EPPO Datasheet: *Thaumetopoea processionea*

Last updated: 2020-11-26

IDENTITY

Preferred name: *Thaumetopoea processionea*
Authority: (Linnaeus)
Taxonomic position: Animalia: Arthropoda: Hexapoda: Insecta: Lepidoptera: Notodontidae
Other scientific names: *Cnethocampa processionea* (Linnaeus)
Common names: oak processionary caterpillar, oak processionary moth
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EU Categorization: PZ Quarantine pest (Annex III)
EPPO Code: THAUPR

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Notes on taxonomy and nomenclature

The genus name *Thaumetopoea* comes from the Greek words "?????" (=miracle) and "????" (=do), quite likely due to some remarkable biological traits such as the gregarious behaviour through egg and larval stages, the urticating setae for the protection against vertebrate predators and the prolonged (up to nine years) diapause as pupa in soil in order to avoid unfavourable environmental conditions that could put its survival at risk (Battisti *et al.*, 2015). The species name refers to the typical behaviour of the larvae that build up a procession (*processionea)* when searching for a place to pupate in the soil.

HOSTS

Thaumetopoea processionea (oak processionary moth) feeds on the different *Quercus* species that can be found across Europe and the Near East. In general, preferred hosts are *Quercus cerris, Q. ilex, Q. pubescens*, *Q. petraea*, *Q. pyrenaica* and *Q. robur* (Dissescu & Ceianu, 1968; Pascual, 1988; Moraal, 1996; Stigter *et al.* 1997; Tomiczek & Krehan, 2003; Damestoy *et al.*, 2020) while in the near East, it can also attack *Quercus infectoria* subsp. *veneris* and *Q. calliprinos* (Démolin & Nemer, 1999; Halperin & Sauter, 1999). Based on observations at the Royal Botanical Gardens (Kew, GB), North American and Asian species can also be infested by the oak processionary moth (Townsend, 2009).

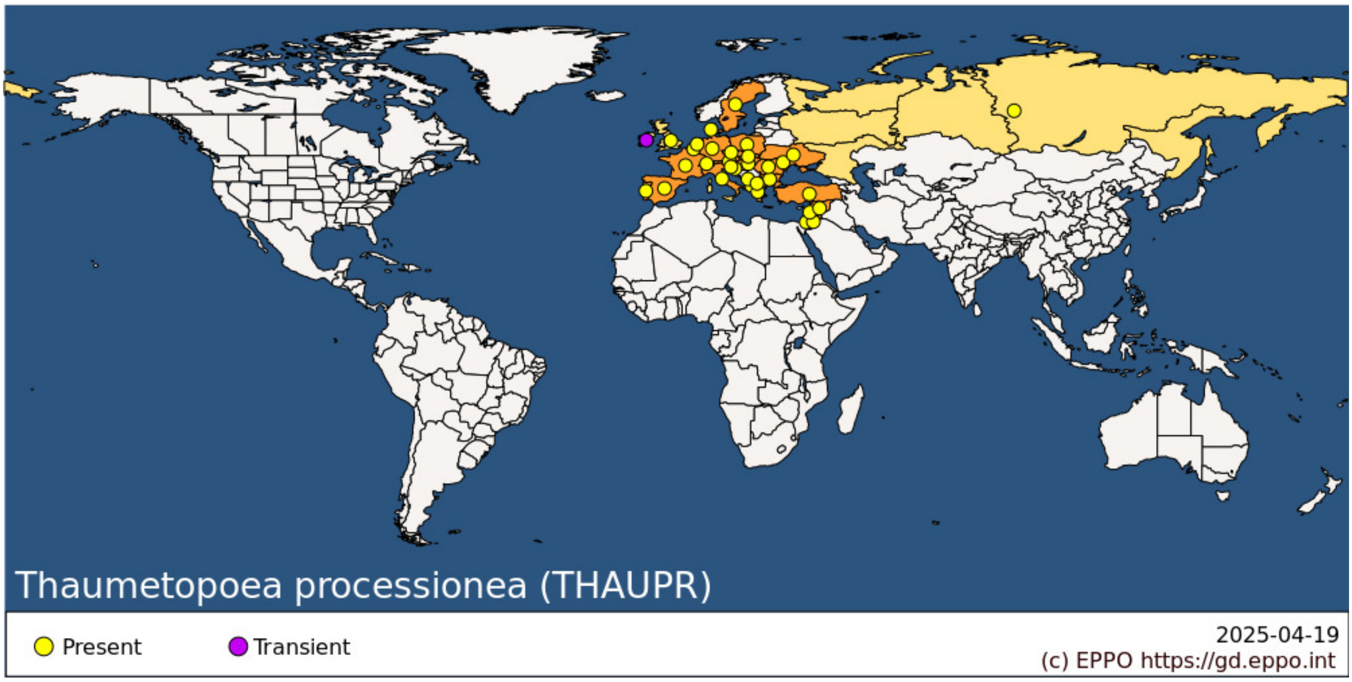
During population outbreaks, other species belonging to genera such as *Acacia*, *Fagus*, *Betula*, *Crataegus*, *Juglans*, *Pistacia*, *Robinia*, *Sorbus* or even *Pinus* have been affected; nevertheless, this pest can complete its development only on *Quercus* spp. and *Fagus* spp. (Nicosia, 1923; Kiriukhin, 1946; Bay, 1961; Carter, 1984; Stigter *et al*. 1997; Evans 2007).

