Phytophthora frigida

Overview

Phytophthora frigida Maseko, Coutinho & Wingfield was described in 2007 in South Africa causing collar and root rot on eucalyptus (*Eucalyptus smithii* R. T. Baker) and *Acacia decurrens* Willd. (Maseko et al., 2007). Alves et al. (2016) reported *P. frigida* causing gummosis on black wattle trees (*Acacia mearnsii* De Wild.) in southern Brazil. The symptoms are necrotic lesions with or without exudation, that are localized in the basal region of the trunk. In Brazil, besides *P. frigida*, gummosis has also been associated with *P. nicotianae* Breda de Haan and *P. boehmeriae* Sawada (Santos and Luz 2007, Santos et al. 2006). In South Africa, gummosis is associated with *P. nicotianae*, *P. boehmeriae* and *P. meadii* McRae (Roux and Wingfield 1997). **Etymology:** The name 'frigida' refers to the cold tolerance of this species.

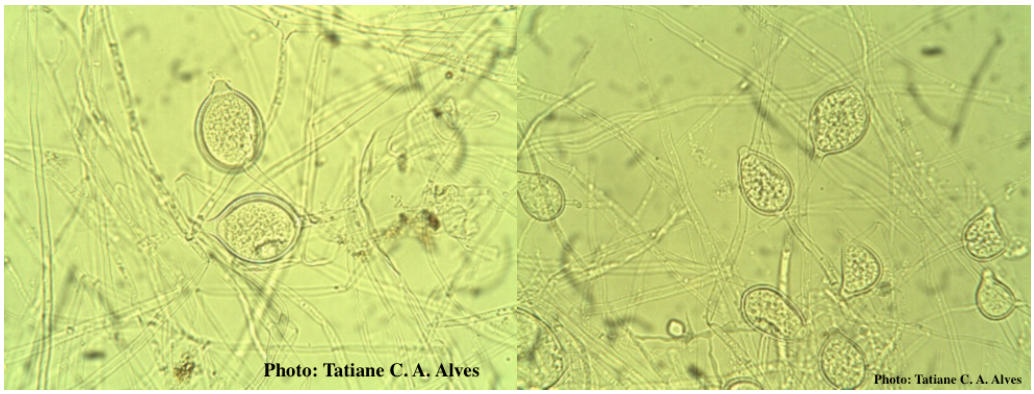

Figure 1. Noncaducous sporangia showing ovoid shape and papillate condition.

Morphology

P. frigida produces sporangia abundantly in 10% nonsterile soil extract when grown under constant light. Most sporangia have prominent papillae. Most isolates have persistent sporangia formed singly or in a loose sympodium. The sporangial shape is predominantly ovoid, although there are other shapes such as globose, ellipsoid, and obpyriform found in some isolates, including some distorted shapes (Fig. 1). The dimensions of sporangia range from 29 to 71 × 20 to 53 μm (avg. 46 × 33 μm), with length-breadth ratios of 1.3 to 1.5 (avg. 1.4). *P. frigida* produces terminal or intercalary globose chlamydospores that measure 21 to 55 μm in diameter (avg. 32 μm) (Fig. 2). *P. frigida* is heterothallic. Oogonial diameters range from 22 to 37 μm (avg. 30 μm). Antheridia are amphigynous and oospores are globose, aplerotic, and 18 to 31 μm (avg. 24 μm) in diameter (Fig. 3) (Alves et al., 2016).

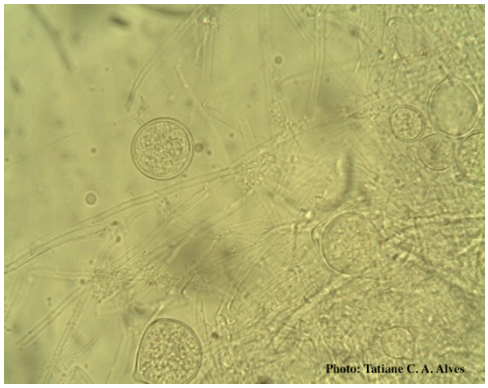

Figure 2. Globose chlamydospores.

