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The Genus *Septoria* (Fungi: Deuteromycetes) in Hawai'i

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Among the pathogenic fungi under consideration as potential biocontrol agents of invasive alien plants in Hawai'i, species of the genus *Septoria* (classified in the order Sphaeropsidales of the form-class Deuteromycetes) have received perhaps a disproportionate amount attention. *Septoria* is a large, ubiquitous genus with over 1,500 species occurring as pathogens on a wide variety of both dicotyledonous and monocotyledonous host genera, representing a number of families, primarily causing leaf lesions which often lead to defoliation. The fungus reproduces by microscopic asexual spores (conidia) which are several-celled and narrowly elongate (i.e., threadlike) in appearance. As is common of

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other fungi which produce a proliferation of microscopic spores, *Septoria* spp. are primarily disseminated by wind, possibly aided in local dispersal by air currents and dripping or splashing rain. Insects or other biotic agents are of less, or little importance in dispersal. These fungi are characterized by their host-specificity, most being limited to a single species, or closely related hosts within a single genus, and are not known to cross into other plant families. Reflecting this host specificity, the species concept within *Septoria* is defined to a significant degree by the host upon which a given isolate occurs. *Septoria* spp. are not likely to be encountered in nature apart from the host with which they are associated. This factor considered together with spore dimensions and, secondarily, dimensions and morphology of pycnidial conidiomata (flask-shaped fruiting bodies) are the traditional basis for species delimitation (Alexopoulos & Mims, 1979). Accordingly, specific epithets within *Septoria* are most frequently derivations of the generic, specific, or common name of the host. Aside from their host specificity, *Septoria*-caused diseases are frequently virulent, leading to leaf death and/or defoliation, which can place the host under significant stress, subsequently decreasing vigor and aggressiveness. Species of *Septoria* sporulate readily *in vivo* and can be readily cultured artificially, lending to their usefulness as biocontrol agents. Their genetic stability is indicated by the fact that of the several species known in Hawai‘i since the late 1800s and early 1900s, none has been known to expand its host range or otherwise shift to other hosts.

Although the origins of microorganisms such as fungi are often more difficult to establish than are those of higher plants or animals, most species of *Septoria* currently known to occur in Hawai‘i are pathogens of introduced crops or ornamentals and, it can be reasonably assumed, were introduced with their hosts. On the other hand, some *Septoria* spp. have been described on endemic species and may be themselves endemic. Although some cases are known of attack of an endemic host by a fungal pathogen known to occur elsewhere, in most cases it is thought that fungi occurring on endemic hosts are also endemic.

Septoria reported from Hawai‘i (listed in order of host family)

Apiaceae

S. apiicola Speg.—Causes late blight of celery (*Apium graveolens*). Reported in Hawai‘i as both *S. apii* (Briosi & Cav.) Chester and *S. apii-graveolentis* Dorogin (Carpenter, 1918; Raabe *et al.*, 1981). According to Farr *et al*. (1989), both of the latter species are currently considered synonyms of *S. apiicola*. Pycnidial conidiomata (referred to by Saccardo as perithecia) 60–80 µm diam.; conidia 30–45 × 1.5 µm, 3–7 septate (Saccardo, 1892: 366).

S. petroselini Desm.—Causes leaf spots on parsley (*Petroselinum crispum*), a cultivated crop in Hawai‘i (Carpenter, 1918). Pycnidial conidiomata small; conidia 35–40 × 1–2 µm, indistinctly septate (Saccardo, 1884: 530).

Septoria sp.—Causes leaf spots on Asiatic pennywort [*Centella erecta* (= *C. asiatica*)] (Raabe *et al*., 1981; Parris, 1939). No identifying characteristics were given by Parris.

Arecaceae

Septoria sp.—Causes leaf spots on coconut palm (*Cocos nucifera*) (Unpubl. Univ. Hawai‘i Pl. Dis. Clinic Files).

Asteraceae

S. callistephi Gloyer—Causes leaf blight on China aster (*Callistephus chinensis*) (Parris, 1939). Pycnidial conidiomata 76–95 µm diam.; conidia (28–)33.5(–42) × 1–1.5 µm, 3-septate (Gloyer, 1921).

S. chrysanthemi Allesch.—Causes leaf spots on chrysanthemum (*Chrysanthemum sinense, C. morifolium, C. monfolium*) (Unpubl. Univ. Hawai'i Pl. Dis. Clinic Files). Conidia 40–50 × 2–2.5 µm (no other measurements given by Saccardo (1895: 542).

