9 Dec 1900, von Höhnel, Herb. Prof. Dr Fr. v. Höhnel ex 10208, Nectrioid, 3323a, plus 3 prepared slides. (FH)

[Holotype of P. lonicerae].

Notes: Petrak (1922b) discussed the synonymy of D. deflectens and P. lonicerae, and described the monotypic genus Ascochytlina for this fungus. Ascochytlina was considered to be distinct from Ascochyta by the somewhat stromatic form of the conidioma, the presence of a clypeus, and the large conidia. Earlier, Potebnia (1907) had suggested that D. deflectens might better belong in Ascochyta (subgenus Ascochyta), but he did not propose a new combination. P. lonicerae was transferred to Ascochyta because of its brown pycnidial conidiomata (von Höhnel, 1915).

The genus has been accepted by later authors, although the conidioma is now recognized to be pycnidial, not stromatic. Morgan-Jones & Kendrick (1972) described and illustrated A. deflectens, but without reference to a clypeus. These authors examined only Petrak's Flora Bohemiae et Moraviae exsiccati no. 1554 (FH). Sutton (1973, 1980) illustrated the fungus with a clypeus.

Didymella moravica Petrak, with ascomata of similar appearance to conidiomata of A. deflectens and on the same host, is probably the teleomorph of A. deflectens (Petrak, 1922b).

Additional literature and illustration: Potebnia (1907, p. 10, 17, taf. III, fig. 32).
4.2 **CONIOTHYRIUM** Corda nom. cons., *Icones Fungorum hucusque cognitorum*

4: 38 (1840).

*Coniothyrium* was described by Corda (1840) for species characterised by thin-walled conidiomata, splitting circularly or rupturing irregularly, and conidia 'simple'. Four species were originally listed, *C. pini* Corda, *C. palmarum* Corda, *C. subtile* Corda, and *C. glomeratum* Corda, but a type species was not designated. The genus is discussed here because three of the original species of *Ascochytella* Tassi are conspecific with *C. palmarum*.

Saccardo (1880, p. 7) emended *Coniothyrium* to include only those species with nonseptate, dark brown conidia, and in so doing excluded three of Corda's species with hyaline conidia. These three were transferred to *Leptothyrium* Kunze apud Kunze & Schmidt and *Aposphaeria* Sacc., leaving only the brown spored *C. palmarum* in *Coniothyrium*. Saccardo's concept of *Coniothyrium* Corda was accepted by most mycologists, except Kuntze and von Höhnel (*fide* Petrak & Sydow, 1927; Wakefield, 1939), and by 1931 almost 350 species had been described in the genus.

As the only remaining original species, *C. palmarum* should have been designated the lectotype species of *Coniothyrium*. Diedicke (1913, 1914) reported that *C. palmarum* had both nonseptate and uniseptate conidia and was, therefore, outside the accepted generic limits of *Coniothyrium* Corda emend. Sacc. He recombined the fungus as *Microdiploodia palmarum* (Corda) Diedel. Petrak & Sydow (1927) described the species in detail, regarding it as a transitional form between *Coniothyrium* and *Microdiploodia*. These authors considered many species of *Coniothyrium* to be forms of *Microdiploodia* species in which the conidia remained nonseptate. Petrak & Sydow (1927) and Wakefield (1939) sought to maintain the Saccardoan concept of *Coniothyrium*, and proposed, in place of *C. palmarum*, a new lectotype species, *C. fuckelii* Sacc., the first of two species listed by Saccardo (1880) for the emended genus. However, a proposal by Rogers (1949) was accepted to conserve
Coniothyrium Corda, with the type species, *C. palmarum*.

Thus, *Coniothyrium* now applies to fungi with dark, immersed, ostiolate, pycnidial conidiomata, with (0-)1-septate, verruculose, brown conidia (Morgan-Jones *et al*., 1972b; Sutton, 1971a, 1980). Most described *Coniothyrium* species have nonseptate, smooth, brown conidia and are not congeneric with the type species. Sutton (1971a) suggested that the phialidic genus *Microsphaeropsis* Höhnel could be a suitable genus for many of these species. A revision of the several hundred names in *Coniothyrium* is required.

The conidiogenous cells of *C. palmarum* are considered to be annellides (Sutton, 1971a, 1980) or proliferating phialides (Morgan-Jones *et al*., 1972b). My examination of specimens of *C. palmarum* indicated the presence of simple, nonproliferating phialides with typical collarettes enclosing a thickened periclinal wall.

*Coniothyrium* Corda is distinguished from *Ascochyta* Lib. by the dark brown, sometimes nonseptate, verruculose conidia, and from *Diplodia* Fr. by the enteroblastic conidiogenesis. Teleomorph connections are reported to be with *Paraphaeosphaeria* O. Erikss. and *Curreya* Sacc. (Müller, 1979).

Additional literature: Saccardo (1884, p. 305); Lindau (1900, p. 364); Allescher (1901, p. 22); Grove (1937, p. 1); Wollenweber & Hochapfel (1937); Biga *et al.* (1958); Morgan-Jones (1974); Kohlmeyer & Kohlmeyer (1979, p. 523).

**CONIOThYRium PALMARum** Corda, Icones Fungorum hucusque cognitorum 4: 38, taf. 8, fig. 106 (1840); non Cooke & Massee (1887).

≡ Microdiploedia palmarum (Corda) Diedicke, Kryptogamen-Flora der Mark Brandenburg, Pilze VII, 9(3): 592 (1914).

≡ Diplodia depaazooides Durieu & Montagne in Durieu de Maisonneuve, Exploration scientifique de l’Algérie, Botanique I, 1(14): 575 (1849) [not seen].
Lesions: grey with a brown or red brown margin, often at leaf tip.

Conidiomata: pycnidial, solitary, gregarious, more or less in rows parallel to leaf veins, amphigenous, nonstromatic, unilocular, subepidermal, erumpent, black, oval to elliptical or conic, laterally compressed, 180-350(-500) μm
Fig. 36

Coniothyrium palmarum:

A, (0-)1-septate conidia
B, older, multiseptate conidia
C, conidiogenous cells
D, median vertical section of conidioma

A-D, Diplodia pinnarum, Fungi della Mortola (PAD).
long x 100-200(-250) μm wide, nonpapillate, nonstiolate, glabrous; dehiscence by rupture at conidiomatal apex.

Conidiomatal wall: in vertical section textura angularis; at the conidiomatal base often flat, wall 1-2 cells wide, 3-8 μm, of hyaline, isodiometric, thin-walled cells; wall of the conidiomatal sides and roof 1-3 cells wide, of more irregularly shaped and larger, thicker walled cells, outermost cells brown, innermost cells hyaline; towards the conidiomatal apex, wall somewhat wider.

Conidiogenous cells: phialidic, mostly at the conidiomatal base, discrete, arising directly from cells of the wall, hyaline, subglobose to conic, periclinal wall thickened, not obviously proliferating, 5-8 μm high x 5-9 μm wide.

Conidia: mostly medianly uniseptate, sometimes nonseptate, occasionally inflating with age and becoming multiseptate, brown, elliptical, oblong, or obvoid, sometimes slightly constricted at septum, constriction more pronounced in old conidia, base somewhat truncate or broadly rounded, apex broadly rounded, straight, verruculose, eguttulate, 1-septate (7-)8.5-10.5(-12.5) x (3.5-)4-5.5(-8) μm; multiseptate up to 18 x 9 μm.

Habitat: on leaves of Chamaerops humilis L., Phoenix dactylifera L., Phoenix sp. (Arecales).

Distribution: Europe (Portugal, France, Italy, Algeria). Additional records in Diedicke (1914), Sutton (1980).

Holotype: Wohnt auf Blättern der Chamaerops humilis L. in Sizilien.

Specimens examined:

Coniothyrium palmarum:

Portugal - an liegenden und wellenden Blättern der Dattel-Palme, Phoenix dactylifera Lin. Häufig in Gemeinschaft mit Graphiola phoenicis Poit., Baleia bei Coimbra, Jul 1879, A. Fr. Möller,
v. Thümen Herb. mycol. oeconomicum 674 (PRM 661850).
- ad folia languida sed plerumque emortua adhuc pendula Phoenicis dactyliferae Lin., socia saepe Graphiola phoenicis Poit., Coimbra, Aug 1879, Ad. Fr. Möller, de Thümen Mycotechca universalis 1482 (PRM 661849).

**Diplodia depazaeoides:**

Algeria - cum Cryptosporium ? chamaeropis DM et Montag. cum Sphaeria steinbeill Montg., incipuinte, Durieu (PC).
- in foliis Chamaeropis (PC).

France - au Jardin Botanique, Marseille, M. Castagne, no. 1173 (PC).

Portugal - on Phoenix dactylifera, Coimbra, Portugal, Nov 1903, A. Möller, no. 118 (PAD).

**Diplodia passeriniana:**


Italy - in Phoenicis dactyliferae foliis vivis, in consortione Graphiolae phoenicis Poit., St. Remo, Liguria, Mar 1875, G. Passerini, de Thümen Mycotheca universalis 473 (FI, PAV, PRM 671205, RO)
[isotypes of D. passeriniana].
- in foliis vivis v. languidis Phoenicis, May 1924, Herbarium Horti Ticinensis, Collectio pathologica (PAV).
- in foliis Chamaeropis humilis prope Cadenabbia (Comum.), G.B. Traverso legit. - Aestate, Pollacci, Fungi Longobardiae exsiccati 328 (PAV).
Diplodia pinnarum:

Italy - on palm, Apr 1899, Herbarium Horti Ticinensis, Collectio pathologica (PAV).

Italy? - on Phoenix dactylifera, Fungi della Mortola, O. Penzig (PAD).

Notes: Type material of C. palmarum was not available from Corda's herbaria at PR, PRC, or PRM. Ascochyta depazeoides, A. passeriniana, and A. pinnarum were three of the original thirteen species in Ascochyta Tassi. From the specimens examined, all three are considered to be conspecific with C. palmarum.

Corda (1840) described and illustrated C. palmarum with spores rare, nonseptate, coffee bean shaped, large, and semitransparent greyish yellow. Subsequent authors, from Diedicke (1913) onwards, found that the conidia were uniseptate. Misinterpretation of conidial morphology by Corda may have resulted from the confusing array of conidia of different fungi, often densely covering the palm leaf surfaces, as seen in the specimens which I examined. Graphiola phoenicis (Moug.) Poit., for example, with small, globose to irregular, hyaline spores, often grows with C. palmarum.

Although Morgan-Jones et al. (1972b) reported ostiolate conidiomata for C. palmarum, dehiscence appears to occur by rupture at the apex and cracking of the host surface, without a preformed conidiomatal opening. In the specimens sectioned, conidia were produced from simple phialides. The proliferating phialides described by Morgan-Jones et al. (1972b), and the annellides described by Sutton (1971a) were not observed. Conidia were predominantly uniseptate, but in most collections a few older conidia were inflated, with additional transverse and thin oblique septa, often more strongly constricted at the transverse septa (Fig. 36B). Germinated uniseptate conidia were present, suggesting that the multiseptate condition
is not necessary for conidial maturity and may serve a resting function. The verruculose conidial wall, evident at all stages of septation, is a useful diagnostic feature of this species.

No confirmed teleomorph is known for *C. palmarum*, although Passerini (1880) reported Diplodia pinnarum as an anamorph of Leptosphaeria pinnarum Pass. var. rachidis Pass. (≡ Metasphaeria rachidis (Pass.) Sacc.).

Additional literature and illustrations: Saccardo (1884, p. 318); Allescher (1901, p. 4, 45, 91); Petrak & Sydow (1927, p. 328-33); Grove (1937, p. 29); Biga et al. (1958, p. 318); Sutton (1971a, fig 18B-D); Morgan-Jones et al. (1972b, p. 7, 8); Morgan-Jones (1974).

4.3 **DIPLODIA** Fries in Montagne, Annales des Sciences Naturelles, Botanique et biologie végétale, ser. 2, 1: 302 (1834).

For synonyms, see Webster et al. (1974).

**Diplodia** is discussed since it occupies a position in the Phaeodidymae similar to that held by *Ascochyta* in the Hyalodidymae. It was characterised by subcutaneous to erumpent, slightly carbonaceous, black, papillate, pycnidial conidiomata, producing ellipsoid, ovoid, or oblong, uniseptate, dark brown conidia, from simple, hyaline conidiogenous cells (Saccardo, 1884). As with *Ascochyta*, numerous genera have been segregated from *Diplodia*, mostly on the basis of characters of the conidiomata, such as the presence of a stroma, paraphyses, hairs, beaked apex, or superficial habit.

Taubenhaus (1915) considered four genera, *Botryodiplodia* Sacc., *Chaetodiplodia* P. Karsten, *Diplodiella* (P. Karsten) Sacc., and *Lasiodiplodia* Ell. & Ev. to be synonymous with *Diplodia*, and extended *Diplodia* to include species with hairy, stromatic, paraphysate, and superficial conidiomata.
This broad concept was not accepted by Zambettakis (1954) in his reassessment of the Phaeodidymae. He restricted Diplodia to its earlier definition, but unfortunately erroneously recombined the type species, D. mutila Fr. in Metadiplodia H. Sydow.

Webster et al. (1974) studied the growth of Diplodia and Diplodia-like fungi under varying cultural conditions. They found a wide variation in conidiomatal morphology, but conidial characters were stable. Conidial shape, ornamentation, and size were proposed as useful characters at the species level. They emended Diplodia to cover all fungi producing dark, didymosporous, nonappendaged conidia within stromatic or nonstromatic 'pycnidial' conidiomata, and brought twenty-seven genera into synonymy with Diplodia. Conidiogenesis was not examined, and thus confirmation of their proposed synonymy must await determination of this character for each genus.

Specimens of the type species, D. mutila, were examined from K. The fungus has holoblastic conidiogenesis and brown conidia. These characters, together with the presence of conidiophores (Sutton, 1980), separate Diplodia from Ascochyta.

Diplodia is heterogeneous with respect to conidiogenesis. D. ulicis Sacc. & Speg., for example, has phialidic ontogeny (isotype, K!). Two other species with phialidic conidiogenesis, D. maydis (Berk.) Sacc. and D. macrospora Earle, were recently redispersed to Stenocarpella H. & P. Sydow (Sutton, 1980). These two species had previously been recognized as distinct from Diplodia because of the production of a minority of 2- and sometimes 3-septate conidia (Sutton, 1964). Stenocarpella was described by Sutton (1980) as having thick-walled, dark brown, ostiolate, pycnidial conidiomata, discrete phialides, and pale brown, 0-3 septate conidia. Apart from the thick wall of the conidioma, this genus appears to be very close to Ascochyta, several species of which have 1(-3) septate,
pale brown conidia. Comparison of the type species, S. macrospora (Earle) Sutton, with Ascochyta is warranted.

Teleomorphs of Diplodia species have been reported in the bitunicate Ascomycete genera, Botryosphaeria, Cucurbitaria, Massaria, and Otthia, and in the unitunicate genus, Physalospora (Kendrick & DiCosmo, 1979).

Illustrations: D. mutila - Sutton (1980, fig. 29); Stenocarpella - Sutton (1964, figs 7-9; 1980, fig. 260).


For synonyms, see Sutton (1977, 1980).

This genus was established by Westendorp (1857) for the species, Diplodina salicis Westend., which he described with dark, thin-walled, globose, immersed, papillate conidiomata, 700 μm diam., and with fusiform, hyaline, uniseptate conidia, 15 x 3.5 μm.

Saccardo (1884) accepted the genus, regarding it as an hyaline analogue of Diplodia, and added several Diplodia species with hyaline to very pale coloured, uniseptate conidia. Confusion then arose as to the distinction between Diplodina and Ascochyta, both genera characterised by similar uniseptate conidia. Allescher (1899) separated the genera by their position on the host; Diplodina species growing on stems and branches, Ascochyta species growing on leaves. Lindau (1900) described Diplodina as not forming conidiomata in lesions, whereas Ascochyta species produced lesions on stems and leaves. Diplodina was redefined by Tassi (1902) to include only those species with conidia longer than 15 μm, and growing on stems and leaves. Species with smaller conidia, on stems, were redisposed to Diplodinula Tassi, and those on leaves to Ascochyta.
However, Saccardo & Saccardo (1906) relegated Diplodinula to subgeneric status within Diplodina, and Sutton (1980) regarded it as a probable synonym of Diplodina. Diedicke (1912b) characterised Diplodina as having a parenchymatic, Phoma-like conidiomatal wall, in contrast to the delicate, pseudopycnidial wall of Ascochyta. While admitting ignorance of Diplodina salicis, the type species, Petrak (1925b, p. 5) reported that the genus Diplodina, in the sense used by most authors, was no different from Ascochyta, an opinion supported by Potebnia (1907), Grove (1935), Sprague & Johnson (1950), Mel'nik (1977), and Punithalingam (1979).

