# EPPO Datasheet: *Elsinoë australis*

Last updated: 2020-10-27

## IDENTITY

**Preferred name:** *Elsinoë australis*
**Authority:** Bitancourt & Jenkins
**Taxonomic position:** Fungi: Ascomycota: Pezizomycotina: Dothideomycetes: Dothideomycetidae: Myriangiales: Elsinoaceae
**Other scientific names:** *Elsinoe australis* Bitancourt & Jenkins, *Sphaceloma australis* Bitancourt & Jenkins, *Sphaceloma fawcettii var. viscosa* Jenkins
**Common names:** scab of sweet orange
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**EU Categorization:** Quarantine pest ((EU) 2019/2072 Annex II A)
**EPPO Code:** ELSIAU

### Notes on taxonomy and nomenclature

Scab diseases of citrus are caused by two *Elsinoë* species, *E. fawcettii* (citrus scab) and *E. australis* (sweet orange scab); *E. fawcettii* being more widely spread than *E. australis*. *E. australis* was originally described from *Citrus sinensis* (sweet orange) in Brazil causing cork-like necrotic tissues on fruit. Its description was based on the asexual morph *Sphaceloma australis* (Bitancourt & Jenkins, 1936) and has only few differentiating morphological characters from *E. fawcettii*. The teleomorph is only known from Brazil. According to the 'one fungus/one name rule' (Hawksworth *et al*., 2011) adopted in fungal nomenclature, the preferred name is now *E. australis*.

*E. australis* has high intraspecific diversity and comprises at least five pathotypes described based on host range and geography (Hyun *et al.*, 2009, 2001; Miles *et al*., 2015, Zhao *et al*., 2020). The sweet orange pathotype is known in South America on satsuma mandarin and Valencia sweet orange (*Citrus unshiu, C. sinensis*,) (Hyun *et al.*, 2001). The natsudaidai pathotype was described in the Republic of Korea on natsudaidai (*C. natsudaidai*) fruit (Hyun *et al.*, 2009). In Australia, two pathotypes, Finger Lime and Jojoba Black, have been described associated with finger lime ( *Citrus australasica*) and jojoba (*Simmondsia chinensis*) respectively (Miles *et al*., 2015). Another pathotype was characterised and is associated with poplar spot anthracnose in China (Zhao *et al*., 2020).

