EPPO Datasheet: *Ceratocystis platani*

Last updated: 2020-10-12

IDENTITY

Preferred name: *Ceratocystis platani*
Authority: (Walter) Engelbrecht & Harrington
Taxonomic position: Fungi: Ascomycota: Pezizomycotina: Sordariomycetes: Hypocreomycetidae: Microascales: Ceratocystidaceae
Other scientific names: *Ceratocystis fimbriata f. sp. platani* Walter, *Endoconidiophora fimbriata f. platani* Walter
Common names: canker of sycamore (US), canker stain of plane
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EPPO Categorization: A2 list
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EU Categorization: Quarantine pest ((EU) 2019/2072 Annex II B)
EPPO Code: CERAFP

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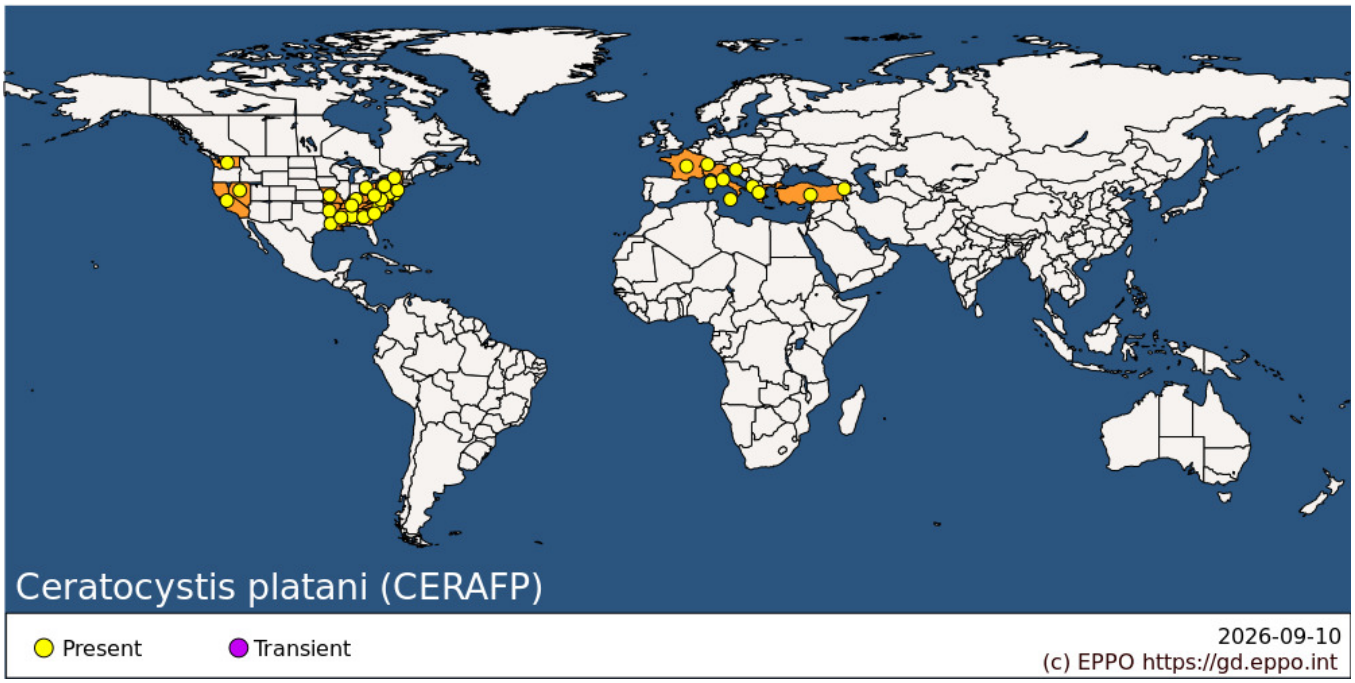
HOSTS

Platanus spp. are the only known hosts of *Ceratocystis platani*, with *P.* x *hispanica* (=*P.* x *acerifolia*) (widely planted as an amenity tree in many parts of Europe) and its eastern parent *P. orientalis*, being the most severely affected species (Panconesi, 1981). The North American parent of *P.* x *hispanica*, *P. occidentalis* is less badly affected by infections (McCracken & Burkhard, 1977). Mortality of *P. racemosa* has also been recorded in street trees of Modesto, California (Perry and McCain, 1988), but infections have not been found on other North American species of *Platanus*, or on *P. kerrii* which occurs in Laos and Vietnam.