Although many species of Diplodina are now considered to belong to Ascochyta (Mel'nik, 1977), the type species does not. The eustromatic conidiomata of D. salicis, with integrated, elongate phialides (Sutton, 1980), are fundamentally different from the simple pycnidial conidiomata and discrete, ampulliform phialides of Ascochyta. The characters of D. salicis provide for clear delimitation of the genus and the exclusion of Ascochyta-like species.

Nomenclature:

Controversy, however, still surrounds the correct name for the genus and type species. Boerema (1970b) considered Diplodina to be a later synonym of Discella Berk. & Broome, with the type species Discella salicis (Westend.) Boerema. Sutton (1977) maintained the generic name Diplodina, but with Diplodina microsperma (Johnston) Sutton, (= Stilbospora microsperma Johnston) as the type. An examination of the nomenclature and history of Diplodina and Discella establishes that both interpretations are incorrect (Fig. 37). The genus Discella Berk. & Broome was described in 1850 with four new species and a new combination, Discella carbonacea (Fr.) Berk. & Broome (= Phacidium carbonaceum Fr. ex Fr.) which was later chosen by von
Höhnel (1915) as the lectotype species. *Discella carbonacea*, as understood by Berkeley & Broome and most later authors, is conspecific with *Diplodina salicis*. The problem centres on the nomenclatural relationship between these two species.

The Discomycete, *Phacidium carbonaceum* Fr. ex Fr. (≡ *Xyloma carbonaceum* Fr.), described by Fries (1823, p. 574), appeared as no. 210 in both editions of Fries's Scleromyceti Sueciae of 1821 and 1834. The two editions, however, bear different fungi under no. 210. The first edition exsiccata (UPS) bears a Rhabdospora sp., probably *R. longispora* Ferraris (Boerema, 1970b), and the same fungus was also present on the first edition exsiccata (K) that I examined. A unitunicate Ascomycete with hyaline, fusiform, medianly uniseptate, 10-17 x 2-2.5 μm ascospores was also found on the exsiccata (K), and is probably *P. carbonaceum*. Dr Martha Sherwood (pers. comm.) found the *Phacidium* on the exsiccata at FH and, although lacking ascospores, identified it as *Coccomyces carbonaceus* (Fr.) Quélet. S.S. 210 of the second edition (UPS) contains a number of fungi, including a pycnidial fungus that matches the description of *Discella carbonacea* Berk. & Broome (Boerema, 1970b). This fungus has not been found on S.S. 210 of the first edition.

The holotype of *Phacidium carbonaceum*, and thus also of *Discella carbonacea* (Art. 7.10), is the first edition of Fries's Scleromyceti Sueciae no. 210 (Holm & Nannfeldt, 1962), bearing a Discomycete in the K and FH specimens. *Discella carbonacea* was, therefore, based on a misidentification (S.S. 210, second edition) and the name must be considered synonymous with *Phacidium carbonaceum* (Art. 55).

The fate of the generic name, *Discella*, follows that of its type species. *Discella* thus becomes a synonym of *Phacidium*. Boerema (1970b), while accepting that *Discella carbonacea* was misapplied, cited *Discella* as an earlier name for *Diplodina*. Such an opinion can only be defended
Diagrammatic representation of the taxonomic and nomenclatural history of the generic names *Diplodina* and *Discella*. The two interpretations concerning the status of these names by Sutton (1977) and Boerema (1970b) are contrasted.
Sutton (1977)

Diplodina Westend.
Type sp. Diplodina microsperma (Johnston) Sutton = Diplodina salicis Westend.

Discella is an obligate synonym of Rhabdospora (Durieu & Mont.) Mont.

Boerema (1970b)

Discella Berk. & Broome
= Diplodina Westend.
Type sp. Discella salicis (Westend.) Boerema = Diplodina salicis Westend.

Discella carbonacea = Phacidium carbonaceum is a synonym of Rhabdospora longispora

Westendorp (1857)

DIPLODINA Westend.
Type sp. Diplodina salicis Westend.

Berkeley & Broome (1850)

Misnamed: Stilbospora microsperma Johnston.
- considered to be a synonym of Discella carbonacea.

1831: Johnston mentioned S. microsperma
1824: Stilbospora microsperma Pers. ex Grev.
1796: Stilbospora microsperma Pers.

1834: Phacidium carbonaceum Fr. ex Fr. Scl. Suec. no.210. Ed.2. (misidentified)
1818: Xyloma carbonaceum Fr.
if the choice, by von Höhnel, of Discella carbonacea as lectotype of
Discella, is overthrown. However, the choice of lectotype species does
not appear to have been based on a misinterpretation of the protologue,
or to have been made arbitrarily, and must therefore stand (Art. 8).
Furthermore, of the five original species in Discella, only D. carbonacea
and D. abnormis Berk. & Broome remained after Saccardo (1884) emended the
genus; the other three were disposed to Melanconium Link ex Fr. and
Discula Sacc. Discella abnormis is the only species that could be chosen
as an alternative lectotype. Type material of this species, however, is
no longer located at K and is presumed lost (P.S. Green, K, pers. comm.).
Grove (1937, p. 149) stated that D. abnormis was 'certainly not a Discella'.
By elimination, D. carbonacea remains the only possible lectotype species,
and the name Discella cannot be retained because of the above argument.

Sutton (1977) accepted Diplodina Westend., synonymising the type
species, Diplodina salicis Westend. with Diplodina microsperma (Johnston)
Sutton (= Stilbospora microsperma Johnston). S. microsperma was listed by
Berkeley & Broome (1850) as a synonym of Discella carbonacea, and was
considered by Sutton to be an earlier name for Diplodina salicis. However,
this interpretation is incorrect. Johnston (1831, p. 192) under Stilbospora
Hab. On dead branches of beech and willow.' Clearly, Johnston (1831) did
not describe a new species, but merely referred to S. microsperma Pers.,
which was validated by Greville (1824). According to Sutton (1980),
S. microsperma Pers. was validated earlier by Mérat in 1821. Fries (1832,
p. 488) considered S. microsperma to be a Melanconium, and the exsiccata
specimen, Mougeot & Nestler no. 384 at E, is a Melanconium (B.J. Coppins,
E, pers. comm.). Johnston's collection of S. microsperma at E is a
Diplodina (B.J. Coppins, pers. comm.) and may, in fact, be a misidentification
of Persoon's fungus. Thus, Sutton (1977) has perpetuated the error first
made by Berkeley & Broome (1850), and Diplodina microsperma (Johnston)
Sutton must be rejected as a persistent source of error (Art. 69).

The name Diplodina Westend. is therefore accepted and, in the
absence of an earlier epithet, the type species is Diplodina salicis
Westend.

The limits of the genus as perceived by Sutton (1980) are followed.
Diplodina species have eustromatic, dark brown, immersed, flattened,
multilocular or convoluted conidiomata, with walls of hyaline to pale
brown textura angularis and textura intricata. Dehiscence is by rupture,
and not through an ostiole as described by Westendorp (1857). Hyaline,
septate, branched conidiophores line the cavity and bear phialidic
conidiogenous cells. Conidia are elliptical to fusiform, (0-)1(-2)
septate, hyaline, and smooth-walled. Teleomorphs belong to Cryptodiaporthe
Petrak.

DIPLODINA SALICIS Westendorp, Bulletins de L'Académie Royale des Sciences,
≡ Discella salicis (Westend.) Boerema, Netherlands Journal of

≡ Discella carbonacea (Fr.) auct. non Berkeley & Broome, Annals and
Magazine of Natural History. ser. 2, 5: 377 (1850).
(≡ Septomyxa salicis Grove, fide Sutton (1980)).

Teleomorph: Cryptodiaporthe salicella (Fr.) Petrak, Annales mycologici
19: 182 (1921).
Fig. 38.

Lesions: absent

Conidiomata: eustromatic, solitary or sometimes confluent in pairs or
small groups, scattered, immersed in periderm, erumpent, upper surface
convoluted when dry, brown to black, lenticular, oblong, oval, or irregular, 400-1200(-1800) μm long, nonpapillate, nonostiolate, glabrous; dehiscence by cracking of the host periderm and rupture of conidiomatal roof.

Conidiomatal wall: convoluted, in vertical section base and sides textura intricata outermost, textura angularis innermost, mostly 3-5 cells wide, 10-25 μm; cells smooth, thin-walled, pale brown; on the conidiomatal roof, wall of pale brown textura intricata, 16-33 μm wide.

Conidiophores: lining the cavity, arising directly from cells of the wall from which often scarcely differentiated, 1-3 septate, sometimes branched, smooth, thin-walled, hyaline.

Conidiogenous cells: phialidic, integrated, forming a dense hymenium particularly at the conidiomatal base, hyaline, elongate, cylindrical, tapering, straight or sometimes curved, collarette sometimes slightly flared, periclinal wall thickened, rarely proliferating, 8-18 μm high x 2-4 μm wide.

Conidia: medianly 1-septate, occasionally nonseptate, rarely 2-septate, hyaline, oval to elongate-elliptical, not constricted at septum, base rounded or often with a short, flattened protuberance which is 0.5-1.5 μm wide, straight, smooth-walled, eguttulate, (11-)13-15(-20) x (3.5-)4.5-5 (-5.5) μm.


Distribution: Europe (England, France, Belgium, Germany, Sweden); North America (South Dakota, U.S.A.).

Holotype: Sur les branches du saule pleureur, dans le parc de S'-Georges, à Courtrai (BR!).
Fig. 38

Diplodina salicis:

A, conidia

B, conidiophores and conidiogenous cells

C, median vertical section of conidioma

A, B, C, holotype (BR).
Specimens examined:

Diplodina salicis:

Belgium - sur ram. de Saule pleureur au parc de S'George à Courtrai, prov. W. Vlaanderen, Westendorp (BR) [holotype of D. salicis].
- sur les branches du Saule-pleureur, dans le parc de Saint George, à Courtrai, Westend. & Wall. Herb. Crypt. Belg. No. 1229 (K)
[isotype of D. salicis; fungus not found on this specimen].

Discella carbonacea:

England - on willow, King's Cliffe, 31 May 1859, ex Herb. Berkeley (K).
- on Salix smithiana, Kew Gardens, 20 Apr 1885, Fungi Exsiccati Selecti, ex Herb. M.C. Cooke (K).
- King's Lynn, M.C. Cooke: Fungi Britannici Exsiccati, Editio Secunda, No. 27 (B).
- Mendlesham, Suffolk, 29 Mar 1906, ex Herb. W.B. Grove (K).
- with Diplodina salicis on willow twigs, Hightown, 5 Jun 1915, ex Herb. Dr J.W. Ellis (K).

- sur Salix caproea et S. alba, Parc de St Cloud, Mar 1908, F. Ludwig (PC).

Germany - auf Ästen von Salix vitellina, Brandenburg: Sophienstädte bei Ruhlsdorf, Kreis Nieder-Barnim, 9 Jun 1919, P. Sydow, Sydow Mycotheca germanica no. 1716 (K).
- on Salix caprea, Krombach, near Siegen, 14 May 1921, A. Ludwig, Flora von Westfalen, Herb. Dr A. Ludwig (B).
U.S.A. - on Salix cordata, Northville, South Dakota, 15 Mar 1924,
J.F. Brenckle, Fungi Dakotenses, Brenckle, no. 555, F. Petrak
Pilzherbarium (B).

**Stilbospora microsperma:**

England? - an Phacidiunm carbonaceum junius, Herbarium Hookerianum
1867 (K).

**Notes:** The specimens examined represent a small sample of those extant.
A further fifty are in K and a similar number in B. Sutton (1980) cited
sixteen collections from IMI.

Specimens at different developmental stages were examined. The
conidioma when young is surrounded by a yellowish brown halo, 100-150 μm
wide, but this later disappears. As the stroma becomes more erumpent,
the overlying host periderm cracks either in a stellate manner or
longitudinally then transversely. The stroma roof then ruptures, usually
longitudinally, and opens, pushing back the periderm and exposing the
yellowish brown hymenial layer. The mature conidioma is thus cup-shaped
or plate-shaped. Conidia, produced as a yellow brown ooze, often require
staining before the septa become obvious.

The mature conidiomata of *D. salicis* were probably mistaken for
ascomata of a Discomycete when Fries misidentified this fungus as Phacidiunm
*Discella carbonacea* (Fr.) Berk. & Broome, which was based on this mis-
identification, and is therefore a misapplied name, is conspecific with
*Diplodina salicis*.

*Stilbospora microsperma* Johnston nom. inval., cited as a synonym
of *Discella carbonacea* by Berkeley & Broome (1850), became the basionym
for *Diplodina microsperma* (Johnston) Sutton. The collection of *S. microsperma*
Johnston examined from K and Johnston's specimen in E (B.J. Coppins, E,
pers. comm.) both bear Diplodina salicis.

Additional literature and illustrations: Berkeley & Broome (1850, p. 377, pl. 12, fig 8d); Westendorp (1857, tab. 1, fig. 6); Kickx (1867, p. 394); Saccardo (1884, p. 411); Allescher (1899, p. 695; 1902, p. 433); Diedicke (1914, p. 753, p. 754, fig. 1); Clements & Shear (1931, pl. 49, fig. 8); Grove (1935, p. 337; 1937, p. 148, 285); Butin (1958, p. 411-13); Moore (1959, p. 137); Sutton (1980, p. 606, fig. 372 A, D).

4.5 **MICRODIPLODIA** Allescher, Rabenhorst Kryptogamen-Flora von Deutschland, Oesterreich, und der Schweiz I. Die Pilze, Abt. 7: 78 (1901).

This genus is discussed because of the frequent reference to synonyms of Ascochytula and Ascochytella species in Microdiplodia. Petrak & Sydow (1927, p. 333-4, 339) drew a comparison between Microdiplodia and Ascochytella.

The present status of Microdiplodia is not well defined. The genus was described by Allescher (1901) for Diplodia-like fungi with conidia not longer than 15 μm. He listed fifty-six species and four varieties but a type species was not designated.

Tassi (1902) described Microdiplodia Tassi for small-spored Diplodia-like species. This is a later homonym, and therefore illegitimate (Art. 64), and many of Tassi's species were later combinations of Allescher's names. A type species was not indicated among the seventy-nine species and three varieties reported.

Sutton (1977) mistakenly considered Microdiplodia Allescher to date from 1903, and thus to be a later homonym of Tassi's name. According to the publication dates printed as a supplement in Rabenh. Krypt.-Fl. I. Abt. 8, p. 852 (1907), Allescher's protologue appeared in 1901, predating
Tassi's name by one year.

Clements & Shear (1931) chose Allescher's first-listed species, M. conigena Allescher, as lectotype species, but this was possibly an arbitrary decision. Hawksworth & Dyko (1979) reported that type material of M. conigena was not available from B, HBG, or M, and its identity is thus uncertain.

The separation of genera on the basis of conidial size is not justified, and Microdiplodia Allescher, as originally described, is not accepted (Zambettakis, 1954; Sutton, 1977). Zambettakis (1954, p. 243) emended Microdiplodia Allescher, recognizing other differences between Microdiplodia and Diplodia, such as the thinner conidiomatal wall of Microdiplodia species. He accepted a reduced number of species in the genus, and excluded the lectotype, which he considered to be a synonym of the stromatic species, Microbotryodiplodia atra (Berl. & Bresad.) Camara*. Zambettakis (1954) selected, as a new lectotype species, M. perpusila (Desm.) Allescher, from among the original species of Allescher. Since the choice by Clements & Shear (1931) of Allescher's first species, M. conigena, as lectotype, appears to have been arbitrary (Art. 8), the designation of a new lectotype species, M. perpusila (Desm.) Allescher for Microdiplodia Allescher emend. Zambettakis is probably justified. M. perpusila was not examined in this study, and the description by Zambettakis lacked details of conidiogenesis. Clements & Shear (1931) and Webster et al. (1974) listed Microdiplodia as a synonym of Diplodia, but until the type species is fully examined, the affinities of this genus cannot be determined.

Additional literature: Migula (1921, p. 310-13, taf. 39).

* Pettrak (1962) has since considered Microbotryodiplodia Camara to be a synonym of Microdiplodia, as the conidiomata of the type species, M. myopori Camara, although seated in a stroma, are separate from one another.
4.6 **Pseudodiplodia** (P. Karsten) Saccardo, Sylloge fungorum 3: 621 (1884); non Spegazzini (1920).

\[=\] Diplodia Fr. in Mont. subgenus Pseudodiplodia P. Karsten, 
Hedwigia 23: 87 (1884).

