Thaumetopoea processionea

Scientific Name
Thaumetopoea processionea

Synonyms:
Cnethocampa processionea Linnaeus
Liparis processionea Linnaeus
Phalaena processionea Linnaeus
Thaumetopoea luctifica Staudinger and Rebel
Thaumatopoea processionea Linnaeus

Common Names
Oak processionary moth

Type of Pest
Moth

Taxonomic Position
Kingdom: Animalia, **Phylum:** Arthropoda; **Class:** Insecta, **Order:** Lepidoptera; **Family:** Thaumetopoeidae

Reason for inclusion in manual
CAPS Priority Pest (FY 2010 – FY 2013)

Pest Description
Eggs: Females will lay 100-200 eggs in single layer rows making a plaque covered in grayish scales; they are found on small branches and twigs in the host canopy (Anonymous n.d.). The eggs hatch from April to May in central and southern Europe (Townsend 2008). Eggs are oblong and covered with hairs from the female's abdomen (Stigter et al. 1997).

Figure 1. Young larvae on the egg mass [Image from Louis-Michel Nageleisen, Dèpartement de la Santè des Forêts, www.bugwood.org

Larvae: Newly hatched larvae are brown with a darker head. As they mature, their bodies lighten to a greyish color, but their heads remain dark (Anonymous n.d.). Older larvae have a dark stripe down the middle of their dorsal side with a whitish line on either side (Anonymous n.d.). Reddish-orange pinacula are

present down the length of the body with clumps of long white hairs protruding from them (Anonymous n.d.). More difficult to see, smaller, shorter hairs are also present and are approximately 0.1-0.2 mm in length (Stigter et al. 1997). These hairs contain the toxin that can cause health hazards to humans (Anonymous n.d.). The larvae have six instars, molting inside the nest between each stage (Anonymous n.d.). Younger larvae can be hard to see as the third instar larvae are still less than 1 cm long (Tree Health Division of Forest Research, n.d.).

Figure 2. Larvae of *T. processionea* [Image from Gyorgy Csoka, Hungary Forest Research Institute, www.bugwood.org]

Figure 3. Adult *T. processionea* [Image from Gyorgy Csoka, Hungary Forest Research Institute, www.bugwood.org]

Adults: Adults have grey and white forewings that serve as camouflage against oak trees when adults are at rest (Anonymous n.d.). Forewings have a "small, faint dark central cresent mark, smooth, rather wavy blackish crosslines, and pale basal area" (Townsend 2008). "The hindwings are whitish with diffuse grey postmedian fascia. Males are marked more clearly and they are often remarkably smaller than females" (Stigter et al. 1997). Wingspan in males is approximately 31-35 mm while female wingspan is approximately 36-41 mm (Stokes 2004). The last abdominal segment in females has a dark, short patch of hair (Stigter et al. 1997). Antennae are feathered (Townsend 2008).

Biology and Ecology

In Europe, *T. processionea* has one generation per year (Anonymous 2009) and is nocturnal (Dissescu and Ceianu 1968). Mating usually occurs within or on the nest (EFSA 2009). Females lay eggs in the summer and prefer open, sunny habitats for egg laying (Townsend 2008) or edges of woods (EFSA 2009). Oviposition usually occurs on 1-2 year old twigs; the first instar overwinters within the egg and hatches in mid to late April (EFSA 2009).

Larvae of this pest hatch along with the sprouting oak leaves in spring (Breuer et al. 2003). Unlike some defoliators, this pest can survive if hatching occurs before budburst (EFSA 2009). Development takes approximately 2-3 months with pupation occurring in early summer (Breuer et al. 2003). Dissescu and Ceianu (1968) found that the larval stage lasts approximately 60-70 days while the pupal stage lasts 20 to 46 days. When small, the larvae spin leaves and twigs together to rest under during the day (Stigter et al. 1997). Once the larvae reach the third instar, they build communal nests on the trunk, bough or main stem (Townsend 2008) and begin to develop urticating hairs (EFSA 2009). Smaller colonies can unite into larger ones capable of housing thousands of caterpillars (EFSA 2009, Stigter et al. 1997). When leaving from and returning to their nests, the larvae follow in long processions (Anonymous 2009). Dissescu and Ceianu (1968) found that each *T. processionea* larvae consumed an average of 6-8 oak leaves during their development and subsequent female fecundity was directly related to amount of food consumed. If leaves become scarce, larvae can collectively move to other nearby hosts (EFSA 2009). Caterpillars produce firm cocoons from webs and hairs and pupate in the nest around June or July (Stigter et al. 1997, Townsend 2008).

