EPPO Datasheet: *Thaumetopoea pityocampa*

Last updated: 2020-11-26

IDENTITY

Preferred name: *Thaumetopoea pityocampa*
Authority: (Denis & Schiffermüller)
Taxonomic position: Animalia: Arthropoda: Hexapoda: Insecta: Lepidoptera: Notodontidae
Other scientific names: *Cnethocampa pityocampa* (Denis & Schiffermüller)
Common names: pine processionary, pine processionary caterpillar, stone-pine processionary caterpillar
view more common names online...
EU Categorization: PZ Quarantine pest (Annex III)
EPPO Code: THAUPI

more photos...

Notes on taxonomy and nomenclature

The genus name *Thaumetopoea* originates from the Greek words “?????” (=miracle) and “????” (=do), quite likely due to some biological traits that seems remarkable as for example 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 on the other hand is much more straightforward, as *pitus* is Aleppo Pine (*Pinus halepensis*) and *campa* is larva in Ancient Greek (Roques and Battisti, 2015).

HOSTS

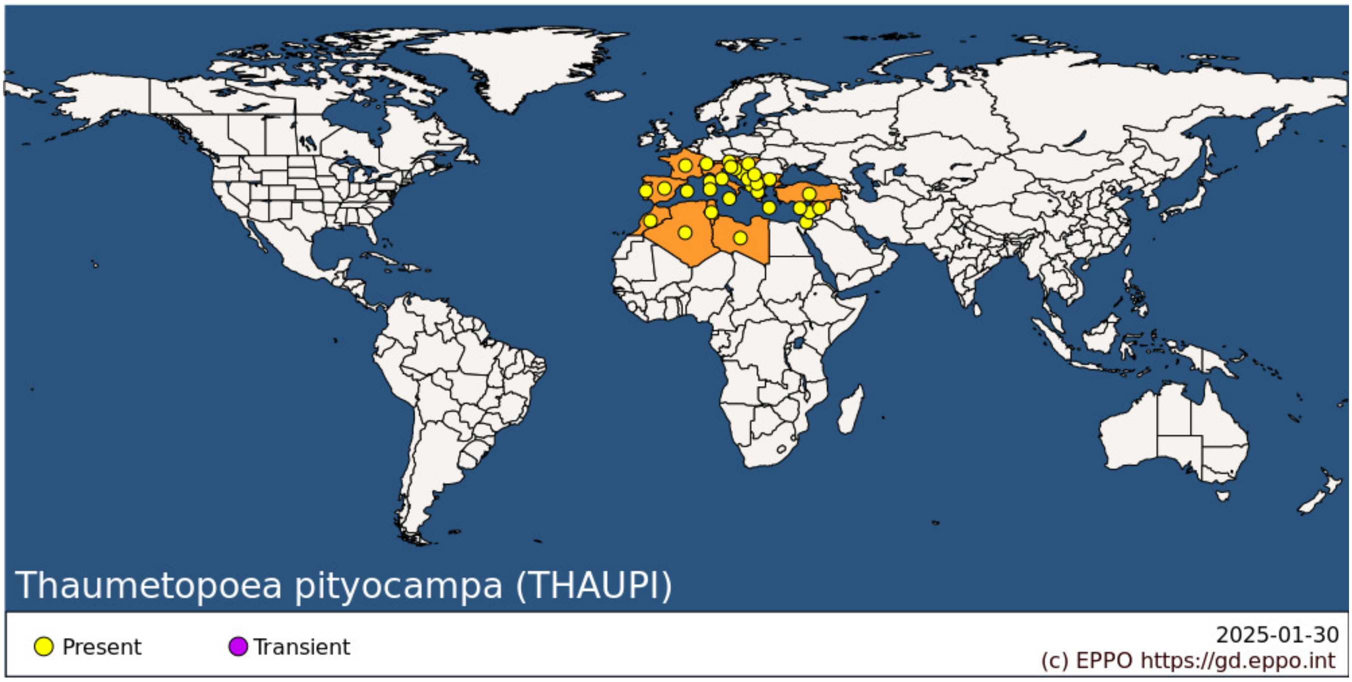
Thaumetopoea pityocampa is considered oligophagous on *Pinus* and *Cedrus*, both native European and introduced species, while it can also occasionally attack *Pseudotsuga menziesii*, *Larix decidua* and *Abies concolor* (Battisti 1988; Masutti and Battisti, 1990; Martin 2005; Zamoum and Démolin, 2005; Pimentel *et al.*, 2006; Stastny *et al.*, 2006; Mirchev *et al.*, 2007; Jacquet *et al.*, 2013; Sebti and Chakalli, 2014; Battisti *et al.* 2015, Jactel *et al.* 2015). Even within the same genus, species vary in susceptibility, due to physical features (dimensions, morphology) and chemical composition of needles (Schopf and Avtzis, 1987; Devkota and Schmidt, 1990), that influences larval development and growth (Avtzis, 1986; Hódar *et al.*, 2002; Petrakis *et al.*, 2005). Based on their susceptibility, Demolin first (1969a) concluded a list of the preferred host species, that was later on revised by EPPO (2004) and currently includes (in order of preference): *Pinus nigra* var. *austriaca, P. sylvestris, P. nigra* var. *laricio, P. pinea, P. halepensis, P. pinaster, P. canariensis*, followed by *Cedrus atlantica* and finally *Larix decidua*.

However, it should be mentioned that differences in host selection do not necessarily apply outside the regions where the pest were originally observed. For example, *Cedrus* has been observed to remain undamaged in the Mont Ventoux area (France), but is infested with high population levels of the pest in North Africa (Géri, 1980).