The name Pseudodiplodia was used for the new species Diplodia (Pseudodiplodia) lignariar P. Karsten in Karsten (1884a, b). Saccardo (1884), and subsequent authors, have cited Karsten (1884b) for the subgenus Pseudodiplodia, but the abbreviation 'N.sp', which follows the species name only in Karsten (1884a), suggests that Karsten (1884a) is the protologue. Diplodia lignariar was reported by Karsten to be distinct from the genus Diplodia in having a waxy-fleshy pycnidial conidioma with a wide mouth.

Saccardo (1884) elevated Pseudodiplodia to generic level, with P. lignariar as the type species, but incorrectly listed it in the Nectrioideae. This family was characterised by fleshy or waxy, bright coloured (white, yellow, red, or orange) conidiomata, whereas those on the holotype (H) of P. lignariar are dark brown to black. This mistake was perpetuated by Diedicke (1914), von Höhnel (1915), Migula (1921), Clements & Shear (1931), and Petch (1943). The type specimen was apparently lost during part of this period (Diedicke, 1914), but has since been rediscovered.

Petrak (1953) removed Pseudodiplodia from the Nectrioideae, and broadened the generic concept. Conidiomata were described as immersed to ± superficial, with a simple pore or ostiole, and a soft, pseudo-parenchymatic wall, varying from thin and very pale-coloured for species on leaves, to thicker and darker brown for species on stems and branches. The pale-coloured, (0-)1(-3) septate conidia were reported to arise from short, conical, papillate, or rod-shaped conidiogenous cells. Petrak considered Ascochyttella Tassi to be synonymous with Pseudodiplodia, and
made fifty new combinations in *Pseudodiplodia*, forty-five from *Ascochyttella* and five from *Ascochyttula* Died.

Sutton (1977, 1980) agreed with this synonymy, adding to Petrak's generic description that the conidiomata were dark brown with a somewhat bilayered wall of 2-4 cells wide, brown outermost except for the hyaline base. The conidiogenous cells were described and illustrated as phialidic, with a minute collarette and narrow channel.

Zambettakis (1954) listed *Pseudodiplodia* as a synonym of the clypeate genus *Ascochyttulina* Petrak, but this is considered to be incorrect because a clypeus is not present in *P. ligniaria*. Rupprecht (1959) and Mel'nik (1977) accepted Petrak's synonymy. Punithalingam (1979) examined the graminicolous species of *Ascochyttella* and *Ascochyttula* which had been transferred to *Pseudodiplodia*, and concluded that no boundary line could be defined between any of these three genera and *Ascochyta* Lib. The generic synonymy was not formalised, however, and there is no indication that Punithalingam examined *P. ligniaria*.

In the present study, *P. ligniaria*, and the five species transferred from *Ascochyttula* to *Pseudodiplodia* by Petrak (1953), were examined. *P. ligniaria* was found to be distinct from these other species, four of which are considered to belong in *Ascochyta*. The characters of *P. ligniaria* suggest that the generic limits of *Pseudodiplodia* should be narrower than those accepted by Petrak (1953). Von Höhnel (1915) considered that *P. ligniaria* was distinct from all seven other species then described in *Pseudodiplodia*, and he transferred these seven species to the genera, *Stylonectria* Höhnel, *Stylonectriella* Höhnel, and *Cyanochyta* Höhnel. Von Höhnel regarded these species as anamorphs of species of *Nectria* Fr. and *Nectriella* Nitschke, although Sutton (1977) doubted the validity of these connections. Teleomorphs for other *Pseudodiplodia* species are unknown (Kendrick & DiCosmo, 1979).
Pseudodiplodia contains many Ascochyta-like species with pale brown didymosporous conidia, named by authors who limit Ascochyta to species with hyaline conidia. It is likely that many of these species will be found to belong in Ascochyta when type specimens are re-examined.

Pseudodiplodia Lignaria (P. Karsten) Saccardo, Sylloge fungorum 3: 621 (1884).


Fig. 39.

Lesions: absent.

Conidiomata: pycnidial, scattered or closely aggregated in small groups, nonstromatic, immersed in periderm, erumpent, black, flattened subglobose, 120–250 μm diam., nonpapillate, preformed ostiole lacking, dehiscence apparently by rupture at apex to produce a pore, glabrous.

Conidiomatal wall: in vertical section textura angularis, 1–3 cells wide, 5–12 μm; cells smooth-walled, outermost cells somewhat thicker walled, brown at the roof fading to very pale or light brown at the conidiomatal base, innermost cells hyaline, thin-walled.

Conidiogenous cells: annellidic, lining the cavity, discrete, arising directly from cells of the wall, hyaline, ampulliform to obpyriform with a distinct neck, 4–7.5(-10) μm high x 4–5 μm wide.

Conidia: medianly uniseptate, brown to olivaceous brown, septum darker brown but paler at circumference, oval or broadly ellipsoidal, not or sometimes weakly constricted at septum, base broadly rounded or slightly tapering and truncate, apex broadly rounded, straight, smooth-walled, eguttulate, (9.5–)10.5–13(-14) x (5.5–)6–6.5(-7) μm; immature nonseptate conidia hyaline.
Fig. 39

Pseudodiplodia ligniaria:

A, conidia
B, conidiogenous cells
C, vertical section of conidioma
    A, B, C, holotype (H).

(overleaf)

D, thin section through conidia (x8,400).
E, F, G, thin sections through conidiogenous cells,
    showing annellations (arrowheads) on necks
    of the cells. E (x14,800), F (x17,500),
    G (x19,500).
D-G, holotype (H).
Habitat: on dead wood, from unknown host.

Distribution: Europe (Finland).

Holotype: In ligno vetusto ad Helsingforsiam (W. Nylander) (H!).

Specimen examined:

Pseudodiplodia ligniaria:

Finland - on wood, Nylandia, Helsingfors, 1850, W. Nylander, Herbarium Petter Adolf Karsten (1834-1917) No. 1488 (H) [ Holotype of P. ligniaria].

Notes: The conidiogenesis of P. ligniaria is thought to be anellidic, rather than phialidic as described by Sutton (1980). The neck of the conidiogenous cell, as seen under the light microscope, often appeared to be somewhat roughened. When examined under the electron microscope, despite the poor preparation resulting from the age and condition of the material, a series of flared wall layers could be seen on the neck of the conidiogenous cell (Figs 39E, F, G). These are interpreted as annellations, since each layer appears to arise at a slightly different level. There was no evidence of more than one conidium developing at a locus, as in a proliferating phialide.

Additional literature: Saccardo (1884, p. 621); Karsten (1890, p. 39); Petrak (1953, p. 302-5); Sutton (1980, p. 431, fig. 259).
4.7 **Scolecosporiella** Petrak, *Annales mycologici* **19**: 30 (1921); non Höhnel (1923).


Petrak (1921a) described the genus *Scolecosporiella* for the single species, *S. typhae* (Oudem.) Petrak (= *Hendersonia typhae* Oudem.). The genus was characterised as being similar to *Hendersonia*, apart from the absence of a true conidiomatal wall. The conidiomata were described as flattened-globose, subepidermal cavities, opening through the host epidermis, and producing conidia which were narrow, fusiform, multiseptate, and honey-yellow to brown.

Von Höhnel (1902, 1909) first reported the apparent absence of a conidiomatal wall in *Hendersonia typhae*, and on this basis renamed the fungus, *Scolicosporium typhae* (Oudem.) Höhnel. However, Petrak (1921a) found that the type species of *Scolicosporium*, *S. fagi* Lib. (= *S. macrosporium* (Berk.) Sutton), was similar to an Hyphomycete and was not congeneric with *S. typhae*. The latter species was redispersed to typify the new genus, *Scolecosporiella*.

Von Höhnel (1923) published *Scolecosporiella* Höhnel without any listed species and, as a later homonym, it is illegitimate (Art. 64). Clements & Shear (1931) considered *Scolecosporiella* Höhnel to be synonymous with *Scolicosporium* Lib. These authors also listed *Scolecosporiella* Petrak as a synonym of 'Hendersonia Westend.'

Sutton (1968) added two further species to *Scolecosporiella*, reporting that these, and the type species, possessed distinct ostiolate pycnidial conidiomata with walls of up to 5 layers of thin-walled, pseudoparenchymatic cells. Holoblastic conidiogenous cells lined the cavity and produced pale brown, smooth-walled, transversely and sometimes longitudinally septate
Conidia (Sutton, 1980). Conidia were considered conspicuous in having a truncate base with a frill, and an apical cell extended into a filiform appendage. This appendage, with stainable cell contents, appears to be present in conidia of three of the five species in the genus, but it is not obvious in conidia of the type species, S. typhae, nor of S. spraguei (= Ascochyta paspali (H. Sydow) Punith.). Having examined S. typhae and S. spraguei, I concur with the description of Scolecosporiella in Sutton (1980), although I do not consider the conidial apical appendage to be diagnostic for this genus.

The genus is distinguished from Ascochyta principally by its holoblastic conidiogenesis, and phragmosporous conidia.

Additional literature: Morgan-Jones et al. (1972a, p. 33-4).

Scolecosporiella typhae (Oudem.) Petrak, Annales mycologici 19: 31 (1921).

≡ Hendersonia typhae Oudemans, Nederlandsch kruidkundig archief ser. 2, 1: 255, tab. IX, fig. 7 (1873).


Fig. 40.

Lesions: absent.

Conidiomata: pycnidial, solitary, scattered between parallel veins of leaf, amphigenous, nonstromatic, subepidermal, weakly erumpent, black, globose or sometimes laterally compressed, 100-180 μm diam., papillate, nonostiolate, glabrous; preformed ostiole lacking, opening by a pore at the apex.

Conidiomatal wall: in vertical section textura angularis, 2-3 cells wide, 8-12 μm; cells thin-walled, smooth, and hyaline, often compressed
Scolecosporiella typhae:

A, conidia

C, median vertical section of conidioma

A, IMI 88870b

C, ex Fungi Bohemic (GRO)

(overleaf)

B, conidiogenous cells, IMI 88870b
in older pycnidia; towards the conidiomatal apex, wall slightly wider and cells pale brown.

Conidiogenous cells: holoblastic, lining the cavity, discrete, arising directly from cells of the wall, hyaline, ampulliform, sometimes with a distinct neck, 6-15 μm high x 5-10 μm wide.

Conidia: phragmosporous, (3-5)-6(-9) septate, light brown, cylindrical to navicular, often slightly constricted at septa, base truncate or rounded, sometimes with a short frill, apical cell longest and tapering, straight or sometimes curved, smooth-walled, sometimes guttulate, (40-48)-63(-100) x (5-5.5)-7(-8) μm.

Habitat: on leaves of Typha angustifolia L. and T. latifolia L. (Typhaceae).

Distribution: Europe (England, Netherlands, Germany).

Holotype: in culmis Typhae angustifoliae (Veen bij Achttenhoven) in consortio Phomae cujusdam et Sphaeriae scirpicolaet (GRO?)

Specimens examined:

Hendersonia typhae:
- in fol. T. angustif. Gall.(?) ad Moug.(?) (GRO) [probable holotype of H. typhae].
  Germany - in fol. Typhae angustifoliae, ad Gross Skal, 28 Sep 1904, Kabat, Fungi Bohemicí (GRO, IMI 108537 - slide only, ex GRO).

Scolecosporiella typhae:
- in fol. T. angustifolia, Ex type collection of Hendersonia typhae Oudem. (IMI 108536, slide only, ex GRO).

Scolecosporium typhae:
Notes: The identity of the holotype of *S. typhae* is uncertain. Oudemans's herbarium, originally located at GRO but now at L, apparently contains only two collections of *H. typhae*. The first was collected by J.E. Kabát and authenticated by Oudemans in a letter accompanying the specimen. The second specimen, which lacks discernable collection details, was presumed by Sutton (1968) to be the holotype. The herbarium sheet bearing these two specimens also has attached to it Oudemans's original illustration of *H. typhae*, which appears in fig. 7 of the protologue. In both illustrations, the conidia were mistakenly drawn upside down. Handwriting on the illustration does not match that on the adjacent specimen packet but, in the absence of other known collections, the second collection from GRO is accepted as the holotype.

Von Höhnel (1902, 1909) and Petrak (1921a) reported that *S. typhae* lacked a conidiomatal wall. In old conidiomata which I examined, the wall was present but thin, with cells compressed, flattened, and often difficult to discern from the surrounding tissue. A pore was present only in some conidiomata, suggesting the absence of a preformed ostiole, and the later development of a simple pore at conidiomatal maturity. Sutton (1968) described *S. typhae* with circular, papillate ostioles, up to 20 μm wide.

In culture, Webster (1955) found *S. typhae* to have larger pycnidial conidiomata, up to 350 μm diam., of variable shape, with a wall 8-10 cells wide, olive-brown towards the outside. Conidia were (3-)5(-8) septate, yellow to brown, (30-)60-70(-90) x (6-)7(-8) μm, with a 4 μm long apical appendage. The elongate tapering apical cell seen in the conidia from the type collection is not considered to be an appendage. The fungus was shown to be the anamorph of *Leptosphaeria typharum* (Desm.) P. Karsten (Webster, 1955).
Additional literature and illustrations: Saccardo (1884, p. 435); Allescher (1901, p. 243); Diedicke (1915, p. 875, 870, fig. 6); Grove (1937, p. 340); Sutton (1968, fig. 5); Morgan-Jones et al. (1972a, p. 33); Sutton (1980, fig. 35).

4.8 STAGONOSPORA (Saccardo) Saccardo, nom. cons., Sylloge fungorum 3: 445 (1884).

≡ Hendersonia Berkeley subgenus Stagonospora Sacc., Michelia 2: 8 (1880).

≡ Hendersonia Berk., nom. rej., Annals and Magazine of Natural History Ser. 1, 6: 430 (1841).

Additional synonyms in Sutton (1980).

Hendersonia, with the type, and only species, H. elegans Berk., was described by Berkeley (1841) for fungi with immersed pycnidia and long, multiseptate, hyaline conidia. The addition to the genus of H. sarmentorum, Westendorp (1851, p. 391) (BR!), with brown, 3-septate conidia, marked a departure from Berkeley's concept of hyaline conidia in the genus. The addition of further brown-spored species led Saccardo (1880) to partition the genus into two subgenera: Euhendersonia for species with coloured conidia, characterised by H. biseptata Sacc. and H. elegans, and Stagonospora for species with hyaline conidia, characterised by H. paludosa Sacc. & Speg. and H. graminella Sacc. Saccardo was mistaken in describing H. elegans as having brown conidia; they are hyaline (Berkeley, 1841).

Stagonospora was elevated to generic rank by Saccardo (1884), leaving an emended Hendersonia accommodating only those species with conidia olivaceous to 'sooty' in colour. H. elegans, the type species of Hendersonia, was recombined in Stagonospora by Cooke (1885, p. 66), and Hendersonia thus became an earlier synonym of Stagonospora. Wakefield (1939)
reported that as a consequence of this synonymy, 228 species named under Stagonospora would need to be transferred to Hendersonia Berk. and 439 species in Hendersonia Berk. emend. Sacc. would require a new generic name. To alleviate this need for extensive transfer of names, Wakefield proposed the conservation of Stagonospora (Sacc.) Sacc., with type species S. paludosa (Sacc. & Speg.) Sacc., against Hendersonia Berk. This proposal was accepted by the Seventh International Botanical Congress (Lanjouw, 1952).

Names of species in Stagonospora, therefore, are recognized under the Code, while those in Hendersonia nom. rej. are left without a genus. Sutton (1980) suggested that Sclerostagonospora Höhnel might be a suitable name for many of these species. This genus, with thin-walled pycnidial conidiomata, holoblastic conidiogenesis, and pale brown, 3-septate conidia, is distinguished from Stagonospora by conidial colour.

Modern treatments of Stagonospora describe the genus as having black, ostiolate, glabrous conidiomata, a wall of textura angularis with cells dark brown and thick-walled outermost, hyaline and thin-walled innermost, conidiogenous cells annellidic, and phragmosporous, smooth-walled, hyaline conidia (Sutton, 1980; Nag Raj & DiCosmo, 1981). Whilst agreeing in general with this description, my examination of the type species, S. paludosa, and of S. elegans suggested holoblastic and/or phialidic conidium ontogeny rather than annellidic. A detailed study of conidiogenesis in Stagonospora, using the electron microscope, is required. Also, the tissue of the conidiomatal wall of S. paludosa and, in particular, of S. elegans, appeared to be textura prismatica rather than textura angularis.

In any future revision of Stagonospora, attention should be given to conidial septation. There are several species, such as S. lophiostoma
Sacc., *S. suaedae* Sydow, and *S. brachypodii* Died., which are described with 1-3 septate conidia (Grove, 1935). On the basis of septation, these species correspond with some *Ascochyta* species, such as *A. paspali* (H. Sydow) Punith and *A. pterophila* (Fautrey) Keissler.

