EPPO Datasheet: *Paysandisia archon*

Last updated: 2020-06-19

IDENTITY

Preferred name: *Paysandisia archon*
Authority: (Burmeister)
Taxonomic position: Animalia: Arthropoda: Hexapoda: Insecta: Lepidoptera: Castniidae
Other scientific names: *Castnia archon* Burmeister
Common names: palm borer moth
view more common names online...
EPPO Categorization: A2 list
view more categorizations online...
EU Categorization: PZ Quarantine pest ((EU) 2019/2072 Annex III)
EPPO Code: PAYSAR



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HOSTS

All known hosts are palms of the family *Arecaceae*. Until now the insect has been recorded, both within and outside its natural distribution, on the following plants: *Brahea armata, B. edulis, Butia capitata, B. yatay, Chamaerops humilis, Butia yatay, Jubaea chilensis, Latania sp., Livistona chinensis, L. decora, L. saribus, Phoenix canariensis, P. dactylifera, P. reclinata, P. roebelenii, P. sylvestris, P. theophrasti, Sabal mexicana, S. minor, S. palmetto, Syagrus romanzoffiana, Trachycarpus fortunei, T. wagnerianus, Trithrinax campestris, Washingtonia filifera* and *W. robusta* (Sarto i Monteys & Aguilar, 2005; EPPO, 2008; Kenis & Branco, 2010; Lopez-Vaamonde *et al.*, 2010; Niamouris & Psirofonia, 2012; EFSA, 2014; Isidoro *et al*., 2017).

Host list: *Arecaceae, Basselinia glabrata, Brahea armata, Brahea edulis, Butia capitata, Butia yatay, Chamaerops humilis, Coccothrinax barbadensis, Coccothrinax macroglossa, Corypha utan, Jubaea chilensis, Latania sp., Livistona australis, Livistona chinensis, Livistona decora, Livistona mariae, Livistona nitida, Livistona saribus, Phoenix canariensis, Phoenix dactylifera, Phoenix loureiroi, Phoenix reclinata, Phoenix roebelenii, Phoenix rupicola , Phoenix sylvestris, Phoenix theophrasti, Ptychosperma elegans, Rhapidophyllum hystrix, Sabal mexicana, Sabal minor, Sabal palmetto, Syagrus romanzoffiana, Trachycarpus fortunei, Trachycarpus martianus, Trachycarpus wagnerianus, Trithrinax campestris, Washingtonia filifera, Washingtonia robusta*

GEOGRAPHICAL DISTRIBUTION

Paysandisia archon is a neotropical species, endemic to northeastern Argentina, Uruguay, Paraguay and Rio Grande do Sul State of Brazil (Sarto i Monteys & Aguilar, 2005) that was first described in Argentina in 1880 by Burmeister (Sarto i Monteys, 2002). In the EPPO region, it was detected for the first time in Spain in a nursery in the region of Girona, Cataluña (2001) on *Trachycarpus fortunei*, *Phoenix canariensis* and *Chamaerops humilis* (Aguilar *et al*., 2001) and later in the Comunidad Valenciana, and is now present at several sites along the Mediterranean coast from Girona to Alicante (Montagud Alario, 2004; Sarto i Monteys & Aguilar, 2005; Agoiz-Bustamante, 2015), Balearic islands (Nuñez, 2013) expanding further to Gibraltar (Perez & Guillem, 2019).