Unlike females, males are good fliers and can fly over 50 to 100 km from July to September; dispersal may be aided by strong winds (Stigter et al. 1997). Females can disperse from 5 to 20 km per year, but distance is dependent on weather and structure of habitat being crossed (Stigter et al. 1997). Adults live from 3 to 4 days (Townsend 2008).

Damage

Because the adult stage does not feed, damage is only caused by the larvae (Townsend 2008). Larvae feed by stripping each leaf to the mid-vein and can leave patches that can sometimes be seen (Townsend 2008). This pest can remain unnoticed initially because nests and defoliation amounts start out small (Stigter et al. 1997).

Looking for communal nests of the larvae is an effective survey method. The nests retain toxic hairs and shed exoskeletons and height varies from ground level to 20 meters or more usually oriented towards the warmer, less shaded side of the tree; the nests can vary in size and are rounded and/or elongated (Townsend 2008). The nest eventually takes on an orange-brown color from shed skin and excrement (Anonymous n.d.).

Larvae can also be found either individually or in groups (groups are more likely). When leaving the nest, they travel in head to tail processions.

Presence of later instar *T. processionea* larvae can lead to skin, eye and/or throat irritation in humans and animals caused by the urticating hairs of the larvae.

Figure 4. Damage with caterpillars [Image from Louis-Michel Nageleisen, Dèpartement de la Santè des Forêts, www.bugwood.org]

Figure 5. Nest with caterpillars [Image from Louis-Michel Nageleisen, Dèpartement de la Santè des Forêts, www.bugwood.org]

Pest Importance

This pest is a defoliator that can cause severe foliage loss at high populations. Although not usually fatal to host plants, over several years it can weaken the host and make it more susceptible to other factors and stresses (Anonymous 2009, Townsend 2008). When combined with other factors, defoliation by *T. processionea* may negatively affect the vitality of oak stands (EFSA 2009).

Small irritating hairs of the larvae can serve as a health hazard to both humans and animals (Anonymous 2009, Stigter et al. 1997, Townsend 2008). The older larvae (third instar on) are covered in thousands of small irritant hairs which contain a poison called thaumetopoein (Anonymous 2009, Townsend 2008). Urticating hairs are easily broken off when disturbed and can float in air (Stigter et al. 1997). "Because of their shape [similar to small arrows with barbs] the hairs can easily penetrate the superficial layers of the skin" (Stigter et al. 1997). Contact or inhalation can cause skin or eye irritation, sore throats, breathing difficulties and allergic reactions known as lepidopterism (Anonymous 2009, Townsend 2008). Renewed or continuous exposure can cause stronger reactions (Stigter et al. 1997). Hairs can remain allergenic from months to years in certain conditions (EFSA 2009).

If this pest were to become established in the United States, it could potentially affect trade. Britain has already begun to require passports on oak trees imported from other EU members stating that the material originated from areas free of pest infestation due to the thought that this pest arrived on imported timber (Eccleston 2008). Evans (2007b) lists the phases of development for *T. processionea* after initial establishment starting with exploration (pre-colonization) and leading to plague stage and population collapse. The most damage to oaks occurs during the plague stage and population collapse phases (Evans 2007b).

Known Hosts

The main hosts of *T. processionea* are oak trees, but they can attack other trees when populations are high.

Hosts	References
*Acacia spp.**	(Stigter et al. 1997)
Betula spp. (Birch)*	(Anonymous n.d., EFSA 2009, Evans 2007a, Stigter et al. 1997)
Carpinus spp. (Hornbeam)*	(Anonymous n.d., EFSA 2009, Evans 2007a)
Castanea spp. (Chestnut)*	(EFSA 2009, Evans 2007a)
Castanea sativa (Chestnut, Sweet)	(Anonymous n.d.)
Corylus spp. (Hazelnut)*	(Anonymous n.d., EFSA 2009, Evans 2007a)
Crataegus spp. (Hawthorn)*	(EFSA 2009 and Stigter et al. 1997)
Fagus spp. (Beech)*	(Anonymous n.d., EFSA 2009, Evans 2007a, Stigter et al. 1997)
Juglans regia (Walnut)	(Carter 1984, Robinson et al. 2007)
Quercus spp. (Oak)	(Dissescu and Ceianu 1968, Evans 2007a, Robinson et al. 2007, Roversi 2008)
Quercus boissieri	(Halperin and Sauter 1999)
Quercus cerris (Oak, Turkey)	(Anonymous n.d., EFSA 2009, Roversi 2008, Stokes 2004)
Quercus frainetto	(EFSA 2009)
Quercus ilex (Oak, Evergreen)	(EFSA 2009, Stokes 2004)
Quercus palustris	(Custers 2003)
Quercus pedunculata (Oak, Pedunculate)	(Stokes 2004)
Quercus petraea (Oak, Sessile)	(Anonymous n.d., EFSA 2009, Stokes 2004)
Quercus pubescens (Oak, Downy)	(EFSA 2009, Savela 2002)
Quercus pyrenaica	(EFSA 2009)
Quercus robur (Oak, English)	(Anonymous n.d., EFSA 2009, EPPO 1998)
Quercus rubra	(EFSA 2009)
Quercus sessiliflora	(EFSA 2009)
*Robinia spp.**	(EFSA 2009)
*Sorbus spp.**	(Stigter et al. 1997)

