

# Section 1

## *General Background*

### 1.1 Introduction

The anamorph genus *Septoria* Sacc. contains as many as two thousand described species (Sutton 1980) and is one of the largest genera of plant pathogens, causing a range of disease symptoms including leaf and fruit spots on many agricultural crops (Halliday 1989). The teleomorphs of *Septoria*, where known, are currently placed in the genera *Mycosphaerella* Johanson and *Sphaerulina* Sacc. Several species of *Septoria* were described from Australia on native host genera last century by Cooke (1891), Cooke and Massee (1880), Saccardo (1890) and McAlpine (1897, 1899), mostly from single collections and with scant descriptions and without illustration. Additional species were described by McAlpine (1901, 1903, 1904), Hansford (1954, 1956), Sydow (1938) and Petrak (1955) during the first half of this century but were also made from single collections and lacked illustration. Only a small number of species world-wide have been fully described using modern morphological characters such as conidiogenesis and even fewer have been described from culture or subjected to extensive host range studies. Most currently available regional studies of *Septoria* are from the Northern Hemisphere and vary in usefulness, many being compilations only, with few or scanty descriptions, or, lacking illustrations.

In Australia, only the more recent studies of species of *Septoria* on Australian native plant hosts by Sutton & Pascoe (1987, 1989) contain full descriptions with details of conidiogenesis and full illustrations of relevant taxonomic features. Consequently, most species of *Septoria* recorded from Australia need redescription. In addition, literature records show that many other species on agricultural, weed and other host plant species have been reported but few, if any, have been compared with type or authentic material, much reliance being placed on the host plant or descriptions compiled in such works as Saccardo's *Sylloge Fungorum* Vols.1-26 (Saccardo *et al.* 1882-1972) for identification.

The need for a critical revision of *Septoria* in Australia based on type studies, conidiogenesis and illustration is obvious for several reasons not least of which is the necessity to put the Australian

representatives of the genus into a modern morphotaxonomic context. In addition a thorough revision will act as a baseline study for future research into possible restructuring of the genus *Septoria* into recognisable segregate groupings based on characters including conidiogenesis, as suggested by Sutton (1980). The need to describe the variation of taxa based on examination of many collections is essential if the occurrence and identity of species of *Septoria* in Australia on its agricultural crops and native flora are to be related to the world flora.

## 1.2 Conservation and Typification

Under the International Code of Botanical Nomenclature (ICBN) the genus *Septoria* Sacc. is a conserved name. The arguments surrounding the proposal to conserve *Septoria* Sacc. over *Septoria* Fr. are very complex and were first moved by the Nomenclature Committee of the British Mycological Society (Wakefield 1940), rejected by Rogers (1949) and again proposed by Donk (1964). A brief historical account is presented below as an aid to clarification of the arguments for and against the proposals.

**1819.** Fries (*Nov. Fl. Suec.* V, 78) used the name *Septaria* (original spelling of Fries) with *S. ulmi* Fr. as the type species.

**1828.** Fries (*Elenchus Fungorum* II, p. 117) replaced *Septaria* with *Septoria* and listed three species, *S. ulmi* Fr., *S. oxyacanthae* (Kuntze & Schmidt) Fr. and *S. fraxini* Fr.

**1832.** Fries (*Syst. Mycol.* III, 480) defined the genus *Septoria* as “*sporidia septata, fusiformia, pellucida, in nucleum simplicem conglobata, dein cum gelatina cirrhorum forma profluenta. Cirrhi haud nigra.*” He referred to his *Elenchus Fungorum* II, p.117 and added that spores may be borne in perithecia or not and that Desmazieres had added new species *S. rosae* Desm. and *S. heraclei* Desm.

**1833.** Wallroth (*Fl. Crypt. Germ.* II, p.176) erected the genus *Phloeospora* and cited two species, *P. ulmi* (Fr.) Wallr. and *P. oxyacanthae* (Kuntze & Schmidt) Wallr.

**1880.** Saccardo (*Michelia* II, p. 6) divided *Septoria* Fr. into four subsections:

(i) *Euseptoria*. Perithecia distincta; spermatia angustissima. Ex. *S. crataegi* Kickx., *S. cytisi* Desm.

(ii) *Phloeospora* (Wallr.). Perithecia obsoleta: spermatia crassiora. Ex. *S. ulmi* Fr., *S. oxyacanthae* Kunze.

(iii) *Phlyctaena* (Desm.). Perithecia subhysteroidea; saepe incompleta. Ex. *S. vagabunda* Desm.

(iv) *Rhabdospora* (Mont. *emend.*). Perithecia majuscula pleosporoidea, papillata, saepius ramicola. Ex. *S. pleosporoides* Sacc.

**1884.** Saccardo (*Sylloge Fungorum III*, p.474) raised those subsections to generic rank and included *Septoria* Fr. *emend.* Sacc. listing the following genera in his Section 7. Scolecosporae which was defined as “*Sporulae bacillares, filiformes vel elongato-fusoideae, continuae vel septatae, hyalinae vel chlorinae.*” Saccardo did not nominate a type species for any of the genera listed.

(i) *Septoria*. Perithecia exigua, lenticularia, completa, pertusa non papillata, saepissime maculicola et foliicola; sporulae saepius angustissimae.

(ii) *Phloeospora* (as *Phleospora*). Perithecia globulosa-lenticularia sed spuria incompleta, foliicola, vix maculicola; sporulae crassiusculae.

(iii) *Rhabdospora*. Perithecia globulosa vel depressa, completa, saepius papillata, rami-caulicola, non vel vix maculicola.

**1898.** Kuntze (*Rev. Gen. Pl. III*, p.520) reinstated the concept of *Septoria* Fr. as non-pycnidial and transferred all of Saccardo's *Septoria* names to *Rhabdospora* leaving *Phloeospora* for all non-pycnidial species as recognised by Saccardo.

*Septoria* had thus been defined in three different ways since its original circumscription:

- (1) In the original Friesian sense for non-pycnidial forms and followed by Kuntze. In this way *Phloeospora* Wallr. is simply a synonym of *Septoria* Fr.
- (2) An expanded Friesian concept of *Septoria* that included both pycnidial and non-pycnidial forms.
- (3) In the sense of Saccardo, *Septoria* was emended to include only pycnidial forms but did not include the original Friesian type *S. ulmi* Fr. which was included under *Phloeospora* Wallr.

Historically the concept that most people followed subsequently was that of Saccardo which led to the proposal to conserve the concept of *Septoria* Sacc. over *Septoria* Fr. By adopting the recommendation

as proposed, *Septoria* Sacc. (with a new generic type as *S. cytisi* Desm.) becomes the name for pycnidial forms. As a consequence *Phloeospora* Wallr. with its type as *P. ulmi* (Fr. ex Kze) Wallr. must be taken up as the generic name for non-pycnidial forms and *Septoria* Fr. in its original definition is synonymous with it.

Rogers (1949) rejected the proposal to conserve *Septoria* Sacc. on the basis that *Septoria* Sacc. did not exist, but only *Septoria* Fr. *emend* Sacc. and that as Saccardo (1880) had included the type species (*S. ulmi*) there was insufficient grounds to conserve *Septoria* Sacc. However he made no recommendation to solve the obvious nomenclatural problem.

The Special Committee for Fungi rejected the proposal to conserve *Septoria* Fr. and recommended that as the genus *Septoria* in the sense of Saccardo had prevailed for many years it be adopted as the generic concept, attributed to Saccardo and conserved with a type species of *S. cytisi* Desm. and that *Septaria* Fr. ex Fr. (1821) and *Septoria* Fr. (1825, 1828) be regarded as nomina rejicienda.

Currently the names *Septoria* Sacc. (type species *S. cytisi* Desm.) and *Phloeospora* Wallr. (type species *P. ulmi* (Fr. ex Kuntze) Wallr.) are conserved under the International Code of Botanical Nomenclature (Greuter *et al.* 1988)

### 1.3 Generic Definition

Based on examination of several collections of the type species *S. cytisi* Desm., Sutton (1980) defined *Septoria* as follows: “mycelium immersed, branched, septate, pale brown. Conidiomata pycnidial, immersed, separate or aggregated, but not confluent, globose, papillate or not, brown, thin-walled; wall of pale brown textura angularis, often with a smaller-celled inner layer, somewhat darker and more thick-walled around the ostiole. Ostiole single, circular, central sometimes papillate. Conidiophores absent. Conidiogenous cells holoblastic, determinate or indeterminate with a limited number of sympodial proliferations and then each locus with a broad flat, unthickened scar, discrete, hyaline, smooth, ampulliform, doliiform or lageniform to short cylindrical. Conidia hyaline, multiseptate, filiform, smooth, continuous or constricted at the septa.”

Since Sutton (1980), the definition of the genus has been expanded to include species whose conidiogenous cells (i) do not show any apparent proliferation (simple holoblastic), (ii) proliferate enteroblastically and secede at the same level (phialidic), (iii) proliferate enteroblastically and percurrently (annellidic), (iv) proliferate sympodially (Constantinescu 1984, Sutton & Pascoe 1987, 1989 and Farr 1991, 1992). The use of the term “phialidic” is probably misleading in so much as the

limitation of the light microscope only allows for such a conclusion to be made. Morgan-Jones *et al.* (1972) concluded that the probability of the phialide and the annellide being a continuum was dependent on further study of the nature of the periclinal wall, and whether the number of layers involved, either visible as periclinal thickening (collarete) or percurrent thickenings, were of the same origin, a problem not entirely solved by Sutton & Sandhu (1968).

The inclusion of such a wide range of conidiogenous types has considerably broadened the concept of *Septoria* based on accumulated evidence that several types of conidiogenesis may be found within one conidioma. Farr (1992) found that both sympodial proliferation and enteroblastic percurrent proliferation could be found in the type species *S. cytisi*. More recent studies by Verkley (1998a, 1998b) have shown that both sympodial and percurrent proliferation within the one conidiogenous cell is possible. Currently, conidiogenesis is used to define genera within the coelomycetes (Sutton 1980) and at least in the genus *Septoria*, the inclusion of a wide range of conidiogenesis has produced a heterogeneous group whose only current defining features are the pycnidial structure of the conidioma and the production of multi-septate filiform conidia; scarcely an advance since Saccardo. The recognition of the variability of conidiogenesis has now produced an unworkable system at the anamorph generic level and subsequent attempts to correlate teleomorph classification with anamorphic condition have also been unsuccessful (Sutton 1996). This would appear to be in part due to the apparent heterogeneity of many teleomorphic genera which makes such correlations difficult. The additional suggestion that identification of mitosporic fungi (due to their being only parts of holomorphic entities) should be independent of the substrate or host identity (Pons & Sutton 1996) may be morphologically feasible but denies evidence of host specificity which has been demonstrated by several species of *Septoria*.