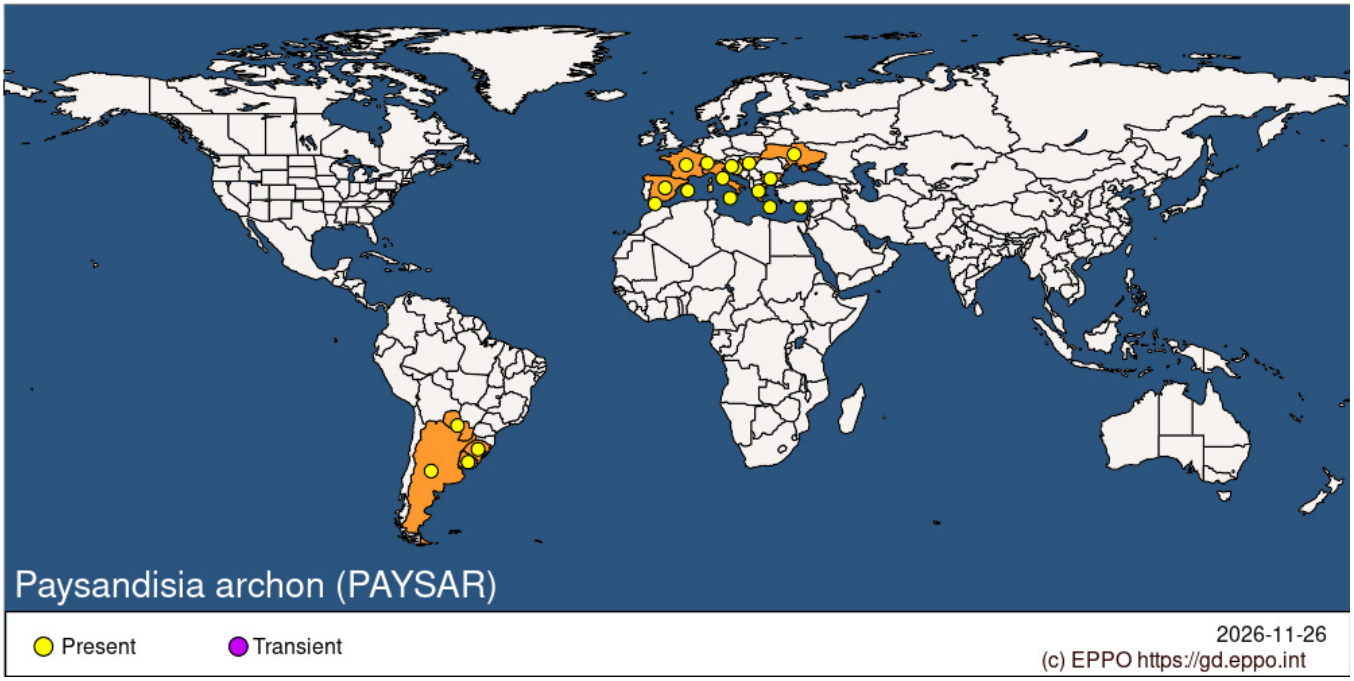
Paysandisia archon was found in France almost simultaneously (summer 2001), near Hyères (Var) and Toulon (Sarto i Monteys & Aguilar, 2001; Drescher & Dufay 2001), and later on in Hérault in 2002 (Reynaud *et al*., 2002). It is now considered established in Alpes-Maritimes, Aude, Gard, Hérault, Var and Vaucluse, and it has also spread into in Aquitaine, Bretagne, Midi Pyrénées, Pays de la Loire (Leraut & Martin, 2016). In the year that followed, *P. archon* has also been found at several locations in Sicily and southern Italy and soon expanded its distribution to the whole country (Espinosa *et al.*, 2003; Riolo *et al.*, 2004; Colazza *et al*., 2005). In Greece it was found for the first time in Heraklion city (Crete) infesting *Washingtonia robusta* and *Chamaerops humilis,* and in Aghios Stefanos (Athens) it was reported infesting *Trachycarpus fortunei* (Vasarmidaki *et al*., 2006). In 2008, the symptoms of *P. archon*

have been detected on imported palm trees in the region of Paphos (Cyprus) (Vassiliou *et al.*, 2009). The most recent detection of *P. archon* comes from Croatia where it has been reported in a nursery near Split (Croatia) (Masten-Milek & Šimala, 2012) and in Bulgaria (Sarto i Monteys, 2013). In Switzerland, only few individuals have been reported (EPPO, 2009; EPPO, 2011) and the pest has been eradicated. In the western part of Slovenia (Seljak, 2013) is now under eradication.

P. archon has also been detected in other countries, without becoming established. In the United Kingdom there have been three isolated records of the pest:

- - in 2002, there was an isolated record of the pest in a private garden in West Sussex (Patton & Perry, 2002)
- - in 2006 in an atrium of an office building in West Malling (Kent) and
- - in 2007, in a nursery in North London on plants imported from Italy (Reid, 2008). As in all these records measures have been taken, *P. archon* in now considered eradicated in the United Kingdom.

