

EPPO Datasheet: '*Candidatus Phytoplasma pyri*'

Last updated: 2023-06-19

IDENTITY

Preferred name: '*Candidatus Phytoplasma pyri*'

Authority: Seemüller & Schneider

Taxonomic position: Bacteria: Tenericutes: Mollicutes:
Acholeplasmatales: Acholeplasmataceae

Other scientific names: *Pear decline phytoplasma*, *Phytoplasma pyri* Seemüller & Schneider

Common names: PD, Parry's disease of pear, decline of pear, leaf curl of pear, moria disease of pear

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EPPO Categorization: A2 list

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EU Categorization: RNQP ((EU) 2019/2072 Annex IV)

EPPO Code: PHYPPY



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Notes on taxonomy and nomenclature

Phytoplasmas are bacteria, belonging to the class Mollicutes within the phylum Mycoplasmatota. Currently, all phytoplasma strains are assigned to the provisional genus '*Candidatus Phytoplasma*' (Wei and Zhao, 2022). One species in this genus is '*Ca. P. pyri*' the causal agent of pear decline (Seemüller and Schneider, 2004).

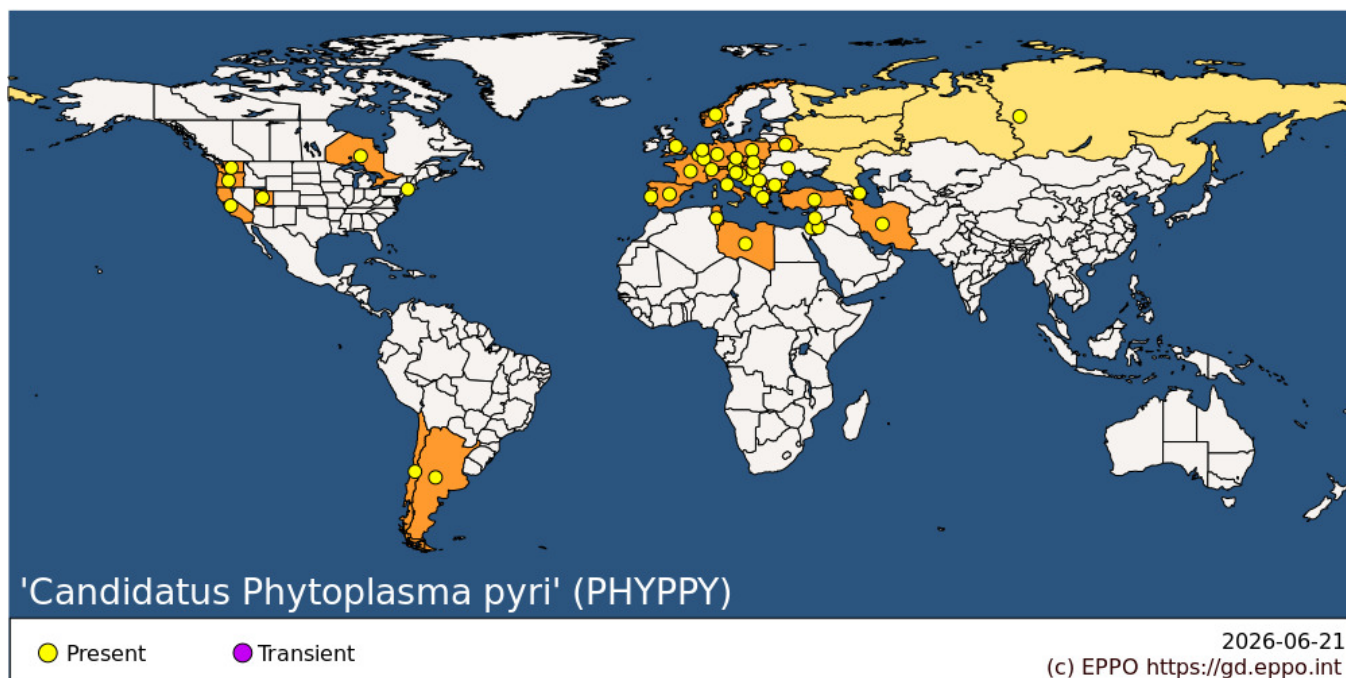
HOSTS

The main hosts of '*Ca. P. pyri*' are pears (*Pyrus* spp.). Pear trees on rootstocks of *P. pyrifolia* and *P. ussuriensis* (and especially scions of Williams, Beurré Hardy and Max Red Bartlett varieties) are prone to tree collapse (quick decline). Pear trees on less susceptible rootstocks, such as seedlings of *P. communis*, *P. betulifolia* and *P. calleryana*, are more likely to be affected by leaf curl (slow decline). The disease has also been observed on quinces (*Cydonia oblonga*), but pear trees grafted on quince rootstocks are reportedly less prone to the disease than pear trees grafted on *P. communis* seedlings (Seemüller *et al.*, 1986). Furthermore, the pathogen naturally infects peach (*Prunus persica*) (Sabaté *et al.*, 2014) and cherry (*Prunus avium*) (Cie?li?ska and Morga?, 2011). Infections of *Ribes* have been reported (Navratil *et al.*, 2004). In laboratory experiments, the insect vector *Cacopsylla pyri* transmitted the pathogen to the herbaceous host *Catharanthus roseus* (Ça?layan *et al.*, 2010).

Host list: *Cydonia oblonga*, *Prunus avium*, *Prunus dulcis*, *Prunus persica*, *Pyrus betulifolia*, *Pyrus calleryana*, *Pyrus communis*, *Pyrus pyrifolia*, *Pyrus ussuriensis*

GEOGRAPHICAL DISTRIBUTION

Pear decline was first reported in North America in the late 1940s, but it is believed to be of European origin (Seemüller and Schneider, 2004).



EPPO Region: Albania, Austria, Azerbaijan, Belarus, Belgium, Bosnia and Herzegovina, Bulgaria, Croatia, Czechia, France (mainland), Germany, Greece (mainland), Hungary, Israel, Italy (mainland), Jordan, Luxembourg, Moldova, Republic of, Netherlands, Norway, Poland, Portugal (mainland), Russian Federation, Serbia, Slovakia, Slovenia, Spain (mainland), Switzerland, Tunisia, Türkiye, United Kingdom (England)