The use of conidiogenesis as a character for defining sub-groupings within the coelomycetes as suggested by Sutton (1980) has apparently been abandoned in favour of a much broader concept of genera such as *Septoria* than previously accepted. The premise that limits between genera can be based on the structure of the conidioma being either acervular, pycnidial or eustromatic was rejected by von Arx (1983) who synonymized several genera under *Septoria* including *Phloeospora* Wallr. (acervular), *Cytostagonospora* Bubák (pycnidial) and *Dothistroma* Hulbary (acervular to eustromatic). However this has not been supported by later authors who retain the conidiomatal types, and hence those genera, as distinct.

It is obvious that some genera such as *Septoria* currently exhibit considerable heterogeneity in conidiomatal structure and conidiogenesis. The recognition that species within *Septoria* can exhibit a

wide range of conidiogenesis and conidiogenous cell proliferation indicates a need to completely reappraise the relationships between *Septoria* and its closest related genera similar to that proposed by von Arx (1983) for the anamorphs of *Mycosphaerella*.

*Septoria* Sacc. is a genus of the group of fungi defined by Hawksworth *et al.* (1995) as the mitosporic fungi (formerly the Fungi Imperfecti, Deuteromycotina), a miscellaneous assemblage of anamorph genera characterised by (1) the absence (or presumed absence) of a known teleomorphic state (2) absence (or presumed absence) of any meiotic reproductive structures and (3) presence of conidia formed by mitosis or presumed mitosis. The decision by Hawksworth *et al.* (1995) to abandon the terminology of anamorph and teleomorph was opposed by Korf & Hennebert (1993). Kendrick (1989) had already proposed the use of Fungi Anamorphici to replace the Deuteromycotina since it clearly indicated the informal grouping of anamorphic taxa and their not being part of a formal taxonomic hierarchy. This terminology has been adopted by Walker (1996) who in addition proposed group name Coeloanamorphoses to replace coelomycete.

The term coelomycete was first used by Grove (1919) and later expanded by him in his two volume treatise on the *British Stem and Leaf Fungi* (Grove 1935, 1937) where the term was used to describe those fungi that form conidia in a cavity lined by fungal or host tissue or, both. The wider use of the orders Melanconiales and Sphaeropsidales to separate pycnidial and stromatic forms from acervular forms had been abandoned in favour of a single class, the coelomycetes, as a descriptive term encompassing all of the conidiomatal types. The divisions formally known as the coelomycetes and hyphomycetes as formal taxonomic ranks has been rejected on the basis that there is difficulty in finding a clear distinction between the two groupings. The use of conidiomatal structure to separate these groups has now been replaced by conidiogenesis which in itself has certain problems but appears to “indicate relationships between taxa much more satisfactorily than conidiomatal structure ever did “ (Sutton 1980). *Septoria* is placed in the coeloanamorphoses (Walker 1996) which produce their conidia in pycnidial, acervular, pycnothyrial, cupulate or stromatic conidiomata. The Fungi Anamorphici are a heterogenous group of organisms whose only fault is to currently defy any attempt to impose any sort of workable classification by mycologists. As a large number of anamorphs are important plant pathogens, their accurate identification is essential and producing a workable system for both mycologists and plant pathologists is necessary.

## 1.4 Taxonomic characters

The delimitation of species in the fungi is a difficult task that has been faced by mycologists who have attempted to incorporate the species concept developed by plant taxonomists to the fungi. However it is now recognised that delimitation of species based on e.g. no intermediate forms, does not have any place in fungal taxonomy. The approach taken in the systematics of the fungi, and in particular the Fungi Anamorphici, which contains the majority of plant associated pathogens and saprophytes, has predominantly been morphological with increasing use of pathogenic, cultural, biochemical and serological characters (Nag Raj 1981). Ciferri (1932) recognised that the characteristics used to delimit fungal species fell into two major groups, being (i) **morphological** comprising macro, micro- and biometric characters and (ii) **biological** which included matrical characters such as host specialisation, ecological, pathographic and cultural characters.

Fischer & Shaw (1953) in an attempt to bring more stability to the taxonomy of the smut fungi proposed that an acceptable species concept should be based on a practicable degree of morphological variation and on host specialisation at the family level. The addition of more modern techniques have been utilised in addition to those described by Ciferri (1932). Durbin (1966) used soluble protein patterns in a study of *Septoria avenae*, *S. nodorum* and *S. tritici* but urged caution in interpretation of patterns since variation within species even using a large number of isolates appeared to limit the technique. The approaches to fungal taxonomy using biochemical methods were outlined by Tyrrell (1969) and the use of DNA and protein analysis were both promoted as possible future tools for taxonomy (Hall 1969). Although their application at the time had been limited to the yeasts, more studies in recent years have used both of these methods. Isozyme analysis as outlined by Micales *et al.* (1986) has been used successfully by Bonde *et al.* (1991) to confirm the conspecificity of *S. citri* Pass. in both the United States of America and Australia. McDonald & Martinez (1990) used DNA analysis to study populations of *S. tritici*. Kohn (1992) discussed these recent techniques, their advantages and pitfalls.

Morphological characters have been used as the principal method for classifying most micro-organisms and will continue to do so despite the development of the above newer techniques. The use of type specimens and other reference collections in the systematics of fungi is essential for establishing variation and interpreting morphological characters not available in molecular and other biochemical methods.

#### 1.4.1 Conidiomata:

The type of conidioma currently accepted in *Septoria* is the **pycnidium** which is defined by Michaelides *et al.* (1979) as having three main features - (1) the conidia form more or less completely enclosed by fungal integument, (2) conidiogenous cells line more or less the complete cavity, and (3) there is a well defined and usually restricted ostiole. This type of pore, seen also in *Phoma* Sacc. and *Ascochyta* Lib. is pre-formed (Boerema 1964) and is usually defined by the cells lining the pore being thickened. Pycnidia may be immersed in host tissue, erumpent or superficial and may be internally uni- or pluri-locular. In *Septoria*, the conidioma is defined as pycnidial (Sutton 1980) with a single apical ostiole. An **acervulus** is defined as an immersed conidioma consisting of a flat layer of pseudoparenchyma upon which conidia are initiated and produced while still covered by host tissue (Michaelides *et al.* 1979, Sutton 1980) and a **stroma** as a distinctly structured tissue, unilocular or pluri-locular, within which conidia are produced and ejected through non-preformed openings (modified from Sutton 1980).

The development of the pycnidial conidioma in *S. lycopersici* Speg., has been studied by Harris (1935). The primordium of the pycnidium was stated to be **symphogenous** (*i.e.* formed from the intermingling of several hyphal branches, see Punithalingam 1966), the pycnidial chamber formed by both schizogenous breaking of hyphae and dissolution leading to the formation of a gelatinous substance which is displaced by conidia. The formation of the ostiole was reported to be due to tension (1) between the epidermis of leaf tissue and the developing pycnidium, and (2) caused by the developing conidial mass, however no mention was made of the presence of darkened cells to indicate any preformed nature of the opening. Punithalingam (1966) studied four species of *Septoria* from *Chrysanthemum* and found that the development of the pycnidial primordium could be both symphogenous and **meristogenous** (*i.e.* formed from the division of one or more cells of a single hypha), the formation of the pycnidial cavity being similar to that reported by Harris (1935) with the schizogenous splitting of the hyphal layers and lysigenous dissolution of the hyphae prior to conidium formation. The ostiolar beaks were formed as the pycnidia matured and the ostiole was formed by similar tensions reported by Harris (1935). The process of the formation of the conidioma in *Septoria* appears to be identical with that reported by Boerema (1964) for *Phoma herbarum* Westend. where the pycnidial primordium is formed both symphogenously and meristogenously, the cavity formed by combined process of lysis and schizogenous cell division and the ostiole preformed, dark hyphal cells being apparent soon after the cavity is formed.

#### 1.4.2 Tissue:

The tissue found in conidiomata can best be described as being comprised of two elements. *Pseudoparenchyma* is defined as derived tissue not seen to be made of hyphal elements (Hawksworth *et al.* 1983). This derived tissue can be further divided into resultant textura types. The textura types found in the apothecial ascomycetes have been outlined by Korf (1951, 1973) and illustrated by Hawksworth *et al.* (1983) but are now widely used throughout the ascomycetes and coelomycetes to describe tissues found in various structures including conidiomata. The tissue type found in the conidioma and reported in species of *Septoria* is *textura angularis* i.e tightly packed isodiametric cells without intercellular spaces formed as a direct result of the development of the conidioma. At maturity the outer layers often become pigmented and thickened. In the descriptions prepared in this study, tissue type designations are based on the conidiomatal wall in surface view. The structure of the wall is separately described as pseudoparenchymatous.

#### 1.4.3 Conidiogenesis:

The conidiogenous cells develop from the inner layer of the conidiomatal wall after the formation of the cavity of the conidioma. According to Harris (1935), during the development of *S. lycopersici*, undifferentiated cells at the periphery of the cavity push out a short protusion. This protusion continues to elongate and forms the conidium which separates from the conidiogenous cell by basal restriction. A similar pattern was reported by Punithalingam (1966). According to Boerema (1964) the spore-forming cells do not constitute a true hymenium since they are only slightly differentiated pseudoparenchymatic peridial cells. Studies of patterns of conidiogenesis in genera and species of the Coelomorphoses using both light and electron microscopy have allowed for much closer scrutiny and delimitation of the processes involved. Sutton & Sandhu (1968) investigated the conidial development and secession of several species using electron microscopy and this was followed by a series of papers investigating phialidic and annellidic conidiogenesis using light microscopy (Morgan-Jones 1971a, 1971b, 1971c, Morgan-Jones *et al.* 1972). The recognition of the plasticity of conidiogenesis similar to that observed in normal hyphal growth has been outlined by Minter (1987). This plasticity can lead to a large divergence in the appearance of mature conidia and conversely conidia that appear remarkably similar in appearance can be produced through different developmental pathways. Minter (1987) concluded that the use of terms such as “blastic”, “annellidic” and “phialidic” are misleading in that they can merely represent plasticity of development and are not generic characteristics. The terminologies used to describe the patterns of blastic conidial ontogeny are defined as follows:

**Holoblastic** is defined as the mode of blastic conidium ontogeny in which all wall layers of the conidiogenous cell are involved in the formation of the conidial wall (see Minter *et al.* 1982).

**Enteroblastic** is defined as the mode of blastic conidium ontogeny in which only the inner wall of the conidiogenous cell contributes to the conidium wall (see Minter *et al.* 1982).

Both of these terms are used only to describe the ontogeny of the conidium itself with a separate terminology used to describe the proliferation of the conidiogenous cell as follows:

**Sympodial proliferation** allows for more than one conidium to be produced from a single conidiogenous cell where after producing the first conidium holoblastically, the conidiogenous cell elongates to one side below the first conidium and produces another conidium holoblastically.

**Percurrent proliferation** involves the production and secession of the first-formed conidium holoblastically followed by proliferation of the conidiogenous locus enteroblastically and successively, often leaving a visible series of rings or annellides. The periclinal thickening and collarete observed in “phialides” appear to be the result of non-progressive or retrogressive percurrent proliferation at the same level.