Host list: *Acacia*, *Betula*, *Crataegus*, *Fagus*, *Juglans*, *Pinus*, *Quercus calliprinos*, *Quercus cerris*, *Quercus frainetto*, *Quercus ilex*, *Quercus infectoria subsp. veneris*, *Quercus petraea*, *Quercus pubescens*, *Quercus pyrenaica*, *Quercus robur*, *Quercus rubra*, *Sorbus*

GEOGRAPHICAL DISTRIBUTION

T. processionea is present in almost all European countries and also in parts of the Middle East, including Israel, Lebanon and Jordan (Maksymov, 1978; Bogenschütz *et al.* 1988; Stigter & Romejin, 1992; Roskams, 1995; Mirchev *et al.*, 2011; Roversi, 2008; Groenen, 2010; Groenen & Meurisse, 2012). *T. processionea* is present in all countries located on the northern shore of the Mediterranean Sea, in Anatolia (Turkey), and in the mountains surrounding the Dead Sea (Groenen & Meurisse, 2012). In the north of Europe, this species is present in the Netherlands, Germany and Ukraine while recently it has been rediscovered in Poland after a long period of absence (Groenen & Meurisse, 2012). Males of this species have also been caught in Denmark and Sweden (Skule & Vilhelmsem, 1997; Lövgren &

Dalsved, 2005). Finally, this species was caught in the United Kingdom for the first time in 2006, which was considered quite likely to be due to the international plant trade (Baker *et al.*, 2009; Mindlin *et al.*, 2012).



EPPO Region: Albania, Austria, Belgium, Bulgaria, Croatia, Czechia, Denmark, France (mainland), Germany, Greece (mainland), Hungary, Ireland, Israel, Italy (mainland), Jersey, Jordan, Moldova, Republic of, Montenegro, Netherlands, North Macedonia, Poland, Portugal (mainland), Romania, Russian Federation (the), Slovakia, Slovenia, Spain (mainland), Sweden, Switzerland, Türkiye, Ukraine, United Kingdom
Asia: Israel, Jordan, Lebanon, Syrian Arab Republic

BIOLOGY

T. processionea is univoltine, with the eggs hatching in spring (April to May) depending closely on the temperatures of the preceding period (Pascual, 1988; Custers, 2003, Wagenhoff and Delb, 2011; Meurisse *et al.*, 2012; Wagenhoff *et al.*, 2013), and highly synchronized with oak bud flushing (Stigler *et al.*, 1997; Wagenhoff & Veit, 2011; Wagenhoff *et al.*, 2013; Damestoy *et al.*, 2020). Larvae go through six instars and may feed until the end of June or the start of July, depending on ambient temperatures as higher temperatures favour a more rapid development (Dissescu & Ceianu, 1968). Larvae live in groups, with younger ones moving and feeding during daytime, and older ones feeding during the night as they spend the daytime in a silk tent (Schmidt, 1974; Wagenhoff *et al.*, 2013). From the 3rd instar onwards, *T. processionea* larvae develop urticating setae on the dorsal parts of the abdomen, which are actively released once larvae are disturbed (Lamy, 1990; Maier *et al.*, 2004; Battisti *et al.*, 2011; Petrucco Toffolo *et al.*, 2014). The silk tent is located on the lower part of the trunk, and is constructed during the fifth or sixth instars using silk, hairs, faeces and old larval skins (Battisti *et al.* 2015). Under very warm conditions, tents can be even partially on the ground (Dissescu & Ceianu, 1968).