Africa: Libya, Tunisia

Asia: Iran, Islamic Republic of, Israel, Jordan, Lebanon

North America: Canada (Ontario), United States of America (California, Connecticut, Oregon, Utah, Washington)

South America: Argentina, Chile

BIOLOGY

Phytoplasmas are small bacterial parasites with the ability to replicate in plants and insects. Within the plant, phytoplasmas colonize the phloem. They secrete various effector proteins, which are transported within the plant and induce a wide range of physiological changes in their hosts. Phytoplasmas are transmitted by phloem feeding insect species. After ingestion by a vector insect, the phytoplasmas multiply in various insect tissues and invade the salivary gland cells from where they can be introduced into a new host plant with the insect saliva. Infectious insects keep infectivity for the rest of their life (Weintraub and Beanland, 2006; Hogenhout *et al.*, 2008; Sugio *et al.*, 2011).

The main inoculum sources for 'Ca. P. pyri' are infectious insect vectors and infected propagation material. So far, the capability to transmit the pathogen has been confirmed for three species of pear suckers, *Cacopsylla pyri*, *C. pyricola* and *C. pyrisuga* (Hemiptera, Psyllidae) (Jensen *et al.*, 1964; Lemoine, 1984; Riedle-Bauer *et al.*, 2022). Two of them, namely *C. pyri* and *C. pyricola*, are polyvoltine and are found on pear trees all year round. They not only transmit pear decline, but also cause damage *per se* by injecting phytotoxins in their saliva into leaves as they feed. Their nymphs excrete vast amounts of sticky honeydew that may drip onto the fruits. Dark sooty molds growing on the honeydew might cause fruit russetting. Adults of both species are seasonally dimorphic, a larger, darker overwintering form and a smaller, lighter summer form are developed (Burckhardt and Hodkinson, 1986). Both species predominantly overwinter as adults in bark crevices of the trees, in the case of *C. pyricola*, however, the winter form has also been recorded outside pear orchards (Ossiannilsson, 1992; Horton *et al.*, 1994). The number of insect generations per year depends on the climatic area, for *C. pyri* 2-8, for *C. pyricola* 3-5 generations have been reported (Garcia Chapa *et al.*, 2005; Hodkinson 2009; Civolani, 2012; Jarausch *et al.*, 2019a, Riedle-Bauer *et al.*, 2022). In contrast, *C. pyrisuga*, is a univoltine migratory species. At the end of winter or in early spring, the adults move to *Pyrus* spp. where they lay eggs and the immature stages develop. The new generation adults leave their *Pyrus* hosts and migrate to conifers, often at higher altitudes, where they spend the rest of the year (Ossiannilsson, 1992; Jarausch *et al.*, 2019a). From the first larval stage onwards, the three pear sucker species feed on the phloem sap of *Pyrus* trees, which may lead to ingestion of the pathogen and to the development of infectious individuals.