Much of the accumulated knowledge of conidiogenesis culminated in a series of papers by Minter *et al.* (1982, 1983a, 1983b) which has led to the current recognition of thirty four “events” in conidiogenesis encompassing the ontogeny of the conidium, its delimitation and mode of secession, subsequent conidiogenous cell wall maturation and proliferation of the conidiogenous cell (Sutton 1993). Verkley (1998a) has shown that in *Septoria chrysanthemella* both sympodial and percurrent proliferation can occur in the same conidiogenous cell further demonstrating the plasticity of conidiogenesis *in-vitro* at least. The four conidiogenous cell “events” commonly described in the genus *Septoria* are defined as follows. The event number is that used by Sutton (1993), mitospore = conidium and mitosporogenous cell = conidiogenous cell.

**Event 1. (*Holoblastic simple*)** Mitospore ontogeny holoblastic, one locus per mitosporogenous cell, solitary mitospores, delimitation by one septum, maturation by diffuse wall building, secession schizolytic, no mitosporogenous cell proliferation.

**Event 9. (*Holoblastic sympodial*)** Mitospore ontogeny holoblastic, regularly alternating with holoblastic sympodial mitosporogenous cell proliferation, maturation by diffuse wall building, delimitation by one septum, secession schizolytic, more than one locus per mitosporogenous cell.

**Event 13.** (*Enteroblastic non-progressive*) Mitospore ontogeny holoblastic, delimitation by one septum, secession schizolytic, maturation by diffuse wall building, percurrent mitosporogenous cell proliferation followed by mitospore ontogeny, successive mitospores seceding at the same level, collarette visible, one locus per mitosporogenous cell.

**Event 16.** (*Enteroblastic percurrent*) Mitospore ontogeny holoblastic, delimitation by one septum, secession schizolytic, maturation by diffuse wall building, percurrent enteroblastic mitosporogenous cell proliferation followed by holoblastic mitospore ontogeny, successive mitospores seceding at progressively higher levels, collarettes variable, mostly minute, one locus per mitosporogenous cell.

#### 1.4.4 Conidia:

Conidia in *Septoria* are hyaline, smooth-walled, normally filiform and multi-septate, however 1-septate conidia have been included. As one of the primary taxonomic characters used by most authors, the length, width and septation of conidia still have a primary role in separating species. The use of conidial length has limitations as a reading of descriptions of most species shows such great variation, producing overlapping of conidial length within species on the same host species or host family that other characters are required to be used. Conidial width appears to be the most stable character, varying little over a narrow range. It is rare to find conidia varying more than 1µm and narrow conidia in the range of 1-2µm appear to vary even less. Conidial shape such as degree of tapering (obclavate or cylindrical) and curvature can also be employed as accessory characters in species separation. An attempt to group species of *Septoria* using conidial characters as published in Saccardo's *Sylloge Fungorum* was produced by Garman & Stevens (1920) but merely showed that similar species morphologically have been described from unrelated host families. Any attempt to unite species on this basis alone appears simplistic at best without research into host specificity.

The structure of conidia in many plant pathogenic fungi has been studied principally in order to study infection processes. The conidia in *Septoria* are **euseptate**, defined by Luttrell (1963) as having a single outer wall and true septa formed as inward extensions of the lateral walls, the septum developing as a closing diaphragm with a pore connecting the two cells separated by the septum. **Distoseptate** conidia have a common outer wall enclosing cells each surrounded by an individual wall (Luttrell 1963); such conidia are found in *Drechslera* Ito and its segregates.

The modes of germination of conidia of species of *Septoria* have not been reported widely and there are little data available. MacMillan & Plunkett (1942) figured the germination of conidia of *S. apiicola* (as *S. apii-graveolentis*) as symmetrical from one side only of the conidium. Shaw (1951) for *S. pepli* Shaw found germination to be asymmetrical, and, Harris (1935) for *S. lycopersici* showed that germination was asymmetrical. The finding of Luttrell (1963) that conidium germination type in *Helminthosporium* appeared to be correlated with type of conidiophore proliferation has not been investigated in the genus *Septoria* but may be worthy of consideration as a taxonomic character. Similarly, the germination of ascospores in *Mycosphaerella* spp. associated with leaf blotch disease of *Eucalyptus* L'Her. has been demonstrated to be a reliable taxonomic character in species separation (Crous & Wingfield 1997). Correlation of germination patterns of conidia of species of *Septoria* could provide a possible avenue for future research; *S. apiicola* (germination symmetrical, proliferation enteroblastic), *S. lycopersici* and *S. pepli* (germination asymmetrical, proliferation holoblastic sympodial).

#### 1.4.5 Host and host specificity:

The majority of species described in *Septoria* have been described on the basis of host, followed by small variation in characters such as conidial length, width and septation. The problem of using host or biological specificity as a species character is a challenging one particularly when taxa that may be morphologically identical in all other respects occur on host plants in different plant families. It is apparent that in a practical sense, the criteria used to delimit taxa must be rendered useful and host specificity is one character that can be employed to such an end. There is evidence in the literature to suggest a limited proven host specificity, most published studies merely demonstrating pathogenicity to the originating host (Koch's Postulates) rather than a true demonstration of host specificity. The most comprehensive study of host specialisation was published by Beach (1919) who studied a wide range of *Septoria* spp. and demonstrated both host and biological specificity of all species studied. The results showed that species of *Septoria* do not have a broad host range and infectivity rarely extends beyond two or three related genera of a host family. In the case of *S. apiicola* Speg., the extensive host range studies of Cochran (1932) and Sheridan (1968) showed that *S. apiicola* would only infect *Apium graveolens* and *A. australe*. Lee (1996) inoculated *S. glycines* Hemmi onto 13 genera and 30 different species of the Fabaceae, in addition to two woody weed species, *Abutilon* (Malvaceae) and *Cynanchum* (Asclepiadaceae), and found that only *Cicer arietinum* L. and *Cynanchum* failed to be infected under glasshouse conditions, but the latter was infected in the field. This study has shown a much expanded host range for *S. glycines* and an obvious need for further studies of the other species described from hosts which were shown to be hosts of *S. glycines*.

Much more restricted inoculation studies have been carried out for other taxa such as the *Septoria* species on the cultivated *Chrysanthemum*. The studies by Hemmi & Nakamura (1927), Waddell & Weber (1963) and Punithalingam & Wheeler (1965) all merely demonstrated pathogenicity to host genera *Chrysanthemum* or *Leucanthemum* but no other genera within the Asteraceae or from closely related plant families have been inoculated. Similar studies have been published for *S. rubi* Westend. (Demaree & Wilcox 1943), *S. pepli* (Shaw 1951) and *S. helianthina* (Petrov & Arsenijevic 1996). In conclusion, the case for studies of morphologically similar species at the host family level as proposed by Fischer & Shaw (1953) remains strong.

## 1.5 Other scolecospored anamorphic genera

There are many other anamorphic genera with hyaline, filiform, multi-septate conidia that are currently separated by conidiomata structure or pattern of conidiogenesis. The list of genera discussed below is not complete but indicates the range of variation in conidiogenesis and conidiomatal structure associated with many scolecospored genera.

### 1.5.2 Acervular forms

#### (i) *Cylindrosporium* Grev., *Scottish Crypt. Flora* 1: 27 (1823)

Type species: *C. concentricum* Grev.

Conidiomata are defined as acervular, conidiogenesis is enteroblastic non-progressive and conidia are non-septate. The genus is monotypic and the teleomorph of the type species (*C. concentricum* Grev.) is *Pyrenopeziza brassicae* Sutton & Rawlinson which belongs in the Helotiales. The relationship of *Cylindrosporium* to *Septogloeum* based on conidiogenesis is unclear. Elucidation of any relationship with *Phloeosporella* will depend on the status of *P. padi* within the genus with its teleomorph *Blumeriella* in the Helotiales closely related to *Pyrenopeziza*. The genus is in need of further revision (Sutton 1980).

#### (ii) *Phloeospora* Wallr., *Fl. Crypt. Germ.* 2: 176 (1833)

Type species: *P. ulmi* (Fr. ex Kze.) Wallr.

Conidiomata are defined as acervular and conidiogenesis is both enteroblastic percurrent and holoblastic sympodial. Conidia are hyaline and septate with an obtuse apex and truncate base. The teleomorphs where known belong in *Mycosphaerella*. According to Sutton (1980) the genus is in need of revision. The morphological separation between *Phloeospora* and *Septoria* relies on the difference in conidiomatal structure with conidiogenesis and teleomorph connections being identical.

(iii) *Phloeosporella* Höhnelt, *Ann. Mycol.* **22**: 201 (1924)

Type species: *P. ceanothi* (Ell. & Everh.) Höhnelt

Conidiomata are acervular and conidiogenesis is holoblastic and sympodial. The teleomorph of *P. padi* (Lib.) von Arx is *Blumeriella jaapi* (Rehm) von Arx a member of the Helotiales.

(iv) *Septogloeum* Sacc., *Michelia* **2**: 11 (1880)

Type species: *S. carthusianum* (Sacc.) Sacc.

Conidiomata are defined as acervular and conidiogenesis is enteroblastic non-progressive.

Teleomorphs have been placed in *Pleuroceras* Reiss, one of the genera of the Diaporthales (Monod 1983)

### 1.5.3 Pycnidial forms

(i) *Cytostagonospora* Bubák, *Ann. Mycol.* **14**: 150 (1916)

Type species: *C. photiniicola* Bubák.

The conidiomata in *Cytostagonospora* are described as being thick-walled and clypeate and conidiogenesis is defined as holoblastic. Von Arx (1983) regarded it as a synonym of *Septoria*, but Sutton (1980) treated it as a separate genus.

(ii) *Jahniella* Petrak, *Ann. Mycol.* **18**: 123 (1920)

Type species: *J. bohémica* Petrak

In *Jahniella* the conidioma differs from *Septoria* in having a sclerenchymatic wall but in all other features is identical to *Septoria* (Sutton 1980). Within *Phoma* Sacc. similar variations are not segregated.

(iii) *Rhabdospora* (Dur. & Mont. ex Sacc.) Sacc., *Sylloge Crypt.*; 227 (1856)

Type species: *R. oleandri* (Dur. & Mont.) Mont.

The concept of this genus is not well defined. Sutton (1977) listed the eleven original species but commented no further on its possible placement. Originally used for *Septoria*-like fungi that occurred on stems, it was not dealt with further by Sutton (1980). Most of the names currently in *Rhabdospora* date from Kuntze (1898) who transferred most of Saccardo's species of *Septoria* to it. The genus has not been circumscribed since Kuntze. Von Arx & Mueller (1975) list *Rhabdospora* as one of the anamorphs of *Leptosphaeria* Ces. & De Not., implying a relationship to *Stagonospora* (see below). *Rhabdospora* is a conserved name under the International Code of Botanical Nomenclature.