*Stagonospora* is similar to *Ascochyta*, but has traditionally been distinguished by conidial septation (Clements & Shear, 1931; Grove, 1935, 1937). Sutton (1980) distinguished the two genera by conidiogenesis and conidial septation, with *Stagonospora* producing phragmosporous conidia from annellides, and *Ascochyta* producing didymosporous conidia from phialides. However, my observations of conidiogenesis of *S. paludosa* differ, and the distinctions between *Stagonospora* and *Ascochyta* are in need of further clarification.

Teleomorph connections for *Hendersonia* Berk. emend. Sacc. have been reported with species of *Cucurbitaria*, *Leptosphaeria*, *Massaria*, *Otthia*, *Phaeosphaeria*, and *Pleospora*. *Stagonospora* has teleomorphs in *Leptosphaeria*, *Massarina*, *Pleospora*, *Physalospora*, and *Pseudopeziza* (Kendrick & DiCosmo, 1979).


**STAGONOSPORA PALUDOSA** (Sacc. & Speg.) Saccardo, Sylloge fungorum 3: 453 (1884)


Fig. 41.
Lesions: absent.

Conidiomata: pycnidial, solitary, scattered or gregarious, between the leaf veins, nonstromatic, subepidermal, immersed, not erumpent, black, globose, 100-240 \( \mu m \) diam., papillate, ostiolate, glabrous; ostiole circular, 20-40 \( \mu m \) wide.

Conidiomatal wall: in vertical section textura angularis to textura prismatica, 3-5 cells wide, 11.5-21.5 \( \mu m \); cells mostly flattened, smooth-walled, 7.5-12.5 \( \mu m \) across, outermost 1-2 layers of cells with thickened, brown walls, innermost layers of cells thin-walled, hyaline; towards the ostiole, wall thicker, 5-7 cells wide, 21-26.5 \( \mu m \), cells smaller, outermost 2-4 layers of cells with thickened, brown walls.

Conidiogenous cells: holoblastic or phialidic, lining the cavity, discrete, arising directly from cells of the wall, hyaline, ampulliform, channel wide, collarette where present prominent, 5-8 \( \mu m \) high \times 4.5-11 \( \mu m \) wide.

Conidia: (4-6)-8(-9) septate, hyaline, fusiform, weakly constricted at the septa, base broadly rounded or somewhat truncate, apex more acutely rounded, straight or slightly curved, smooth-walled, with numerous small guttules in each cell, (39-48-57(-62) \( \times \) (7-8-9.5(-10)) \( \mu m \).

Habitat: on leaves of Carex pseudocyperus L., C. riparia Curt. (Cyperaceae).

Additional records in Grove (1935, p. 353); Cunnell (1956, p. 37).

Distribution: Europe (England, Italy).

Isotype: in foliis Caricis ripariae putrescentibus a Bresséo (Euganei), N. Italy, Feb 1878, Mycoth. Ven. n. 1293 (K).

Specimens examined:

Stagonospora paludosa:

Stagonospora paludosa:

A, conidia

B, conidiogenous cells

C, near-median vertical section of conidioma

A,B,C, IMI 58657.
Notes: Stagonospora paludosa is the lectotype species of the genus Stagonospora. To my knowledge, no detailed ultrastructural study of this fungus has been undertaken to accurately determine conidiogenesis. Sutton (1973) described the genus as having hyaline, doliform annellides, while in Sutton (1980), the generic description refers to holoblastic conidiogenous cells, occasionally annellidic, with a single proliferation. I have seen no evidence of annellidic development in S. paludosa. Conidium ontogeny, as viewed from light microscope sections of S. paludosa (IMI 58657), is in some cases holoblastic, in others phialidic with a distinct collarette and periclinal thickening. This apparent dual ontogeny has also been found in S. elegans (p. 213) and Ascochyta paspali (p. 128).

A study of fresh material, using the electron microscope, is required. Examination of type material is unlikely to yield the mode of conidiogenesis; Cunnell (1956) reported that Saccardo's exsiccate material from K and BM lacked the fungus.


STAGONOSPORA ELEGANS (Berk.) Cooke, Grevillea 14: 66 (1885).

≡ Hendersonia elegans Berkeley, Annals and Magazine of Natural History, Ser. 1, 6: 430 (1841); non Sacc. (1884).
≡ Stagonospora elegans (Berk.) Sacc. & Traverso, Sylloge fungorum 20: 878 (1911).

Lesions: absent.

Conidiomata: pycnidial, solitary, scattered, interveinal, nonstromatic, immersed, erumpent, black, lenticular or often elongate parallel to host veins, 300-800 μm long x 150-300 μm wide, nonpapillate, ostiolate, glabrous; ostiole circular, 20-40 μm wide.

Conidiomatal wall: in vertical section compressed textura prismatica at base and sides, 3-5 cells wide, 8-16 μm, widening to 25 μm at the bottom of the sides; cells thin-walled, flattened, light brown, darkening at the conidiomatal sides; towards the ostiole, wall wider, up to 36 μm, brown, lacking cellular detail, merging with host collenchyma; innermost cells at ostiole hyaline and budding off small globose hyaline cells.

Conidiogenous cells: holoblastic or sometimes phialidic, lining the cavity, discrete, arising directly from cells of the wall, hyaline, elongate ampulliform, collarette where present short, periclinal wall only slightly thickened.

Conidia: (3-)4-5(-6) septate, hyaline, fusiform, not or only weakly constricted at septa, base truncate, apex tapering and rounded, straight or slightly curved, smooth-walled, with numerous guttules or cell inclusions, 54-77 x 8.5-11.5 μm.

Habitat: on dead culms of Phragmites australis (Cav.) Trin. ex Steud. (= P. communis Trin.) (Poaceae).

Distribution: Europe (England).

Holotype: on culms of the common reed. Transor, Norths. Apr. 1838. (K!).
Stagonospora elegans:

A, conidia and conidiogenous cells
B, median vertical section of conidioma (diagrammatic)

Fig. 42

A,B, Cunnell, 1954 (K)
Specimens examined:

Hendersonia elegans:

    England - Transor, Norths., Ex Herb. Hookerianum (K) [holotype of
    S. elegans].

Stagonospora elegans:

    England - on dead submerged stems of Phragmites communis, Gravel
    Pit, Stanwellmoor, Middlesex, 20 Apr 1954, G.J. Cunnell (K).

Notes: Conidiomata were not removed from the holotype since few remain
on the specimen. Cunnell (1957) extensively studied the species and
compared his collections with the holotype. His specimen (K) was found
to be overmature, and the conidiogenous cells were often in poor condition.
Most cells appeared to be holoblastic, but some had a short collarette
and slight periclinal thickening, indicating phialidic development.

Additional literature and illustrations: Berkeley (1841, tab. XI, fig.
9a-e); Grove (1935, p. 356-7); Cunnell (1957, figs. 1-5); Sutton (1980,
fig. 49D).
PART TWO:

LEAF STRIPE DISEASE OF Paspalum dilatatum

CAUSED BY Ascochyta Paspali.
CHAPTER FIVE

INTRODUCTION TO THE DISEASE

5.1 THE HOST, Paspalum dilatatum

Paspalum dilatatum Poir., commonly known as paspalum or Dallis grass, belongs to the tribe Paniceae, subfamily Panicoideae (Berrie, 1977). It is native to the humid subtropics of Argentina, Uruguay, and southern Brazil, and was accidentally introduced to New Zealand from South America in the early 1890's, probably as seed in ballast (Kirk, 1896). Paspalum has been introduced to other countries including Australia, Hawaii, southeastern United States of America, and South Africa (Whyte et al., 1959).

In some parts of New Zealand, this deep rooted, perennial grass is now an important pasture component, due to its prolific summer growth and resistance to drought. Percival (1977) found paspalum to be present in 40-100% of pastures in Northland, Auckland, Waikato, Bay of Plenty, and Poverty Bay. It was less frequent in pastures in the lower half of the North Island, northern Westland, Nelson, and Marlborough Sounds, and was absent from pastures in the remainder of the South Island. Temperature appeared to be the main factor governing its distribution. With a $C_4$ photosynthetic pathway (Hatch et al., 1967), paspalum has a higher optimum temperature for photosynthesis and growth than $C_3$ grasses, such as ryegrass (Forde et al., 1976). A sward composed of paspalum, ryegrass, and white clover is considered to be the ideal pasture for Northland (Arnold, 1953) and is one of the most productive swards in New Zealand (Levy, 1970).
Undesirable characteristics of paspalum include sod-binding and suppression of other components of the sward (Percival, 1977). Heavy grazing may severely depress its productivity (Lambert, 1967), although Hunt (1979) did not agree. The grass is the favourite host of the serious pasture pest, black beetle, *Heteronychus sanctae-helenae* Blanch. (Todd, 1959).

Major weaknesses of paspalum are its low fertility, less than 20% of the florets set seed (Burton, 1962), and the susceptibility of seed to infection by the ergot fungus, *Claviceps paspali* F. Stev. & J. Hall. Germination of New Zealand-grown paspalum seed was recorded by Levy (1923) at 0-4%. Paspalum seed sown in New Zealand is imported from eastern Australia, and has a higher viability, variously reported to be 20% (Ballinger, 1953), 24-32% (Owen, 1977), and 60-80% (Lancashire et al., 1980). The difficulty of producing large quantities of viable seed, coupled with the apomictic habit of paspalum, has hindered attempts to breed improved lines (Burton, 1962; Percival & Couchman, 1979). Ergot infection further reduces fertility of the host, and leads to the production of alkaloids which are toxic to animals grazing the seed heads (Luttrell, 1977). Pastures can be grazed or topped to prevent seed head development.

Two foliar diseases, anthracnose caused by *Colletotrichum graminicola* (Ces.) G. Wilson and a leaf stripe caused by *Ascochyta paspali* (H. Sydow) Punith., are common on paspalum in New Zealand. In the southern United States of America, paspalum plants infected by *C. graminicola* and by *Drechslera micropus* (Drechsler) Subram. & Jain (not recorded on paspalum in New Zealand) can be weakened and killed (Burton, 1962). To my knowledge, *C. graminicola* is not a serious pathogen of paspalum in New Zealand.
5.2 SYMPTOMS OF THE DISEASE

The leaf stripe disease of paspalum caused by A. paspali is readily seen in an infected sward (Fig. 43A). The lesions are amphigenous, light brown to greyish brown, and elongate (Figs 43B, C). They first appear at the tip of the leaf blade or less often at one edge. Expansion of the lesion tends to occur down one side of the lamina or sometimes down the central rib. The margin of the lesion is flat, and often uneven or tapering to a point at its lower end. An infected leaf usually has a single lesion, which may extend the entire length of the blade and into the sheath (Fig. 43C). Within the lesion, numerous dark brown to black pycnidial conidiomata form between the leaf veins (Fig. 43D). The conidiomata usually mature first in the oldest part of the lesion. The conidia are slime spores, liberated from the ostiole of the conidioma in the form of a dark brown cirrus. With age, the lesion dries, becomes light grey, and the leaf curls and dies.

5.3 DISTRIBUTION OF THE DISEASE

In New Zealand, the disease occurs on paspalum in lawns, on roadsides, and in pasture. Its distribution appears to parallel that of the host. The disease is common throughout the upper half of the North Island, wherever paspalum grows. Incidence of the disease has not been assessed in more southern areas of the country, where paspalum is less abundant.

The disease has been recorded in Australia (New South Wales (Anon., 1980), and Victoria (J. Walker, pers. comm.)). It is also known from Tonga, southeastern United States of America (North Carolina, Georgia, Texas) (Sutton & Alcorn, 1974), and from Argentina (Sydow, 1936), where it was first reported. The disease probably originated, along with paspalum, in South America, and has spread to other countries with the host.
Ascochyta paspali leaf stripe disease of Paspalum dilatatum:

A, symptoms in a pasture sward.

B, lesions usually originate at the leaf tip and extend down one margin. The pycnidial conidiomata appear as tiny black spots in these lesions.

C, young paspalum culms with lesions present on leaf blades and sometimes extending into the leaf sheaths.

D, close-up of a portion of a lesion on a leaf blade, to show the black pycnidial conidiomata usually formed between the parallel leaf veins.
5.4 HOST RANGE OF ASCOCHYTA PASPALI

A. paspali is common on Paspalum dilatatum, but only one record on another host has been published. Sutton & Alcorn (1974) described Scolecosporiella spraguei Sutton & Alcorn (= A. paspali) from four collections in the southeastern United States, three on P. dilatatum and one on P. floridanum Michx var. glabratum Engelm. ex Vasey. The holotype of S. spraguei is the specimen on the latter host. Unfortunately, all four collections of S. spraguei are missing from WSP (R. Chacko, pers. comm.), and only a microscope slide remains from each collection, in IMI. These slides serve only to confirm identification of the pathogen. As discussed on p. 127, S. spraguei is considered to be conspecific with A. paspali.

The identity of P. floridanum var. glabratum as a host, however, cannot be confirmed, although in the field P. floridanum var. glabratum and P. dilatatum are unlikely to be confused (Hitchcock, 1950). In the present study, living material of P. floridanum var. glabratum was requested from the United States, and seeds and vegetative material, labelled P. floridanum, were received from North Carolina and Louisiana. The variety, glabratum, is apparently no longer widely recognized (J.K. Saichuk, pers. comm.). Young plants of P. floridanum grown from seed and from vegetative material, and seedlings of P. dilatatum, were inoculated with conidia of A. paspali. None of the P. floridanum plants developed symptoms, whereas all the P. dilatatum seedlings became infected.

Due to the uncertainty of the single record of A. paspali on P. floridanum var. glabratum, the host range of this fungus should be limited at present to P. dilatatum.
5.5 EFFECT OF THE DISEASE ON YIELD OF PASPALUM

The following is an investigation into the effect of infection by A. paspali on the yield of P. dilatatum. Control and inoculated plants were held at different temperatures, and the yields measured.

5.5.1 Methods

Paspalum plants were raised in a glasshouse from Australian-grown commercial seed. They were grown individually in 7 cm wide plastic pots containing U.C. Soil Mix, with a fertilizer added (Baker, 1957; see Appendix). At the 3-4 leaf stage (up to 12 cm high), 64 seedlings were misted for 24 h at 22-24°C, to partially break down the hydrophobic properties of the paspalum leaf surface. The plants were then randomly divided into two groups of equal number. One group was sprayed with a suspension of A. paspali conidia (2 x 10^6 conidia/ml), while the other group, acting as a control, was sprayed with sterile distilled water. Treatments were applied with a hand-operated De Vilbiss atomizer. The conidial suspension was prepared from diseased paspalum leaves collected from the glasshouse and the field. The leaves were incubated under humid conditions at 30°C for 24 h to induce sporulation. Viability of the conidia was checked on agar media, after 3 days at 20-22°C.

Following the treatments, each plant was covered with a polythene bag and returned to the mist cabinets for a further 7 days, at 22-28°C. The bags were then removed, and 8 inoculated and 8 control plants were placed in each of four controlled climate chambers. The plants were arranged in groups of four in separate trays, inoculated and control plants being kept apart. Irrigation was from below.

The controlled climate chambers were operated at different constant temperatures, with the relative humidity adjusted to give an approximately...
equal air moisture level in each chamber, viz 14°/85% RH, 18°/70% RH, 22°/55% RH, 26°/50% RH. The light source in each chamber was a combination of incandescent bulbs and cool white fluorescent tubes. The radiation level at the top of the plants at commencement of the experiment had a quantum flux density of 320 µE.s⁻¹.m⁻². Illumination was on a 12 h on/off cycle with an abrupt light/dark change.

The plants were harvested 49 days after inoculation. To reduce variation, the visually largest and smallest plants of each treatment, in each chamber, were excluded. The fresh weight of roots and tops was measured separately for each plant. Roots and tops were then ovendried at 100° for 48 h, and reweighed.

The experiment was repeated with an additional 16 plants occupying a fifth controlled climate chamber, set at a constant 30°. After inoculation, the plants in this experiment were placed directly into the chambers, without further misting. Polythene bags were removed after 7 days. Viability of the conidia used as inoculum was tested on agar media at the same five temperatures as were used in the controlled climate chambers. At least 200 conidia were scored for germination after 24 h at each temperature. The plants were harvested 58 days after inoculation.

5.5.2 Results and Discussion

Disease symptoms were produced by the fungus on inoculated plants at all temperatures except 30°. Control plants remained free of symptoms.

Viability of the conidia used in the inoculum was tested on agar media. In Experiment One, 90% of the 200 conidia examined had germinated, at 20-22°. In Experiment Two, germination was reduced at the lower temperatures. The percentage of conidia which germinated at each temperature was: 18% at 14°; 44% at 18°; 83.5% at 22°; 94% at 26°; 87% at 30°.
For each experiment, the fresh and dry weight measurements for roots and tops were analysed separately. Measurements were subjected to robust analysis to reduce the effect of a small number of values which were widely divergent from the means. The data were then log-transformed and analysed using the Anova directive of the General Statistic Package (GENSTAT). Yields from the two treatments at each temperature were compared using Tukey's Studentised Range (TSR_{0.05}), and treatment yields over the entire temperature range of each experiment were tested for significance using the F statistics from the analysis of variance (F_{0.05}). The results are summarized in Table 2.