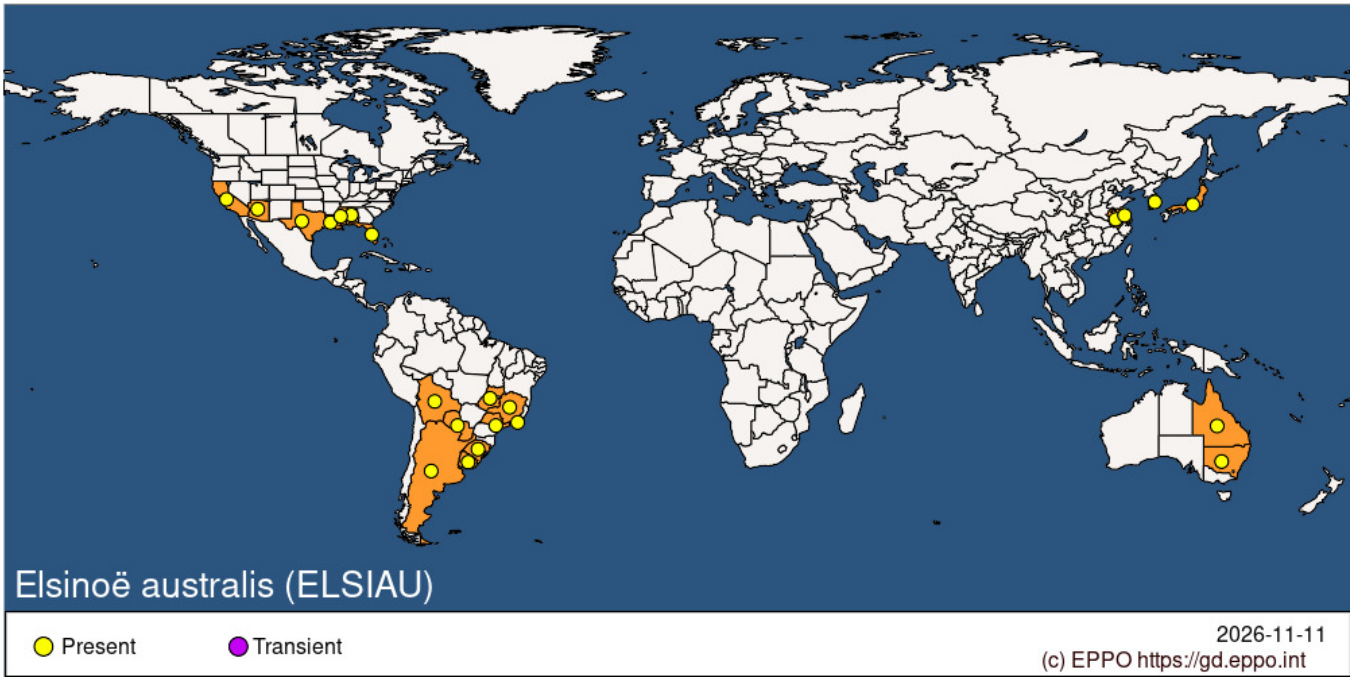
## HOSTS

*E. australis* is most important on oranges (*C. sinensis*) and mandarins (*C. reticulata*) causing fruit scab but not affecting leaves (Timmer *et al.*, 2000). It also infects fruits of sour oranges (*C. aurantium*), lemons (*C. limon*), satsumas (*C. unshiu*), limes (*C. aurantiifolia*), grapefruits (*C. paradisi*), tangor (*Citrus x nobilis*), satsuma (*Citrus unshiu*), calamondin (*x Citrofortunella microcarpa*), natsudaidai (*C. natsudaidai*), and *Fortunella* (*Fortunella* sp., *Fortunella margarita*). In contrast to *E. fawcettii*, *E. australis* is known to occur, in addition to citrus and allies Rutaceae species, on other plant species in different families (e.g. Simmondsiaceae, Salicaceae). In Australia, Ash *et al.* (2012) reported a new pathotype of *E. australis* causing a black scab disease of jojoba (*Simmondsia chinensis*). In south-eastern China, Zhao *et al.* (2020) reported that *E. australis* is causing a spot anthracnose on poplar (*Populus tomentosa* and *P. deltoides*) leaves. Poplar isolates of *E. australis* were able to cause scab symptoms on the fruit of one hybrid citrus but not on fruit of orange, lemon, or grapefruit.

**Host list:** *Citrus australasica, Citrus hystrix, Citrus natsudaidai, Citrus reticulata, Citrus trifoliata, Citrus x aurantiifolia, Citrus x aurantium var. deliciosa, Citrus x aurantium var. paradisi, Citrus x aurantium var. sinensis, Citrus x aurantium var. unshiu, Citrus x aurantium, Citrus x limon, Citrus x limonia var. jambhiri, Citrus x nobilis, Fortunella margarita, Populus deltoides, Populus tomentosa, Simmondsia chinensis, x Citrofortunella microcarpa*

## GEOGRAPHICAL DISTRIBUTION

*E. australis* has a very restricted distribution compared to *E. fawcettii*. It originally occurred only in South America (Chung, 2011), but its presence on citrus in southern USA and Asia (Japan and the Republic of Korea) has recently been confirmed. *E. australis* was first detected in Japan in 2012 as the Natsudaidai pathotype on satsuma mandarin, navel orange and a hybrid of natsudaidai and orange (Hyun *et al.*, 2007). South Korean isolates of *E. australis* also belong to Natsudaidai pathotype (Hyun *et al.*, 2001). In Australia, *E. australis* has been reported on jojoba ( *Simmondsia chinensis*) but not on citrus (Miles et *al.*, 2015). In south-eastern China, *E. australis* has been detected causing a leaf disease on poplar (Zhao *et al.*, 2020) but is not known to occur on citrus. At present (as of September 2020), *E. australis* is absent from the EPPO region. In the literature, there is an old record from Sicily (Ciccarone, 1957) but the fungus has never been there found again.




**Asia:** China (Anhui, Jiangsu), Japan (Honshu), Korea, Republic of
**North America:** United States of America (Alabama, Arizona, California, Florida, Louisiana, Mississippi, Texas)
**South America:** Argentina, Bolivia, Brazil (Goias, Minas Gerais, Rio de Janeiro, Rio Grande do Sul, Sao Paulo), Paraguay, Uruguay
**Oceania:** Australia (New South Wales, Queensland)