(iv) *Stagonospora* (Sacc.) Sacc., *Syll. Fung.* **3**: 621 (1884)

Type species: *S. paludosa* (Sacc. & Speg.) Sacc.

This name has been conserved over *Hendersonia* Berk. The genus is defined as pycnidial with conidiogenesis holoblastic, occasionally enteroblastic percurrent, and conidia are hyaline with several eusepta, cylindrical to fusiform. Many species described have been from hosts in the Poaceae. A large number of names currently in *Hendersonia* have yet to be redispersed into either *Stagonospora* or other genera. The teleomorphs where known are usually placed in *Leptosphaeria* Ces. & De Not. or *Phaeosphaeria* Miyake.

### 1.5.3 Stromatic forms

*Dothistroma* Hulbary, *Bull. Ill. Nat. Hist. Surv.* **21**: 235 (1941)

Type species: *D. septospora* (Dorog.) Morelet (syn. *D. pini* Hulbary)

Conidiomata are variable, sometimes acervular, becoming eustromatic, multilocular or cupulate (Sutton 1980, Evans 1984). Conidiogenesis is holoblastic non-proliferating and the conidia are hyaline, filiform and septate. The teleomorph of *D. septospora* is currently accepted as *Schirria pini* Funk & Parker (syn. *Mycosphaerella pini* E. Rostrup apud Munk). Von Arx (1983) listed *Dothistroma* as a synonym of *Septoria* and transferred *Dothistroma septospora* to *Septoria septospora* (Hulbary) v. Arx. In addition von Arx transferred *Schirria pini* to *Mycosphaerella* creating an invalid homonym of *M. pini* E. Rostrup. Evans (1984) did not accept *Dothistroma* as a synonym of *Septoria* and kept the genera as distinct.

*Septopatella* Petrak, *Ann. Mycol.* **23**: 128 (1925)

Type species: *S. septata* (Jaap) Petrak.

Conidiomata are cupulate and superficial. Conidiogenesis is given by Sutton (1980) as holoblastic with sympodial proliferation. However Dyko & Sutton (1979) clearly indicated that conidiogenous cells can proliferate percurrently through the conidial scar and then resume sympodial proliferation. In addition, annellations were observed on some conidiogenous loci. Such variation has also been observed in *Septoria*.

#### 1.5.4 Sporodochial forms

*Linodochium* Höhnelt, *Sitz. Akad. Wiss. Wien Math. Naturwiss. Kl. Abt.1*, **118**: 1239 (1909)

Type species: *L. hyalina* (Lib.) Höhnelt

Conidiomata are described as sporodochial and conidiogenesis as holoblastic with sympodial proliferation, conidia are hyaline, filiform and multiseptate. Dyko & Sutton (1979) also noted that proliferation can be enteroblastic percurrent. After a study of *Pycnofusarium* Punith., Sutton (1986) concluded that no practical distinction could be made between sporodochial and acervular conidiomata which would place *Linodochium* close to *Phloeospora*.

### 1.6 Teleomorphs of *Septoria*

Teleomorphs that have been reported in the literature for *Septoria* are commonly identified as species of *Mycosphaerella* Johan. or *Sphaerulina* Sacc.

**1.6.1 *Mycosphaerella*** Johanson, *Ofvers. Förh. Kongl. Svenska Vetensk.-Akad.* No.9, **41**:163 (1884)

Type species: *M. punctiformis* (Pers. ex Fr.) J. Schröt.

*Mycosphaerella* is a large genus of the Dothideales (family Mycosphaerellaceae) with many species that are pathogenic (von Arx & Mueller 1975). The anamorphs associated with *Mycosphaerella* have been placed in many genera including *Septoria* and *Phloeospora*. The classification of *Mycosphaerella* into separate genera such as *Septorisphaerella* Kleb. (anamorph *Septoria*), *Cercosphaerella* Kleb. (anamorph *Cercospora* Fres.) and *Ramulisphaerella* Kleb. (anamorph *Ramularia* Unger) is not accepted by current authors (Mueller & von Arx 1962, von Arx & Mueller 1975, von Arx 1983). Von Arx (1949) recognised three sections within the genus as follows (from von Arx & Mueller (1975):

Section *Eu-Mycosphaerella*: ascomata discrete, immersed, non-stromatic; asci fasciculate, narrow, rather numerous.

Section *Didymellina*: ascomata discrete, immersed or erumpent, containing a small number of saccate asci.

section *Cymadothea*: ascomata surrounded by hyphal stroma, often aggregated and erumpent, asci cylindrical, often fasciculate.

Barr (1996) has recently established the new family Planistromellaceae, separated from the Mycosphaerellaceae based on the lack of peridial structure, the presence of interthecial tissue surrounding the basal layer of the asci and the the process of ostiolar formation being schizogenous rather than lysigenous. The anamorphs were given as pycnidial, loculate or acervular, conidiogenesis holoblastic with conidia hyaline to brown, aseptate to multiseptate, smooth to verrucose, with or without appendages. The genera in the new family include *Planistromella* A.W. Ramaley (anamorph *Kellermannia* Ell. & Everh.), *Planistroma* A.W. Ramaley (anamorph *Piptarthron* Mont. ex Höhnelt) and a new genus *Eruptio* Barr (anamorph *Lecanosticta* H. Sydow).

### 1.6.2 *Sphaerulina* Sacc., *Michelia* 1: 399 (1878)

Type species: *S. myriadea* (DC.) Sacc.

*Sphaerulina* is a small genus placed in the Dothideaceae by Barr (1979) or the Mycosphaerellaceae (von Arx & Mueller 1975, Eriksson & Hawksworth 1993). *Sphaerulina* has affinities to *Mycosphaerella* and differs in the septation of the ascospores. Anamorphs have been placed in *Septoria*, *Cercospora* or *Cercosporella* Sacc. (Boerema 1963, von Arx & Mueller 1975, Sivanesan 1984). The anamorph of *Sphaerulina rehmiana* Jaap (ascospores 2-5 septate) is *Septoria rosae* Desm., and *Cylindrosporium rubi* Ell. & Morgan is identified as the anamorph of *Sphaerulina rubi* Desmaz. & Wilcox (ascospores 3-7 septate), although Sivanesan (1984) regards the anamorph as belonging in *Septoria*. The revelation that *Mycosphaerella airicola* Petrak has ascospores that can be 0-3 septate (Eriksson 1981) tends to blur the distinction between *Sphaerulina* and *Mycosphaerella*.

## 1.7 Biogeography

### 1.7.1 World studies

Many published treatments of the *Septoria* are available from various parts of the world but many are limited in their morphological treatment. As noted by Sutton (1980), apart from Saccardo's *Sylloge Fungorum* Vols. 1-26 (Saccardo *et al.* 1882-1927) and Oudemans' *Enumeratio Systematica Fungorum* Vols. 1-5 (Oudemans 1919-1924), the treatments for a number of countries that are available contain only a few species and in a number of cases involve no more than listings of species. Many of those treatments have been unavailable to the author. Lindau (1922), Grove (1935)

for species in the United Kingdom and Jorstad (1965) for Norway are regional in scope. Sukapore & Thirumalachar (1963, 1966), Patil *et al.* (1968) and Verma *et al.* (1988) have treated several new species for India, and Hirayama (1930) and Naito (1940) published several new species for Japan. The enumeration of taxa of *Septoria* in the U.S.A. by Martin (1887) contains useful descriptions.

For species occurring on hosts in the Poaceae there are much more useful works available with excellent treatments to be found in Sprague (1950) for the U.S.A., Fransden (1943) for Denmark, Makela (1975, 1977) for Finland and Jørstad (1967) for Norway. All of these accounts have good descriptions and, except for Jørstad (1967), are accompanied by illustrations of conidia. Teterevnikova-Babayan & Bokhjan (1970) reviewed the species of *Septoria* on *Agropyron* (wheat-grass) in the Soviet Union.

Revisions of *Septoria* spp. on various plant families or genera are also available and include Stone (1916) on species on *Ribes*, Punithalingam & Wheeler (1965) for species on *Chrysanthemum*, Constantinescu (1984) for species on Betulaceae, Farr (1991) for species on *Cornus* and Farr (1992) for species occurring on hosts in the tribe Genistae of the Fabaceae. The studies by Constantinescu (1984) and Farr (1991, 1992) are notable for containing good details of conidiogenesis in addition to excellent illustrations.

### 1.7.2 Australian studies

The first species of *Septoria* described from Australia was *S. myopori* Cooke & Massee in 1887. Several additional species were described or reported from Australia, both Cooke (1892) and Cobb (1893) listing nine species of *Septoria* as occurring in Australia. McAlpine (1895) listed the nine species of Cooke (1892) and Cobb (1893) and, added *S. tritici* from wheat in New South Wales and Victoria. The species listed in McAlpine (1895) were as follows;

*Septoria violae* Westend., on fading violet leaves, Victoria

*Septoria martinii* Cooke, on *Senecio bedfordii*, Victoria

*Septoria oleandrina* Sacc., on *Nerium oleander*, Queensland

*Septoria myopori* Cooke & Massee, on *Myoporum insulare*, Victoria

*Septoria hardenbergiae* Sacc., on *Hardenbergia monophylla*, South Australia

*Septoria phyllodiorum* Cooke & Massee, on *Acacia longifolia*, Victoria

*Septoria epiphyllloidea* Cooke, on *Acacia* sp., Victoria

*Septoria lepidospermi* Cooke & Massee, on *Lepidosperma*, Victoria

*Septoria bromi* Sacc., *Bromus* sp., Victoria

*Septoria tritici* Desm., *Triticum*, New South Wales, Victoria

The apparent disjunct distribution of the species of *Septoria* as listed merely reflected the location of collectors such as McAlpine and Martin both of whom collected widely in Victoria. From 1895 until the 1950's only nineteen new species of *Septoria* were described from both native and introduced hosts in Australia. No new species of *Septoria* were described from Australia for another thirty years until Sutton & Pascoe (1987) revised the species occurring on *Acacia* and described three new species - *S. aureocorona* Sutton & Pascoe, *S. grampianensis* Sutton & Pascoe and *S. lamentana* Sutton & Pascoe. An additional three species were added by Sutton & Pascoe (1989) these being *S. goodeniicola* Sutton & Pascoe on *Goodenia ovata*, *S. paradisi* Sutton & Pascoe on *Olearia argophylla* and *S. tetrathecae* Sutton & Pascoe on *Tetratheca ciliata*. All of these species were described from Victoria. In addition to those described from native host genera, there are many more species listed as occurring in Australia on other plant hosts (see below).

### 1.7.3 Australian species of *Septoria* reported in Australia prior to this study

A complete listing of all species of *Septoria* reported from Australia both named and un-named with its associated literature is given below. This listing has been compiled from available literature, published lists of Australian fungi, State disease listings and reports. The taxa are listed in alphabetical order of specific epithet as published, followed by host and State distribution with published references. Un-named taxa are listed in host order.