S. obesa Syd.—Causes leaf spots on chrysanthemum (*Chrysanthemum morifolium*) (Unpubl. Univ. Hawai'i Pl. Dis. Clinic Files). Pycnidial conidiomata 120–160 µm diam.; conidia 50–100(–120) × 3–4.5 µm, 5–12 septate (Saccardo, 1931: 415; Punithalingam, 1967).

S. lactucae Pass.—Causes leaf spots on lettuce (*Lactuca sativa*) (Parris, 1936; Martin, 1943; Raabe *et al.*, 1981). The host is a commonly cultivated crop in Hawai'i and elsewhere. Pycnidial conidiomata 90 µm diam.; conidia 25–30 × 1.7–2 µm, septation was not described (Saccardo, 1884: 551–52). A species described as *S. lactucae* Peck., with minute pycnidial conidiomata and conidia measuring 20–38 µm in length, but with no other characteristics given, was also listed with which *S. lactucae* Pass. may be confused (Saccardo, 1884: 552). It is not known whether both of these forms occur in Hawai'i, or only *S. lactucae* Pass.

S. leucanthemi Sacc. & Speg.—Causes leaf spot on shasta daisy (*Chrysanthemum maximum*), a cultivated ornamental not considered naturalized in Hawai'i (Raabe, 1966; Wagner *et al*., 1990). Pycnidial conidiomata 200–300 µm diam.; conidia 100–130 × 4–5 µm, septation obscure (Saccardo, 1884: 549).

S. rostrupii Sacc. & Syd. (= *S. chrysanthemum* Rostr.)—Causes leaf spots on *Chrysanthemum indicum*, a host not naturalized in Hawai'i. Stevens (1925) described this fungus with pycnidial conidiomata 45–70 µm diam.; conidia 15–40 × 2–3 µm, 1–3 septate; whereas the description given by Saccardo & Sydow (1899: 973) described the conidia as 40–50 × 2 µm, with no other dimensions given. Stevens (1925) noted this discrepancy in conidial measurements, but stated that ". . . it is not thought best to give this fungus a new specific name." The listing by Raabe *et al.* (1981) of *S. rostrupii* on *C. frutescens* rather than *C. indicum*, with reference to Stevens (1925), was apparently in error.

S. sonchifolia Cooke—Causes leaf spots on sow thistle (*Sonchus oleraceus*) (Raabe *et al.*, 1981). This host is an annual weed of European origin occurring in variety of disturbed habitats in Hawai'i, and widely naturalized prior to 1871 (Wagner *et al.*, 1990). Conidia 20 µm long, with no other descriptive characteristics given by Saccardo (1884).

Campanulaceae

S. clermontiae F. Stevens & P.A. Young—Causes leaf spots on *Clermontia kakeana*, an endemic species. As noted above, the fungus itself also may be endemic. Pycnidial conidiomata 55–145 µm diam.; conidia 10–20 × 1 µm, 1–2 septate (Stevens, 1925).

S. rollandiae F. Stevens & P.A. Young—Causes rotting of leaf tissue, and eventually holes in leaves of *Rollandia crispa* (= *R. lanceolata; Lobelia crispa*) (Stevens, 1925). The host is endemic and rare, having been collected only twice since 1946

(Wagner *et al.*, 1990). As discussed above, the fungus also may be considered endemic and rare. *S. rollandiae* appears similar but distinct from *S. clermontiae*, also reported on an endemic host of the Campanulaceae, in that the fruiting bodies and conidia of *S. rollandiae* do not reach the larger size limits of *S. clermontiae*. Pycnidial conidiomata 55–110 µm diam.; conidia (7–)9–14(–16) × 1–1.5 µm, 1–2 septate, septa sometimes obscure (Stevens, 1925).

Caryophyllaceae

S. cerastii Roberge & Desm.—Causes leaf spots on mouse-ear chickweed (*Cerastium fontanum*), a weedy host native to Eurasia and introduced to Hawai'i prior to 1871, now widely naturalized (Stevens, 1925; Wagner *et al*., 1990). Pycnidial conidiomata 80 µm diam.; conidia 30–40 × 1 µm; septation was not reported (Saccardo, 1884: 518).