Host list: *Platanus occidentalis*, *Platanus orientalis*, *Platanus racemosa*, *Platanus x hispanica*

GEOGRAPHICAL DISTRIBUTION

The fungus is believed to have been introduced from the USA on infected wood packaging material to several Southern European ports at the end of the Second World War. It then spread rapidly in Italy (Panconesi, 1981) but more slowly in France (Vigouroux, 1979a). Initially, the western part of Vaucluse (south-eastern France) was severely affected, but more recently the felling of infected 200-years old *P.* x *hispanica* along the Canal du Midi in south-western France has received considerable media attention. In Spain, the disease was reported several times, but only confirmed in 2010 in Girona, Catalonia, in a region bordering affected areas of France (EPPO, 2014; Riba, 2011). The outbreak in Girona is now considered eradicated. The disease has also been recorded in Switzerland, Greece, Albania and Turkey. There are unverified reports that the disease occurs in Armenia (Simonian and Mamikonyan, 1982) and Iran (Salari *et al*., 2006).



EPPO Region: Albania, Armenia, Croatia, France (mainland, Corse), Greece (mainland), Italy (mainland, Sicilia), Switzerland, Türkiye
North America: United States of America (Alabama, Arkansas, California, Delaware, District of Columbia, Georgia, Kentucky, Louisiana, Maryland, Mississippi, Missouri, Nevada, New Jersey, New York, North Carolina, Ohio, Pennsylvania, South Carolina, Tennessee, Virginia, Washington, West Virginia)

BIOLOGY

The pathogen enters host trees only through wounds in secondarily thickened tissues. Once a wound is infected, colonization of the inner bark (secondary phloem), vascular cambium and sapwood occurs rapidly. Longitudinal spread of up to 2 – 2.5 m per year (in *P.* x *hispanica*) in the sapwood occurs in the xylem vessels, but *C. platani* continues to grow at a rate of 50 – 100 cm per year in the inner bark, causing dark staining. The fungus also grows through medullary rays and can reach the heartwood.

C. platani survives temperatures as low as -17°C with growth limits of 10 - 45°C. The optimum temperature for fungal growth is 25°C. Asexual spores of the fungus can survive for at least 105 days in the soil during winter but are killed when soil temperatures exceed 35-40°C (Accordi, 1989).

Transmission commonly occurs from infected trees to adjacent healthy trees via root-to-root contact, which is common in many *Platanus* species, especially in *P.* x *acerifolia* which are clonal (Accordi, 1986). Insect transmission is common in the Ceratocystidaceae (de Beer *et al.*, 2014) and other ophiostomatoid fungi (Wingfield *et al.*, 1993), and there is some evidence that bark boring and other insects may carry *C. platani* between trees (Crone, 1962; Soulioti *et al.*, 2015). However, this possibility would need to be further verified. In urban trees, *C. platani* is frequently transmitted via pruning wounds and damage caused by other human activities on and around the trees (Tsopelas *et al.*, 2017). Sawdust from diseased trees is highly infective.

None of the spore types produced by *C. platani* is known to be airborne (Panconesi, 1999), but the pathogen may spread in the air locally on sawdust generated during pruning and sanitation felling operations. If these operations occur near a watercourse, the infected sawdust may be carried downstream to affect riparian *Platanus* trees. Spread, therefore, is mainly a result of human activities, including pruning and felling operations.