*Septoria acanthi* Thüm. on *Acanthus mollis*; **Victoria**; Brittlebank (1937-1940), Chambers (1982)

*Septoria allescheri* Syd. on *Ampelopsis* and *Pathenocissus*; **Victoria**; Brittlebank (1937-1940), Chambers (1982)

*Septoria althaea* Thüm. on *Alcea (Althaea) rosea*; **Victoria**; Brittlebank (1937-1940), Chambers (1982)

*Septoria alyxiae* McAlp. on *Alyxia buxifolia*; **Victoria**; Chambers (1982)

*Septoria amygdali* McAlp. on *Prunus*; **Victoria**; McAlpine (1901)

*Septoria anaxaea* Sacc. on *Senecio vagus*; **Victoria**; Brittlebank (1937-1940)

*Septoria andropogonis* J.J. Davis var. *sorghastri* Green & Sprague on *Eulalia trispicata*; **Queensland**; Langdon & Parbery (1963)

*Septoria antirrhini* Rob. & Desm. on *Antirrhinum majus*; **New South Wales**; Noble *et al.* (1935); **Tasmania**; Sampson & Walker (1982); **Victoria**; Brittlebank (1937-1940), Chambers (1982); **Western Australia**; Goss (1964), Shivas (1989)

*Septoria apii* Rostr. on *Apium graveolens*; **New South Wales**; Darnell-Smith (1912), Noble *et al.* (1935); **Western Australia**; Carne (1924)

*Septoria apii-graveolentis* Dorogin on *Apium graveolens*; **New South Wales**; Anon. (1938), Morschel (1951), Anon. (1964); **Tasmania**; Henrick (1938)

*Septoria apiicola* Speg. on *Apium graveolens*, *A. australe*; **Australia**; Gabrielson & Grogan (1964); **New South Wales**; Letham (1985); **Queensland**; Simmonds (1966); **South Australia**; Warcup & Talbot (1981), Cooke & Dube (1989); **Tasmania**; Sampson & Walker 1982; **Victoria**; Harrison *et al.* 1975, Washington & Nancarrow (1983); **Western Australia**; (Shivas 1989)

*Septoria aquilegiae* Penz. & Sacc. on *Aquilegia vulgaris*; **Victoria**; Brittlebank (1937-1940). Chambers (1982)

*Septoria armoraciae* Sacc. on *Cochlearia rusticana*; **Victoria**; Brittlebank (1937-1940)

*Septoria atriplicis* (Westend.) Fuckel on *Chenopodium* spp.; **Victoria**; Brittlebank (1937-1940), Chambers (1982)

*Septoria aureocorona* B. Sutton & Pascoe on *Acacia* spp; **Victoria**; Sutton & Pascoe (1987); **South Australia**; Sutton & Pascoe (1987)

*Septoria australiae* McAlp. on *Viola betonicifolia*; **Victoria**; McAlpine (1903), Brittlebank (1937-1940), Chambers (1982)

*Septoria avenae* Frank on *Avena* spp. and *Triticum aestivum*; **New South Wales**; Noble *et al.* (1935), Murray (1978); **Victoria**; Brittlebank (1937-1940), Woodcock & Clarke (1983); **Western Australia**; Chambers (1962), Tweedie & Shipton (1969), Shivas (1989),

*Septoria azaleae* Voglino on *Rhododendron* spp. cult.; **New South Wales**; Anon. (1941), Anon. (1956), Bertus (1979); **Queensland**; Simmonds (1966); **South Australia**; Warcup & Talbot (1981), Cooke & Dube (1989)

*Septoria bambusae* Brun. on *Bambusa* sp.; **Victoria**; Brittlebank (1937-1940), Chambers (1982)

*Septoria bellidis* Desm. & Rob. on *Bellis perennis*; **Victoria**; Brittlebank (1937-1940), Chambers (1982)

*Septoria berberidis* Niessl in Rabenh. on *Berberis vulgaris*; **Victoria**; Brittlebank (1937-1940), Chambers (1982)

*Septoria betae* Westend. on *Beta vulgaris*; **New South Wales**; Anon. (1950); **Victoria**; McAlpine (1903), Brittlebank (1937-1940), Harrison *et al.* (1975), Washington & Nancarrow (1983)

*Septoria betulae* Pass. on *Betula pendula*; **New South Wales**; Anon. (1963)

*Septoria bromi* Sacc. on *Bromus* spp.; **South Australia**; McAlpine (1895), Brittlebank (1937-1940), Warcup & Talbot (1981), Cooke & Dube (1989); **Victoria**; Cooke (1892), Cobb (1893), McAlpine (1895), Brittlebank (1937-1940), Woodcock & Clarke (1983)

*Septoria calami* P. Henn. on *Calamus caryotoides*; **Queensland**; Hennings (1903)

*Septoria canberrica* Petrak on *Pelargonium australe*; **Australian Capital Territory** (Petrak 1955)

*Septoria carotae* Nagornyj on *Daucus carota*; **Victoria**; Harrison *et al.* (1975), Washington & Nancarrow (1983)

*Septoria carpobroti* Hansf. on *Carpobrotus aequilaterale*; **South Australia**; Hansford (1954, 1957), Warcup & Talbot (1981), Cooke & Dube 1989)

*Septoria carthami* Murashk. on *Carthamus tinctorius*; **New South Wales**; Anon (1972)

*Septoria centaureae* (Roum.) Sacc. on *Centaurea cyanea*; **New South Wales**; Noble *et al.* (1935); **Victoria**; Brittlebank (1937-1940), Chambers (1982)

*Septoria centellae* G. Wint. on *Centella asiatica*; **Western Australia**; Shivas (1989)

*Septoria cerastii* Rob. ex Desm. on *Cerastium glomeratum*; **Victoria**; Brittlebank (1937-1940), Chambers (1982)

*Septoria ceuthosporoides* (Cooke & Harkness) Sacc. on *Eucalyptus* sp; **Victoria**; Brittlebank (1937-1940), Chambers (1982)

*Septoria cheiranthi* Rob. & Desm. on *Cheiranthus cheiri*; **Victoria**; Brittlebank (1937-1940)

*Septoria chenopodii* Westend. on *Chenopodium* spp.; **New South Wales**; Anon. (1960); **South Australia**; Warcup & Talbot (1981), Cooke & Dube (1989); **Victoria**; Chambers (1982)

*Septoria chrysanthemella* Sacc. on *Chrysanthemum indicum*; **Queensland**; Simmonds (1966)

*Septoria cirsii* Niessl. on *Silybum marianum*; **Victoria**; Brittlebank (1937-1940)

*Septoria citri* Pass. on *Citrus* spp.; **New South Wales**; Bertus (1982); **Queensland**; Bonde *et al.* (1991); **South Australia**; Warcup & Talbot (1981), Cooke & Dube (1989); **Victoria**; Washington & Nancarrow (1983)

*Septoria citricola* Ruggieri on *Citrus* spp.; **New South Wales**; Anon. (1940); **Victoria**; Fisher & Freeman (1959), Washington & Nancarrow (1983)

*Septoria confluens* McAlp. on *Mesembryanthemum aequilaterale*; **Victoria**; McAlpine (1903), Brittlebank (1937-1940), Chambers (1982)

*Septoria coprosmae* Cooke on *Coprosma* sp.; **Australia**; Garman & Stevens (1920)

*Septoria crataegi* Desm. ex Kickx. on *Crataegus* sp.; **Victoria**; Brittlebank (1937-1940)

*Septoria cucurbitacearum* Sacc. on *Citrullus*, *Cucumis* and *Cucurbita*; **New South Wales**; Noble *et al.* (1935, 1937); **Queensland**; Alcorn (1972); **Victoria**; Brittlebank (1937-1940), Harrison *et al.* (1975), Washington & Nancarrow (1983)

*Septoria cyclaminis* Dur. & Mont. on *Cyclamen* sp.; **Victoria**; Brittlebank (1937-1940), Chambers (1982)

*Septoria cynodontis* Fuckel on *Cynodon dactylon*; **New South Wales**; Brittlebank (1937-1940)

*Septoria daphnes* Rob. in Desm. on *Daphne* spp.; **Victoria**; Brittlebank (1937-1940), Chambers (1982)

*Septoria daturae* Speg. on *Datura stramonium*; **Victoria**; Brittlebank (1937-1940), Chambers (1982)

*Septoria daucina* Brun. on *Daucus carota*; **Victoria**; Brittlebank (1937-1940)

*Septoria depressa* McAlp. on *Citrus* spp.; **New South Wales**; Noble *et al.* (1935), Morschel (1952), Fraser (1957), Kiely & Long (1960); **South Australia**; Osborn & Samuel (1922); **Victoria**; McAlpine (1899), Brittlebank (1937-1940), Fisher & Freeman (1959), Washington & Nancarrow (1983)

*Septoria dianthi* Desm. on *Dianthus carophyllus*; **New South Wales**; Noble *et al.* (1935), Bertus (1983); **Queensland**; Simmonds (1951), Simmonds (1966); **South Australia**; Warcup & Talbot (1981), Cooke & Dube (1989); **Tasmania**; Sampson & Walker (1982); **Victoria**; Chambers (1982); **Western Australia**; Carne (1925), Goss (1964), Shivas (1989)

*Septoria diospyri* McAlp. on *Diospyros cargillea*; **New South Wales**; McAlpine (1897), Hynes *et al.* (1937); **Victoria**; Brittlebank (1937-1940), Chambers (1982)

*Septoria divaricata* Ell. & Everh. on *Phlox* spp.; **New South Wales**; Hynes *et al.* (1935), Anon. 1946); **Queensland**; Simmonds (1966); **Western Australia**; Shivas (1989)

*Septoria drummondii* Ell. & Everh. on *Phlox* spp.; **Victoria**; Brittlebank (1937-1940), Chambers (1982)

*Septoria effusa* (Lib.) Desm. on *Prunus dulcis*; **Victoria**; McAlpine (1902b), Brittlebank (1937-1940), Fisher & Freeman (1959), Washington & Nancarrow (1983)

*Septoria epiphyllloidea* Cooke on *Acacia* sp.; **Victoria**; Cooke (1892), Cobb (1893), McAlpine (1895), Brittlebank (1937-1940), Chambers (1982)

*Septoria erigerontis* Peck on *Conyza albida*; **New South Wales**; Walker & Priest (1986); on *Erigeron floribundus*; **Queensland**; Alcorn (1972)

*Septoria eucalypti* G. Wint. & Roum. on *Eucalyptus* spp.; **Victoria**; Brittlebank (1937-1940), Chambers (1982)

*Septoria exotica* Speg. on *Hebe* and *Veronica*; **Tasmania**; Sampson & Walker (1982); **Western Australia**; Shivas (1989)

*Septoria flaccescens* McAlp. on *Citrus* spp.; **Victoria**; McAlpine (1899), Brittlebank (1937-1940), Fisher & Freeman (1959), Washington & Nancarrow (1983)