Similarly, *P. archon* has been intercepted in a nursery in Denmark (Larsen, 2009) without indications of establishment while in Germany (EPPO, 2017) and in the Czech Republic (EFSA, 2014) it is considered eradicated since 2018.



EPPO Region: Bulgaria, Croatia, Cyprus, France (mainland), Gibraltar, Greece (mainland, Kriti), Hungary, Italy (mainland, Sicilia), Slovenia, Spain (mainland, Islas Baleares), Switzerland, Ukraine
South America: Argentina, Brazil (Rio Grande do Sul), Paraguay, Uruguay

BIOLOGY

As *P. archon* is not considered to be a pest within its native range, the only available publication is a short note with some biological information (Bourquin, 1933). After the 2000s however, when *P. archon* was introduced into Europe, a significant amount of research was made to describe in detail the life cycle of this pest. Sarto i Monteys and Aguilar (2005) provided the first detailed information on the biology of *P. archon*, based on observations in Cataluña (Spain).

Adults are active flyers during daytime, and they first appear in mid-May. The peak of their flying activity can be found during June-July, and they are not seen from late September. Adult males are very territorial and fly in hot, sunny weather, and females are generally monandrous (Delle-Vedove *et al.*, 2012). Adults become sexually mature shortly after emergence, and eggs are mostly laid singly within the fibre webs closest to or within the palm crowns (Hamidi & Frérot, 2016), it is rare that palm fibres contain several eggs on the same palm crown. The eggs are not

glued to the fibres remaining loose within their thick layers but hidden from predators.

Though the average number of eggs laid in natural conditions is not known, it is suggested that *P. archon* females lay around 140 eggs (Drescher & Jaubert, 2003; Sarto i Monteys & Aguilar, 2005), which is not high compared to other Heterocera (including other Castniidae). Hatching occurs after 12 to 21 days depending on the temperature. Immediately after hatching, the larvae start looking for food and shelter and bore into the host plants. *P. archon* overwinter as larvae and all instars can be found in the palms including prepupal ninth instar larvae.

The larval stage can last from 10.5 to 18.5 months, as *P. archon* can experience unusual lethargic periods. As a consequence, there are larvae that overwinter once (mostly those that hatch from June to August) and others that overwinter twice. Live cocoons can be found from mid-March to mid-September. In Cataluñia the full *P. archon* life cycle lasts on average 389 days (i.e. 12.8 months) for specimens with a one-year life cycle and 673 days for those with a two-year cycle (Sarto i Monteys and Aguilar, 2005). Larvae can be found tunnelling in different parts of the palms largely depending on larval size but they are usually located near the crown of the palm, where they remain until adult emergence.

The prepupal larval stage is long and complex and can be separated into two periods. The first starts before the construction of the cocoon and has a variable duration. The second initiates immediately after the cocoon has been built, and includes the time spent by the larva inside the cocoon before converting into a pupa. It usually lasts around 17 days, while in early summer this period can be shortened to 9 days. Cocoons (with an average length of 5.8 cm) are stout with inner walls smoothly coated by a layer of silk and mucus, while the outer walls are loosely covered by fragments of palm fibres that make them invisible. On average, pupae formed at the end of March need 66 days to complete their metamorphosis to adults, those formed in the first half of April need 52 days and those formed in the first half of July need 43 days (Sarto i Monteys and Aguilar, 2005).

DETECTION AND IDENTIFICATION

Symptoms

Symptoms of infestation by *P. archon* on palms depend on the infestation stage and the height of the palm tree. In general, observation of any of the following symptoms requires a further inspection of the tree (Drescher & Dufay, 2002; Riolo *et al.*, 2004; Sarto i Monteys *et al.*, 2005; Sarto i Monteys, 2013; CABI, 2014) are:

1. presence of sawdust on the palm crown and/or palm trunk
2. presence of perforated or nibbled leaves (non-specific)
3. Presence of holes and larval galleries (axial and transversal) in the trunk (on palmated-leaved palms) or both in trunk and leaf rachises (on pinnate leaved palms).
4. abnormal development of auxiliary leaf buds
5. deformation and abnormal twisting of palm stipes
6. abnormal drying up of the palms, especially the core leaves
7. pupal exuviae on the outside of the stipe
8. flying adults
9. eggs in palm fibres
10. presence of a series of consecutive perforations on a circular section (on palmated-leaved palms) or scattered perforations on the leaves (on pinnate leaved palms)

Nevertheless, it should be mentioned that *P. archon* may infest a palm tree without any apparent symptom (EFSA, 2014).