DETECTION AND IDENTIFICATION

Symptoms

In urban settings, *Platanus* are often planted as a single species along avenues. In these situations, the first noticeable symptom is usually the presence of chlorotic and wilting foliage on a single branching system. In parkland or woodland settings, the same symptoms occur but are obscured by surrounding trees. Closer examination will reveal an extensive canker (lesion) towards the point at which the branch emerges from the stem. Over time, the necrotic bark turns pale-brown and cracks, but remains attached to the tree; no wound callus forms at the lesion margins. When cutting away the bark beyond the lesion, orange staining is visible. These symptoms are most marked at the upper and lower edges of the lesion. When lesions girdle the trunk or a main branch, the bark of the distal part becomes conspicuously reddish-brown as the tissues die. In cross-section, affected branches show bluish-black, then brown, spindle-shaped patches, extending radially and more or less side by side. Infections are always lethal, with the time taken to die varying from a few months to 2.5 – 3 years, depending on the size and vigour of the tree. For more information, see Walter (1946), Griffin (1968), Vigouroux (1979a), Panconesi (1981), Tsopelas *et al.* (2017).

Earlier in infection development, small cankers may be visible as dark patches underneath cracks in the bark surface; sap exudes from the cracks, becoming dark brown with oxidation. These small cankers are more conspicuous on the smooth bark of *P. occidentalis* and *P.* x *hispanica* than on the rough bark of *P. orientalis* (Panconesi, 1981; Walter *et al.,* 1952).

Morphology

Cultures of *C. platani* are at first hyaline and more or less dense, depending on the medium, becoming brownish-green and giving off a pronounced odour of bananas, the intensity of which varies with the growing medium. Growth is rapid (5 mm in 24 h at 24°C on potato dextrose agar). Perithecia (diam: 200 µm) have a very long neck (400-800 µm). However, some strains produce none, while others produce only aborted ones. The ascospores (diam: 4-8 µm) have a distinctive bowler hat shape.

Three types of conidia are formed: (1) hyaline truncated cylindrical endoconidia (5-40 x 3-6 µm) in long rigid arched chains on conidiophores 60-90 µm long; these spores are produced on an approximately daily cycle; (2) more rarely, doliform endoconidia, very pale coloured, 7-12 x 6-9 µm, in short chains; (3) thick-walled endoconidia (chlamydospores) bulbous, brownish-green, 11-19 x 9-15 µm. Conidia are very numerous in infected wood (and thus in sawdust). For more information, see Hunt (1956), Webster & Butler (1967), Ferrari & Pichenot (1974).

Detection and inspection methods

Ceratocystis platani can be baited from infected wood or frass within 48 h by placing colonized tissues in moist chambers or on pieces of autoclaved carrot in Petri dishes at 20 - 25°C. After incubation for 24-48 hours, asexual spores are produced; ascomata form after approximately 7 days (Vigouroux, 1979b; Ocasio-Morales *et al.*, 2007). In culture, the fungus grows well on malt extract agar or potato dextrose agar. A trap/bait technique (Grosclaude *et al.,* 1988) is effective in isolating the pathogen from soil or infected wood: healthy branches of *Platanus orientalis* or *P.* x *hispanica* are stripped of their bark and placed in close contact with the wood or soil sample and are then incubated in a moist chamber or in water at room temperature. Perithecia develop on the branches within a few days. The same approach can be used to detect *C. platani* in river water.

Molecular methods have been developed for the specific detection and identification of *C. platani* without a requirement for isolation. A quantitative PCR technique (Pilotti *et al.*, 2012; Luchi *et al.*, 2013) proved able to detect the presence of *C. platani* DNA in low quantities and with high precision from sample traps placed in the vicinity of infected trees. *Ceratocystis platani* DNA was detected up to 200 m from trees that had been felled for sanitation purposes in Florence, using real-time PCR (Luchi *et al.,* 2013). These methods are useful in monitoring the spread of the disease in a region.

The EPPO Diagnostic Protocol for *C. platani* provides recommendations on how to detect and identify the fungus in plant material, as well as in soil or water samples (EPPO Standard PM 7/14, 2014).

PATHWAYS FOR MOVEMENT

Natural spread from tree to tree via root contact is very slow and unlikely to occur over long distances. Terracing

machinery may carry infested soil and contaminate healthy areas. The fungus may spread in infected *Platanus* wood in countries where this is used, and this route is believed to be how the pathogen was spread from North America to Italy (Panconesi, 1999; Tsopelas *et al.*, 2017). Another means of international spread is by trade of infected host plants. It has been considered that the main pathways for movement of *C. platani* into new areas were host plants for planting, wood (e.g. timber, wood packaging material, wood chips, dunnage, firewood) and machinery (EFSA, 2016).