The population fluctuations of *T. processionea* are largely considered unpredictable, and thus there is still a great debate as to whether their epidemics are cyclic or eruptive (Pascual, 1988; Krehan, 1993; Tomiczek & Krehan, 1996; Wagenhoff & Veit, 2011). However, recently it has been shown that fluctuations are mostly determined by aridity in May-July (Klapwijk *et al.*, 2013; Csóka *et al.*, 2018), and the changing climate appears to be linked to the increase in frequency and intensity of the observed outbreaks (Stigler *et al.*, 1997; Maier *et al.*, 2004; Jans & Franssen, 2008; Moraal & Jagers op Akerhuis, 2011; Groenen & Meurisse, 2012).

DETECTION AND IDENTIFICATION

Symptoms

The main signs of occurrence of *T. processionea* in an oak forest are the following:

- Skeletonized remains of leaves.
- White silken nests at the base of lower branches, on the trunk or at the base of the trunk. Later on, these nests become less bright white due to the shed skins that larvae change during instars.
- Nose-to-tail processions of the caterpillars on the branches of oak trees.

Morphology

Eggs

Eggs are laid by females in batches of 50-200 eggs which are covered by scales. Predominantly these egg batches are laid in rows along the terminal branches of oak trees, most commonly on one- or two-year-old twigs (Dissescu & Ceianu, 1968; Maksymov, 1978; Bin & Tiberi, 1983; Pascual, 1988; Tsankov *et al.*, 1991).

Larva

Larvae go through six larval stages that differ in size and colour, with the newly emerged larvae being brown, and the later instars becoming grey. The 1st instars overwinter within the eggs, and hatch in mid- or late April, just before bud burst. The 3rd instar, larvae which are disturbed produce barbed, urticating setae from the eleventh dorsal segment, that contain thaumetopoein, an allergenic protein. The next larval stages produce urticating setae in other segments (in the 4th instar they are produced in both the 10th and 11th segment, while in the 5th and 6th instars, setae are produced in all abdominal segments). The 5th or 6th instar, larvae build the silken nests.

Pupa

Pupation takes place inside the nests, with the larvae spinning cocoons during mid-summer (late June, early July).

Adult

Adult moths have grey forewings, with white and grey marking, and a wingspan that can be up to approximately 30 mm.

Some diagnostic features for *T. processionea* are included in the EPPO Diagnostic Protocol PM 7/37 *Thaumetopoea pityocampa* (EPPO, 2004).

Detection and inspection methods

Monitoring of *T. processionea* is based on egg and nest counting, visual assessment of the level of tree defoliation (Moller, 2006) or on the use of pheromone traps to assess population dynamics (Bogenschütz 1998b; Breuer *et al.*, 2003; Fransen *et al.*, 2008; Williams *et al.*, 2013).

PATHWAYS FOR MOVEMENT

The pathways that oak processionary moth employs when expanding to new territories include both natural spread and human-mediated transport.

Males are generally considered strong flyers (up to 100 km per year), as in some cases they have been found in light traps far away from places where nests have been reported (Stigter *et al.*, 1997; Lövgren & Dalsved, 2005). On the contrary, females fly much shorter distances, reaching only up to 20 km per year (Stigter *et al.*, 1997).

However, the major pathways that *T. processionea* follows when expanding are human-mediated. Plants-for-planting can be a source of egg masses, larvae or pupae (pupae may be present in nests from April to July). The presence of nests can easily escape attention, as at low population densities, nests are not larger than the size of a tennis ball, something that makes it more difficult to be detected particularly in the case of larger trees (Stigter *et al.*, 1997). Additionally, transported oak roundwood with bark from infested trees may have small nests that contain viable larvae and/or pupae (from April to late July). Nevertheless, it should be noted that, given the fact that oak trees are normally felled during winter, the probability to already have nests with living larvae and pupae is low. Finally, *T. processionea* may expand its distribution through the trade of cut branches of host trees, though this pathway is of much lesser importance compared to the above-mentioned ones.