Morphology

Very detailed descriptions of the different development stages of *P. archon* are given by Drescher & Dufay (2002), Sarto i Monteys *et al.* (2005), Sarto I Monteys & Aguilar (2005) and Sarto i Monteys (2013).

Eggs

The egg of *P. archon* is a typical castniid egg, fusiform, resembling a rice grain. It bears six to eight raised longitudinal ridges which have associated aeropyles along their length, with the micropyle at one end of the long axis. When freshly laid, their colour is creamy pink or light brown becoming rosy brown over the days. Its length is 4.69 ± 0.37 mm (the majority measure between 4.4 - 5.2 mm) and its width, at the widest section, is 1.56 ± 0.11 mm (with the majority ranging between 1.50-1.60 mm).

Larva

In total, *P. archon* larvae have nine larval instars. Immediately after hatching, the young larva (less than 1 cm long) is pink apart from the light brown head capsule and does not exhibit cuticular spinules. Through the first instar, the rosy colour fades towards whitish and the long straight-lined setae become shorter because of multiple folding due to constant friction against the gallery walls where the larva lives. After the first moult, mobility diminishes notably and the larva becomes ivory white, chaetotaxy changes and the setae become much shorter, cuticular spinules appear; all these new traits are retained throughout the remaining larval stages. Earlier instars show a blackish dorsum as a consequence of the blackish longitudinal dorsal vessel clearly seen from outside the body; later instars turn to a more intense ivory white and the dorsal vessel is less obvious. Light brown cuticular spinules on the dorsum of the prothoracic segment form an 'M' mark, more obvious in mid and later instars. From the first to the last instar, the larvae of *P. archon* increase in size dramatically. After emergence, the body length is 7.3 ± 2.2 mm, the width of the head capsule at the widest part being 1.00 ± 0.10 mm. When full grown, but before entering the prepupal stage when some contraction takes place, the larva may reach a body length of 9 cm, width of 1.5 cm at mid-length, and the width of the head capsule at the widest part being 7.84 ± 0.34 mm. When fully developed, the larva enters a prepupal stage. This stage normally occurs in the 9th instar, however occasionally it can be in the 7th or 8th.

Pupa

Right after pupation, the pupa is pale yellowish, and it gradually (in two days) turns reddish brown due to darkening and hardening of the pupal cuticle. The pupae is about 5.5 cm long (EPPO, 2011). Most of the abdominal segments of the pupa exhibit dorsally transversal rows of short spines pointing backwards. The pupa is protected by a palm-fibre cocoon within the burrow and as a result they are not easily seen (Sarto i Monteys & Aguilar, 2005). The cocoons are fusiform with an average length of 5.8 cm (range: 5.2-7-4 cm). Because the spindle is not symmetrical (it is flatter on one of its sides), there is a widest and a shortest width: widest average width 1.9 cm (range: 1.6-2.8 cm); shortest average width 1.7 cm (range: 1.3-2.0 cm).

Adult

Adults are easily visible in flight, having a large wingspan of 9– 11 cm (Montagud Alario, 2004). The forewings are greenish brown, with a blackish brown median band. The hindwings are orange with a wide transverse black band containing five or six white cells. The antennae are clubbed with a typical apical hook. Females are a little larger and are easily recognizable by their chitinous ovipositor at the end of the abdomen.

Detection and inspection methods

Visual inspection is reported as being the most effective monitoring approach (Vassiliou *et al.*, 2009; Tapia *et al.*, 2010) as the symptoms of *P. archon* infestation are very typical and easily recognizable (see Chapin *et al.*, 2002; Drescher & Dufay, 2002; Longo, 2006; EPPO, 2011; Chapin *et al.*, 2013; Sarto i Monteys, 2013).