Host list: *Cedrus atlantica*, *Larix decidua*, *Pinus brutia*, *Pinus canariensis*, *Pinus halepensis*, *Pinus nigra subsp. laricio*, *Pinus nigra*, *Pinus pinaster*, *Pinus pinea*, *Pinus radiata*, *Pinus sylvestris*

GEOGRAPHICAL DISTRIBUTION

T. pityocampa has long been considered a circum-Mediterranean pest, with climatic parameters limiting its broader occurrence (Huchon and Démolin, 1970; Battisti *et al.*, 2005). However, in the last decades, human-mediated transport (Robinet *et al.*, 2011) in concert with the observed increase in temperature has allowed the pine processionary moth to expand its range both in elevation and latitude (Hódar & Zamora, 2004; Battisti *et al.*, 2005; Buffo *et al.*, 2007; Robinet *et al.*, 2007; Robinet *et al*., 2013; Roques *et al.* 2015).



EPPO Region: Albania, Algeria, Austria, Bosnia and Herzegovina, Bulgaria, Croatia, Cyprus, France (mainland, Corse), Greece (mainland, Kriti), Hungary, Israel, Italy (mainland, Sardegna, Sicilia), Montenegro, Morocco, North Macedonia, Portugal (mainland), Serbia, Slovenia, Spain (mainland, Islas Baleares), Switzerland, Tunisia, Türkiye
Africa: Algeria, Libya, Morocco, Tunisia
Asia: Israel, Lebanon, Syria

BIOLOGY

T. pityocampa is normally a univoltine species, with the main feeding activity taking place during winter, contrary to other congeneric species and defoliators in general. However, the life cycle may extend up to two years (semivoltine) in specific parts of its range (e.g. the mountains of Corsica) (Géri, 1983). Recently, an atypical population of *T. pityocampa* was discovered in a plantation of maritime pine in Portugal, with its larvae feeding during summer (Pimentel *et al.*, 2006; Santos *et al.*, 2007; Pimentel *et al.*, 2010).

In general, the life cycle of this pest consists of two phases, one aerial (egg, caterpillar and adult) and one hypogeal (pupa). Depending on the environmental conditions (Géri 1980; Zovi *et al*., 2008; Pimentel *et al.* 2012) females lay about 150-350 eggs in helicoid-arranged batches on needles or twigs at the periphery of the crown, which they then cover with scales. Eggs hatch 30-45 days afterwards, with young larvae boring a very distinctive opening in the chorion of the egg. Larvae from the same egg batch are full siblings and their development goes through five instars. Right after hatching, larvae begin building silk tents which gradually become larger and thicker until the 4th instar, when they build their definitive winter tent which is situated at the branch tips in the upper part of the crown. From the 3rd instar, larvae develop urticating setae which they actively release when disturbed, causing severe allergic reactions in humans and other vertebrates (Démolin 1963; Kaszak *et al.* 2015; Moneo *et al.*,2015; Battisti *et al.* 2017). For later instars, each silk tent may contain aggregates of several hundred individuals (Battisti *et al.* 2015).

Larvae of the 5th instar leave trees in a typical head-to-tail procession in search for a suitable site (e.g. open areas, forest edges) to tunnel underground and pupate in the soil (Démolin, 1969b; Démolin, 1971). A colony was observed to travel 37 m in 2 days in a cold mountainous area of Spain, the first 35 m being covered during the first day (Robredo, 1963). Typically, these processions occur between February and May, though they may appear in December at warmer sites and years (Battisti *et al.*, 2015).

Pupation takes place at a depth of about 5-20 cm and pupae enter diapause which is interrupted one month before adult emergence. However, a certain proportion of pupae may not yield adults in the year of pupation, and experience a prolonged diapause that can be extended over several years (Démolin, 1969b; Géri *et al.*, 1983; Vega *et al.*, 1999; Démolin, 1990; Salman *et al.*, 2016; Salman *et al.*, 2018).

A few hours after the emergence of the adults from the soil, they mate and females oviposit on the nearest pines. Males however, can fly several kilometres (Battisti *et al.*, 2005; Mirchev and Geshev, 2013), something critical for the currently observed northward expansion of the species due to combined effect of climate change and human-mediated long-distance spread (Battisti *et al.* 2005; Robinet *et al.*, 2007; Robinet *et al.*, 2011).

DETECTION AND IDENTIFICATION

Symptoms

The symptoms attributed to *T. pityocampa* infestation in pine stands change during the course of the year depending on the development stage of the insect. The most striking symptoms of *T. pityocampa* infestation are the partially or completely defoliated branches of the host trees, as first instar larvae feed on the current-year needles near the egg batches, and gradually switch over to older needles for the later instars. The partially consumed needles gradually turn to yellow and brown, remaining attached on the twigs.

The typical silken communal tents can be distinctly observed from a distance on branches, while on younger trees, these tents are located in the upper part of the crown. The nests are 12–25 cm long, usually oblong in shape and white to light grey in colour.

Pupal cocoons can be found in the upper layers of the soil mostly during spring (late February to late May), whereas under unfavourable condition, pupae may enter a prolonged diapause lasting up to three years. Adults finally, emerge in mid to late summer (June to end of August).

Morphology

Eggs

Individual eggs are spherical and white, and the female lays them in typical cylindrical egg-masses which are 25–40 mm wide and about 5 mm high and can contain 70–300 eggs in total. Egg masses are covered with scales produced by the female from the tip of her abdomen and are a grey-brown colour which resembles the branches so they are well camouflaged.

Larva

The larvae develop through five instars, which are mainly identified by differences in head capsule width that remains black throughout the instars. The body of the 1st instar larva is dull apple-green, with a head capsule width that ranges between 0.6-0.8 mm. In the 2nd instar, the larval body becomes brownish, and the head capsule width may increase to 1.00 mm. After the second moult (3rd instar), larvae assume their typical appearance with the reddish dorsal urticating hair patches on each body segment appearing arranged in pairs. The pleural setae vary from white to dark-yellow, while the dorsal setae range from yellow to dull orange. The head capsule width of the 3rd instar larvae varies between 1.3 and 1.6 mm. In the 4th instar the width of head capsule reaches 2.3-2.6mm, whereas in the 5th instar this can be doubled, (up to 5mm). The fully-grown larva of the 5th instar is about 40 mm in length.