The trends apparent in fresh weight and in dry weight measurements were the same, although the smaller dry weight values tended to reduce the significance of differences between inoculated and control plants. Maximum top growth of the control plants occurred at 22° in both experiments, while maximum root growth was recorded at 18° in Experiment One, and 22° in Experiment Two.

In both experiments, there was a significant overall reduction in fresh weight of roots and tops of the inoculated plants as compared to the control plants. The yield reductions based on dry weights were smaller, and no longer significant except for roots in Experiment One.

The decrease in weight of roots of inoculated plants may be due either to the symptomless physical presence of the fungus in the roots, hindering root development, or to the reduced growth of the whole plant resulting from infection and symptom development in the leaves.

The reduction in yield was not uniform at all temperatures tested, but was concentrated at a single temperature. The temperature at which yield reduction was significant differed in the two experiments: 18° for both roots and tops in Experiment One; 22° for roots and 26° for tops in Experiment Two (Table 2). This discrepancy may reflect the different
TABLE 2. Mean log-transformed weight (g) of roots and tops of paspalum plants inoculated with Ascochyta paspali, and maintained at different constant temperatures.

<table>
<thead>
<tr>
<th></th>
<th>Dry weight at different temperatures</th>
<th></th>
<th>Fresh weight at different temperatures</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Roots 14 18 22 26 30</td>
<td>Tops 14 18 22 26 30</td>
<td>Roots 14 18 22 26 30</td>
</tr>
<tr>
<td><strong>Experiment One</strong></td>
<td><strong>Control</strong></td>
<td><strong>Inoculated</strong></td>
<td><strong>Standard Error</strong></td>
</tr>
<tr>
<td></td>
<td>-1.734 0.403 0.068 -1.051</td>
<td>-1.296 0.931 1.056 0.457</td>
<td>0.254</td>
</tr>
<tr>
<td></td>
<td>0.924 1.723 2.239 1.099</td>
<td>0.790 2.529 3.169 2.419</td>
<td></td>
</tr>
<tr>
<td><strong>Experiment Two</strong></td>
<td><strong>Control</strong></td>
<td><strong>Inoculated</strong></td>
<td><strong>Standard Error</strong></td>
</tr>
<tr>
<td></td>
<td>-2.308 -0.312 0.317 -1.506 -1.771</td>
<td>-1.706 0.663 1.241 -0.223 -0.269</td>
<td>0.298</td>
</tr>
<tr>
<td></td>
<td>-2.065 -0.698 -0.474 -2.026 -1.637</td>
<td>-1.710 0.588 0.995 -0.773 -0.139</td>
<td></td>
</tr>
<tr>
<td></td>
<td>0.582 1.718 2.012 0.725 0.962</td>
<td>0.425 2.616 3.042 1.206 2.199</td>
<td></td>
</tr>
<tr>
<td></td>
<td>0.394 2.036 2.727 1.186 0.842</td>
<td>0.432 2.716 3.363 2.049 2.044</td>
<td></td>
</tr>
</tbody>
</table>

* = significant as $T SR_{0.05}$  
+ = not significant at $T SR_{0.05}$ but significant at $LSD_{0.05}$  
S = F statistic significant  
NS = F statistic not significant
procedures adopted for the two experiments. In Experiment Two, the plants were introduced into the controlled climate chambers on the same day as treatments were applied, thereby imposing the different temperatures on both the infection phase and the development phase of the disease. In Experiment One, on the other hand, all plants were misted for 7 days at 22-28°C before transfer to the climate chambers. During that time, infection is presumed to have occurred, so that the various temperatures in the controlled climate chambers operated only on the phase of disease development. The results suggest that temperatures of 22°C-28°C may be optimal for initial infection by A. paspali, while a lower temperature, such as 18°C in Experiment One, may be more suitable for disease development, once the fungus has gained entry to the host. In Experiment Two, therefore, the significant yield reduction at 22°C and at 26°C, for roots and tops respectively, may reflect a more favourable temperature for infection than 18°C. An optimum temperature of 22-28°C for infection corresponds with the temperatures at which germination of conidia on agar media was highest, and with the optimum temperature for growth by the fungus in culture (p. 130).

Mitchell (1956) recorded most growth for paspalum at a constant temperature of 29.5°C, in controlled climate chambers with a light intensity of 580.5 μE.s⁻¹.m⁻². The lower light intensity employed in the present study may have been limiting on the host. This, coupled with the use of constant temperatures, hinders extrapolation of the present results to the field situation. However, under controlled conditions a significant reduction in yield of paspalum was recorded at some temperatures following a single inoculation of the fungus. This suggests that the leaf stripe disease may significantly reduce the yield of infected paspalum in a pasture.
CHAPTER SIX

SYSTEMIC GROWTH OF THE FUNGUS WITHIN THE HOST

6.1 INTRODUCTION

*A. paspali* can be readily isolated from lesions on infected paspalum leaves (for method, see p. 14) and grown on artificial culture media (see p. 129). Often, the fungus was also successfully isolated from the green lamina of an infected leaf below the lesion, and sometimes from a symptomless leaf on a tiller bearing other diseased leaves. Furthermore, following inoculation of paspalum seedlings and the appearance of symptoms on inoculated leaves, new leaves produced by the plant sometimes also developed symptoms.

This phenomenon, whereby the pathogen can grow within the host without necessarily inducing symptoms, was studied in detail. Different parts of the paspalum plant were tested for presence of the fungus. The location and growth form of the fungus, and the type of cell in which it was growing, were determined.

6.2 METHODS

6.2.1 Inoculation of paspalum plants

Paspalum seedlings were inoculated with a conidial suspension of *A. paspali*. The suspension was prepared from infected leaves which were collected in the field and incubated in a moist chamber at 30°C for 24 hours to induce sporulation. The conidia were suspended in sterile distilled water and their concentration adjusted to approximately $1 \times 10^6 \text{ ml}^{-1}$. 
Contamination of the suspension by propagules of other fungi growing as saprophytes on paspalum leaves was negligible.

For routine inoculations, conidial suspension was sprayed onto the leaves of paspalum seedlings (see p. 221). Infection could also have been achieved by brushing inoculum onto the leaves, or by injecting the suspension, using a hypodermic syringe and needle, into the base of a tiller just above ground level. Sterile distilled water, instead of conidial suspension, was applied to control plants by the same methods.

Paspalum seedlings were grown and inoculated as on p.221. At 18-22°C, symptoms first appeared 2½ - 3 weeks after inoculation. No transmission of the disease occurred between adjacent infected and control plants grown together in the glasshouse for 12 months or more.

6.2.2 Tests for presence of the pathogen within the host

The presence of *A. paspali* within paspalum plants was assessed by observation of symptoms, by sectioning of plant tissue, and by isolation through plating plant tissue onto agar media.

(a) Sectioning of separate plant parts:

Paspalum plants with disease symptoms on the leaves were prepared for examination by light and transmission-electron microscopes using the methods described previously for fresh fungal material (p. 12,13). Sections were made of the paspalum root, green leaf sheath, green leaf blade, rachis, and seed-containing spikelet. To confirm that any fungus observed in the section was *A. paspali*, tissue adjacent to each sectioned portion was surface sterilised and plated onto oatmeal agar.

(b) External and internal mapping of infected plants:

A few paspalum seedlings were inoculated at the 3-4 leaf stage and maintained at 22°C for 7 weeks. After this period, new leaves, formed since inoculation, often bore lesions caused by *A. paspali*. One plant was
selected at random for detailed examination. The seven tillers of this plant, numbered 1 to 7, were drawn, and the positions and dimensions of all leaves and lesions were recorded. In this way, a picture of the visual expression of the disease was formed. Small pieces of symptomless tissue were then cut from midway along the lamina of 2-4 leaves from each tiller, representing a sample of 21 of the 41 leaves on the plant. The tissue was surface sterilized and plated onto oatmeal agar. Growth of *A. paspali* from these isolations was scored, enabling a picture of the internal occurrence of the fungus to be developed.

A similar mapping procedure was applied to the flowering culms from more mature, glasshouse-grown paspalum plants. A single culm, with lesions on one or more of its attached leaves, was chosen from each of four infected plants. The position of diseased leaves was noted before all leaves were removed. The length of the culm was measured, and small pieces from between each node were surface sterilised and plated onto oatmeal agar. Growth of *A. paspali* from these isolations was scored, and compared with the location of diseased leaves on the culm.

(c) Seed testing:

Six mature, glasshouse-grown paspalum plants were selected, and five flowerheads removed from each plant. Four of the plants had been infected with *A. paspali* several months earlier, while the remaining two were free of the disease and served as controls. Each flowerhead selected from the diseased plants was supported on a culm that bore one or more diseased leaves.

Sixty seeds from each plant were removed randomly and surface sterilised. From each group of sixty seeds, thirty were plated whole onto cornmeal agar. The remaining thirty were each cut in half to separate the embryo-containing portion, nearest the pedicel, from the distal half, before plating onto cornmeal agar. The growth of *A. paspali* from each whole and half seed was
scored. The presence or absence of *A. paspali* in each rachis was determined by removing, surface sterilising, and plating onto cornmeal agar, small portions from between the first and second rachillas.

Seed was also examined for conidiomata, after incubation at 30° for 3 weeks in a Copenhagen seed germination tank. The seed was collected from uninfected plants (250 seeds) grown in the glasshouse, and from infected plants (500 seeds) grown in the glasshouse or the field.

6.3 RESULTS AND DISCUSSION

6.3.1 Growth-form and location of the fungus within the host

The root of paspalum is characterised by a central vascular cylinder surrounded by a cortex of lysogenous lacunae, which in turn is bounded by the hypodermis and epidermis (Fig. 44A). The vascular cylinder consists of a central pith, around which is arranged the xylem consisting of large and small metaxylem vessels with smaller, less-obvious, protoxylem elements lying outermost inside the endodermis. Phloem tissue is located amongst the xylem. Hyphae of *A. paspali* were found in the large and small metaxylem vessels only (Figs 44B, C). One or more hyphae were seen in single large metaxylem elements (Fig. 44B) whereas usually only a single hypha was present in the narrower vessels (Fig. 44C). Loss or disorientation of some hyphae in the larger vessels may have occurred during the transfer of sections from water to the microscope slide. In longitudinal sections, the cells which contain the hyphae could be clearly identified as vessels by their scalariform-reticulate secondary wall thickening (Fig. 44D). Anastomosis of adjacent hyphae in the same vessel was sometimes observed (Fig. 44E).

The paspalum leaf sheath and blade have a common structure. In
Fig. 44

Location of hyphae of *Ascochyta paspali* in the root of infected *Paspalum dilatatum*:

A, thick transverse section through a root (cortex disrupted during sectioning), to show anatomy (x100).

B, C, thick transverse sections through part of vascular tissue just inside the endodermis, to show the location of hyphae in large metaxylem vessels and also in surrounding smaller metaxylem vessels (arrowheads) B (x420), C (x1,050).

D, thick longitudinal section through part of root vascular tissue to show hyphae within a single xylem vessel. The vessel has a characteristic scalariform-reticulate secondary wall thickening (x1,050).

E, thick longitudinal section through a xylem vessel to show anastomosis of hyphae (between arrowheads) (x1,050).
transverse section (Fig. 45A), the parallel-veined blade consists of a large median vein at the prominent midrib, large lateral veins, and several smaller intermediate veins between the lateral veins. Prominent groups of sclerenchyma strands are present on the abaxial side, and to a lesser extent on the adaxial side, of the median, lateral, and larger intermediate veins. The veins are bounded by a single-layered sheath of cells, typical of the Panicoideae (Esau, 1965, p. 441), and contain phloem tissue abaxially and xylem elements adaxially. The xylem consists principally of the central protoxylem vessels, which eventually break down to form lacunae, and two large metaxylem vessels. In transverse sections of apparently healthy tissue from both the sheath (Fig. 45B) and the blade (Fig. 45C), hyphae of A. paspali were confined to the xylem vessels, particularly the metaxylem (Fig. 45B), but sometimes also occurred in the protoxylem (Fig. 45C). In many instances vessels were large enough to accommodate several hyphae in the one element. Hyphae were present in both median and lateral veins. A single protoxylem vessel, with annular thickening, was followed for over 2 mm in a longitudinal section (Fig. 45D). Long lengths of hyphae were observed; conidia were absent. Anastomosis of hyphal strands was common in wide vessels (Fig. 45E).

In light microscope sections of leaf lesions, the bundle sheath and surrounding mesophyll cells also stained with cotton blue, suggesting that the fungus had caused cell necrosis. Distinct hyphae, however, were not observed in the necrotic cells.

The rachis of paspalum has a more or less peripheral arrangement of vascular bundles (Fig. 46A). The bundles are similar in structure to those of the leaf. Hyphae of A. paspali were observed in the protoxylem and metaxylem elements only. Under the electron microscope, the hyphae were seen to be free in the lumen of the xylem vessels and not adhering
Location of hyphae of *Ascochyta paspali* in the green, symptomless leaf of infected *Paspalum dilatatum*:

A, thick transverse section through half a leaf blade to show arrangement of the vascular tissue (x75).

B, thick transverse section through the vascular bundle of the leaf sheath mid-rib to show hyphae (h) in the metaxylem vessels (x260).

C, thick transverse section through the vascular bundle of the leaf blade mid-rib to show hyphae (h) in the metaxylem and protoxylem vessels (x265).

D, thick longitudinal section through a leaf blade to show hyphae (arrowheads) in a xylem vessel. This vessel was followed for over 2mm (0.2mm segment photographed) and contained hyphae throughout (x420).

E, thick longitudinal section through a xylem vessel from a leaf blade to show anastomosis of hyphae (arrowheads) (x1,100).
Fig. 46

Location of hyphae of *Ascochyta paspali* in the rachis of infected *Paspalum dilatatum*:

A, diagrammatic representation of transverse sections of a rachis to show: (i) anatomy and the arrangement of vascular bundles, and (ii) & (iii) hyphae in metaxylem and protoxylem vessels of the large vascular bundles.

(overleaf)

B, thin longitudinal section through a xylem vessel, with characteristic secondary wall thickening, to show a septate hypha (x10,250).

C, thin transverse section through protoxylem and metaxylem vessels to show hyphae, free in the lumen (x4,850).
to the vessel walls (Figs. 46B, C). One to several hyphal strands occurred in single vessels.

Hyphae of *A. paspali* were also observed in xylem vessels of the spikelet and pedicel (Figs. 47A, B, C). On one occasion, a hypha was seen in the cross-section of a xylem parenchyma cell, from a pedicel (Fig. 47C).

6.3.2 Mapping of an infected paspalam plant and of flowering culms

The paspalam plant under study is drawn, diagrammatically to scale, with the position of lesions on leaf sheaths and blades indicated (Fig. 48). Most lesions extended downwards from the tip of the leaf blade, and sometimes into the sheath (e.g. tillers 1 and 5). Occasionally, as on tiller 3, lesions were 'intercalary'. The few original seedling leaves, present at the time of inoculation, were not identified and some had already senesced by the time the plant was examined.

Lesions were evident on 18 (44%) of the 41 leaves on the plant. Of the 21 leaves which were sampled, *A. paspali* was isolated from 15, 10 of which lacked lesions (Fig. 48). Therefore, the fungus was present, either visually with symptoms or internally without symptoms, on at least 28 (68%) of the leaves on the plant. If isolations had been taken from all leaves, the percentage of leaves infected by the fungus is likely to have been higher. Tiller 6, for example, bore 6 apparently disease-free leaves, but 2 of the 3 leaves tested were infected.

The fungus was not necessarily present in all leaves borne on a particular tiller. The leaves which most often lacked the fungus internally were the oldest, lower leaves and the newest, often unfolded leaves on a tiller. It is significant, however, that of the six unfolded apical leaves tested, the fungus had already entered three (tillers, 1, 2, & 3).
Location of hyphae of *Ascochyta paspali* in the spikelet and pedicel of infected *Paspalum dilatatum*:

A, thin transverse section through a spikelet to show hyphae (h) in xylem vessels (x4,300).

B,C, thin transverse sections through xylem of the pedicel to show hyphae in vessels (xv) and also in the xylem parenchyma (xp). B (x8,700), C (x7,500).
Fig. 48

Diagrammatic representation of a paspalum plant to show the position of lesions caused by Ascochyta paspali and location of the fungus within the plant. The plant was inoculated with A. paspali seven weeks previously as a 3-4 leaf seedling. The seven tillers, drawn to scale, are numbered (1-7) at their base. The youngest, unexpanded leaf of each tiller is drawn in line with the pseudostem, while the other leaf blades are drawn at a common angle to the pseudostem. Lesions on leaf blades and sheaths are indicated by dotted lines. Isolations to test for the systemic presence of A. paspali were made from green leaf tissue (solid lines) at the points marked by circles. A solid circle denotes positive isolation; an open circle a negative result.