S. dianthi Desm.—Causes leaf spots on carnation (*Dianthus caryophyllus*). Since carnation is not naturalized in Hawai'i, and the pathogen has not been reported on the naturalized species of *Dianthus* (i.e., *D. armeria*) (Wagner *et al*., 1990; Raabe *et al.*, 1981), reports of *S. dianthi* in Hawai'i may be limited to incidental occurrences on flowers imported for ornamental purposes. Dimensions of pycnidial conidiomata not given; conidia 30–44 × 4 µm, septation not given (Saccardo, 1884: 516).

Convolvulaceae

S. bataticola Taubenh.—Causes leaf spots on sweet potato (*Ipomoea batatas*) (Carpenter, 1918). Pycnidial conidiomata 70–130 µm diam.; conidia 15–80 × 0.35–0.50 µm; septation not given (Saccardo, 1931: 419–20).

Ericaceae

S. azaleae Voglino—Causes leaf scorch of rhododendron (*Rhododendron* sp.) (Raabe, 1966). No dimensions given for pycnidial conidiomata; conidia 12–18 × 1.5–2.5 µm, 1–3 septate (Saccardo & Sydow, 1899: 976).

Septoria sp.—Causes leaf spots on *'ohelo* (*Vaccinium reticulatum*), an endemic host, with the fungus itself being probably endemic. Pycnidial conidiomata about 90 µm diam.; conidia 50–65 × 3 µm, 5–7 septate (Gardner & Hodges, 1988).

Septoria sp.—Causes leaf spots on tree *'ohelo* (*Vaccinium calycinum*), an endemic host, with the fungus itself being probably endemic. Pycnidial conidiomata about 60 µm diam.; conidia 30–50 × 1.5 µm, 3–4 septate (Gardner & Hodges, 1988).

Fabaceae

S. canavaliae Lyon—Causes leaf spots on jack bean (*Canavalia ensiformis*) (Lyon, 1913; Gardner, 1982). *S. canavaliae* was described as a new species on *C. ensiformis* in Hawai'i, although the host is not native to Hawai'i, being cultivated in the West Indies. Pycnidial conidiomata 60–90 µm diam.; conidia 30–50 × 2–2.8 µm, 3–7 septate (Saccardo, 1931: 436).

S. molleriana Bres. & Roum.—Causes leaf spots on *Canavalia kauensis*, an ecologically notable endemic species currently considered a synonym of *C. hawaiiensis* (Wagner *et al.*, 1990). Pycnidial conidiomata 80 µm diam.; conidia (15–)20–40(–46) × 1.5–4.5 µm; (1–)2–5(–6) septa (Gardner, 1982). The *Septoria* parasitizing *C. hawaiiensis* may well represent a new, endemic species. However, for

the purpose of reporting the leaf spot disease itself, this pathogen was referred to *S. molleriana*, a species described from Italy on a *Canavalia* host (i.e., *C. obtusifolia*) and whose description (pycnidial conidiomata 70–80 µm diam.; conidia 25–30 × 3–4 µm, 3–5 septate) closely approximates that of the Hawaiian fungus (Saccardo, 1892: 362). Therefore, as currently defined, the occurrence of *S. molleriana* on *C. hawaiiensis* represents an example of an introduced species of *Septoria* parasitizing an endemic host. It should be noted that the fungus described here appears clearly distinct from *S. canavaliae*, described above.

Septoria sp.—Causes leaf spots on yardlong bean (*Vigna sesquipedalis)* (Unpubl. Univ. Hawai'i Pl. Dis. Clinic Files).

Heliconiaceae

Septoria sp.—Causes leaf spots on heliconia (*Heliconia bihai*) (Unpubl. Univ. Hawai'i Pl. Dis. Clinic Files).

Lamiaceae

S. salviae-pratensis Pass.—Causes leaf spots on Texas sage (*Salvia coccinea*) (Stevens, 1925). This host is native from the southeastern US to South America and has been naturalized in Hawai'i prior to 1871 (Wagner *et al.*, 1990). Stevens (1925) described *S. salviae-pratensis* from 'Iao Valley, Maui, with pycnidial conidiomata 35–80 µm diam.; conidia 25–40 × 2 µm, few-septate. This description differs somewhat in conidial dimensions from that given by Saccardo (1892: 375), with conidia 30–32 µm long (but no other descriptive characteristics given). Stevens (1925) acknowledged this variation, but nevertheless considered the fungus in question to be *S. salviae-pratensis*.

Marantaceae

Septoria sp.—Causes leaf spots on *Calathea vaginata* (Unpubl. Univ. Hawai'i Pl. Dis. Clinic Files).