Pupa

The pupa is in an oval, brown-white silken cocoon. The obtect pupae are about 20 mm in length, oval, and a pale brownish-yellow that later turns to dark reddish-brown.

Adult

Male and female moths have a wing-span of 30-40 mm and 35-50 mm, respectively. Antennae are filiform in females and pectinate in males, but they both have a hairy thorax. In females, the abdomen is stout and its last segments are covered with a tuft of large scales with which they cover the egg batches, while the abdomen of males is brushy and sharp. The forewings are dull ashen-grey; the veins, margins and three transverse bands are darker. The hindwings are white, grey-fringed, with a characteristic dark spot in the anal region.

For further details, see the EPPO Diagnostic Protocol PM 7/37 *Thaumetopoea pityocampa* (EPPO, 2004), Avtzis *et al.* (2013) and Battisti *et al.* (2015).

Detection and inspection methods

T. pityocampa adults prefer taller trees which are located at stand edges (Démolin, 1969a; Démolin, 1969b; Samalens and Rossi, 2011; Dulaurent *et al.*, 2012) that can be associated with higher solar radiation (Buffo *et al.*, 2007) but also with the proximity to open forest areas where pupae burial takes place (Barbaro *et al.*, 2007; Dulaurent *et al.*, 2011). As a consequence, the cylindrical egg batches are easily detectable as they are situated at the lower branches and needles of the crown. Silk tents, particularly those of the later instars which are located on the upper part of the crown, are also clearly visible and typical for the species. Finally, both sexes are attracted to UV light traps, while males can be captured using traps baited with sex pheromones.

PATHWAYS FOR MOVEMENT

Though initially it was assumed that female flight is limited compared to male based on release-recapture field trials (Démolin, 1969b), recent studies in a flight mill found that female flight averaged about 5km, with a maximum distance of 27 km (Battisti *et al.*, 2005). Recently however, it has been shown that, in addition to natural dispersal, human-mediated transportation plays a decisive role in the expansion of the species over long distances (Robinet *et al.*, 2011). However, the risk of human-mediated transport is not uniform in all stages; eggs and larvae can be easily detected on imports while adults are highly unlikely to be present on imported plants. Pupae, on the other hand, may be transported with plants for planting as they are buried in the attached growing medium or soil and thus any plant cultivated near an area where *T. pityocampa* is present may harbour pupae (Starzewski, 1998). The impact of this pathway is magnified by climate change, as previously unfavourable environmental conditions become suitable for *T. pityocampa* (Robinet *et al.*, 2007). From 1972 to 2004, *T. pityocampa* has expanded northwards in France by 87 km and in altitude by 110-230 m (in Italy) (Battisti *et al.*, 2005).

PEST SIGNIFICANCE

Economic impact

T. pityocampa is one of the most important forest pests throughout the temperate regions of the Mediterranean basin, infesting mainly pine but also cedar trees (the latter in North Africa). Defoliation caused by *T. pityocampa* significantly impairs the vitality of host trees, affecting both their growth (Cadahía and Insua, 1970; Carus, 2004; Jacquet *et al.*, 2013) and their susceptibility to other secondary, bark and wood boring insects (Masutti & Battisti, 1990; Zamoun, 2002).

In recreational and residential areas infestation by *T. pityocampa* has an additional aesthetic impact, in addition to the severe deterioration of the trees and greater maintenance costs. The urticating setae that larvae develop from the 3rd instar onward induces a variety of allergic reactions such as skin irritation, conjunctivitis, respiratory congestions and asthma in humans and animals (Vega *et al.*, 1999; Battisti *et al.*, 2011; Vega *et al.*, 2011). These effects occur not only when the caterpillars are present, but also during the following summer because of the persistence of allergenic setae in the remains of winter nests (Moneo *et al.*, 2015). This problem not only affects recreational and residential areas but also hinders sylvicultural operations and grazing in forests (Marti Morera and Barri Baya, 1959).

Control

Chemical control treatment initially involved the application of DDT (Grison *et al.*, 1959) that was soon replaced by Diflubenzuron (Robredo, 1980; Démolin and Millet, 1983; Démolin *et al.*, 1993) and pyrethroids (Robredo and Obama, 1991) that had a reduced impact on beneficial insects. However, shortly after this, treatment based on preparations of the bacterium *Bacillus thuringiensis* HD-1 subsp. *kurstaki* were developed (Fernandez de Cordova and Cabezuolo, 1995; Démolin and Martin, 1998), the use of chemical insecticides was drastically reduced in favour of *Btk*-based products (Battisti *et al.*, 1998; Rausell *et al.*, 1999; Cebeci *et al.*, 2010), which are currently recognized as the most effective control agents against *T. pityocampa* particularly during population outbreaks.

In small areas or areas with low population densities, additional alternative control approaches have been suggested and assessed. For example, mechanical control by removing egg mases and larval colonies or destroying winter tents can effectively control the population of *T. pityocampa* particularly in urban green areas (Martin, 2015), while sex pheromone traps can also be used primarily for monitoring and even for mass trapping of adults (Cadahía *et al.*, 1975; Montoya, 1984; 1988). Trunk barrier and adhesive barrier trap devices have been recently developed and evaluated with the results clearly showing their potential particularly on isolated trees (Martin *et al.*, 2012; Colacci *et al.*, 2018). Mating disruption has also been successfully tested (Martin and Frérot, 2006; Michaelakis *et al.* 2020) while the repulsive effect of volatiles emitted from broadleaf branches constitutes also an alternative and promising control approach (Jactel *et al.*, 2011; Jactel *et al.*, 2012).