## BIOLOGY

Inoculum for new infections consists mainly of conidia. These are produced in the acervuli on the surface of scab lesions on young fruits and leaves throughout the year. *E. australis* produces only hyaline, one-celled, elliptical conidia and does not produce spindle-shaped conidia in scab lesions (those are only produced by *E. fawcettii* ). Survival and infectious ability of conidia are reliant on wet conditions, quickly dying if exposed to dry conditions. Conidia are formed abundantly on wet scabs, in a nearly saturated atmosphere at optimum temperature between 20 and 28°C. Dispersal of *E. australis* is mostly by rain or irrigation water. Insects and, to a certain extent, wind-carried water droplets containing spores may also contribute to the spread (CABI, 2020). Infection severity depends on the available inoculum load and the incidence of wetting periods. Germination of conidia and infection do not require liquid water, both processes being possible with dew, fog or under high moisture conditions. A minimum wetness period of 1-2 h is needed for sporulation while a wet period of 2.5-3.5 h is needed for conidial infection (Timmer, 2000). Scab incidence is usually much higher in low-lying areas with frequent wetting, compared to elevated areas (Chung, 2011). The temperature range required for germination of conidia is 13-32°C, but infection does not take place below 14°C or above 25°C (Whiteside, 1975). The incubation period is of at least 5 days. The optimal temperature for disease development is 20-21°C (Timmer, 2000).

The sexual form of *E. australis* is very uncommon and has been reported only in Brazil (Bitancourt & Jenkins, 1936,

1937). Stromata contain numerous spherical asci, each harboring eight filamentous hyaline ascospores (Holliday, 1980). There is no information available on the role played by the ascospores in the disease propagation.

*E. australis* is able to survive in scab pustules on fruits remaining on the tree (Chung, 2011), providing the inoculum for the next season. Even in resistant cultivars, the fungus can survive on diseased shoots sprouting from susceptible rootstocks (Whiteside, 1988; Yamada, 1961).

## DETECTION AND IDENTIFICATION

### Symptoms

Lesions of sweet orange scab vary with age and host plant species. Similar to symptoms caused by *E. fawcettii*, citrus tissues infected with *E. australis* show erumpent scab pustules (Chung, 2011). In contrast with *E. fawcettii* which affects all parts of citrus, *E. australis* affects mostly fruit. Fruits are infected in the early stages of their development, i.e. when not more than 20 mm across. They grow misshapen, becoming scarred and distorted, and are subject to premature fall (CABI, 2020). On the rind of developed fruits, raised lesions are formed with different shapes, sizes and colours according to the species and cultivar affected. They appear as scattered protuberances, conical projections or crater-like outgrowths, or they coalesce to give scabby patches or extensive areas of fine eruptions. Scab lesions do not extend into the albedo. *E. australis* forms larger, smoother, more circular scabs than *E. fawcettii* scabs, which are typically irregular, warty and deeply fissured.

Sweet orange scab may be confused with other diseases, e.g. bacterial canker (*Xanthomonas citri* pv. *citri*) and melanose (*Diaporthe citri*), or with injuries caused by various agents and it is difficult to differentiate it based on symptom alone (Fawcett, 1936; Brun, 1971; Knorr, 1973; Klotz, 1978; Whiteside *et al.*, 1988).

### Morphology

Ascomata pulvinate, globose, dark, pseudoparenchymatous, multilocular, up to 80-120 µm thick. Asci up to 20 per locule, subglobose or ovoid, bitunicate, inner wall thickened at the top, 12-16 µm diameter, eight-spored. Ascospores hyaline, ellipsoidal or oblong-ellipsoidal, with two to four cells, usually constricted at the central septum, 4-8 x 12-20 µm diameter. The sexual form is only known from Brazil.

Acervuli intra-epidermal or sub-epidermal, scattered or confluent, pseudoparenchymatous. Conidiogenous cells originated from the upper cells of the pseudoparenchyma or from the hyaline or pale-brown phialidic conidiophores, which have 2-4 septa. Conidia hyaline, unicellular, ellipsoid, biguttulate, 5-10 x 2-5 µm. Mycelium hyaline, scanty, septate, short-branched. Colonies in culture rose to purple coloured, and clearly raised above the agar surface and covered by tufts of short erect hyphae.

Isolates of *E. australis* grow slowly in culture, lack extensive aerial hyphae and often produce red or brown pigments (Sivanesan & Critchett, 1974a, b, c).

### Detection and inspection methods

Other pathogens of citrus cause lesions similar to those of citrus scab, therefore, detection of *E. australis* cannot be based solely on the visual observation of symptoms. Isolation of the fungus is very challenging; but semi-selective media containing antibiotics and fungicides (dodine) have been developed to successfully isolate *E. australis* from scab lesions (Whiteside, 1988). For species separation, Timmer *et al.* (1996) found out that it is not possible to distinguish *Elsinoë* species by cultural characteristics such as conidial size and shape and colony colour, and they are more reliably differentiated by pathogenicity. Pathogenicity tests have been implemented for species and pathotype identification (Timmer *et al.*, 1996; Tan *et al.*,1996). In addition, *E. australis* can be pathologically separated from *E. fawcettii* by its inability to infect citrus leaves. The possibility of using immunochemical methods for pathogen detection has been also envisaged (Peláez Abellán *et al.*, 1986).