--- = pseudostem with lesion on outer sheath.
--- = pseudostem without lesion on outer sheath.
---- = leaf blade or portion of blade with lesion.
----- = leaf blade or portion of blade without lesion.
• = site of positive isolation of A. paspali.
○ = site of negative isolation of A. paspali.

Fig. 49

Paspalum seed taken from infected plants. Black pycnidial conidiomata (arrowheads) of Ascochyta paspali appeared after incubation of seed under moist conditions.
The fungus was invariably isolated from the region of the blade between the base of a terminal lesion and the ligule.

The results of isolations from culm internodes are summarised in Table 3. The plants had been inoculated at the seedling stage, long before development of a flowering culm, yet several leaves borne on each culm were diseased and the fungus could be isolated from all but the uppermost internodes. The presence of the fungus between two nodes did not necessarily correlate with the expression of symptoms on the leaf arising from the lower of these two nodes. Leaves such as numbers 2 and 3 of culm 3 (Table 3) which did not have lesions may, however, have been internally infected. There was a consistent correlation between the occurrence of a leaf with lesions and isolation of the fungus from all internodes below the node of origin of that leaf. For example, lesions were present on the flag leaf of all culms, and the fungus was isolated from all internodes below the flag leaf node. In culms 2 and 4, the fungus grew beyond the uppermost node, suggesting that it could potentially infect the inflorescence.

**TABLE 3.** Presence of *Ascochyta paspali* on leaves and in culms of diseased paspalum plants.

<table>
<thead>
<tr>
<th>Culm Number</th>
<th>Height of culm to first rachis (cm)</th>
<th>Visible presence of lesions on leaves</th>
<th>Positive isolation of <em>A. paspali</em> at internodes</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>1*</td>
<td>2-3</td>
</tr>
<tr>
<td>1</td>
<td>126</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>2</td>
<td>134</td>
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</tr>
<tr>
<td>3</td>
<td>137</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>4</td>
<td>39</td>
<td>+</td>
<td>+</td>
</tr>
</tbody>
</table>

* 1 = oldest leaf, 4 = youngest.
The mapping exercises confirmed internal growth of *A. paspali* within an infected plant. From the results it is suggested that the fungus can enter the base of an uninfected tiller from an infected part of the plant, and grow upwards to infect successive leaves.

### 6.3.3 Seed testing

The fungus occurred in 11.2% of the 240 seeds tested from the infected plants; no control seeds were infected. Of the 120 whole seeds, 12.5% were infected (Table 4). *A. paspali* was isolated from 10% of the proximal half seeds and from 8.3% of the distal half seeds. Only proximal half

<table>
<thead>
<tr>
<th>Seed source</th>
<th>Number of seeds* from which <em>A. paspali</em> isolated.</th>
<th>Number of seeds which germinated.</th>
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</thead>
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<tr>
<td></td>
<td>Whole seed</td>
<td>Half seed</td>
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<td>A</td>
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<tr>
<td>Inoculated B</td>
<td>7</td>
<td>7</td>
</tr>
<tr>
<td>plants</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>C</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>D</td>
<td></td>
<td></td>
</tr>
<tr>
<td>% total no. of seeds</td>
<td>12.5</td>
<td>10.0</td>
</tr>
<tr>
<td>Control E</td>
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<td>0</td>
</tr>
<tr>
<td>plants</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>% total no of seeds</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

* 30 whole seeds and 30 half seeds tested from each plant.
seeds germinated, demonstrating that this half of the seed, nearest the 
pedicel, contained the embryo. The fungus is therefore not localized 
in the embryo, but is more widespread in the seed. There was little 
difference between the percentage germination of seed harvested from 
infected plants and healthy, control plants.

A. pspali did not grow out of any germinating seed from infected 
plants, and the resultant seedlings did not contain hyphae in their 
vascular tissue, as determined by direct examination. The percentage 
germination was too low to draw conclusions as to the effect of infection 
on seed viability.

The seed from infected plants had been collected from 20 rachises, 
11 of which (55%) had been found, by isolation, to be infected by 
A. pspali. The lower rate of seed infection (10-12.5%) suggests that 
the fungus, although present in the rachis between the first and second 
rachillas, may not have spread throughout the inflorescence to infect 
seed on all rachises.

Infection was also demonstrated on seed held in the Copenhagen 
seed germination tank. Of the 500 seeds from infected plants, 95 (19%) 
bore conidiomata on their outer surface (Fig. 49), these not being confined 
to any specific location on the infected seed. They were absent from 
all 250 seeds collected from uninfected plants. Germination of the 750 
seeds used was less than 1% and none of the seed with conidiomata germinated.
6.4 GENERAL DISCUSSION

6.4.1 Systemic growth

Although symptoms of leaf stripe disease are expressed only on paspalum leaf blades and sheaths, hyphae of *A. paspali* occur within roots, leaves, culms, rachises, and seeds of infected plants. The fungus exists as mycelium within the host; conidia were never seen internally. In all parts of the host, outside of the lesions, the hyphae were confined to the metaxylem and protoxylem elements of the vascular tissue. Within lesions, cell necrosis occurred, but hyphae were not seen to leave the xylem and invade other cells, except immediately adjacent to the conidiomata.

The xylem of Angiosperms is ideally suited as a unobstructed pathway for systemic invasion by a fungus. The xylem vessels are long columns made up of elongate, dead vessel elements connected end to end and separated from one another by a perforated wall (Esau, 1965). A vessel functions in the upward conduction of water, inorganic solutes, and low concentrations of amino acids and sugars (Dimond, 1970), which together make up the transpiration stream. Since the vascular tissue is continuous throughout the plant, hyphae growing in the vessels are provided not only with nutrients from the vessel contents, but also with access to all parts of the host, including roots and seed. Transverse vascular bundles within the leaves enable the hyphae to move from vessels in one vascular bundle to vessels in another.

*A. paspali* was seen to be present throughout a mature paspalum plant which had been inoculated as a 3-4 leaf seedling. Its presence in culms and leaves which were absent at the time of inoculation is explained by systemic growth of the fungus in the vascular tissue. Plants were watered only from below, to reduce the possibility of disease spread to the new leaves by slimy conidia from sporulating conidiomata that might be produced.
on seedling leaves. Control plants adjacent to infected plants with sporulating conidiomata were still free of the disease more than twelve months later, indicating that under the conditions of the experiments conidia did not readily move from infected to uninfected leaves.

The results suggest that the fungus is able to grow in the xylem vessels in both directions from an infection site, i.e. either towards the tip of the blade, or towards the base of the sheath from whence it could reach the basal stem and thereby infect other leaves and new tillers. It could also infect the roots. The vascular interconnection of tillers of a paspalum plant has been demonstrated by Watson & Ward (1970). Labelled sugars, inoculated into the tip of a paspalum tiller, were followed by autoradiography, and seen to be translocated into other tillers and into the roots of the plant. Although sugars move in the phloem, their movement throughout the plant suggests the probability of xylem vascular connections between tillers. These connections would also be available to systemic organisms such as *A. paspali*.

Depending on the vessels entered by the fungus, some tillers could remain uninfected, or certain leaves of an infected tiller could be free, initially at least, of the hyphae. The oldest and the newest leaves of a tiller, for example, sometimes lacked the fungus, when other leaves on the same tiller were infected (Fig. 48). In the case of young expanding leaves, rapid growth and elongation of the leaf might initially outstrip extension of the fungal hyphae which may later catch up as the leaf matures and growth slows.

Upward growth by the fungus, in the mature plant, is most clearly documented in the flowering culm. Rachises are absent in seedlings, so that infection of the vascular tissue of a rachis in a plant inoculated as a seedling must originate from its base. The presence of hyphae in vessels at all points up a culm, and even in the rachilla and seed, can
only be accounted for by mycelial continuity from the base of the rachis upwards. More rapid invasion of a plant could perhaps be achieved by the production of microconidia in vessels, the microconidia then moving upwards in the transpiration stream, as occurs in some vascular wilt diseases. There is no evidence, however, that microconidia of *A. paspali* are produced within the paspalum xylem, although such conidia are common in cultures of the fungus.

Hyphae are often present in the vascular tissue without any accompanying necrosis of host cells. This raises the question of the factor(s) which trigger the fungus to change from an endophytic to a necrotrophic existence. Lesions usually develop from the leaf tip, the oldest portion of the blade. This suggests that the age of host tissue could be important, with old cells becoming more leaky and providing the fungus with a larger nutrient base. However, disease lesions can develop at the tips of young leaves soon after expansion and before cells are likely to be aged sufficiently. Another explanation might involve a requirement to exceed a biomass threshold of fungal hyphae, before activation occurs of localized enzymes, produced by the fungus, in sufficient concentrations to cause cell death.

Other fungi which occur systematically within their hosts include: *Cephalosporium gramineum* Nisikado & Ikata, the vascular wilt pathogens, and some endophytic species, as well as several smut fungi and *Drechslera graminea* (Rabenh. ex Schlecht.) Shoemaker on barley.

*Cephalosporium gramineum* is a systemic pathogen of wheat and, like *A. paspali*, produces a leaf-stripe, but does not sporulate within the lesion. *C. gramineum* infects through wounds in the roots and occurs in xylem vessels, primarily as conidia (Wiese, 1972). This fungus has been reported, by Mathre & Johnston (1975) to be capable of downward movement from the site of inoculation on one tiller, to infect the crown where
secondary tillers form.

Systemic fungi which cause vascular wilts of their hosts include species of *Fusarium*, *Verticillium*, and *Ceratocystis*. The vascular wilt pathogens are similar to *A. paspali* in that they may occur as mycelium within the xylem vessels of the host plant. However, they differ in other respects. Infection by the wilt fungi occurs through wounds in the roots and stems of their hosts, and once inside the xylem vessels, conidia are often produced from the mycelium. These conidia are rapidly transported upward in the sap, a fact which explains the frequent lack of continuity of hyphae in wilted plants (Dimond, 1970). In contrast, conidia of *A. paspali* were never seen within infected paspalum. Vascular blockages, which are induced in the host by vascular wilt fungi, have not been observed in sections from infected paspalum tissue. The physical presence of hyphae in paspalum vessels may slow the translocation flow, but occlusion of vessels by hyphae has not been seen. The browning of vascular tissue, caused by oxidation and polymerization of induced host phenolic compounds in vascular wilt infections, was also absent from infected paspalum.

The systemic habit and the symptoms expressed by *A. paspali* on paspalum leaves have certain parallels with other systemic pathogens, as discussed above. On the other hand, the systemic habit of this fungus coupled with an absence of symptoms in infected paspalum roots, culms, and seeds, and sometimes also in leaves, suggests a commensal relationship with the host, similar to that of endophytic fungi. Neill (1940, 1941) reported endophytic fungi in seed and aerial tissue of *Lolium* and *Festuca* grasses. The hyphae of these fungi were entirely intercellular, rather than vascular, and no symptoms appeared on the host. Carroll et al. (1977) and Petrini & Müller (1979) isolated several endophytic fungi from
leaves of European conifer species, but only one, Guignardia philoportun (Berk. & Court.) van der Aa, was thought to be systemic. These endophytes have no apparent deleterious effect on their hosts.

6.4.2 The life cycle of Ascochyta paspali

A. paspali has a specialised and very successful relationship with paspalum, which fulfills the following criteria: the availability of a stable host, a dispersal mechanism for fungal propagules to infect other plants, and a possible mechanism for fungal genetic variation.

Paspalum is a stable habitat since a single plant can be occupied by the fungus year-round. Rarely, if ever, does the host die of infection by A. paspali. From late autumn to early spring, when fungal lesions are absent, the fungus is thought to persist as mycelium within the roots and the persistent crown of paspalum. Evidence for this comes mainly from observation of inoculated, glasshouse-grown plants which first developed lesions in summer and then became free of lesions during winter. In the following spring, new lesions developed on these same plants, without any subsequent reinoculation. Positive isolation of the fungus from roots of glasshouse-grown plants has been achieved in autumn, but not in winter. The overwintering mycelium may possibly be in a dormant state and thus unable to grow. Hyphae were seen in root xylem of naturally infected paspalum plants in August, but the identity of the hyphae was not confirmed in culture. An analogous situation might be the systemic hyphae of Peronospora sparsa Berk., which act as the overwintering stage, in roots and crowns of brambles (K.G. Tate, pers. comm.).

Conidia are produced in conidiomata which develop in lesions from spring to autumn. The conidia are slime spores, liberated under moist conditions and presumably dispersed principally by rainsplash. The site and mechanism of infection by conidia is unknown. Few conidia,
sprayed in suspension onto the surface of attached and detached paspalum leaves, germinated, and germ tubes were seen to pass over stomata, suggesting that entry into leaves may be by direct penetration. No appressoria were seen. Entry at the site of guttation at leaf tips is also possible. Once inside the host, the fungus ramifies throughout the xylem vessels, as described above.

The occurrence of *A. paspali* in seed suggested that the fungus may also spread by means of infected seed. Results of isolations from seed (Table 4) and sections from seed (Fig. 47A-C) both showed that the fungus was present as hyphae in vascular tissue and was not confined to the embryo. Unfortunately, no seed known to be infected by *A. paspali* germinated in this study, and systemic transfer of mycelium from seed to seedling must remain speculative. However, seed may function in dispersal of the fungus by another mechanism. Conidiomata of *A. paspali* can develop on the seed coat of infected seed, so that infected seed on or in the soil could act as an inoculum source.

A teleomorph for *A. paspali* has not been discovered despite close examination of living, dead, senescing, and overwintering host material, and of cultures. It is postulated that this anamorphic fungus is itself capable of overwintering and genetic variation, both functions often performed by a teleomorph. Anastomosing hyphae of *A. paspali* observed in xylem vessels suggest perhaps a parahaploid cycle. Paraphenotypy has been described in vitro for another Ascochyta species, *A. imperfecta* Peck (Sanderson & Srb, 1965).
CHAPTER SEVEN

SEASONAL FLUCTUATION OF THE HOST AND DISEASE LEVELS IN THE FIELD

7.1 DETERMINATION OF SPECIES COMPOSITION IN A PASTURE

The numerous methods for analysis of species composition in a pasture sward have been reviewed by Lynch (1966) and Sturme (1977). The choice of method depends largely on the parameters to be measured. Mountier & Radcliffe (1964) listed four parameters:

(i) weight of a species
(ii) area covered by a species
(iii) number of individuals of a species
(iv) frequency of a species.

In the present study, assessments were made of the first two parameters, (i.e. (i) and (ii)) to study the variation in species composition with time. Two methods were employed, viz direct sampling of the pasture to determine the weight of each species, and point quadrat analysis to measure the area covered by each species. Parameters (iii) and (iv) were not measured.

7.1.1 Direct sampling and herbage dissection

The weight of a species in a sward is best determined by manual herbage dissection of samples from the pasture. The separated material is then oven-dried, weighed and the proportion contributed by each species or pasture component to the total weight is calculated. Although time consuming and destructive, this method is very accurate, providing that the individual pasture components can be readily distinguished. The broad, hairy leaf blade of paspalum simplified separation of this species from
the rest of the sward in the present study. VanKeuren & Ahlgren (1957) considered herbage dissection and dry weight determination to be the standard procedure against which to evaluate all other methods of species composition assessment.

7.1.2 Point quadrat analysis

The area covered by a species can be estimated in several ways including visual assessment, point quadrat analysis, photography, or the use of an electronic capacitance meter or weighted disc meter (Sturme, 1977). Visual observation of a sward enclosed within a frame or quadrat is the most rapid method to determine the area of coverage of a species, but is subject to observer variation, particularly with inexperienced observers (VanKeuren & Ahlgren, 1957). Point quadrat analysis is based on an extension of the visual assessment method; when the dimensions of the sample quadrat are progressively reduced, the quadrat diminishes to become a single point. Observation of a suitable number of these point quadrats will yield an estimate of vegetation composition. Levy & Madden (1933) first introduced the point quadrat method of pasture analysis, using a row of ten steel pins mounted vertically on a frame. The legs of the frame were pushed into the ground, and the pins lowered individually. Contact between a pin and plant material was recorded, thereby sampling all plants vertically above a single point of ground.

