Cherry leaf scorch - *Apiognomonia erythrostoma*

*Apiognomonia erythrostoma* is a perithecial ascomycete known primarily from Europe, although it has also been reported from eastern Asia. The early spotting of leaves and fruits of *Prunus* species, particularly cherry and apricot, can result in significant defoliation and loss of yield in certain years when weather conditions are favorable for infection by airborne ascospores. Although there is no record of introduction of the fungus to new areas, which would most likely require transport of trees still bearing infected leaves and fruit, some countries list it as a quarantine pathogen. The fungus has been reported from many countries of Europe (IMI, 1993) and a few in East Asia. Smith et al. (1988) consider it primarily a problem for eastern Europe, while ERMES Agricultura (2009) describe the disease as occurring in central and southern Europe and the Balkan Peninsula. Records for Japan and China represent observation of the anamorph only (Tai, 1979: Kobayashi, 2007) while the pathogen is reported in South Korea as *Gnomonia erythrostoma* (Cho and Shin, 2004). Leaf scorch disease can be epidemic under the right conditions of temperature and rainfall, which do not occur every year. Although the fungus survives in dead leaves and fruit, it is unlikely to be transported in those materials unless they are attached to a living tree, and that tree must usually pass any quarantine inspection. *Prunus* species are subject to quarantine for the more threatening plum pox virus (USDA/APHIS, 2008; DAFF, 2009). Even if introduced, the fungus may not be able to establish itself on local trees within the single year of its life cycle or due to chemical treatments being applied to control other fungal foliar diseases of cultivated *Prunus* species.

*Apiognomonia erythrostoma* (Pers. : Fr.) Höhn.

Perithecia hypophyllous, partially immersed, globose, reddish-brown, 200-350 um diameter. Beak central, erect, 100-250 x 60-130 um.

Asci oblong, with tapering base and apical ring, eight-spored, (65-)78-80(-95) x 10-13 um, free in perithecium at maturity. Periphyses clavate, 3-4 mm thick.

Ascospores biseriate, hyaline, 15-20 x 4-6 um, two-celled, the lower cell much smaller, the upper cell usually biguttulate.

Pycnidia hypophyllous or epiphyllous, immersed, spherical or subspherical, ostiolate, 100-160 um. Phialides in short chains, 5-9 x 3um, terminal phialide longer, collarettes minute.

Conidia filiform, bent, gradually tapered to apex, 17-25 x 0.7-2 um.

See Munk, 1957; Sutton, 1967; Monod, 1983; and Stoykov and Assyov, 2006.

**Notes:** Höhnel (1918) created the genus *Apiognomonia* to include species with ascospores in which one cell is much shorter than the other, as contrasted with *Gnomonia*, in which the cells are equal or almost equal. The genus is supported by molecular phylogenetic studies, but the significance of the septum location as a diagnostic character is diminished (Sogonov et al., 2008). The pycnidial anamorph is currently placed in *Phomopsis*; the genus *Libertina* was created for this anamorph, which produces only the beta-type spores of a *Phomopsis* (Sutton, 1967, 1969).

*Gnomonia pruni* Fuckel and *G. prunicola* (Hohn.) Monod are described from dried leaves and fruit, respectively, of *Prunus domestica* L. (plum), an unlikely host of *A. erythrostoma*, by Monod (1983). These species produce black perithecia containing much smaller asci, ascospores are also smaller and the lower cell is nearly equal in length to the upper cell.

More serious and widespread diseases of *Prunus* leaves are caused by other fungi may appear similar. Two species cause a shot-hole symptom, in which the necrotic tissue in limited spots dries and falls out of the leaf. Infections by *Blumeriella jaapii* (Rehm.) Arx develop quickly in the spring, creating small angular purple spots (Smith et al., 1988). Conidia produced in the spots by the anamorph, Phleospora padi, are filiform, one-septate, and 60-75 um long (Ellis and Ellis, 1996). The hyphomycete *Thyrostroma carpophilum* (Lev.) B. Sutton (= Wilsonomyces carpophiilus = *Stigmina carpophila* = *Coryneum beijerinckii*), a serious pathogen in all areas where stone fruits are grown, causes large circular purple-brown spots with chlorotic haloes. On apricot fruit, the spots may become corky. Buds and twigs are also affected (Smith et al., 1988; European and Mediterranean Plant Protection Organization, 2004). The brownish conidia are fusiform with a truncate base, 3-7-septate and 30-60 x 9-18 um (Ellis and Ellis, 1996).