For molecular methods, a PCR test based on random amplified polymorphic DNA (RAPD) of ITS sequences has been used for differentiating *E. australis* from *E. fawcettii* (Tanh *et al.*,1996) and partially resolved *E. australis*

pathotypes (Hyun *et al.*, 2009). In addition, specific primers have been designed and successfully used for detecting both species individually. The PCR tests are effective for either fungal cultures or infected plant tissues. Combined analysis of several genetic loci is more effective for distinguishing *Elsinoë* species causing citrus scab (Hyun *et al.*, 2009; Fan *et al.*, 2017). Sequence analysis of the internal transcribed spacer (ITS) region and the translation elongation factor 1 ? (TEF) gene clearly distinguished isolates of *E. fawcettii* and *E. australis*, and provided fixed nucleotide differences that distinguished subgroups separated by RAPD-PCR within the two species. Fan *et al.* (2017) employed combined analyses of ITS, LSU, rpb2 and TEF1-? DNA to refine the phylogeny and taxonomy of *Elsinoë* with descriptions of new species based on isolates originally identified as causal agents of citrus scab.

Validated international protocols for detection and characterization of *E. fawcettii* are currently not available

## PATHWAYS FOR MOVEMENT

The international trade of citrus fruits, originating in infested countries, may favour long-distance movement of *E. australis*. Local and short-distance dissemination of the pathogen in orchards is mostly via rain (or irrigation water), although insects and, to a certain extent, wind-carried water droplets containing spores may contribute to the spread.

## PEST SIGNIFICANCE

### Economic impact

*E. australis* is economically more significant than *E. fawcettii* as it attacks all sweet orange cultivars as well as some tangerines and their hybrids which are widely grown. Severely infected fruits are scarred and distorted, and consequently unmarketable.

Citrus scab is important only in areas where susceptible species or cultivars of citrus fruit are grown for the fresh market and where young plants or new growth develops under favourable conditions of temperature, moisture and shade (CABI, 2020). Losses largely depend on seasonal and local weather conditions and impact may be extremely reduced in areas with a limited annual rainfall of less than 1300 mm.

### Control

Scab disease caused by *E. australis* can be controlled both in the nursery and in the orchard by agricultural practices, sanitation, chemical treatments. Management measures may include the use of resistant citrus cultivars (Ieki, 1982; Yoshida & Shichijo, 1984; Reddy *et al.*, 1986), as well as adequate tree spacing, row orientation and pruning in order to improve ventilation within the orchard. Sanitation measures represent the most effective strategy for scab management and aim to eliminate inoculum sources of *E. australis*, through removal of symptomatic fruits and even destruction of all diseased trees. In countries where the disease occurs, chemical control is widely used and several synthetic fungicides such as benomyl, thiophanate methyl, azoxystrobin, trifloxystrobin, pyraclostrobin, ferbam, as well as copper compounds have been proven effective. When using copper in preventive treatments several sprays are needed as the entire fruit surface must be continuously covered by a copper layer during the susceptible stage (Gopal *et al.*, 2014). However, sustainability of chemical control requires the use of appropriate fungicide spray programmes to avoid the development of resistance (González, 1980; Rao, 1983; Reddy *et al.*, 1983). For example, benomyl-tolerant strains of the pathogen have been found (Whiteside, 1980).

### Phytosanitary risk

The import of citrus fruits from countries where the pathogen is present may present a risk of introduction of *E. australis* into the citrus-growing areas of the EPPO region. Citrus plants, the main hosts of *E. australis*, are cultivated on a vast area around the Mediterranean Basin. It has been considered that the conditions prevailing in most citrus-growing areas of the EPPO region were favourable to the establishment of *E. australis* (EFSA, 2017). Additionally, the prevailing climate in these citrus-growing areas combined to the practice of sprinkle and micro-sprinkle irrigation might create climatic conditions suitable to the establishment of *E. australis* (EFSA, 2017). Once established, the pest is highly likely to spread naturally or by means of human assistance.

## PHYTOSANITARY MEASURES

As the main pathway is the movement of infected citrus fruit, restrictions on fruit trade are usually implemented in the EPPO region. It can be requested that fruit should originate from pest-free areas or from pest-free places of production as demonstrated by crop inspections and laboratory testing prior to export.

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### Datasheet history

This datasheet was first published in the second edition of CABI/EPPO 'Quarantine Pests for Europe' in 1997 and revised in 2020. 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.

CABI/EPPO (1997) *Quarantine Pests for Europe (2nd edition)*. CABI, Wallingford (GB).

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