The point quadrat method has been successfully applied in numerous studies of botanical composition, e.g. Drew (1944), Sears (1951), Goodall (1952), Radcliffe & Mountier (1964a), and Sturme (1977). A strong correlation between the results obtained from point quadrat analysis and those obtained from herbage dissection was reported by VanKeuren & Ahlgren (1957). Other workers, such as Sears (1951), have found poor
correlation, because of wide variations between species in the ratio of leaf area to dry weight. The results from both point quadrat and herbage dissection analyses, when viewed in combination however, can provide a comprehensive picture of species composition (Sears, 1951). Considerably less time is required for point quadrat analysis than for the herbage dissection method (Mountier & Radcliffe, 1964).

Several parameters can be measured at each point by the point quadrat method. Radcliffe & Mountier (1964a) listed the following:

(i) the first plant species which is hit (first hits).
(ii) the first crown which is hit (crown hits).
(iii) the first hit of each species; a species is either absent or present at the point (cover hits).
(iv) all hits on each species; a species may be hit several times at the point (total hits).

First hits and crown hits, although simple to record, are of limited use, suitable only for particular plant associations (Radcliffe & Mountier, 1964a). First hits, for example, can lead to bias in associations where a taller, spreading species overlies other species. Both cover hits and total hits provide an accurate estimation of the ground covered by each species. Total hits take into account the layering or density of a species, but since the point quadrat method is best suited to the determination of area covered, rather than volume occupied, by a species (Radcliffe & Mountier, 1964a), cover hits were recorded in the present study. Results were expressed as the number of cover hits for each species per 100 points sampled, otherwise called percentage cover (Goodall, 1952). Other treatments of point quadrat data have been discussed by Goodall (1952) and Sturme (1977).

Several factors are known to influence the accuracy of point quadrat analysis. Goodall (1952) found that a large pin diameter (4 mm
in his studies) caused overestimation of the area covered by a species. This was readily overcome by mounting a fine needle at the end of the steel pin and recording contact at the point only of this needle (Radcliffe & Mountier, 1964a). Rigidity of the frame and pin guide holes is important. Movement of the sward by wind can become a further source of error. Observer variation does occur (Mountier & Radcliffe, 1965) but is eliminated if, as in the present study, a single observer is used throughout.

Tall, dense vegetation in swards can hinder observation of the passage of the needle to ground level. Radcliffe & Mountier (1964b) reported that changes in pasture height during a study can have a marked effect on point quadrat figures. They found that increasing height was linearly related to the number of cover hits, between sward heights of 2.5 and 10 cm, but that a considerably larger effect, resulting from changing height, occurred when the number of total hits was measured. The point quadrat frame has been inclined at various angles in an attempt to improve observation of the passage of the needle through a dense sward. The advantages of inclined versus vertical frames have been discussed by Sturme (1977).

The number of points considered necessary to estimate species composition accurately varies. Levy & Madden (1933) reported that 100 points in a sward adequately measured the composition of the dominant species, but 400-500 points were required for the lesser components. Sears (1951) and Lynch (1966) recommended the use of 400 points, Drew (1944) used 200, and Radcliffe & Mountier (1964a) 100 points. Goodall (1952) concluded that a priori, the number of points required to provide a certain degree of precision cannot be determined. Furthermore, variance in percentage cover between needles within a frame is greater than that between frames (Goodall, 1952). This means that the same precision gained by
examining 200 points from 20 positions of a 10 needle frame could also be achieved by examining a much smaller number of individual points. The number of points used appears to have been chosen arbitrarily by most authors. Goodall (1952) and Lynch (1966) advised that repeated sampling of fixed, rather than random points or locations, was preferable for studies of change in percentage cover with time.

Analysis by the point quadrat method has been applied to measure the effects of mowing, grazing, different seed combinations, fertilizers, rabbit populations, and climate on species composition in a sward (Sturme, 1977). In the present study, covering a 14-month period, measurements were required of the relative abundance of paspalum in relation to other pasture species, and also of the proportion of this paspalum which showed symptoms of infection by Ascochyta paspali. To obtain this information, samples for herbage dissection were taken at random throughout a paddock, while point quadrat analysis was confined to three small areas within the sample paddock. To my knowledge, the point quadrat method has not previously been applied to disease assessment studies.

7.2 METHODS

Pasture analyses were conducted on a private farm at Arapohue, Northland (hereafter called the Arapohue farm) from January 1979 to March 1980. The farm was selected because of its history of a high incidence of paspalum in the pasture. A square, level, lowland paddock, of approximately one hectare on Kaipara clay, was chosen for regular assessment. The main plants in the sward were ryegrasses, clovers, and paspalum. Dairy cattle, at a stocking rate of 2.5 cows per hectare, grazed the paddock on a rotating schedule controlled by the farmer. The paddock was surveyed
fortnightly during the summer and less frequently during winter.

A second paddock, one hectare in area, on a private farm east of Ruawai, Northland (hereafter called the Ruawai farm) was sampled fortnightly from December 1979 to March 1980. This paddock on level, Kaipara clay contained a very tall (up to knee-high) ungrazed sward in which paspalum was the dominant species. In 1977 and 1978, the paddock had been used for cropping maize and sudax but problems were experienced in the control of paspalum during establishment of the crop plants.

Two methods were employed to sample the sward at the Arapohue farm, but only the second of these was suitable at the Ruawai farm.

7.2.1 Point quadrat analysis

At the Arapohue farm, three areas, each measuring 2.5 x 1 m were sampled regularly from January, 1979 to January, 1980, using the point quadrat pasture analyser. The areas were selected for their higher-than-average proportion of paspalum in the sward, compared with that for the rest of the paddock. They were marked with short pegs, and were open to grazing by the cattle.

The point quadrat analyser (Fig. 50) consisted of a rigid, rectangular, aluminium frame, holding five 55 cm long, spring-loaded, steel shafts, spaced 10 cm apart. At the base of each shaft was mounted a sewing machine needle with a fine tip, 0.2 mm diameter. An aluminium leg, at either end of the frame, was pushed into the ground to support the frame in a vertical position. Each needle was carefully lowered vertically through the sward, and contact between the point of the needle and living plant material (stem, leaf, or flower) was recorded. The first contact only with each component (cover hits) was noted at each point. The components were:
Fig. 50

Point quadrat pasture analyser. The analyser is held vertical to the sward by two legs pushed into the ground. The five spring-loaded steel shafts are lowered individually, and contacts between the point of the sewing needle, at the base of the shaft (enlarged in lower figure), and vegetation are recorded.
(i) paspalum, lacking symptoms of *A. paspali* infection
(ii) paspalum, with symptoms of *A. paspali* infection. This category includes hits of green areas of infected leaves.
(iii) other grasses, principally ryegrasses
(iv) clovers
(v) absence of cover (bare ground).

The point quadrat frame was placed in 40 positions along each sample area, beginning at one end of the area and moving the frame forward by 5 cm intervals. All five needles were lowered and scored at each position, totalling 200 sample points for each of the three sample areas.

Point quadrat analysis was not practicable at the Ruawai farm because of the rank growth of the sward.

7.2.2 **Direct sampling at random locations**

(a) **Arapohue farm:** A plastic ring of 11.5 cm internal diameter was placed on the sward at 50 randomly selected locations in the paddock. Vegetation within this ring was cut with scissors at ground level and each sample was placed in a separate polythene bag for later analysis. Only those plants whose roots were within the ring were included in the cut sample.

The random locations were generated using a table of random numbers between 1 and 99 inclusive to produce a series of coordinate pairs \((x, y)\). Each coordinate pair represented a location in the paddock which was arrived at by pacing out the coordinate pairs in steps of approximately 1 m. The number of steps corresponding to the first coordinate \((x)\) was paced out along one side of the paddock \((x\, \text{axis})\), followed by the number of steps for the second coordinate \((y)\) in the direction perpendicular to the \(x\) axis. On approaching the required number of steps for the second coordinate,
care was taken to avoid watching final placement of the leading foot, so as to reduce any bias in determining the sample location. The sampling ring was then placed immediately in front of the leading foot. For ease of procedure, random location coordinates were arranged before sampling in order of their x coordinates. A new set of coordinates was generated for each sampling date.

The fifty bagged samples were analysed individually in the laboratory. Paspalum was separated by hand from other pasture species. The number of paspalum leaves, or part leaves where these had been cut, was counted. A count was also made of the number of these paspalum leaves with symptoms of infection by Ascochyta paspali. Counts of other species were not taken. The paspalum (healthy and infected together) and the non-paspalum materials were placed in separate paper bags and all 100 bags dried in an oven at 60°C for 3 days. The contents of each bag were weighed, and the mean dry weight per sample determined for paspalum and for the other species.

(b) Ruawai farm: The same method as above was used, except that a reduced number of coordinate locations were sampled, 25 on each of the first three visits, and 15 on the remaining four. In addition, the paspalum leaves with symptoms of A. paspali infection were weighed separately from those without symptoms, to determine the percentage of infection, based on dry weights.

No attempt was made in this study to extrapolate data to estimate the yield on a per hectare basis. The change in dry weight with time was more relevant than the absolute values on any given date.

7.2.3 Climate data

Records were obtained of rainfall from the meteorological station at the Arapohue farm (A63091 Arapohue, Lat.36°00'S, Long. 173°56'E), and temperature from the nearby Dargaville Demonstration Farm (A53982 Dargaville, Lat. 35°37'S, Long. 173°50'E), courtesy of the New Zealand Meteorological Service.
7.3 RESULTS

7.3.1 Arakohue farm

The point quadrat analysis of species composition in the three small plots is illustrated in Fig. 51 (see also Table 5). The dominant component of the sward throughout the year was 'other grasses' which mainly consisted of rye grasses. This component peaked in spring and declined over summer to a low point in late autumn/early winter. Clover was relatively constant over summer and autumn, declined during winter, and increased again in the spring. A cyclic pattern was evident for paspalum, from highest abundance, comprising up to 37% of ground cover in March, to virtual absence from the pasture during winter months. Regrowth occurred in the spring.

Leaves of paspalum with and without symptoms of A. paspali infection were recorded separately. The proportion of paspalum with disease symptoms was greatest at the beginning of the sampling period, in January 1979, when it represented 37% of the total paspalum in the sample plots. This percentage then declined, despite further increases in total paspalum levels, and the disease was absent from the sward over winter. Results for the summer of 1979-80 (Figs 51, 52, 53) showed a considerably reduced yield, compared with that attained in 1978-79, of both paspalum and infected paspalum and of the sward in general.

The percentage of ground without any vegetation cover was low at the beginning of 1979, but increased dramatically during early winter and remained relatively high throughout the rest of the year.

A comparable pattern of results was produced from random sample analysis of the paddock, particularly with reference to paspalum. Dry weight measurements of the samples (Fig. 52, Table 6) showed that the greatest production by the sward occurred in January and February, and least production from May to October. Paspalum, as a proportion of the total dry weight, was most abundant in the period from January to April
<table>
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<th>Paspalum with symptoms of A. paspali</th>
<th>Absence of Ground Cover</th>
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<td>74.0</td>
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<td>63.8</td>
<td>43.0</td>
</tr>
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<td></td>
<td>Mar 30</td>
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<td>51.5</td>
<td>54.5</td>
<td>54.7</td>
<td>39.0</td>
</tr>
<tr>
<td></td>
<td>Apr 13</td>
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<td>57.5</td>
<td>58.0</td>
<td>57.8</td>
<td>49.5</td>
</tr>
<tr>
<td></td>
<td>Apr 27</td>
<td>61.0</td>
<td>63.0</td>
<td>52.0</td>
<td>58.7</td>
<td>41.5</td>
</tr>
<tr>
<td></td>
<td>Jun 8</td>
<td>37.0</td>
<td>49.5</td>
<td>44.0</td>
<td>43.5</td>
<td>21.5</td>
</tr>
<tr>
<td></td>
<td>Jul 6</td>
<td>48.0</td>
<td>54.0</td>
<td>42.5</td>
<td>48.2</td>
<td>33.5</td>
</tr>
<tr>
<td></td>
<td>Sep 14</td>
<td>68.5</td>
<td>72.0</td>
<td>56.5</td>
<td>65.7</td>
<td>18.5</td>
</tr>
<tr>
<td></td>
<td>Sep 28</td>
<td>67.0</td>
<td>77.0</td>
<td>59.0</td>
<td>67.7</td>
<td>12.0</td>
</tr>
<tr>
<td></td>
<td>Oct 12</td>
<td>69.0</td>
<td>78.0</td>
<td>56.0</td>
<td>67.7</td>
<td>10.0</td>
</tr>
<tr>
<td></td>
<td>Oct 26</td>
<td>59.0</td>
<td>69.0</td>
<td>55.0</td>
<td>61.0</td>
<td>11.0</td>
</tr>
<tr>
<td></td>
<td>Nov 9</td>
<td>70.0</td>
<td>71.0</td>
<td>53.5</td>
<td>64.8</td>
<td>25.5</td>
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<tr>
<td></td>
<td>Nov 23</td>
<td>73.0</td>
<td>69.5</td>
<td>62.0</td>
<td>68.2</td>
<td>17.0</td>
</tr>
<tr>
<td></td>
<td>Dec 7</td>
<td>67.0</td>
<td>69.0</td>
<td>52.5</td>
<td>62.8</td>
<td>24.0</td>
</tr>
<tr>
<td></td>
<td>Dec 21</td>
<td>65.0</td>
<td>65.0</td>
<td>57.0</td>
<td>62.3</td>
<td>20.0</td>
</tr>
<tr>
<td>1980</td>
<td>Jan 4</td>
<td>53.0</td>
<td>58.0</td>
<td>55.0</td>
<td>55.3</td>
<td>27.0</td>
</tr>
<tr>
<td></td>
<td>Jan 18</td>
<td>57.0</td>
<td>70.0</td>
<td>57.0</td>
<td>61.3</td>
<td>23.0</td>
</tr>
</tbody>
</table>
Fig. 51

Point quadrat analysis, Arapohue farm. Mean percentage ground cover of each pasture component:

● = grasses other than paspalum (mainly ryegrasses).
△ = clovers.
■ = paspalum without symptoms of Ascochyta paspali.
□ = paspalum with symptoms of A. paspali.
○ = absence of cover.
### TABLE 6. Mean dry weight and mean leaf number, assessed by random sampling of sward at Arapohue farm.

<table>
<thead>
<tr>
<th>Date</th>
<th>Dry weight (g) per sample</th>
<th>Number of paspalum leaves per sample</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Paspalum</td>
<td>Other plants</td>
</tr>
<tr>
<td>1979</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Jan 5</td>
<td>0.27</td>
<td>4.09</td>
</tr>
<tr>
<td>Jan 19</td>
<td>0.29</td>
<td>3.48</td>
</tr>
<tr>
<td>Feb 2</td>
<td>0.34</td>
<td>4.02</td>
</tr>
<tr>
<td>Feb 16</td>
<td>0.40</td>
<td>3.91</td>
</tr>
<tr>
<td>Mar 2</td>
<td>0.40</td>
<td>3.44</td>
</tr>
<tr>
<td>Mar 16</td>
<td>0.26</td>
<td>3.05</td>
</tr>
<tr>
<td>Mar 30</td>
<td>0.24</td>
<td>2.50</td>
</tr>
<tr>
<td>Apr 13</td>
<td>0.23</td>
<td>2.62</td>
</tr>
<tr>
<td>Apr 27</td>
<td>0.24</td>
<td>1.71</td>
</tr>
<tr>
<td>May 18</td>
<td>0.14</td>
<td>2.45</td>
</tr>
<tr>
<td>Jun 8</td>
<td>0.03</td>
<td>2.21</td>
</tr>
<tr>
<td>Jul 6</td>
<td>0.03</td>
<td>1.63</td>
</tr>
<tr>
<td>Sep 14</td>
<td>0.03</td>
<td>1.64</td>
</tr>
<tr>
<td>Sep 28</td>
<td>0.02</td>
<td>2.50</td>
</tr>
<tr>
<td>Oct 12</td>
<td>0.03</td>
<td>2.48</td>
</tr>
<tr>
<td>Oct 26</td>
<td>0.03</td>
<td>1.77</td>
</tr>
<tr>
<td>Nov 9</td>
<td>0.04</td>
<td>2.62</td>
</tr>
<tr>
<td>Nov 23</td>
<td>0.13</td>
<td>2.89</td>
</tr>
<tr>
<td>Dec 7</td>
<td>0.11</td>
<td>3.17</td>
</tr>
<tr>
<td>Dec 21</td>
<td>0.14</td>
<td>3.38</td>
</tr>
<tr>
<td>1980</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Jan 4</td>
<td>0.26</td>
<td>3.56</td>
</tr>
<tr>
<td>Feb 1</td>
<td>0.20</td>
<td>2.63</td>
</tr>
<tr>
<td>Feb 22</td>
<td>0.24</td>
<td>1.88</td>
</tr>
<tr>
<td>Mar 14</td>
<td>0.25</td>
<td>2.08</td>
</tr>
</tbody>
</table>
Mean dry weight of paspalum and of other plants, assessed by random sampling of sward at Arapohue farm.