*Septoria fragariae* (Lib.) Desm. on *Fragaria* x *ananassa*; **Victoria**; Brittlebank (1937-1940), Fisher & Freeman (1959), Washington & Nancarrow (1983)

*Septoria fuchsiae* Roum. on *Fuchsia* sp.; **Victoria**; Brittlebank (1937-1940), Chambers (1982)

*Septoria galinsogae* Speg. on *Galinsoga parviflora*; **New South Wales**; Anon. (1950)

*Septoria geranii* Rob. ex Desm. on *Geranium* spp.; **New South Wales**; Costin (1954), Walker, Fahy & Priest (1990)

*Septoria gerberae* Syd. on *Gerbera jamesonii*; **New South Wales**; Hynes *et al.* (1941), Anon. (1951); **Queensland**; Simmonds (1966); **South Australia**; Warcup & Talbot (1981), Cook & Dube (1989); **Victoria**; Chambers (1982); **Western Australia**; Goss (1964); Shivas (1989)

*Septoria gladioli* Pass. on *Gladiolus* x cult.; **New South Wales**; Hynes *et al.* (1941), Anon. (1965), Bertus (1984); **Queensland**; Simmonds (1966); **Western Australia**; Goss (1953), Goss (1964), Shivas (1989)

*Septoria glumarum* Pass. on *Triticum aestivum*; **New South Wales**; McAlpine (1898)

*Septoria gomphocarpi* P. Henn.; *Gomphocarpus* sp; **Queensland**; Garman & Stevens (1920), Brittlebank (1937-1940)

*Septoria gomphrenae* Sacc. & D. Sacc. on *Gomphrena globosa*; **Victoria**; Brittlebank (1937-1940), Chambers (1982)

*Septoria goodeniicola* Sutton & Pascoe on *Goodenia ovata*; **Victoria**; Sutton & Pascoe (1989)

*Septoria graminum* Desm. on *Aira caryophylla*; **South Australia**; Warcup & Talbot (1981), Cooke & Dube (1989); on *Triticum aestivum*; **Western Australia**; Carne (1925)

*Septoria grampianensis* B. Sutton & Pascoe on *Acacia myrtifolia*; **Victoria**; Sutton & Pascoe (1987)

*Septoria grossulariae* (Lib.) Westend. on *Ribes grossularia*; **Victoria**; Brittlebank (1937-1940)

*Septoria halophila* Speg. on *Hordeum* spp.; **Western Australia**; Shivas (1989)

*Septoria hardenbergiae* Sacc. on *Hardenbergia monophylla*; **South Australia**; Saccardo (1890), McAlpine (1895), Warcup & Talbot (1981), Cooke & Dube (1989); **Victoria**; Cobb (1893), Brittlebank (1937-1940), Chambers (1982)

*Septoria hederæ* Desm. on *Hedera helix*; **Victoria**; Brittlebank (1937-1940), Chambers (1982)

*Septoria helianthi* on *Helianthus annuus*; **New South Wales**; Anon. (1977); **Queensland**; Simmonds (1956), Simmonds (1966); **Victoria** ; Brittlebank (1937-1940), Woodcock & Clarke (1983)

*Septoria hippocastani* Berk. & Br. on *Aesculus hippocastanum*; **New South Wales**; Anon. (1954)

*Septoria holci* Pass. on *Holcus lanatus*; **Victoria**; Brittlebank (1937-1940)

*Septoria hoyae* Sacc. on *Hoya carnosae*; **Victoria**; Chambers (1982)

*Septoria hydrocotyles* Desm. on *Hydrocotyle* spp.; **New South Wales**; Priest & Walker (1987); **Queensland**; (BRIP); **South Australia**; Warcup & Talbot (1981), Cooke & Dube (1989); **Victoria**; Brittlebank (1937-1940), Chambers (1982)

*Septoria hyperici* Desm. on *Hypericum perforatum*; **Victoria**; Brittlebank (1937-1940)

*Septoria intermedia* Ell. & Everh. on *Solidago* sp.; **Australia**; Garman & Stevens (1920)

*Septoria iridis* C. Massal. on *Iris germanica*; **Victoria**; Brittlebank (1937-1940), Chambers (1982)

*Septoria ixodiae* Hansf. on *Ixodia achilleioides*; **South Australia**; Hansford (1956), Warcup & Talbot (1981), Cooke & Dube (1989)

*Septoria japonica* Oudem. on *Euonymus japonica*; **Victoria**; Brittlebank (1937-1940), Chambers (1982)

*Septoria lactucae* Pass. on *Lactuca sativa*; **New South Wales**; Noble *et al.* (1935), Brittlebank (1937-1940), Anon. (1945), Anon. (1971); **Northern Territory**; Pitkethley (1970); **Queensland**; Blackford (1944), Aberdeen (1946), Simmonds (1966); **Tasmania**; Sampson & Walker (1982); **Victoria**; Brittlebank (1937-1940), Harrison *et al.* (1975), Washington & Nancarrow (1983); **Western Australia**; Shivas (1989)

*Septoria lagenophorae* McAlp. on *Lagenophora billardieri*; **Victoria**; McAlpine (1903)

*Septoria lamentana* B. Sutton & Pascoe on *Acacia verniciflua*; **Victoria**; Sutton & Pascoe (1987)

*Septoria lamii* Pass. on *Lamium amplexicaule*; **South Australia**; Cooke & Dube (1989)

*Septoria lathyri* Ell. & Everh. on *Lathyrus odoratus*; **Victoria**; Brittlebank (1937-1940), Chambers (1982)

*Septoria lavandulae* Desm. on *Lavandula* spp.; **New South Wales**; Anon. (1953); **Victoria**; Brittlebank (1937-1940), Chambers (1982)

*Septoria lepidii* Desm. on *Lepidium draba*; **South Australia**; Warcup & Talbot (1981), Cooke & Dube (1989); **Victoria**; Brittlebank (1937-1940), Chambers (1982)

*Septoria lepidospermatis* Cooke & Massee on *Lepidosperma gladiatum*; **South Australia**; Hansford (1957), Warcup & Talbot (1981), Cooke & Dube (1989); **Victoria**; Cook & Massee (1891), Cooke (1892), Cobb (1893), McAlpine (1895), Brittlebank (1937-1940), Woodcock & Clarke (1983), Sutton & Pascoe (1989)

*Septoria limnanthemii* Theum. on *Nymphoides crenata*; **New South Wales**; Walker & McLeod (1984); on *Nymphoides indica*; **Victoria**; Brittlebank (1937-1940), Chambers (1982)

*Septoria linicola* (Speg.) Garassini on *Linum usitatissimum*; **New South Wales**; Conroy (1949), Butler (1949), Millikan (1951); **Queensland**; McKnight (1950); **South Australia**; Cooke & Dube (1989); **Victoria**; Millikan (1951), Freeman (1964), Woodcock & Clarke (1983); **Western Australia**; Millikan (1951), Shivas (1989)

*Septoria lobeliae* Peck on *Lobelia* sp.; **South Australia**; Warcup & Talbot (1981), Cooke & Dube (1989)

*Septoria lolii* (Cav.) Sacc. on *Lolium perenne*; **Australia**; Garman & Stevens (1920); **Victoria**; Brittlebank (1937-1940), Woodcock & Clarke (1983)

*Septoria lycopersici* Speg. on *Lycopersicon esculentum*; **New South Wales**; Johnston (1910), Noble *et al.* (1935), Anon. 1966; **Queensland**; Veitch & Simmonds (1929), Aberdeen (1945), Simmonds (1966); **South Australia**; Osborn & Samuel (1922), Osborn 1924, Warcup & Talbot (1981), Cooke & Dube (1989); **Tasmania**; Sampson & Walker (1982); **Victoria**; Brittlebank (1924), Brittlebank (1937-1940), Washington & Nancarrow (1983); **Western Australia**; Carne (1925), Shivas (1989)

*Septoria malvicola* Ell. & Mart. on *Malva neglecta*; **Victoria**; Brittlebank (1937-1940)

*Septoria martiniae* Cooke on *Aster bedfordii*; **Tasmania**; Sampson & Walker (1982); **Victoria**; Cooke (1890), Cobb (1893), Brittlebank (1937-1940), Hansford (1956), Chambers (1982)

*Septoria martiniana* Sacc. on *Acacia sophorae*; **South Australia**; Warcup & Talbot (1981), Cooke & Dube (1989); **Victoria**; Brittlebank (1937-1940), Chambers (1982), Sutton & Swart (1986)

*Septoria medicaginis* Rob. & Desm. on *Medicago sativa*; **Victoria**; Brittlebank (1937-1940), Woodcock & Clarke (1983)

*Septoria meliloti* Sacc. on *Melilotus* sp.; **Victoria**; Brittlebank (1937-1940)

*Septoria mortolensis* Penz. & Sacc. on *Eucalyptus* spp.; **Victoria**; Brittlebank (1937-1940), Chambers (1982)

*Septoria myopori* Cooke & Massee on *Myoporum insulare*; **New South Wales**; Anon. (1963); **South Australia**; Warcup & Talbot (1981); **Victoria**; Cooke & Massee (1887), Cooke (1892), Cobb (1893), McAlpine (1895), Brittlebank (1937-1940), Chambers 1982)

*Septoria narcissi* Pass. on *Narcissus* sp.; **Victoria**; Brittlebank (1937-1940), Chambers (1982)

*Septoria nodorum* (Berk.) Berk. & Br. on various Poaceae; **Australia**; Brown (1975); **New South Wales**; Noble *et al.* (1935), Brittlebank (1937-1940), Butler (1950), Magee (1951), Murray (1978); **Queensland**; Simmonds (1951), Simmonds (1966) **South Australia**; Anon. (1976), Warcup & Talbot (1981), Cooke & Dube (1989); **Tasmania**; Sampson & Walker (1982); **Victoria**; Brittlebank (1937-1940), Freeman (1964), Woodcock & Clarke (1983); **Western Australia**; Carne (1925), Brittlebank (1937-1940), Cass Smith (1963), Shipton (1966), Shipton & Tweedie (1968), Shivas (1989)

*Septoria normae* Heather on *Eucalyptus viminalis*; **Tasmania**; Sampson & Walker (1982)

*Septoria obesa* Syd. on *Chrysanthemum* spp.; **Victoria**; Chambers 1982; **Western Australia**; Shivas (1989)

*Septoria oenotherae* Westend. on *Oenothera* spp.; **Victoria**; Brittlebank (1937-1940), Chambers (1982)

*Septoria oleandrina* Sacc. on *Nerium oleander*; **Queensland**; Cooke (1892), Cobb (1893), McAlpine (1895), Brittlebank (1937-1940), Simmonds (1966)

*Septoria olivae* Pass. & Theum. on *Olea europea*; **Victoria**; Brittlebank (1937-1940), Fisher & Freeman (1959), Washington & Nancarrow (1983)

*Septoria orchidearum* Westend. on undetermined orchid; **Victoria**; Brittlebank (1937-1940), Chambers (1982)