Studies including *C. pyri* and *C. pyricola* indicate that their ability to transmit the pathogen varies greatly over the course of the year. The highest rates of PCR positive specimens and the highest transmission efficiencies were observed in late summer, in autumn and in late winter/early spring (Carraro *et al.* 2001; Sabaté *et al.*, 2018; Riedle-Bauer *et al.*, 2022). Comparatively high infection rates and successful phytoplasma transmission experiments have also been reported for the overwintered *C. pyrisuga* generation, remigrating from conifers back to *Pyrus* in late winter and early spring (Riedle-Bauer *et al.*, 2022).

In addition to these three species, other pear sucker species could play a role in pathogen spread. For example, ‘*Ca. P. pyri*’ was observed in *C. bidens*, but up to now, successful transmission experiments have not been reported (Etopolska *et al.*, 2015). Furthermore, the pathogen has been transmitted by grafting (Schneider, 1970). Previous studies have indicated that the decline of the phloem in the aerial parts of the trees during winter leads to the elimination of the phytoplasmas in the above ground parts of the trees. Accordingly, earlier trials in Germany have indicated a greatly reduced or even absent risk of pathogen transmission with scion material collected in late winter (Seemüller *et al.*, 1984). In contrast, other investigations in Spain proved a pathogen transmission throughout the winter (Errea *et al.*, 2002). It is possible that phytoplasma degeneration in the aerial parts of the trees during winter is influenced by the temperature conditions (Seemüller *et al.*, 1984). According to a recent study, ‘*Ca. P. pyri*’ infections of pears cause an increased viscosity and relative density of the phloem sap and an enhanced deposition of callose in the phloem (Gallinger *et al.*, 2021).

DETECTION AND IDENTIFICATION

Symptoms

Pear

Two types of decline symptoms are recognized: quick decline and slow decline or leaf curl. The degree to which decline symptoms are expressed is governed by the sensitivity of the rootstock.

Quick decline

Where the phloem at the bud union is sufficiently damaged to starve the roots during the growing season, fruits cease to develop and both fruits and leaves wilt rapidly. This may be followed by some leaf scorching and leaf death. Trees generally die within a few weeks.

Slow decline

There is a progressive weakening of the tree, which may fluctuate in severity. Terminal growth is reduced or may cease completely. Leaves are few, small, leathery and light-green, with slightly up-rolled margins; they become abnormally red in autumn and drop prematurely. Although blossoming is heavy in the early stages of attack, later on, fewer flowers are produced, fruit set is reduced, and fruit does not attain the normal size.

The reduced growth in successive seasons results in shoots appearing as tufts of leaves. Most of the feeder roots are killed, while larger roots may appear normal. On removing the bark at the graft union, a brown line may be visible on the cambial face in the bark surface at or directly below the union, and vertically fluted ridges may also be seen.

It should be noted that symptoms similar to those of pear decline described above can also be produced by other factors, such as rootstock-scion incompatibility, girdling, bad drainage, malnutrition, winter injury and drought.

Peach

Disease symptoms include early reddening, leaf curling, decline, abnormal fruits, and in some cases chlorosis and death of trees (Sabaté *et al.*, 2014).

Morphology

Phytoplasmas are small bacterial pathogens with a diameter of 0.08–0.8 µm, surrounded by a single membrane. Due to the lack of a rigid cell wall, they are pleiomorphic. Phytoplasma genomes consist of a single chromosome ranging from 600–880 kb, e.g. '*Ca. Phytoplasma mali*', a close relative of '*Ca. P. pyri*', possesses a linear chromosome of 602 kb. The phytoplasma genome comprises genes for basic cellular functions but lacks relevant metabolic genes. Therefore, phytoplasmas entirely depend on the metabolism of their hosts (Hogenhout *et al.*, 2008; Kube *et al.*, 2012; Sugio *et al.*, 2011; Oshima *et al.*, 2013).