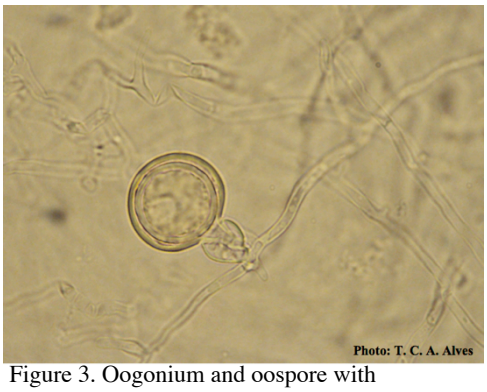

Figure 3. Oogonium and oospore with amphigynous antheridium.

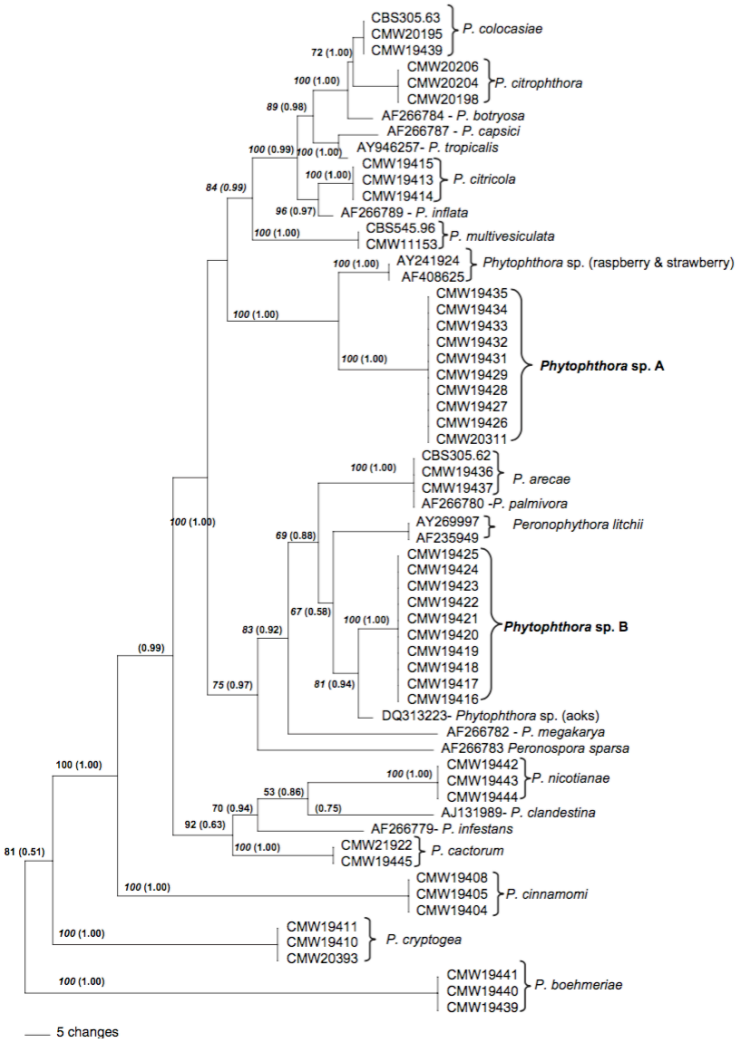

Figure 4. Phylogenetic tree from Maseko et al. 2007 based on analysis of ITS sequence data. *Phytophthora* sp. A = *P. frigida*.

Genetics:

Phytophthora frigida is placed in Clade 2 (Kroon et al., 2012). A phylogenetic tree from Maseko et al (2007) is shown (Fig. 4).