*Septoria oxyspora* Penz. & Sacc. on *Phragmites australis*; **South Australia**; Warcup & Talbot (1981), Cooke & Dube (1989)

*Septoria paeoniae* Westend. on *Paeonia officinalis*; **New South Wales**; Anon. (1950)

*Septoria paradisi* Sutton & Pascoe on *Olearia argophylla*; **Victoria**; Sutton & Pascoe (1989)

*Septoria passerinii* Sacc. on *Hordeum* and *Poa* spp.; **New South Wales**; Noble *et al.* (1935), Brittlebank (1937-1940), Anon. (1969), **Victoria**; Brittlebank (1937-1940), Woodcock & Clarke (1983); **Western Australia**; Carne (1925, 1927), Brittlebank (1937-1940), Shivas (1989)

*Septoria passiflorae* Louw on *Passiflora edulis*; **New South Wales**; Anon. (1951a); **Queensland**; Simmonds (1966)

*Septoria passifloricola* Punith. on *Passiflora edulis*; **Western Australia**; Shivas (1989)

*Septoria pastinacina* Sacc. on *Pastinaca sativa*; **New South Wales**; Noble *et al.* (1935)

*Septoria pelargonii* Syd. on *Pelargonium australe*; **South Australia**; Warcup & Talbot (1981), Cooke & Dube (1989); on *Pelargonium zonale* and *Pelargonium* sp; **Victoria**; Brittlebank (1937-1940), Chambers (1982)

*Septoria pepli* Shaw on *Euphorbia peplus*; **New South Wales**; Shaw (1951); **Tasmania**; Shaw (1951), Sampson & Walker (1982)

*Septoria perforans* McAlp. on *Cryptostemma calendula*; **Victoria**; McAlpine (1903), Brittlebank (1937-1940)

*Septoria petroselini* (Lib.) Desm. on *Petroselinum crispum*; **New South Wales**; Noble *et al.* 1935, Brittlebank 1937-40; **South Australia**; Brittlebank (1937-1940), Warcup & Talbot (1981), Cooke & Dube (1989); **Tasmania**; Sampson & Walker (1982); **Victoria**; Harrison *et al.* (1975), Washington & Nancarrow (1983)

*Septoria petroselini* Desm. var *apii* Briosi & Cavara on *Apium graveolens*; **Western Australia**; Carne (1925)

*Septoria phlogis* Sacc. & Speg. on *Phlox* spp.; **Western Australia**; Brittlebank (1937-1940), Goss (1964), Shivas (1989)

*Septoria phyllodiorum* Cooke & Massee on *Acacia sophorae*; **South Australia**; Cooke & Massee (1890); **Victoria**; Cobb (1893), McAlpine (1895), Brittlebank (1937-1940), Chambers (1982), Sutton & Swart (1986)

*Septoria phyllodiorum* Sacc. on *Acacia* sp.; **Victoria**; Saccardo (1890), Sutton & Pascoe (1987)

*Septoria phytolaccae* Cav. on *Phytolacca americana*; **Victoria**; Brittlebank (1937-1940), Chambers (1982)

*Septoria pisi* Westend. on *Pisum sativum* and *Lathyrus odoratus*; **New South Wales**; Noble *et al.* (1935), Letham (1981); **South Australia**; Cooke & Dube (1989); **Tasmania**; Wade (1951), Sampson

& Walker (1982); **Victoria**; Anon. (1943), Harrison et al. (1975), Chambers (1982), Washington & Nancarrow (1983), Woodcock & Clarke (1983); **Western Australia**; Shivas (1989)

*Septoria plantaginea* Pass. on *Plantago varia*; **Victoria**; Chambers (1982)

*Septoria plantaginis* (Ces.) Sacc. on *Plantago lanceolata*; **Victoria**; Brittlebank (1937-1940), Chambers (1982)

*Septoria polyadelpa* Syd. on *Brassica sinapistrum*; **New South Wales**; Sydow (1938), Hynes *et al.* (1941)

*Septoria polygonati* Kabat & Bubak on *Polygonatum* sp.; **New South Wales**; Anon. (1954)

*Septoria polygonorum* Desm. on *Polygonum* sp.; **Victoria**; Brittlebank (1937-1940), Chambers (1982)

*Septoria primulae* Bucknall on *Primula* sp.; **Victoria**; Brittlebank (1937-1940), Chambers (1982)

*Septoria pruni* Ellis on *Prunus armeniaca*; **Victoria**; Brittlebank (1937-1940), Fisher & Freeman (1959)

*Septoria pyrethri* Bres. & Krieg. on *Chrysanthemum pyrethrum* and *Tanacetum parthenium*; **Victoria**; Brittlebank (1937-1940), Chambers (1982)

*Septoria ranunculacearum* Lev. on *Ranunculus* sp.; **Victoria**; Brittlebank (1937-1940), Chambers (1982)

*Septoria rhapontici* Thuem. on *Rheum rhaponticum*; **Victoria**; Brittlebank (1937-1940)

*Septoria rhododendri* Cooke on *Rhododendron* sp. cult.; **Victoria**; Brittlebank (1937-1940)

*Septoria ribis* (Lib.) Desm. on *Ribes* spp.; **Tasmania**; Wade (1949, 1949a), Sampson & Walker (1982); **Victoria**; Brittlebank (1937-1940), Fisher & Freeman (1959), Washington & Nancarrow (1983)

*Septoria rosae* Desm. on *Rosa* sp.; **Queensland**; Brittlebank (1937-1940); **Victoria**; Chambers (1982)

*Septoria rubi* Westend. on *Rubus* spp.; **New South Wales**; Anon. (1962); **Queensland**; Simmonds (1966); **South Australia**; Brittlebank (1937-1940), Warcup & Talbot (1981), Cooke & Dube (1989); **Tasmania**; Sampson & Walker (1982); **Victoria**; Brittlebank (1937-1940), Fisher & Freeman (1959), Washington & Nancarrow (1983); **Western Australia**; Shivas (1989)

*Septoria sambucina* Peck on *Sambucus xanthocarpa*; **Victoria**; Brittlebank (1937-1940), Chambers (1982)

*Septoria schizeilematis* Petrak on *Schizeilema fragoseum*; **New South Wales**; Petrak (1955)

*Septoria selenophomoides* Cash & Watson on *Dendrobium* spp.; **New South Wales**; Walker, Fahy & McLeod (1985)

*Septoria silenae* Desm. on *Silene gallica*; **Tasmania**; Sampson & Walker (1982)

*Septoria silenicola* Ell. & Mart. on *Silene gallica*; **Victoria**; Brittlebank (1937-1940), Chambers (1982)

*Septoria siybi* Pass. on *Silybum marianum*; **New South Wales**; Anon. (1974); **South Australia**; Hansford (1954), Warcup & Talbot (1981), Cooke & Dube (1989); **Victoria**; Brittlebank (1937-1940), Chambers (1982)

*Septoria sisymbrii* Ellis on *Sisymbrium officinale*; **Victoria**; Brittlebank (1937-1940), Chambers (1982)

*Septoria sonchi* Sacc. on *Sonchus oleraceus*; **Victoria**; Brittlebank (1937-1940), Chambers (1982)

*Septoria sonchina* Thüm. on *Sonchus oleraceus*; **Victoria**; Brittlebank (1937-1940), Chambers (1982)

*Septoria spergulae* Westend. on *Spergula arvensis*; **Victoria**; Brittlebank (1937-1940)

*Septoria stachydis* Rob. ex Desm. on *Stachys* sp.; **Victoria**; Brittlebank (1937-1940)

*Septoria stellariae* Rob. & Desm. on *Stellaria media*; **New South Wales**; Anon. (1955); **South Australia**; Warcup & Talbot (1981), Cooke & Dube (1989); **Victoria**; McAlpine (1902a), Brittlebank (1937-1940), Chambers (1982)

*Septoria suaedae-australis* Hansf. on *Suaeda australis*; **South Australia**; Hansford (1954), Warcup & Talbot (1981), Cooke & Dube (1989)

*Septoria syringae* Sacc. & Speg. on *Syringa vulgaris*; **Victoria**; Brittlebank (1937-1940), Chambers (1982)

*Septoria tabacina* McAlp. on *Nicotiana suaveolens*; **Victoria**; McAlpine (1900), Brittlebank (1937-1940), Chambers (1982)

*Septoria tassiana* Syd. on *Vitis antarctica*; **Queensland**; Brittlebank (1937-1940),

*Septoria tetraethecae* B. Sutton & Pascoe on *Tetraetheca ciliata*; **Victoria**; Sutton & Pascoe (1989)

*Septoria thelymitrae* McAlp. on *Thelymitra aristata*; **Victoria**; McAlpine (1903), Brittlebank (1937-1940), Chambers (1982)

*Septoria transversalis* Sacc. on *Aspidistra* sp.; **Victoria**; Brittlebank (1937-1940), Chambers (1982)

*Septoria tristaniae* P. Henn. on *Tristania laurina*; **Queensland**; Brittlebank (1937-1940)

*Septoria tritici* Rob. ex Desm. on various Poaceae; **Australia**; Brown (1975); **New South Wales**; McAlpine (1895), Noble *et al.* (1935), Butler (1950), Shaw (1950), Murray (1978); **Queensland**; Simmonds (1951), Simmonds (1966); **South Australia**; Anon. (1976), Warcup & Talbot (1981), Cooke & Dube (1989); **Tasmania**; Sampson & Walker (1982); **Victoria**; McAlpine (1895), Freeman (1964), Woodcock & Clarke (1983); **Western Australia**; Carne (1927), Cass Smith (1963), Shipton (1966), Shipton & Tweedie (1968), Shivas (1989)

*Septoria urticae* Desm. & Rob. on *Urtica* spp.; **New South Wales**; Anon. (1948); **South Australia**; Warcup & Talbot (1981), Cooke & Dube (1989); **Victoria**; Brittlebank (1937-1940), Chambers (1982)

*Septoria varia* McAlp. on *Plantago varia*; **Victoria**; McAlpine (1903), Brittlebank (1937-1940), Chambers (1982)

*Septoria verbenae* Rob. & Desm. on *Verbena* sp.; **Victoria**; Brittlebank (1937-1940), Chambers (1982)

*Septoria veronicae* Desm. on *Veronica* sp.; **Victoria**; Brittlebank (1937-1940), Chambers (1982)

*Septoria viburni* Westend. on *Viburnum opulus*; **Victoria**; Brittlebank (1937-1940), Chambers (1982)

*Septoria vignae* P. Henn. on *Vigna sinensis*; **New South Wales**; Anon. (1950); **Queensland**; Punithalingam (1985)

*Septoria violae* Westend. on *Viola odorata*; **Victoria**; Brittlebank (1937-1940), Chambers (1982)

*Septoria vitis* Lev. on *Vitis vinifera*; **Victoria**; Brittlebank (1937-1940), Fisher & Freeman (1959), Washington & Nancarrow (1983)

*Septoria westraliensis* McAlp. on *Citrus aurantium*; **Western Australia**; McAlpine (1899), Carne (1925), Brittlebank (1937-1940), Shivas (1989)