Detection and inspection methods

In general, diagnosis and identification of '*Ca. P. pyri*' is achieved by molecular methods (EPPO, 2020). Leaf, petiole, shoot or cane samples should be collected from summer to early autumn. In roots, the pathogen can be detected all year round. Samples should be taken randomly from at least three parts of the tree. DNA is extracted from leaf mid-vein tissue and/or vascular tissue (phloem) from bark or roots. For pathogen detection and identification specific or generic real-time PCR protocols, protocols for nested/conventional PCR followed by restriction fragment length polymorphism (RFLP) analysis and a Loop-mediated-isothermal amplification (LAMP) have been recommended.

Phytoplasma diagnosis can also be carried out by fluorescence microscopy. For this procedure, frozen sections of root or stem samples are stained with a DNA-binding fluorochrome (e.g. DAPI). In the sieve tubes, small, brightly fluorescent particles appear (singly or in clusters). However, the procedure is less sensitive than molecular methods (EPPO, 1999). Grafting on suitable woody indicators such as *Pyrus communis* cv. 'Precocious' may be a useful method for e.g. the testing of mother plants in the frame of a certification scheme (Seemüller, 1989; EPPO, 1999).

PATHWAYS FOR MOVEMENT

Natural movement of insect vectors plays a relevant role for pathogen spread. *C. pyri* and *C. pyricola* predominantly spread the phytoplasma over short distances, from tree to tree, within the same orchard or between adjacent orchards. Due to its migratory lifestyle, *C. pyrisuga* might transmit the phytoplasma on a wider scale and therefore between more distant pear orchards. In international trade, the disease is liable to be carried in infected pear trees, scion wood and rootstock and possibly in insect vector stages colonizing the transported plant material.

PEST SIGNIFICANCE

Economic impact

Pear decline causes economic loss in all the EPPO countries in which it is present. Considerable damage is caused by this pathogen; affected trees may die within a few years after infection or they may live for many years. Fruits, if produced, can be small and few. In certain regions of the USA, pear production has been reduced by half. In Italy, between 1945-47, over 50 000 trees were destroyed.

Control

Disease-free, budwood and rootstocks are of primary importance in control. However, at least in some parts of the EPPO region, high infection rates of pear trees and a frequent occurrence of all three vectors result in a considerable infection risk. In these regions, additional measures will be required to keep the disease below an economically bearable level. The most promising strategy seems to be the use of tolerant rootstocks. In a longstanding selection process, pear decline tolerant rootstocks with promising pomological traits were selected (Seemüller *et al.*, 1998, 2009). They are currently being evaluated in field trials in several European countries (Jarausch *et al.*, 2019b).

The presence of several vector species with different biology and vectoring characteristics may result in a high risk of phytoplasma transmission over most of the year. As a consequence, vector control alone will probably be insufficient for disease management. However, studies have indicated that the winter generation of *C. pyri* and *C. pyricola* as well as the remigrant *C. pyrisuga*, present in the orchards in late winter and early spring are the most

efficient pathogen vectors. If registered products are available, measures against these developmental stages in late winter and early spring would be expected to reduce infection rates in the trees.

Phytosanitary risk

Due to the high rate of infected trees in several parts of Europe and the widespread occurrence of at least three vector species, the pathogen might be expected to spread rapidly. Studies have shown that a long time span may elapse between the infection of a (mother) tree and a positive laboratory test. Therefore, a certain risk of spread by propagation material can be encountered.

PHYTOSANITARY MEASURES

In order to prevent entry or spread of pear decline phytoplasma, imported host material (plants for planting, except seeds) should come from a place of production and its immediate vicinity subject to growing-season inspection and found free from the disease (EPPO, 2021). It can also be recommended that planting material should derive from tested mother plants. The EPPO certification scheme for *Malus*, *Pyrus* and *Cydonia* (EPPO, 1999) covers pear decline phytoplasma and should give a high security for phytoplasma-free planting material.

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Datasheet history

This datasheet was first published in the EPPO Bulletin in 1978 and revised in the two editions of 'Quarantine Pests for Europe' in 1992 and 1997, as well as in 2023. It is now maintained in an electronic format in the EPPO Global Database. The sections on 'Identity', 'Hosts', and 'Geographical distribution' are automatically updated from the database. For other sections, the date of last revision is indicated on the right.

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