Natural populations of *T. pityocampa* are effectively regulated by a number of parasitoids and predators (Biliotti, 1958; Biliotti *et al.*, 1965; Cadahía *et al.*, 1967; Démolin and Delmas, 1967; Battisti, 1989; Buxton, 1990; Tiberi *et al.*, 1991; Mirchev *et al.*, 1998; Tsankov *et al.*, 1998; Battisti *et al.*, 2000; Mirchev *et al.*, 2004; Mirchev *et al.*, 2007; Barbaro *et al.*, 2008; Branco *et al.*, 2008; Barbaro and Battisti, 2011; Charbonnier *et al.* 2014; Martin, 2015), each of which is effective against a specific development stage of *T. pityocampa*. It should be noted however that, in most of the cases, these biocontrol programs proved to be not cost-effective (Masutti *et al.*, 1993).

- **- On eggs**, the major parasitoids are *Baryscapus servadeii* and *Ooencyrtus pityocampae* and the predators *Ephippiger ephippiger* and *Barbitistes fischeri*.
- **- Larvae** are predominantly parasitized by *Phryxe caudata* and predated by *Xanthandrus comtus* while later instars are also effectively attacked by tits (*Parus* sp.). Entomopathogenic organisms affecting larvae also include cytoplasmic and nuclear viruses, nematodes and fungi, some of which have shown promising results that should however be further explored (Vago, 1958; Atger, 1964; Triggiani and Tarasco, 2002; Er *et al.*, 2007).
- **- Pupae** are mostly parasitized by *Villa brunnea* and *Coelichneumon rudis*, while their most common predator is hoopoe *Upupa epops.*
- **- Adults** are effectively hunted by bats, which has been increasingly studied in recent years (Garin *et al.*, 2019).

Phytosanitary risk

T. pityocampa is not listed as a quarantine pest by EPPO or by any National Plant Protection Organization in the EPPO region. Within the EPPO region *T. pityocampa* is likely to be a damaging pest primarily in pine forests of the Mediterranean region but also in stands of the other hosts as well. Currently, it is not present only on a few islands (e.g. the Canary Islands are protected by phytosanitary measures taken by the Spanish Department of Agriculture). *T. pityocampa* is a risk for any region that has Mediterranean climate and where *Pinus* or the other host species are either native or planted.

PHYTOSANITARY MEASURES

Plants for planting of the host genera, with a particular focus on *Pinus*, should be inspected for the presence of egg masses and larval colonies of *T. pityocampa*. In the same manner, nursery plants with attached soil or growing medium should be inspected for the presence of pupae. It should be noted, that pupae could be associated with any plant for planting from an infested area, not just the host species, as they can be found in the soil or growing medium attached to them. Ideally, consignments of plants for planting, in particular those with attached growing medium, should come from an area and its surroundings that are free from *T. pityocampa*.

REFERENCES

Atger P (1964) Rôle d'un enchaînement virus-bactérie dans le déclenchement d'épizootie chez *Thaumetopoea pityocampa* Schiff. *Comptes Rendus de l'Académie des Sciences* Série D 258, 2430-2432.

Avtzis N (1986) Development of *Thaumetopoea pityocampa* Schiff. (Lepidoptera: Thaumetopoeidae) in relation to food consumption. *Forest Ecology and Management* **15**, 65-68.

Avtzis ND, Avtzis DN, Vidakis KG (2013) Forest Insects of Greece. Photo/Graphs Studio EE. Drama, Greece. 383 pages. [in Greek]

Barbaro L, Rossi JP, Vétillard F, Nezan J, Jactel H (2007) The spatial distribution of birds and carabid beetles in pine planation forests: the role of landscape composition and structure. *Journal of Biogeography* **34**, 652-664.

Barbaro L, Couzi L, Bretagnolle V, Nezan J, Vetillard F (2008) Multiscale habitat selection and foraging ecology of the Eurasian hoopoe (*Upupa epops*) in pine plantations. *Biodiversity and Conservation* **17**, 1073-1087.

Barbaro L, Battisti A (2011) Birds as predators of the pine processionary moth (Lepidoptera: Notodontidae). *Biological Control* **56**, 107-114.

Battisti A (1988) Host-plant relationships and population dynamics of the pine processionary caterpillar *Thaumetopoea pityocampa* (Denis & Schiffermüller). *Journal of Applied Entomology* **105**, 393-402.

Battisti A (1989) Field studies on the bevavior of two egg parasitoids pf the pine processionary moth *Thaumetopoea pityocampa. Entomophaga* **34**, 29-38.

Battisti A, Longo S, Tiberi R, Triggiani O (1998) Results and perspectives in the use of *Bacillus thuringiensis* Berl. var. *kurstaki* and other pathogens against *Thaumetopoea pityocampa* (Den. et Schiff.) in Italy (Lep., Thaumetopoeidae). *Anzeiger für Schädlingskunde, Pflanzenschutz, Umweltschutz* **71**, 72-76.

Battisti A, Bernardi M, Ghiraldo C (2000) Predation by the hoopoe on pupae of T*haumetopoea pityocampa* and the likely influence on other natural enemies. *BioControl* **45**, 311-323.

Battisti A, Stastny M, Netherer S, Robinet C, Schopf A, Roques A, Larsson S (2005) Expansion of geographic range in the pine processionary moth caused by increased winter temperatures. *Ecological Applications* **15**, 2084–2096.

Battisti A, Holm G, Fagrell B, Larsson S (2011) Urticating hairs in Arthropods: their nature and medical significance. *Annual Review of Entomology* **56**, 203-220.

Battisti A, Avci M, Avtzis D, Ben Jamaa M, Berardi L, Berretima W, Branco M, Chakali G, El Alaoui El Fels M, Frérot B, Hóddar J, Ionescu-M?l?ncus I, ?pekdal K, Larsson S, Manole T, Nemer N, Paiva M, Pino J, Protasov A, Rahim N, Rousselet J, Santos H, Sauvard D, Schopf A, Simonato M, Yart A, Zamoun M (2015) Chapter 2: Natural history of the processionary moths (*Thaumetopoea* spp.) – New insights in relation to climate change. In *Processionary moths and climate change: an update* (ed Roques A), pp. 15-81. Springer Dordrecht.