■ = paspalum.
□ = other plants.

Mean number of paspalum leaves with and without symptoms of Ascochyta paspali, assessed by random sampling of sward at Arapohue farm.

■ = leaves with symptoms.
□ = leaves without symptoms.
when it comprised 6-12% of the sward. By early winter, it had declined substantially. Infected paspalum first appeared in the pasture in late October (Fig. 53, Table 6). Incidence was greatest in terms of leaf number in January, 1979 and thereafter declined.

Climatological data is listed in Table 7. The period of study, late 1978 to early 1980, was atypical with respect to rainfall. The total annual rainfall for 1979 was the third highest in the past 26 years. Rainfall nearly twice the monthly average was recorded for February, March, and December of 1979, contributing to wet summers in both 1978-79 and 1979-80. In contrast, October, November, 1978 and January, April, May, 1979 had rainfalls of less than half the monthly means. These led to a dry spring in 1978 and a dry autumn in 1979. The temperatures over the study period were close to average, except for a very warm March, 1979.

7.3.2 Ruawai farm

The assessment of species composition at this farm covered the summer period only of 1979-80. The results in Fig. 54 and Table 8 do not show well-defined trends. However, it is significant to note that, on a dry weight basis, paspalum was in excess of 50% of total vegetation, from December to the end of February. Paspalum levels peaked in January. The numerical proportion of paspalum leaves with symptoms of *A. paspali* ranged from 5-16% over the sample period, while the dry weight of infected leaves varied from 4-17% of the total paspalum weight. The sward was cut for silage in early February.
TABLE 7. Rainfall at Arapohue farm and temperature at Dargaville demonstration farm.

<table>
<thead>
<tr>
<th>Year</th>
<th>JAN</th>
<th>FEB</th>
<th>MAR</th>
<th>APR</th>
<th>MAY</th>
<th>JUN</th>
<th>JUL</th>
<th>AUG</th>
<th>SEP</th>
<th>OCT</th>
<th>NOV</th>
<th>DEC</th>
<th>ANNUAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>1978</td>
<td>69</td>
<td>25</td>
<td>28</td>
<td>150</td>
<td>88</td>
<td>183</td>
<td>240</td>
<td>111</td>
<td>92</td>
<td>49*</td>
<td>50*</td>
<td>81</td>
<td>1166</td>
</tr>
<tr>
<td>1979</td>
<td>36*</td>
<td>185*</td>
<td>185*</td>
<td>48*</td>
<td>61*</td>
<td>215</td>
<td>124</td>
<td>143</td>
<td>110</td>
<td>116</td>
<td>146</td>
<td>156*</td>
<td>1525</td>
</tr>
<tr>
<td>1980</td>
<td>120</td>
<td>103</td>
<td>121</td>
<td>65</td>
<td>52</td>
<td>189</td>
<td>134</td>
<td>113</td>
<td>55</td>
<td>46</td>
<td>97</td>
<td>102</td>
<td>1197</td>
</tr>
</tbody>
</table>

1955-80

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>Std.Dev.</th>
<th>Max.</th>
<th>Min.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>83</td>
<td>62</td>
<td>255</td>
<td>4</td>
</tr>
<tr>
<td>Std.Dev.</td>
<td>91</td>
<td>65</td>
<td>220</td>
<td>12</td>
</tr>
<tr>
<td>Max.</td>
<td>84</td>
<td>49</td>
<td>187</td>
<td>16</td>
</tr>
<tr>
<td>Min.</td>
<td>100</td>
<td>54</td>
<td>230</td>
<td>40</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Year</th>
<th>Daily mean temperature (°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1978</td>
<td>19.0 19.8 18.9 17.3 14.0 12.2 11.4 11.6 11.7 12.2 14.9 16.9 15.0</td>
</tr>
<tr>
<td>1979</td>
<td>19.4 19.0 20.2* 16.0 14.0 12.9 10.8 11.6 12.4 13.6 15.7 16.7 15.2</td>
</tr>
<tr>
<td>1980</td>
<td>19.0 19.0 16.8 14.5 13.3 11.8 10.9 10.7 13.1 14.7 15.2 16.6 14.6</td>
</tr>
</tbody>
</table>

1943-80

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>Std.Dev.</th>
<th>Max.</th>
<th>Min.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>18.6</td>
<td>1.0</td>
<td>20.4</td>
<td>16.6</td>
</tr>
<tr>
<td>Std.Dev.</td>
<td>1.2</td>
<td>0.9</td>
<td>22.3</td>
<td>15.6</td>
</tr>
<tr>
<td>Max.</td>
<td>19.0</td>
<td>0.2</td>
<td>18.7</td>
<td>11.9</td>
</tr>
<tr>
<td>Min.</td>
<td>18.1</td>
<td>0.8</td>
<td>15.0</td>
<td>9.6</td>
</tr>
</tbody>
</table>

* atypical record during period of study.
TABLE 8. Mean dry weight and mean leaf number, assessed by random sampling of sward at Ruawai farm.

<table>
<thead>
<tr>
<th>Date</th>
<th>Dry weight (g) of paspalum per sample</th>
<th>Dry weight (g) of other plants per sample</th>
<th>Number of paspalum leaves per sample</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>- with symptoms of A. paspali</td>
<td>- without symptoms of A. paspali</td>
<td></td>
</tr>
<tr>
<td>1979 Dec 7</td>
<td>0.17</td>
<td>1.73</td>
<td>1.81</td>
</tr>
<tr>
<td>Dec 21</td>
<td>0.12</td>
<td>1.71</td>
<td>1.70</td>
</tr>
<tr>
<td>Jan 4</td>
<td>0.28</td>
<td>2.97</td>
<td>1.82</td>
</tr>
<tr>
<td>Jan 18</td>
<td>0.54</td>
<td>3.27</td>
<td>2.03</td>
</tr>
<tr>
<td>Feb 22</td>
<td>0.08</td>
<td>2.07</td>
<td>1.83</td>
</tr>
<tr>
<td>Mar 14</td>
<td>0.08</td>
<td>1.28</td>
<td>1.53</td>
</tr>
<tr>
<td>Apr 4</td>
<td>0.33</td>
<td>1.58</td>
<td>2.47</td>
</tr>
</tbody>
</table>
Random sampling of sward, Ruawai farm:

A, mean dry weight of paspalum, with and without symptoms of *Ascochyta paspali*, and of other plants.

■ = paspalum with symptoms.
□ = paspalum without symptoms.
Ø = other plants.

B, mean number of paspalum leaves with and without symptoms of *A. paspali*.

■ = leaves with symptoms.
□ = leaves without symptoms.
7.4 DISCUSSION

7.4.1 Species composition

The seasonal fluctuations of component species in the Arapohue farm sward (Fig. 51) are supported by similar results from other pasture composition studies in New Zealand. For example, a spring peak for rye-grass was reported by Lynch (1953) and Barrs (1976), both working at Dargaville. Likewise, a peak for clover production during summer was recorded by these same authors. Paspalum has been widely reported to show highest yield, by dry weight measurements, in summer to early autumn (Lynch, 1953; Lambert, 1967; Barrs, 1976; Taylor et al., 1976; Percival, 1977; and Sithamparanathan, 1979). Sturme (1977) found a similar result using point quadrat analysis. The determination of paspalum levels by point quadrat analysis and by dry weights produced complementary results in the present study. This further supports the use of the point quadrat method for the study of pasture composition. Point quadrat analysis required considerably less time than the dry weight method.

7.4.2 Paspalum infected by A. paspali

The quantity of paspalum which was infected by A. paspali constituted a significant proportion of the total paspalum present, although it did not rise above 10% as a component of the total sward (Figs 51, 54A). Several types of measurements were made of this component. At the Arapohue farm, up to 37% of the paspalum ground cover was infected on January 19, 1979. The plots sampled by point quadrats, however, had been selected for their higher-than-average incidence of paspalum and, more particularly, of infected paspalum. More realistic values for the paddock as a whole were gained from the proportion of paspalum leaves which were
infected in random samples (Fig. 53). A maximum of 20% of paspalum leaves showed infection in early January, 1979. This value then dropped to 12-13% for the next three sample dates.

At the Ruawai farm, comparable peak values of 14-16% were recorded by random sampling in January, 1980 (Fig. 54B), but in addition 16% of the paspalum leaves were infected in April, 1980. Analysis by dry weight produced a similar double peak. The Ruawai farm, however, was not representative of other farms in the area. The vegetation was rank and not managed. Paspalum smothered the other components of the sward, which included a large proportion of weed species. The paspalum was not subjected to the same competition pressures as would occur in a managed sward. Measurement of yield was seriously affected by cutting for silage in early February.

The results show a seasonal fluctuation in incidence of the disease which basically followed the fluctuation in paspalum levels. The disease first appeared in October, and peaked in January to February. January and February have the highest mean daily temperatures, suggesting that high temperature may favour disease development. Incidence of the disease declined during late summer and the disease was absent in the winter months.

The probable impact of the disease, in terms of reduced pasture yield, was small in the present study since paspalum was only a minor component of the sward at the Arapohue farm. A dry summer, instead of the wet season of 1979, could have markedly increased paspalum levels. For a managed sward in which paspalum is the dominant component, as at Ruakura Dairy No. 5 (Sturme, 1977), a level of 20% infection could have a significant effect. A higher percentage of infection could be expected if climatic conditions occurred which were more favourable to the requirements of the pathogen, and less favourable to the host.
7.4.3 Factors affecting the analysis

The study covered a relatively short period of 14 months, and suffered from atypical rainfall throughout. The near-record annual rainfall of 1979 resulted in a wet summer, winter, and following spring. These conditions were not favourable for paspalum growth. Paspalum is most abundant during a relatively dry summer, when it competes favourably with other components of the pasture, particularly ryegrass, which are more sensitive to drought. On Kaipara clay, the deep rooting system of paspalum is well adapted in drought conditions to draw on the permanently high water table (Barrs, 1976). Under heavy rainfall, however, paspalum lacks an advantage. Furthermore, the flat, poorly drained Kaipara clay is susceptible to flooding (Lynch, 1953). Floods occurred in the Arapohue sample paddock in July and November, 1979. Grazing under such conditions markedly altered and damaged the sward. The prolonged, above-average rainfall of the latter half of 1979 hindered recovery of the pasture.

Small areas of the sward, such as those sampled for point quadrat analysis, are particularly vulnerable to disruption by hoof damage, animal dung, and by cattle lying on the plot. Apart from hoof damage, these factors were not significant in the present study. Point quadrat sampling of fixed transects rather than marked areas could overcome these difficulties. On the other hand, diseased paspalum was a minor component of the total paddock sward, and it would have required an increased number of point quadrats to attain the same sampling precision as that gained in small selected areas.
APPENDIX

The appendix contains details of: optical and electron microscopic
stains used, the procedure and chemicals involved in the preparation of
fungal material for electron microscopy, and the fertiliser and potting
mix used for glasshouse-grown plants.

Lactophenol Cotton Blue (Anon., 1968), a stain for optical microscopy.

- Phenol crystals 20g
- Lactic acid 20g
- Glycerol 40g
- Water 20ml
- Cotton blue 0.1g

Modified Spurr's Resin (after Spurr, 1969), an embedding resin for electron
microscopy.

- ERL - 4206 (Vinyl cyclohexene dioxide) 20g
- D.E.R. 736 (Diglycidyl ether of polypropylene glycol) 12g
- NSA (Nonenyl succinic anhydride) 52g
- DMP 30 (2,4,6-tri (dimethylaminomethyl) phenol) 1g

The accelerator, DMP 30, has replaced the toxic chemical, S-1
(dimethylaminoethanol) of Spurr (1969).

Lead Citrate (Roland, 1978), a stain for electron microscopy.

Three stock solutions are prepared and stored in a refrigerator:

Solution A: trisodium citrate, 37.7 g in 100 ml water

" B: lead nitrate, 33.1 g in 100 ml water

" C: 1 N sodium hydroxide, 4.0 g in 100 ml water
The solutions are combined in the following mixture, centrifuged, and the liquid drawn off as the stain.

water 16 ml
Solution A 3 ml
" B 2 ml
" C 4 ml

**Uranyl Acetate**, a stain for electron microscopy.

A saturated solution of uranyl acetate in 50% ethanol.

**Procedure for the preparation of fungal herbarium specimens for electron microscopy**

(i) Rehydration: 3% potassium hydroxide (10 min.)
sterile distilled water (15 min., x 4)
embed in 2% water agar

(ii) Fixation: 3% glutaraldehyde in 0.1 M phosphate buffer -
pH 7.2 (2 h at room temperature)
buffer wash (15 min., x 3)
material can be stored in buffer in refrigerator
postfixed in 1% osmium tetroxide (60 min. at room
 temperature; overnight in refrigerator;
60 min. at room temperature).
sterile distilled water (10 min., x 3)

(iii) Dehydration
70% ethanol (20 min.)
95% ethanol (30 min.)
100% ethanol (30 min., x 3)
(iv) Infiltration: 50% propylene oxide (P.O.): 50% ethanol (10 min.)
100% P.O. (5 min., x 3)
70% P.O. : 30% Spurr's resin (2 h)
50% P.O. : 50% Spurr's resin (2 h, rotation)
30% P.O. : 70% Spurr's resin (overnight, rotation)
100% Spurr's resin (4 changes over 2.5 days, rotation)

(v) Embedding: Spurr's resin in silicone rubber flat moulds at 70°C for 2 days to polymerize resin.

U.C. soil mix and added fertilizer (Baker, 1957, table 4, p. 73), a medium for the growth of container grown plants in a glasshouse. U.C. soil mix C - 1 part pumice sand : 1 part peat (pH ca. 6.0).

Fertilizer - based on U.C. fertilizer I (C); quantities added to 1 m³ of U.C. soil mix:

- potassium nitrate: 148 g
- potassium sulphate: 148 g
- superphosphate: 1.5 kg
- dolomite: 4.5 kg
- agricultural lime: 1.5 kg
- dried blood: 1.5 kg
- 'Sporumix B'(Yates Corp.): 186 g
REFERENCES


Cooke, M.C. 1885: British Sphaeropsidaceae. Provisional list of species hitherto found in the British Islands. Grevillea 14: 61-76.


Dickinson, C.H.; Pugh, G.J.F. 1965a: The mycoflora associated with Halimione portulacoides. I. The establishment of the root surface


Lynch, P.B. 1966: Conduct of field experiments. New Zealand Department of Agriculture bulletin No.399.


Petrak, F. 1923 : Mykologische Notizen. VI. Annales mycologici
21: 182-335.

Petrak, F. 1924 : Mykologische Notizen. VII. Annales mycologici

Petrak, F. 1925a : Beiträge zur Pilzflora Südost-Galiziens und der

Petrak, F. 1925b : Mykologische Notizen. VIII. Annales mycologici
23: 1-143.

Petrak, F. 1930-1944 : Verzeichnis der neuen Arten, Varietäten, Formen,
Namen und wichtigsten Synonyme. Just's botanischer Jahresbericht
57: 592-631; Abt.1, 58: 447-570; Abt.1, 60: 449-514; Abt.2, 63:
805-1056.

Petrak, F. 1943 : Über die systematische Stellung und Nomenklatur von
Ascochyta boltshauseri Sacc. und Stagonospora curtisii (Berk.)Curt.
Annales mycologici 41: 190-195.

Sydowia 1: 127-141.

Petrak, F. 1950 : Index of fungi 1936-1939. List of new species and
varieties of fungi, new combinations and new names published 1936-

Petrak, F. 1952 : Ergebnisse einer Revision der Grundtypen verschiedener
Gattungen der Askomyzeten und Fungi imperfecti. III. Sydowia

Petrak, F. 1953 : Ergebnisse einer Revision der Grundtypen verschiedener
Gattungen der Askomyzeten und Fungi imperfecti. IV. Sydowia
7: 295-308.


Mycological Institute and British Mycological Society.

Rogers, D.P. 1949: Nomina conservanda proposita and nomina confusa -

Roland, J.-C. 1978: General preparation and staining of thin sections.
In: Hall, J.L. ed., Electron microscopy and cytochemistry of plant

Montréal.

Rupprecht, H. 1959: Beiträge zur Kenntnis der Fungi imperfecti III.
Sydowia 13: 10-22.


Saccardo, P.A. 1882: Index alphabeticus generum et specierum in hoc

Saccardo, P.A. 1884: Sylloge fungorum omnium hucusque cognitorum.
Vol.3. Padua.

Saccardo, P.A. 1892: Sylloge fungorum omnium hucusque cognitorum.

Saccardo, P.A.; Saccardo, D. 1906: Sylloge fungorum omnium hucusque

Saccardo, P.A.; Trotter, A. 1913: Sylloge fungorum omnium hucusque


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