PEST SIGNIFICANCE

Economic impact

During the first years of known outbreaks in the eastern states of the USA, cities lost high proportions of planted *Platanus* trees, most of which were *P.* x *hispanica*, over a 20 – 30 year period (Walter *et al.*, 1952; Crone, 1962). Around Marseille in south-eastern France, *C. platani* has killed thousands of street trees (Ferrari & Pichenot, 1974; 1976). When the disease spread out of Marseille and into the neighbouring Vaucluse département it was estimated that 1 500 to 1 700 infected and adjacent trees were felled annually, with over 30 000 trees removed in the region of Provence Alpes Côte d'Azur in 25 years (Chapin and Arcangioli, 2007). More recently, the disease has been highlighted in the media, as it has spread and infected *P.* x *hispanica* trees that were planted on each side of the Canal du Midi, along a substantial part of this artificial waterway which connects the Atlantic Ocean to the Mediterranean Sea through western France. Since the initial findings of *C. platani* near Toulouse in the early 2000s (Bonnet and Collet, 2007), the pathogen spread quickly, possibly in the watercourse itself. Along the Canal du Midi, almost 10 000 to 13 000 trees known to be infected have been felled (VNF, 2019).

In Italy, the fungus invaded the north of the country within a few years and killed many trees, especially those recently planted along avenues (Panconesi, 1981; 1999). A notable outbreak occurred in and around Naples after World War II, where American Service personnel were stationed, resulting in the loss of some 90% of street trees before 1991 (Panconesi, 1999). Subsequently, the disease spread throughout the Italian peninsula, affecting trees in all major cities (Panconesi, 1999).

Of particular concern was the spread of the disease into the natural stands of *P. orientalis* in Sicily (Granata & Pennisi, 1989). This event preceded the pathogen reaching Greece, probably in the late 1990s (Tsopelas & Angelopoulos, 2004), firstly affecting Peloponnese but rapidly spreading to north-western Greece. The high level of susceptibility of *P. orientalis* to *C. platani* has led to devastation of the natural populations of this tree, arguably the most important riparian species in Greece, other Balkan countries and countries to the east. In Greece alone, estimates of losses are in the range of tens of thousands of trees (Ocasio Morales *et al.*, 2007; Tsopelas *et al.*, 2017). The disease was also reported in Albania (Tsopelas *et al.*, 2015), causing significant mortality in natural ecosystems and towns.

In Turkey, further spread occurred into the European part of Istanbul, where *Platanus* are dominant trees in urban parks and streets (Lehtijärvi *et al.*, 2018), presumably due to the import of infected trees.

Control

Apart from phytosanitary measures, control methods are not immediately available. Breeding for resistance and related research produced a more resistant hybrid of *P.* x *hispanica*, named 'Vallis Clausa' (Vigouroux & Olivier, 2004), but more work is required to find a wide range of resistant genotypes, particularly given the apparent extreme susceptibility of *P. orientalis*.

Phytosanitary risk

Platanus are key amenity tree species for planting in urban environment in temperate climates. As the disease is invariably lethal and spreads rapidly, it presents a serious threat to many EPPO countries.

PHYTOSANITARY MEASURES

As spread is mainly resulting from human activities, it can be limited by strict application of standard horticultural

propagation and production methods (Smith, 1985). Planting material must be obtained from regions where the disease is not present, and the plants should have been grown in a place found free from *C. platani* during the last growing season. Pruning tools should be disinfected with alcohol before any pruning operation, even in uninfected regions. In infected regions, this disinfection must be repeated between every tree. Any terracing machinery used near to infected *Platanus* trees should be treated with pressurized water and an approved fungicide before being moved to another site (Blankart & Vigouroux, 1982), as adhering infective propagules may be transferred over considerable distances via this route (Tsopelas & Soulioti, 2014). When infected trees are felled, all debris and sawdust should be sprayed abundantly with fungicide before sweeping up and disposal. All potentially infected wood should be burned, and transport of infected firewood to disease-free areas must be discouraged.

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Datasheet history

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