Battisti A, Larsson S, Roques A (2017) Processionary moths and associated urtication risk: global change-driven effects. *Annual Review of Entomology* **62**, 323-342

Biliotti E (1958) Parasites et prédateurs de *Thaumetopoea pityocampa* (Lepidoptera). *Entomophaga* **3**, 23-24.

Biliotti E, Démolin G, Du Merle P (1965) Parasitisme de la processionaire du pin par *Villa quinquefasciata* Wied. apud Meig. (Diptère, Bombyliidae). Importance du comportement de ponte du parasite. *Annales des Epiphyties* **16**, 279-288.

Branco M, Santos M, Calvão T, Telfer G, Paiva M-R (2008) Arthropod diversity sheltered in *Thaumetopoea pityocampa* (Lepidoptera, Notodontidae) larval tents. *Insect Conservation and Diversity* **1**, 215-221.

Buffo E, Battisti A, Stastny M, Larsson S (2007) Temperature as a predictor of survival of the pine processionary moth in the Italian Alps. *Agricultural and Forest Entomology* **9**, 65–72.

Buxton RD (1990) The influence of host tree species on timing of pupation on *Thaumetopoea pityocampa* Schiff. (Lep., Thaumetopoeidae) and its exposure to parasitism by *Phryxe caudata* Rond. (Dipt., Larvaevoridae). *Journal of Applied Entomology*

109, 302-310.

Cadahía D, Démolin G, Biliotti E (1967) [*M. versicolor* var. *decoloratus*, a new parasite of *T. pityocampa*]. *Entomophaga* **12**, 355-361.

Cadahía D, Enriquez L, Sanchez A (1975) [Sexual attraction in *Thaumetopoea pityocampa* Schiff.]. *Boletín del Servicio de Defensa contra Plagas e Inspección Fitopatológica* **1**, 1-11.

Cadahía D, Insua A (1970) [Assessment of damage by *Thaumetopoea pityocampa* Schiff. in areas reforested with *Pinus radiata* D. Don.]. *Boletín del Servicio de Plagas Forestales* **26**, 159-171.

Carus S (2004) Impact of defoliation by pine processionary moth (*Thaumetopoea pityocampa*) on radial, height and voume growth of Calabrian pine (*Pinus brutia*) trees in Turkey. *Phytoparasitica* **32**, 459-469.

Cebeci HH, Oymen RT, Acer S (2010) Control of the pine processionary moth with *Bacillus thuringiensis* in Antalya, Turkey. *Journal of Environmental Biology* **31**, 357-361.

Charbonnier Y, Barbaro L, Theillout A (2014) Numerical and functional responses of forest bats to a major insect pest in pine plantations. *PLOS One* **9**, e109488.

Colacci M, Kavallieratos NG, Athanassiou CG, Boukouvala MC, Rumbos CI, Kontodimas DC, Pardo D, Sancho J, Benavent-Fernández E, Gálvez-Settier S, Sciarretta A, Trematerra P (2018) Management of the pine processionary moth, *Thaumetopoea pityocampa* (Lepidoptera: Thaumetopoeidae), in urban and suburban areas: trials with trunk barrier and adhesive barrier trap devices. *Journal of Economic Entomology* **111**, 227-238.

Démolin G (1963) Les 'miroires' de la processionnaire du pin *Thaumetopoea pityocampa* Schiff. *Revue de Zoologie Agricole Appliquée* Nos 11-12, 8 pp.

Démolin G (1969a) Comportement des adultes de *Thaumetopoea pityocampa* Schiff. Dispersion spatiale, importance économique. *Annales des Sciences Forestières* **26**, 81-102.

Démolin G (1969b) [Bioecology of the pine processionary, *Thaumetopoea pityocampa* Schiff. Incidence of climatic factors]. *Boletín del Servicio de Plagas Forestales* **23**, 1-13.

Démolin G, Delmas JC (1967) Les Ephippigères (Orthoptères, Tettigoniidae), prédateurs occasionnels, mais importants de *Thaumetopoea pityocampa* Schiff. *Entomophaga* **12**, 399-401.

Démolin G, Millet A (1983) Le dimilin utilisé à trois doses sur la processionnaire du pin *Thaumetopoea pityocampa* Schiff. *Revue Forestière Française* **35**(2), 107-111.

Démolin G, Martin JC, Lavanceau P (1993) Lutte contre la processionnaire du pin. L'évolution des insecticides à base de *Bacillus thuringiensis*. *Phytoma* **452**, 13–16.

Démolin G, Martin JC (1998) Lutte contre la Processionnaire du pin. Efficacité et persistance d'action de deux formulations a base de *Bacillus thuringiensis*. *Phytoma* **507**,11-14.

Devkota B, Schmidt GH (1990). Larval development of *Thaumetopoea pityocampa* (Den. & Schiff.) (Lep., Thaumetopoeidae) from Greece as influenced by different host plants under laboratory conditions. *Journal of Applied Entomology* **109**, 321–330.

Dulaurent AM, Porté AJ, van Halder A, Vétillard F, Menassieu P, Jactel H (2011) A case of habitat complementation in forest pests: Pine processionary moths pupae survive better in open areas. *Forest Ecology and Management* **261**, 1069-1076.

Dulaurent AM, Porté AJ, van Halder A, Vétillard F, Menassieu P, Jactel H (2012) Hide and seek in forests: colonization by the pine processionary moth is impeded by the presence of nonhost trees. *Agricultural and Forest Entomology* **14**, 19-27.