*Septoria* sp. on *Acacia saligna*; **Western Australia**; Shivas (1989)

*Septoria* sp. on *Abutilon* sp.; **Victoria**; Chambers (1982)

*Septoria* sp. on *Arbutus unedo*; **New South Wales**; Walker & McLeod (1969)

*Septoria* sp. on *Avena fatua*; **New South Wales**; Noble *et al.* (1935)

*Septoria* sp. on *Avena sativa*; **South Australia**; Warcup & Talbot (1981), Cooke & Dube (1989)

*Septoria* sp. on *Briza maxima*; **South Australia**; Warcup & Talbot (1981), Cooke & Dube (1989); **Western Australia**; Shivas (1989)

*Septoria* sp. on *Bromus hordeaceus*; **Tasmania**; Sampson & Walker (1982)

*Septoria* sp. on *Burchardia umbellata*; **Victoria**; Chambers (1982)

*Septoria* sp. on *Carissa macrocarpa*; **South Australia**; Warcup & Talbot (1981), Cooke & Dube (1989)

*Septoria* sp. on *Carthamus tinctorius*; **New South Wales**; Anon. (1975)

*Septoria* sp. on *Chrysanthemum x morifolium*; **South Australia**; Cooke & Dube (1989)

*Septoria* sp. on *Chrysanthemum maximum*; **New South Wales**; Noble *et al.* (1937)

*Septoria* sp. on *Chrysanthemum* spp.; **Tasmania**; Sampson & Walker (1982)

*Septoria* sp. on *Convolvulus arvensis*; **New South Wales**; Noble *et al.* (1935)

*Septoria* sp. on *Cyclamen* sp.; **New South Wales**; Noble *et al.* (1935)

*Septoria* sp. on *Cymbonotus lawsoniana*; **Victoria**; Chambers (1982)

*Septoria* sp. on *Cynodon dactylon*; **New South Wales**; Noble *et al.* (1935)

*Septoria* sp. on *Daphne* sp.; **Victoria**; Chambers (1982)

*Septoria* sp. on *Ehrharta longiflora*; **Western Australia**; Shivas (1989)

*Septoria* sp. on *Erodium cygnorum*; **New South Wales**; Shaw (1949), Anon. (1950)

*Septoria* sp. on *Euphorbia peplus*; **New South Wales**; Noble *et al.* (1935)

*Septoria* sp. on *Euphorbia stevenii*; **South Australia**; Warcup & Talbot (1981), Cooke & Dube (1989)

*Septoria* sp. on *Glyceria* sp.; **Victoria**; Woodcock & Clarke (1983)

*Septoria* sp. on *Veronica imperialis*; **New South Wales**; Noble *et al.* (1941)

*Septoria* sp. on *Hordeum distichon*; **Tasmania**; Sampson & Walker (1982)

*Septoria* sp. on *Hordeum vulgare*; **Victoria**; Woodcock & Clarke (1983)

*Septoria* sp. on *Iris* sp.; **Victoria**; Chambers (1982)

*Septoria* sp. on “*Kentia*”; **Victoria**; Chambers (1982)

*Septoria* sp. on *Leptospermum* sp.; **Western Australia**; Goss (1964), Shivas (1989)

*Septoria* sp. on *Ligustrum ovalifolium*; **Tasmania**; Sampson & Walker (1982)

*Septoria* sp. on *Lobelia purpurascens*; **Queensland**; Simmonds (1966)

*Septoria* sp. on *Lophochloa pumila*; **Western Australia**; Shivas (1989)

*Septoria* sp. on *Matthiola incana*; **Western Australia**; Goss (1964). Shivas (1989)

*Septoria* sp. on *Nicotiana rosulata*; **Western Australia**; Shivas (1989)

*Septoria* sp. on *Nymphoides crenata*; **New South Wales**; Walker & McLeod (1983); **Victoria**; Chambers (1982)

*Septoria* sp. on *Passiflora edulis*; **New South Wales**; Anon (1944); **Victoria**; Washington & Nancarrow (1983)

*Septoria* sp. on *Pelargonium australe*; **Tasmania**; Sampson & Walker (1982)

*Septoria* sp. on *Poa annua*; **New South Wales**; Noble *et al.* (1941)

*Septoria* sp. on *Populus alba*; **Australian Capital Territory**; Singh & Heather (1981)

*Septoria* sp. on *Phlox drummondii*; **Tasmania**; Sampson & Walker (1982)

*Septoria* sp. on *Pratia purpurascens*; **New South Wales**; Walker, Fahy & McLeod (1985)

*Septoria* sp. on *Ranunculus lappaceus*; **New South Wales**; Anon. (1970); **Western Australia**; Goss (1964), Shivas (1989)

*Septoria* sp. on *Ranunculus asiaticus*; **Victoria**; Chambers (1982)

*Septoria* sp. on *Rhododendron* sp.; **Victoria**; Chambers (1982)

*Septoria* sp. on *Rubus idaeus*; **New South Wales**; Noble *et al.* (1935)

*Septoria* sp. on *Samolus repens*; **Victoria**; Chambers (1982)

*Septoria* sp. on *Silene gallica*; **New South Wales**; Hynes *et al.* (1935, 1941); **Western Australia**; Shivas (1989)

*Septoria* sp. on *Solanum nigrum*; **Queensland**; Simmonds (1966)

*Septoria* sp. on *Sonchus oleraceus*; **New South Wales**; Hynes *et al.* (1941); **Victoria**; Chambers (1982)

*Septoria* sp. on *Stephanotis floribunda*; **New South Wales**; Walker & Priest (1986)

*Septoria* sp. on *Stipa* sp.; **South Australia**; Warcup & Talbot (1981), Cooke & Dube (1989)

*Septoria* sp. on *Veronica spicata*; **Tasmania**; Sampson & Walker (1982)

*Septoria* sp. on *Villarsia exaltata*; **New South Wales**; Walker (1986)

*Septoria* sp. on *Viola* sp.; **Victoria**; Cooke (1892), Cobb (1893), McAlpine (1895)

*Septoria* sp. on *Wahlenbergia gracilentia*; **South Australia**; Hansford (1954), Warcup & Talbot (1981), Cooke & Dube (1989)

*Septoria* sp. on *Zea mays*; **Queensland**; Simmonds (1966)

## Section 2

### *Materials and Methods*

#### 2.1 Sources of Collections :

##### 2.1.1 *Herbarium Collections* :

The collections used in this study have been sourced principally from collections contained in Australian herbaria. Type material of described Australian taxa has been borrowed from several herbaria overseas as well as many other type collections which were required to define more fully many taxa on introduced hosts. Authentic material has also been examined, principally from collections held in Australian herbaria. Where available, living and/or dried culture material has also been examined. Collections have been borrowed from the following institutions:

**ADW:** Mycology Collections, Waite Institute, University of Adelaide, Glen Osmond, South Australia, **Australia** (now transferred to DAR)

**B:** Museum Berlin-Dahlem, Berlin, **Germany**

**BPI:** National Fungus Collections, USDA, Beltsville, Maryland, **U.S.A.**

**BRIP:** Plant Pathology Herbarium, Department of Primary Industries, Indooroopilly, Queensland, **Australia**

**DAR:** Plant Pathology Herbarium, NSW Agriculture, Orange Agricultural Institute, Orange, New South Wales, **Australia**.

**FH:** The Farlow Herbarium, Harvard University, Cambridge, Massachusetts, **U.S.A.**

**K:** Herbarium, Royal Botanic Gardens, Kew, Surrey, **United Kingdom**

**IMI:** International Mycological Institute, Egham, Surrey, **United Kingdom**

**LPS:** Instituto de Botanica Spegazzini, Universidad Nacional de la Plata, La Plata, **Argentina**

**MEL:** The Herbarium, Royal Botanic Gardens, Melbourne, Victoria, **Australia**

**NE:** The Herbarium, Botany Department, University of New England, Armidale, New South Wales, **Australia**

**NY:** The Herbarium, The New York Botanical Garden, Bronx, New York, **U.S.A.**

**PAD:** Herbarium Patavianum, Padua, **Italy**

**PERTH:** The Herbarium, Department of Conservation and Land Management, Perth, Western Australia, **Australia**

**S:** Swedish Museum of Natural History, Stockholm, **Sweden**

**VPRI:** Plant Pathology Herbarium, Institute for Horticultural Development, Knoxfield, Victoria, **Australia**

**W:** Naturhistorisches Museum, Wien, **Austria**

### **2.1.2 Cultures:**

Very few taxa (less than fifteen) examined are accompanied by dried culture reference material or have been available for study as living cultures. Cultural characters have been included in descriptions including the media used and conidia from cultures have been illustrated. Cultures were grown at 25°C in a twelve hour dark-twelve hour light regime utilising Black light. Colony colour is from Rayner (1970) *A Mycological Colour Chart*. Commonwealth Mycological Institute. The media used were as follows:

**Potato Dextrose Agar (PDA):** 200gm potatoes, 20 gm dextrose, 20 gm agar, 1 litre of water .

**Carnation Leaf Agar:** Gamma-irradiated leaf pieces of carnation placed onto Tap Water Agar (see Fisher *et al.* 1982).

## **2.2 Data Collection:**

### **2.2.1 Macroscopic Characters:**

Macroscopic characters of leaf lesion size and colour, and disposition of conidiomata were elucidated using a stereo-microscope.

### **2.2.2 Microscopic Characters:**

Conidiomata were sectioned from dried herbarium material using a Reichert freezing-microtome with a water-cooled stage, or by hand. Hardened material or conidiomata in woody tissues were softened first by soaking in 3% KOH for several minutes before sectioning. For study of the conidiogenous cells, internal tissue of the conidiomata was squashed out by tapping lightly on the cover slip of the microscope slide made from sectioned material and stained using Erythrosin in 10% Ammonia solution (Sutton 1980). This stain was found to be the best for observing conidiogenous cells and septation of conidia which often could not be observed using normal stains such as Acid Fuchsin.

Proliferation of conidiogenous cells was confirmed using a Zeiss Winkel compound microscope using Nomarski Interference Contrast. Semi-permanent microscope slides made from herbarium material have been deposited in DAR.

### **2.2.3 Illustrations:**

Illustrations of conidiomata, conidiogenous cells and conidia were drawn using a Zeiss Drawing tube attached to a Zeiss Winkel compound microscope at 40x magnification (conidiomata) and at 100x magnification under oil immersion (conidiogenous cells and conidia). The figures in Section 3 illustrate vertical sections of conidiomata (v.s.), conidiogenous cells and conidia *in-vivo* and *in-vitro* where available.

## **2.3 Identification of taxa:**

Identification of taxa was made by direct comparison with the type material where available. In the absence of type material, authentic named collections and other named exsiccatus material have been examined. All collections examined are listed under each taxon. Published descriptions including the original description have also been referred to in order to identify many taxa for which extralimital collections were unavailable.