**Detection and Inspection Methods:** Leaves will show yellow to red leaf spots not restricted by leaf veins, often coalescing and turning brown. Affected leaves readily wither, curl up, and fall prematurely in the summer or remain on the tree through winter. Pycnidia containing filiform conidia form in the spots.
during the summer, and beaked perithecia develop in the leaves on the tree and on the ground in autumn.

**Diagnostic Method:** No DNA sequences for *A. erythrostroma* have been published, but many for several regions of DNA of related species, particularly *A. errabunda*, are available through GenBank (NCBI, 2009). Therefore, sequencing would provide data sufficient to distinguish *A. erythrostroma* from other fungal leaf pathogens of *Prunus* sp.

**Notes on Crops/Other Plants Affected:** All *Prunus* spp. are considered possible hosts (see Hecht and Zinkernagel, 2006), but it is not clear that this would include the invasive species *P. serotina*. In Korea, the host reported is *Prunus serrulata* var. *spontanea* (Cho and Shin, 2004).

**Symptoms-Description:** In Spain, pale green spots appear on cherry leaves 4-8 wks after infection in the spring. The spots turn yellow to red, depending on the tree variety. Leaves fall prematurely. Reddish spots develop on the fruit and sometimes on its stem (Sanchez and Becedas, 2007). On apricot, spots are yellow to red, may become larger or merge, since they are not limited by leaf veins, and the affected areas or entire leaves become necrotic, turn brown and dry up (Smith et al., 1988). Spots are often irregular with chlorotic margins. Some leaves or fruits may fall prematurely, while others remain attached on the tree, providing the distinctive symptom of this disease (Lang, 2004; ERMES Agricoltura, 2009).

**Biology and Ecology:** *Apiognomonia erythrostroma* overwinters in dead leaves on the ground and on trees (Hecht and Zinkernagel, 2006). In cherries in southern Germany, the first perithecia appear in the leaves in October, perithecia mature during the winter and early spring, and the first spores are ejected in March or April. Higher winter temperatures allow for earlier maturation and ejection of ascospores in spring. Release of ascospores occurs after rains or periods of high humidity, but only if ascospores are mature (Hecht and Zinkernagel, 2006). The role of conidia of the anamorph formed on leaves (Lang, 2004), which could spread the fungus farther on the tree or in an orchard, as they do in related tree pathogens (Sinclair and Lyon, 2005), is unclear. Hecht and Zinkernagel (2006) did not observe germination of conidia on water agar 5-25 C. Conidia do not appear to cause secondary infections on apricot in northern Italy (ERMES Agricoltura, 2009). On the other hand, conidia of the related *A. errabunda* do infect leaves of its host *Fagus sylvatica* and can persist in them as endophytes (Viret and Pettrini, 1994). Infection appears to require at least 6 hours of leaf wetness. In the laboratory, the maximum level of germination of ascospores was obtained after 24 hr at 15-20 C. (Hecht and Zinkernagel, 2006). Leaves were first infected near the end of May, and fruit were first infected in mid-June, in one year, but earlier in spring the next year. The incubation period before symptoms appeared on sweet cherry leaves was two to three weeks in southern Germany (Hecht and Zinkernagel, 2006). In northern Italy, infection of apricot occurred from the end of March and beginning of May (ERMES Agricoltura, 2009). Based on their observations, Hecht and Zinkernagel (2006) concluded that cherry leaves must be unfolded and the fruit must have attained a visible size, to be infected.

**Movement and Dispersal:** Natural dispersal: Ascospores are ejected from perithecia after rains (Hecht and Zinkernagel, 2006) and disseminated by wind (Sanchez and Becedas, 2007). Dead leaves carrying the fungus might also be distributed locally by wind. Accidental introduction: The fungus could be introduced to new areas on young trees bearing infected leaves or fruit.