Over the years, several surveillance and detection approaches have been tested and partially developed in an effort to promptly detect infestation by *P. archon*, as this facilitates greatly the effectiveness of the control measures (Soroker *et al.*, 2017). These include:

- - Acoustic detection, that can be employed during the larval stage, as larval activity can produce distinct sounds,
- - Chemical detection, as the infested trees emit characteristic volatile cues,
- - Thermal detection, as a pest feeding in the palm trunk causes fermentation that increases the local temperature,
- - Monitoring traps baited with semiochemicals that attract individuals of the pest. Although a sex pheromone

of *P. archon* has not been identified (Ollivier & Frérot, 2006; Sarto i Monteys *et al*., 2012), which made the development of a specific trap for this pest more difficult (Closa *et al.*, 2017), it has been found that females are attracted by plant volatiles (Ruschioni *et al*., 2015) and by compounds produced by males when they rub their midlegs against the upper side of palm leaves (Frérot *et al.*, 2013; Quero *et al*., 2017). In addition to these compounds, three others have been isolated and identified in males of *P. archon*, which could be involved in short-range courtship behaviour (Sarto i Monteys *et al*., 2012; Delle-Vedove *et al*., 2014; Quero *et al*., 2017).

These detection methods should be tested in large-scale field experiments to determine their efficacy against *P. archon*.

PATHWAYS FOR MOVEMENT

Natural dispersal is ensured by flying adults. Sarto i Monteys & Aguilar (2005) reported an Natural dispersal is ensured by flying adults, which are considered strong flyers (Peltier, 2007). Sarto i Monteys & Aguilar (2005) reported an infestation on old palm trees 10 km away from the Girona outbreak with no link to an introduction of potentially infested material in the vicinity. Nonetheless, the most effective long dispersal pathway of *P. archon* is international trade of palm plants carrying larvae, which are difficult to detect. *P. archon* was probably introduced into the EPPO region between 1990 and 1995 on *B. yatay* and *T. campestris* plants from Argentina (Drescher & Dufay, 2002; Sarto i Monteys & Aguilar, 2005). Nevertheless, as there are still no molecular studies, it is still not clear whether the expansion and recorded outbreaks in the EPPO region have resulted from separate introductions, from movement of infested plants within the region, or from spread of flying adults.

PEST SIGNIFICANCE

Economic impact

Though *P. archon* has not been reported as a damaging pest in its native range in South America, serious damage and plant mortality have been reported in France, Italy and Spain (Aguilar *et al*., 2001; Dreschner & Dufay, 2001; Riolo *et al*., 2004). The presence of numerous dead palm trees in nurseries in France (more than 50 000 dead palm trees from 2002-2012) was one of the main indications of the presence of the pest (André & Tixier Malicorne, 2013; Rochat, 2013). In Italy (Marche region), Riolo *et al*. (2004) reported that in many nurseries severe damage and plant mortality were observed in 2003, leading to 90% loss of production (Verdolini, 2013). The palm nursery has been severely negatively impacted both by *P. archon* and *Rhynchophorus ferrugineus* (Suma *et al.*, 2017). Initially it was thought that the impact of *P. archon* would remain confined to plant nurseries. Nevertheless, the detection of *P. archon* in old palm trees (Sarto i Monteys & Aguilar, 2005; Porcelli *et al*., 2006), showed the expansion potential of this species. The infestation of date palms (*P. dactylifera*) by *P. archon* (Liu, 2003) presents a significant risk to this highly important cultivated palm.

In addition to the economic aspect of *P. archon* infestation, its potential impact on the environment should also be highlighted. Specific autochthonous palm tree species (such as *Chamaerops humilis* and *Phoenix theophrasti*) which are considered protected, are susceptible to *P. archon* (Sarto i Monteys & Aguilar, 2005; Niamouris & Psirofonia, 2012). In addition to them, ecosystems of unique importance (e.g. Palmeral de Elche in Alicante) are threatened by the increase of *P. archon* populations (Montagud Alario, 2004; André & Tixier Malicorne, 2013). Finally, as specific palm tree species (such as *C. humilis*) are used to regenerate vegetation cover under extreme conditions (arid areas), damage to these plants or not being able to use them could have negative impacts on the ecosystem services such as erosion regulation, soil formation and nutrient cycling (EFSA, 2014).