EPPO (2004) EPPO Standards: *Thaumetopoea pityocampa*- PM7/37. *EPPO Bulletin* **34**, 295–298.

Er MK, Tunaz H, Gökçe PA (2007) Pathogenenicity of entomopathogenic fungi to *Thaumetopoea pityocampa* Schiff. (Lepidoptera, Thaumatopoeidae) larvae in laboratory conditions. *Journal of Pest Science* **80**, 235-239.

Fernandez de Cordova J, Cabezuelo P (1995) Efficacy of some active ingredients and formulations against the processionary pine moth (*Thaumetopoea pityocampa* Schiff.) by artificial contamination. *Boletin Sanidad Vegetal Plagas* **21**, 59-74.

Garin I, Aihartza J, Goiti U, Arrizabalaga-Escudero A, Nogueras J, Ibáñez C (2019) Bats from different foraging guilds prey upon the pine processionary moth. *PeerJ* **7**, e7169.

Géri C (1980) Application des méthodes d'études demecologiques aux insectes défoliateurs forestiers. Cas de *Diprion pini* L. (Hymenoptère, Diprionidae). Dynamique des populations de la processionnaire du pin *Thaumetopoea pityocampa* Schiff. (Lepidoptère, Thaumetopoeidae) dans l'île de Corse. *Thèse presentée àl'Université de Paris-Sud Centre d'Orsay pour l'obtention du grade de Docteur Es-Sciences*.

Géri C (1983) Repartition et evolution des populations de la processionnaire du pin *Thaumetopoea pityocampa* Schiff, (Lep., Thaumetopoeidae) dans les montagnes corses. I. Regimes d'apparition de l'insecte et dynamique des populations. *Oecologia Applicata* **4**, 247-268.

Grison P, Vago C, Maury R (1959) La lutte contre la processionnaire du pin, *Thaumetopoea pityocampa* Schiff, dans le massif du Ventoux. Essai d'utilisation pratique d'un virus spécifique. *Revue Forestière Française* **5**, 353–370.

Hódar JA, Zamora R, Castro J (2002) Host utilization by moth and larval survival of pine processionary caterpillar *Thaumetopoea pityocampa* in relation to food quality in three *Pinus* species. *Ecological Entomology* **27**, 292-301.

Hódar JA, Zamora R (2004) Herbivory and climatic warming, a Mediterranean outbreaking caterpillar attacks a relict, boreal pine species. *Biodiversity and Conservation* **13**, 493-500.

Huchon H, Démolin G (1970) La bioécologie de la processionnaire du pin. Dispersion potentielle – Dispersion actuelle. *Revue Forestière Francaise* **22**, 220–234.

Jacquet J-S, Bosc A, O'Grady AP, Jactel H (2013) Pine growth response to processionary moth defoliation across a 40-year chronosequence. *Forest ecology and management* **293**, 29-38.

Jactel H, Barbaro L, Battisti A, Bosc A, Branco M, Brockerhoff E, Castagneyrol B, Dulaurent A-M, Hódar JA, Jacquet J-S, Mateus E, Paiva M-R, Roques A, Samalens J-C, Santos H, Schlyter F (2015) Chapter 6: Insect – tree interactions in *Thaumetopoea pityocampa*. In *Processionary moths and climate change: an update* (ed Roques A), pp. 265-310. Springer Dordrecht.

Jactel H, Birgersson G, Andersson S, Schlyter F (2011) Non host volatiles mediate associational resistance to pine processionary moth. *Oecologia* **166**, 703-711.

Jactel H, Branco M, Duncker P, Gardiner B, Grodzki W, Langstrom B, Moreira F, Netherer S, Nicoll B, Orazio C, Piou D, Schelhaas M, Tojic M (2012) A multicriteria risk analysis to evaluate impacts of forest management alternatives on forest health in Europe. *Ecology and Society* 17(4), 52.

Kaszak I, Planellas M, Dworecka-Kaszak B (2015) Pine processionary caterpillar, *Thaumetopoea pityocampa* Denis and Schiffermüller, 1775 contact as a health risk for dogs. *Annals of Parasitology* **61**(3), 159-163.

Marti Morera A, Barri Baya PN (1959) [Contribution to study of allergic diseases: clinical study of the disease originated to equine and ovine stocks by the pine and oak processionary caterpillars (*Thaumetopoea pityocampa, Th. processionea*). *Noticias Neosanitarias* **95**, 33-50.

Martin JC (2005) La processionnaire du pin, *Thaumetopoea pityocampa* (Dennis et Schiffermüller). Biologie et protection des forêts. Synthèse des recherches bibliographiques et des connaissances, INRA Avignon, France, 62p.

Martin JC, Frérot B (2006) Evolution de la lute contre la processionnaire du pin: vers l'utilisation de la pheromone de synthèse. *Les Cahiers du DSF* **1**, 29-31.

Martin JC, Leblond A, Brinquin AS, Decoin M (2012) Processionaire du pin, revue des méthodes alternatives. *Phytoma* **657**, 13-21.

Martin JC (2015) Development of environmental-friendly strategies in the management of processionary moths. In *Processionary moths and climate change:an update* (ed Roques A), pp. 411-427. Springer Dordrecht.

Masutti L, Battisti A (1990) *Thaumetopoea pityocampa* (Den. & Schiff.) in Italy bionomics and perspectives of integrated control. *Journal of Applied Entomology* **110**, 229-234.

Masutti L, Battisti A, Milani N, Zanata M, Zanazzo G (1993) In vitro rearing of *Ooencyrtus pityocampae* (Mercet) (Hym., Encyrtidae). Preliminary note. *Entomophaga* **38**, 327-333.

Michaelakis A, Anastasaki A, Milons PG, Papachristos DP, Kontodimas D, Pontikakos CM< Raptopoulo DG, Babilis NA, Konstantopoulou MA (2020) Efficacy of communication disruption of *Thaumetopoea pityocampa* (Lepidoptera: Thaumetopoeidae) with low pheromone formulation. *Hellenic Plant Protection Journal* **13**, 42-53.