PEST SIGNIFICANCE

Economic impact

Though the exact impact of *T. processionea* on tree health remains relatively unknown, repeated defoliation in spring increases tree susceptibility to drought and secondary pests and reduces earlywood width (Blank, 1997; Chauvel, 2000; McManus & Csóka, 2007; Nageleisen, 2008; Roversi, 2008; Hirka *et al.* 2011). Moreover, the infestation by *T. processionea* has been hypothesized to be associated with oak decline which has repeatedly emerged during the past centuries and particularly in the most recent decades. This syndrome of oak decline has been attributed to single or combined effects of abiotic and biotic factors, among which defoliating insects seem to play a significant role (Thomas *et al.*, 2002). However, the exact impact of these biotic factor still needs to be further evaluated.

In addition to the effect on forest health, outbreaks of *T. processionea* have an even greater impact on health due to the urticating setae the larvae produce after the 3rd larval stage that cause ocular and respiratory problems in animals and humans (Lamy, 1990; Maier *et al.*, 2004; Gottschling & Meyer, 2006; Jans & Franssen, 2008; Green 2015; Battisti *et al.* 2011; Petrucco Toffolo *et al*., 2014; Battisti *et al*. 2017).

Control

A variety of different natural enemies have been described to regulate the populations of *T. processionea* in natural stands (Battisti *et al.*, 2015). These range from egg-, larvae- and pupae-specific parasitoids (Stratan, 1971; Tschorsnig, 1993; Stigter *et al.*, 1997; Zwakhals, 2005) to generalist insect predators (Maksymov, 1978; Dajoz, 2000) and birds (Wagenhoff *et al.*, 2013). In addition to these, late instar larvae and pupae have been found to be infected by microsporidia (Hoch *et al.*, 2008) and nuclear polyhedrosis baculovirus (Murphy *et al.*, 1995). Nevertheless, it should be noted that the influence of these natural enemies on the populations oak processionary moth has been investigated only at a qualitative and not quantitative perspective and thus, none of these approaches has been evaluated in their efficacy to control the populations of *T. processionea*.

The only method that is currently used to control the population outbreaks of *T. processionea* is based on the use of *Bacillus thuringiensis* var. *kurstaki* (B.t.k.) agents (Bogenschütz, 1988; Bogenschütz 1998a; Bub *et al.* 2005; Fransen *et al.*, 2008) and insect growth regulators (Pascual *et al.*, 1990; Stigter *et al.*, 1997). These approaches are primarily implemented in highly frequented public places in order to avoid the impact of urticating setae, and secondarily to protect infested oak stands from repeated defoliation. In addition, the physical removal of nests can be effective, in areas where the level of infestation is limited.

Phytosanitary risk

Though the exact impact of *T. processionea* on the health of oak stands and its contribution to the general syndrome of oak decline is still under investigation, the effects on human and animal health have been clearly shown.

PHYTOSANITARY MEASURES

Due to the natural dispersal ability of the species in concert with its broad distribution in Europe, it is highly unlikely that any phytosanitary measures could effectively prevent the natural dispersal of the oak processionary moth. However, measures aimed at plants-for-planting could reduce the probability of introduction in areas where it is currently absent or under control.

Examples of phytosanitary measures for *T. processionea* have been applied in the European Union (EU, 2019) where protected zones have been identified (i.e. Ireland and some areas of the United Kingdom). For these areas, oak trees that are used as plants-for-planting of a girth of at least 8 cm measured at 1.2 m height from the root collar should be examined. In addition oak trees should have a certificate that these plants have been grown throughout their life a) in places of production where *T. processionea* is not known to occur, b) in an area free from *T. processionea* established by the NPPO in accordance with ISPM 4 (2017) and c) in a site with complete physical protection against the introduction of *T. processionea* and have been inspected at appropriate times and found to be free from this pest.

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CABI resources used when preparing this datasheet

CABI Datasheet on *Thaumetopoea processionea* (available at https://www.cabi.org/isc/datasheet/53502)

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