Control

As *P. archon* is an insect species that remains mostly in the palm tissues (larvae are endophagous except for the very short time elapsed from eclosion to entering the hostplant), the most effective way to control its spread and avoid population outbreaks is early eradication (Ruiz *et al.*, 2017). In such early stages, containment can be achieved by mechanical and management means such as removal and chipping of infested palms which can effectively eliminate larvae (Muñoz-Adalia & Colinas, 2020).

Similarly, good results were obtained by wetting the palm crown and palm trunk with contact and/or systemic organophosphorus insecticides (chlorpyrifos, acephate and dimethoate) (Sarto i Monteys & Aguilar, 2005). Imidacloprid tree injections have also been used against this pest in Europe (Reid & Moran, 2007). However, it should be emphasised that the application of these products and active substances depends on the national legislation and their use is often limited in urban areas as well as in natural stands.

Even though, natural enemies of *P. archon* have been reported and described within its native range, including both parasitoids and predators (such as ants and birds) (Sarto i Monteys & Aguilar, 2005; Liégois *et al.*, 2016), very few of them have been tested *in-situ* to assess their effectiveness. One of the most recent approaches involved *Trichogramma* species, that showed very promising results under laboratory conditions. Nevertheless, prior to a wide-scale application of such an approach, field experiments should be carried out (Ortega-Garcia *et al.*, 2017).

Among the various entomopathogens frequently observed in other insect species, viruses and bacteria seem to have minimal if any, impact on *P. archon* mortality (Ortega-Garcia *et al*., 2017). On the contrary, entomopathogenic nematodes have shown a much greater potential against *P. archon*, as in addition to the two most commonly genera (*Heterorhabditis* and *Steinernema*) (Nardi *et al*., 2009; Ricci *et al*., 2009; Pérez *et al.*, 2010; Chapin *et al*., 2013), the genus *Rhabditis* has also been recorded infesting *P. archon* (Sarto i Monteys & Aguilar, 2005). In a similar approach, different strains of the entomopathogenic fungus *Beauveria bassiana* have been isolated and tested with success on different stages of the insect (Millet *et al*., 2007; Besse-Millet *et al*., 2008; Decoin, 2010).

Phytosanitary risk

Based on Pest Risk Analysis conducted for *P. archon* (EFSA, 2014; EPPO, 2006), the fact that climatic conditions similar to those of origin exist in the EPPO region coupled with the fact that the species has managed to survive and become established in countries where it was introduced (e.g. Italy, Spain, France) it was concluded that *P. archon* posed a significant risk to the Mediterranean region. As ornamental palms are being transported throughout the whole year and they are widely planted as amenity trees in the whole Mediterranean area, the risk of introducing *P. archon* to other regions with imported palm trees is high. The biological cycle of *P. archon* further increases the risk potential of this pest. The fact that the pest remains, through most of its development stages, inside the host plant and the infestation symptoms are sometimes not apparent, means that the occurrence of the pest can be difficult to detect. Finally, the fact that *P. archon* adults are strong and efficient flyers, and their natural dispersal ability is high, increases the phytosanitary risk of the species.

PHYTOSANITARY MEASURES

P. archon is established in parts of the EPPO region and causes damage to many ornamental palm species. In order to limit the spread of *P. archon* plants for planting of *Palmae* should come from countries that are known to be free from *P. archon*, or from places of production that have been found free from the pest for at least 2 years before being moved or exported. Host plants should be produced under protected conditions (e.g. under a net) to prevent infestations. Within the European Union and in the framework of its plant health legislation (EU Regulation 2016/2031 on protective measures against pests of plants), measures are taken to protect parts of the EU territory that are still free from *P. archon*, and restrictions are imposed on the movements of plants for planting of several palm species (species belonging to the genera: *Brahea, Butia, Chamaerops, Jubaea, Livistona, Phoenix, Sabal, Syagrus, Trachycarpus, Trithrinax, Washingtonia* with a stem at the base of over 5 cm).

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