Mirchev P, Schmidt GH, Tsankov G (1998) The egg parasitoids of the pine processionary moth *Thaumetopoea pityocampa* (Den. And Schiff.) in the Eastern Rhodope, Bulgaria. *Bolletino di Zoologia Agraria e di Bachicoltura* **30**, 131-140.

Mirchev P, Schmidt GH, Tsankov G, Avci M (2004) Egg parasitoids of *Thaumetopoea pityocampa* (Den. And Schiff.) (Lep., Thaumetopoeidae) and their impact in SW Turkey. *Journal of Applied Entomology* **128**, 533-542.

Mirchev P, Tsankov G, Avci M, Matova M (2007) Study of some aspects of ecology of pine processionary moth, *Thaumetopoea pityocampa* (Den. & Schiffe.) (Lep., Thaumetopoeidae) and its egg parasitoids in Turkey. *Silva Balcanica* **8**, 66-78.

Mirchev P, Geshev G (2013) Dispersal of male butterflies of pine processionary moth (*Thaumetopoea pityocampa*). *Silva Balcanica* **14**(1), 102-108.

Moneo I, Battisti A, Dufour B, García-Ortiz JC, González-Muñoz M, Moutou F, Paolucci P, Petrucco-Toffolo E, Rivière J, Rodríguez-Mahillo A-I, Roques A, Roques L, Vega JM, Vega J (2015) Medical and veterinary impact of the urticating processionary larvae. In *Processionary moths and climate change:an update* (ed Roques A), pp. 359-410. Springer Dordrecht.

Montoya R (1984) [Description of a new trap model for capturing males of the pine processionary moth]. *Boletín de la Estación Central de Ecología* **13**, 99-103.

Montoya R (1988) [An example of pheromone application: the pine processionary moth]. In: [*Biorational insecticides*]. Consejo Superior de Investigaciones Científicas, Madrid, Spain.

Petrakis PV, Roussis V, Papadimitriou D, Vagias C, Tsitsimpikou C (2005) The effect of terpenoid extracts from 15 pine species on the feeding behavioral sequence of the late instars of the pine processionary caterpillar *Thaumetopoea pityocampa*. *Behavioural Processes* **69**, 303-322.

Petsopoulos D, leblois R, Sauné L, ?pekdal K, Aravanopoulos FA, Kerdelhué C, Avtzis DN (2018) Crossing the Mid-Aegean Trench: vicariant evolution of the Eastern pine processionary moth *Thaumetopoea wilkinsoni* (Lepidoptera: Notodontidae), in Crete. *Biological Journal of the Linnean Society* **124**, 228-236.

Pimentel C, Calvao T, Santos M, Ferreira C, Neves M, Nilsson J-Å (2006) Establishment and expansion of a *Thaumetopoea pityocampa* (Den. & Schiff.) (Lep. Notodontidae) population with a shifted life cycle in a production pine forest, Central-Coastal Portugal. *Forest ecology and management* **233**, 108-115.

Pimentel C, Ferreira C, Nilsson JÅ (2010) Latitudinal gradients and the shaping of life-history traits in a gregarious caterpillar. *Biological Journal of the Linnean Society* **100**, 224-236.

Pimentel C, Santos M, Ferreira C, Nilsson J-Å (2012) Temperature, size, reproductive allocation, and life-history evolution of a gregarious caterpillar. *Biological Journal of the Linnean Society* **105**, 340-349.

Rausell C, Martinez-Ramirez AC, Garcia-Robles I, Real MD (1999) The toxicity and physiological effects of *Bacillus thuringiensis* toxins and formulations on *Thaumetopoea pityocampa*, the pine processionary caterpillar. *Pesticide Biochemistry Physiology* **65,** 44–54

Robinet C, Baier P, Pennerstorfer J, Schopf A, Roques A (2007) Modelling the effects of climate change on the potential feeding activity of *Thaumetopoea pityocampa* (Den. & Schiff.) (Lep., Notodontidae) in France. *Global Ecology and Biogeography* **16**, 460–471.

Robinet C, Imbert C-E, Rousselet J, Sauvard D, Garcia J, Goussard F, Roques A (2011) Human-mediated long-distance jumps of the pine processionary moth in Europe. *Biological invasions* **14(8)**, 1557-1569.

Robinet C, Rousselet J, Pineau P, Miard F, Roques A (2013) Are heatwaves susceptible to mitigate the expansion of a species progressing with global warming? *Ecology and Evolution* **3**, 2947-2957.

Robredo F (1963) [The pupation procession in *Thaumetopoea pityocampa* Schiff.]. *Boletín del Servicio de Plagas Forestales* **12**, 122-129.

Robredo F (1980) [Extensive treatments with diflubenzuron against the pine processionary caterpillar in Spain]. *Boletín del Servicio de Defensa contra Plagas e Inspección Fitopatológica* **6**, 141-154.

Robredo F, Obama E (1991) [Efficacy trials with cypermethrin and deltamethrin against *Thaumetopoea pityocampa* (Den. & Schiff.)]. *Informe para el Registro Oficial de Productos y Material Fitosanitario*. Archivos de la Subdirección General de Sanidad Vegetal, Madrid, Spain.

Roques A, Battisti A (2015) Chapter 1: introduction. Chapter 2: Natural history of the processionary moths (*Thaumetopoea* spp.) – New insights in relation to climate change. In *Processionary moths and climate change:an update* (ed Roques A), pp. 1-13. Springer Dordrecht.