**Seedborne Aspects of Disease:** Cultivated fruit trees are not grown from seeds

**Impacts:** Economic impact: The economic impact of *A. erythrostroma* depends on the severity of the leaf scorch disease, that varies by region and year. Significant outbreaks occurred in France in the 1940s (Gaudineau, 1949), in Austria in the 1980s (Vukovits and Wittmann, 1990), in Germany during the 1990s (Hecht and Zinkernagel, 2006) and most recently in Northern Italy (Spada et al., 2006). Because the same conditions may favor other pathogenic fungi on *Prunus* leaves as well (see Smith et al., 1988), the relative impact of one fungus may be difficult to measure separately.

**Prevention:** Non-European countries where *Prunus* species are grown can prevent introduction by quarantine of any tree material, as is currently done, in any case, for *Prunus* pathogens such as the plum pox virus (Canadian Food Inspection Agency, 2008; USDA-APHIS, 2008; DAFF, 2009). Although the fungus is unlikely to be carried by trees unless infected leaves or fruits are present, *A. erythrostroma* may be included as a quarantine organism.

**Control:** The disease varies in severity from year to year, depending on weather conditions and likely the susceptibility of the host.

**Cultural control and sanitary measures:** Reduction in the amount of inoculum before spring can be accomplished by collection and destruction or burying of the fallen leaves and fruit on which the fungus can sporulate (Smith et al., 1988; Sanchez and Becedas, 2007). Also, wild or escaped *Prunus* species which may harbor the pathogen could be removed from the areas around orchards.

**Chemical Control:** Because the pathogen survives and sporulates in the many dead leaves that remain on the trees, eradicative and preventative chemical applications to the trees are recommended both in
the fall, before ascospores are mature, and in the spring, to prevent infection of the new leaves and fruit (Sanchez and Becedas, 2007). The same chemicals that are used to control the more destructive pathogens *Blumeriella jaapii* (Smith et al., 1988) and *Wilkinsonyces carpophilus* (European and Mediterranean Plant Protection Organization, 2004) will be or can be effective against *A. erythrostoma*. These include bitertanol, carbendazim, copper, dithianon, dodine, fenbuconazole, and ziram (European and Mediterranean Plant Protection Organization, 2004.). Of the fungicides authorized for use, only fenbuconazole was useful in controlling leaf scorch in apricot in northern Italy (Spada et al., 2006).

**Host resistance:** Some varieties of apricot and cherry show partial resistance to *A. erythrostoma* (European and Mediterranean Plant Protection Organization, 2004). Based on leaf symptoms, Holb et al. (2007) identified the apricot cultivars Budapest and Mandulakajsz as the most resistant to natural inoculation in the orchard. The disease affected a number of apricot varieties in Emilia-Romagna, Italy, but none was reported as particularly susceptible or resistant (ERMES Agricoltura, 2009).

**IPM:** Hecht and Zinkernagel (2006) provide some initial data towards a model for prediction of spore release and infection that would guide appropriate and timely application of protective chemicals in the spring. As they note, more data are needed. The most useful predictions must consider both the particular host crop species and the local conditions.

**Gaps in Knowledge/Research Needs:** The role of conidia in the life cycle of the fungus and epidemiology of the disease remains unclear. Likewise, investigation of the extent to which the fungus may survive perennially on other parts of trees has not been reported.

**References:**


Leaf spots on *Prunus avium*. 7.5X BPI 0382852

Pycnidia on underside of leaf of *Prunus avium* 10X BPI 0382852

Beaks of perithecia emergent from underside of dead leaf of *Prunus avium* 10X BPI 0611408

Beaks of perithecia emergent from upper side of dead leaf of *Prunus* sp. 30X BPI0611397

Conidia from pycnidia in leaf collected in August. 1000X BPI 0382853

Ascospores in ascus from dead leaf collected in March. 1000X BPI 0611397
Ascospores in ascus from dead leaf collected in March.
1000X BPI 0611397