Growth in culture:

Cultures of *P. frigida* on carrot agar medium exhibit colonies with dense aerial mycelium. Five different colony patterns have been observed: stellate, cottony, petaloid-to-cottony, slightly stellate, and slightly rosaceous (Alves et al., 2016). The colony growth rate of *P. frigida* isolates on carrot agar medium is 12 mm/day at 24 to 30°C (Alves et al., 2016).

Distinguishing characteristics for identification

Phytophthora frigida is not easily distinguished from *P. nicotianae* by morphological characteristics, because both produce papillate, persistent, ovoid sporangia, and are heterothallic with amphigynous antheridia. Many isolates of *P. frigida* may have been classified as *P. nicotianae* until 2007, since the occurrence of this was long associated with gummosis in black wattle (Alves et al. 2011). They can be separated by molecular analysis of the ITS region, putting *P. frigida* in Clade 2 and *P. nicotianae* in Clade 1.

Phytophthora frigida can be distinguished from *P. boehmeriae* because the latter is homothallic, produces deciduous sporangia with short pedicels (<5 μm), and does not grow at 32ºC (Santos et al., 2006). *Phytophthora meadii* differs from *P. frigida* because it produces deciduous sporangia on medium-length pedicels (18 μm) (Gallegly and Hong 2008).

In black wattle plantations, it is not possible to differentiate the symptoms of gummosis caused by *P. frigida* and *P. nicotianae*. The two pathogens cause similar symptoms characterized by necrotic lesions, with or without gum exudation, that are localized in the basal region of the trunk, not reaching heights greater than 1.5 m (Fig. 5) (Alves et al. 2016; Santos et al. 2005, Santos et al. 2007).

Disease History

The etiology of gummosis was elucidated in South Africa by Zeiljemaker (1971), who demonstrated the pathogenic association of *P. nicotianae*. Santos et al. (2005) also recorded this species in black wattle in Brazil. Other species found were *P. boehmeriae* and *P. meadii* in South Africa (Roux and Wingfield 1997). *Phytophthora boehmeriae* was also found in Brazil (Santos et al., 2006). In 2016, *P. frigida* was reported causing gummosis in trunks of black wattle trees in southern Brazil (Alves et al., 2016).

Figure 5. Symptoms of gummosis on black wattle (Courtesy A.F. dos Santos).

Impacts in the forest

The bark of black wattle is used for the extraction of tannin to be used in the leather industry. Additionally, wood of black wattle is utilized in the production and export of wood chips for cellulose (Mochiutti 2007). Trees with gummosis interfere with the bark removal operation, reducing production. Timber with symptoms of gummosis is also unsuitable for use in the production of chips (Fig. 6) (Santos et al. 2007).

Figure 6. Bark and wood with symptoms of gummosis (Courtesy A.F. dos Santos).

Forest and Wildland Hosts and Symptoms:

Phytophthora frigida has a limited number of hosts, occurring only on *Eucalyptus smithii* and *Acacia* spp. (Maseko et al. 2007, Alves et al. 2016). In Brazil, it is found only in black wattle (Table 1) (Alves et al., 2016).

Table 1. *Phytophthora frigida* hosts, symptoms, and locations.

Host Latin name	Host common name	Symptoms	Habitat	Region
Acacia mearnsii	Black wattle; Acácia-negra (Portugese)	Canker, gummosis	Plantations	Brazil
Acacia decurrens	Green wattle	Collar rot, root rot	Plantations	South Africa
Eucalyptus smithii	Eucalyptus; Gully gum	Collar rot, root rot	Plantations	South Africa

Management and education resources

Forest Phytophthoras – a hidden threat to take a serious note of:
http://www.fabinet.up.ac.za/newsitem/240-forest_Phytophthoras.pdf

Gomose de *Phytophthora* da acácia-negra:
http://forestphytophthoras.org/sites/default/files/educational_materials/com_tec101.pdf

O complexo gomose da acácia-negra:
http://forestphytophthoras.org/sites/default/files/educational_materials/circ-tec44.pdf

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