Roques A, Rousselet J, Avci M, Avtzis DN, Basso A, Battisti A, Ben Jamaa M, Bensidi A, Berardi L, Berretima W, Branco M, Chakali G, Çota E, Dautbaši? M, Delb H, El Alaoui El Fels MA, El Mercht S, El Mokhefi M, Forster B, Garcia J, Georgiev G, Glavendeki? M, Goussard F, Halbig P, Henke L, Herna?dez R, Hódar JA, ?pekdal K, Jurc M, Klimetzek D, Laparie M, Larsson , Mateus E, Matoševi? D, Meier F, Mendel Z, Meurisse N, Mihajilovi? L, Mirchev P, Nasceski S, Nussbaumer C, Paiva M-R, Papazova I, Pino J, Podlesnik J, Poirot J, Protasov A, Rahim N, Sa?chez Peña G, Santos H, Sauvard D, Schopf A, Simonato M, Tsankov G, Wagenhoff E, Yart A, Zamora R, Zamoun, Robinet C (2015) Chapter 3: Climate warming and past and present distribution of the processionary moths (*Thaumetopoea* spp.) in Europe, Asia Minor and North Africa. In *Processionary moths and climate change: an update* (ed Roques A), pp. 81-163. Springer Dordrecht.

Salman MHR, Hellrigl K, Minerbi S, Battisti A (2016) Prolonged pupal diapause drives population dynamics of the pine processionary moth (*Thaumetopoea pityocampa*) in an outbreak expansion area. *Forest Ecology and Management* **361**, 375–381.

Salman MHR, Giomi F, Laparie M, Lehmann P, Battisti A (2018) Prepupal diapause synchronizes adult emergence in the pine processionary moth *Thaumetopoea pityocampa* (Lepidoptera: Notodontidae). *Agricultural and Forest Entomology* **20**, 582-588.

Samalens J-C, Rossi JP (2011) Does landscape composition alter the spatiotemporal distribution of the pine processionary moth in a pine plantation forest? *Population Ecology* **53**, 287–296.

Santos H, Rousselet J, Magnoux E, Paiva MR, Branco M, Kerdelhué K (2007) Genetic isolation through time, allochronic differentiation of a phenologically atypical population of the pine processionary moth. *Proceedings of the Royal Society of London* Serie B **274**, 935-941.

Schopf R, Avtzis N (1987) Die Bedeutung von Nadelinhaltstoffen für die Disposition von fünf Kiefernarten genenüber *Thaumetopoea pityocampa* (Schiff.). *Journal of Applied Entomology* **105**, 340–350.

Sebti S, Chakali G (2014) Distribution and importance of the pine processionary moth winter nests *Thaumetopoea pityocampa* (Denis & Schiffermüller) (Lepidoptera: Notodontidae) in the forests cedar of the national park of Chréa (Algeria). *International Journal of Agricultural Science and Research* **4**, 77-84.

Starzewski K (1998) Caterpillars of the pine processionary moth *Thaumetopoea pityocampa* ([Denis & Schiffermüller], 1775) (Lepidoptera: Thaumetopoeidae) overwintering on imported *Pinus sylvestris*. *Entomologist's Gazette* **49**, 247-248.

Stastny M, Battisti A, Petrucco?Toffolo E, Schlyter F, Larsson S (2006) Host?plant use in the range expansion of the pine processionary moth, *Thaumetopoea pityocampa*. *Ecological Entomology* **31**, 481-490.

Tiberi R, Roversi P, Bin F (1991) Egg parasitoids of pine and oak processionary caterpillars in central Italy. *Redia* **74**, 249-250.

Triggiani O, Tarasco E (2002) Efficacy and persistence of entomopathogenic nematodes in controlling larval populations of *Thaumetopoea pityocampa* (Lepidoptera, Thaumetopoeidae). *Biocontrol Science and Technology* **12**, 747-752.

Tsankov G, Schmidt GH, Mirchev P (1998) Studies on the egg parasitism of *Thaumetopoea pityocampa* over a period of four years (1991-1994) at Marikostino/Bulgaria. *Anzeiger für Schädlingskunde Pflanzenschutz Umweltschutz* **71**, 1-7.

Vago C (1958) Virose intestinal chez la processionnaire du pin *Thaumetopoea pityocampa* Schiff. (Lepidoptera). *Entomophaga* **3**, 35-37.

Vega JM, Moneo I, Armentia A, Fernández A, Vega J, De la Fuente R, Sánchez P, Sanchís ME (1999) Allergy to pine processionary caterpillar (*Thaumetopoea pityocampa*). *Clinical and Experimental Allergy* ***29***, 1418–1423.

Vega JM, Moneo I, Ortiz JCG, Palla PS, Sanchi ME, Vega J, Gonzalez-Muñoz M, Battisti A, Roques A (2011) Prevalence of cutaneous reactions to pine processionary moth (*Thaumetopoea pityocampa*) in an adult population. *Contact Dermatitis* **64**, 220-228.

Zamoun M (2002) Quelques éléments pour la préservation de la santé des forêts en Algérie. *Revue de la Forêt Algérienne* **4**, 4-7.

Zamoum M, Démolin G (2005) The life cycle of the pine processionary caterpillar in the bioclimatic conditions of a sub-Saharan region. Entomological Researches. In: *Mediterranean Forest Ecosystem*. (Eds Lieutier F, Ghaioule D). Pp 107-116. INRA Editions, Paris.

Zovi D, Stastny M, Battisti A, Larsson S (2008) Ecological costs on local adaptation of an insect herbivore imposed on host plants and enemies. *Ecology* **89**, 1388-1398.

ACKNOWLEDGEMENTS

This datasheet was prepared in 2020 by Dr. Dimitrios N. Avtzis (Forest Research Institute – Hellenic Agricultural Organization Demeter). His valuable contribution is gratefully acknowledged.

How to cite this datasheet?

EPPO (2025) *Thaumetopoea pityocampa*. EPPO datasheets on pests recommended for regulation. Available online. https://gd.eppo.int

Datasheet history

This datasheet was first published in 1997 in the second edition of 'Quarantine Pests for Europe' 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).

Co-funded by the
European Union