Poaceae

S. cynodontis Fuckel—Causes leaf spots on Bermuda grass (*Cynodon dactylon*) (Ellis & Everhart, 1897; Saccardo, 1884: 562). Pycnidial conidiomata minute, stromatic; conidia 50–60 × 1.7–2 µm, septation not reported.

S. poae-trivialis Cocconi—Causes leaf spots on annual bluegrass (*Poa annua*) (Stevens, 1925). According to Stevens: ". . . found on *Poa annua* (at Kilauea, Hawai'i), and although it varies somewhat from the brief description given by Saccardo & Sydow (1899: 980), since it agrees in host it is considered as the same fungus. The measurements were found to be both shorter and longer than the original, and ranged from 0.7–1.2 µm wide." Pycnidial conidiomata 76–85 µm diam.; conidia 26–29 µm long (no other characteristics given by Saccardo).

Septoria sp.—Causes leaf spots on corn (*Zea mays*) (Unpubl. Univ. Hawai'i Pl. Dis. Clinic Files).

Polemoniaceae

S. phlogis Sacc. & Speg.—Causes leaf spots on phlox (*Phlox drummondii*) (Parris, 1940). Phlox is locally cultivated but has not become naturalized in Hawai'i (Wagner *et al.*, 1990). Pycnidial conidiomata 150–200 µm diam.; conidia 40–60 × 1–2 µm, 1–3 septate (Saccardo, 1884: 533). A species described as *S. phlogis* Syd.,

with conidia measuring 30–52 × 1.5–2 µm (no other characteristics given) is also listed by Saccardo & Sydow (1902: 967) with which *S. phlogis* Sacc. & Speg. may be confused.

Polygonaceae

S. vulcani Gardner—Causes leaf spots on *Rumex skottsbergii* and *R. giganteus*, endemic hosts (Wagner *et al.*, 1990). The fungus itself therefore may be endemic. Pycnidial conidiomata 50–80 µm diam.; conidia (20–)23–28(–40) × 2–3 µm, 1–4 septate (Gardner, in press; R. Wright, Unpubl. Univ. Hawai'i Plant Dis. Clinic Files).

Polypodiaceae

Septoria sp.—Causes leaf spots on fern (Unpubl. Univ. Hawai'i Pl. Dis. Clinic Files).

Rubiaceae

S. gouldiae F. Stevens & P.A. Young—Causes leaf spots on *Gouldia lanceolata* [=*G. terminalis* var. *lanceolata)* and *Hedyotis* (=*Kadua) grandis*], endemic hosts (Stevens, 1925). The genus *Gouldia* currently is considered a synonym of *Hedyotis*, resulting in the binomial *H. terminalis* (Wagner *et al.*, 1990). The fungus may also be endemic. Pycnidial conidiomata 90–115 µm diam.; conidia 50–90 × 2 µm; septation obscure (Stevens, 1925).

S. hawaiiensis F. Stevens & Plunkett—Causes leaf spots on *Hedyotis* sp. (= *Gouldia*), an endemic host (see above). The fungus itself therefore may be endemic. Pycnidial conidiomata 25–40 µm diam.; conidia 14–18 × 2–2.5 µm; septation not given (Stevens, 1925).

Scrophulariaceae

S. exotica Speg.—Causes leaf spots on shrubby veronica [*Hebe* (=*Veronica*) *speciosa*], a flowering shrub cultivated at higher elevations, but not naturalized in Hawai'i (Raabe, 1966; Wagner *et al.*, 1990). Pycnidial conidiomata 80–90 µm diam.; conidia 15–30 × 1–1.5 µm; septation was not reported (Saccardo, 1884: 533–34).

Solanaceae

S. lycopersici Speg.—Causes leaf spots on tomato (*Lycopersicon esculentum*) and eggplant (*Solanum melongena*), commonly cultivated crops in Hawai'i (Carpenter, 1918; Parris, 1936). No dimensions given for pycnidial conidiomata; conidia 70–110 µm long, 3–many septate (Saccardo, 1884: 535).

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New Naturalized Plant Records for Kaua'i

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The following collections represent new records based on information published in Wagner *et al.* (1990), Imada *et al.* (1989), and supplemental information from papers published in *Records of the Hawaii Biological Survey for 1994, part 2* (Evenhuis & Miller, 1995) and *Records of the Hawaii Biological Survey for 1995, parts 1 & 2* (Evenhuis & Miller, 1996). Ten new island records for naturalized species as well as new state records for 4 species previously unrecorded as being naturalized in the Hawaiian Islands are reported. All of the identifications have been made by the authors.

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