*These are considered occasional hosts only (EFSA 2009, Stigter et al. 1997)

Known Distribution

Thaumetopoea processionea is native to central and southern Europe but is expanding its range northward. Climate change is seen as a reason for *T. processionea's* increasing potential eco-climate range (Evans 2007a).

Asia: Cyprus, Israel[1], and Russia; **Europe:** Albania, Austria, Belgium, Bosnia and Herzegovina, Bulgaria, Croatia, Czech Republic, Denmark, France, Germany, Greece, Hungary, Italy, Luxembourg, Macedonia, Moldova, Montenegro[2], Netherlands, Poland,

Portugal, Romania, Serbia, Sicily, Slovakia, Slovenia, Spain, Sweden, Switzerland, Ukraine, and United Kingdom.

(Anonymous n.d., Skule and Vihelmsen 1997, Stigter et al. 1997, EPPO 1998, Halperin and Sauter 1999, Stokes 2004, Lövgren and Dalsved 2005, Evans 2007a, Kimber 2007, EFSA 2009, Fauna Europaea 2009, Mirchev et al. 2011)

[1]Questionable due to the fact that identification was provisional (Halperin and Sauter 1999).
[2]Listed under former Yugoslavia.

Pathway

Neither the species nor genus has been intercepted at U.S. ports of entry. This species does have the potential to move through international trade. It is believed that this species was introduced into the United Kingdom through imported timber (Eccleston 2008).

Potential Distribution within the United States

Because this pest is found throughout most of central and southern Europe with an expanding range northward, this pest may be able to establish throughout a large part of the United States. Temperate areas are found throughout the east in the United States.

If this pest were to be introduced into the United States, it would have a lot of host material present to aid it in establishing. In the eastern United States, oaks make up the majority of forests while they make up approximately 17% of forests in the western United States.

A recent risk analysis by USDA-APHIS-PPQ-CPHST illustrates the abundance of host material in the eastern as well as portions of the western United States. Host density is greatest in the southeast.

Survey

CAPS-Approved Method*:

The CAPS-approved method is a trap and lure combination. The trap is a wing trap kit. The lure is effective for 28 days (4 weeks).

Any of the following Trap Product Names in the IPHIS Survey Supply Ordering System may be used for this target:

Wing Trap Kit, Paper
Wing Trap Kit, Plastic

The Lure Product Name is "*Thaumetopoea processionea* Lure."

IMPORTANT: Placing lures for two or more target species in a trap should never be done unless otherwise noted here.

Trap spacing: When trapping for more than one species of moth, separate traps for different moth species by at least 20 meters (65 feet).

*For the most up-to-date methods for survey and identification, see Approved Methods on the CAPS Resource and Collaboration Site, at http://caps.ceris.purdue.edu/.

Literature-Based Methods:
Visual inspections of oaks from the ground were used when surveying for this pest in London in 2007 (Townsend 2008). Ground surveys were good at determining presence of colonies; tree climbers were then used to find further nests not visible from the ground. Binoculars were used to visually inspect trees from all angles only in favorable light. Surveying did not occur during rain. Pheromone traps were also used in conjunction with visual surveying. Surveyors only caught adults with bucket traps (not delta traps) with traps being hung at a height of 3-5 meters in oak trees and remaining throughout the entirety of the flight period.

The pheromone component, (Z,Z)-11,13-hexadecadienyl acetate, was found in the female gland extracts (Breuer et al. 2003). Breuer et al. (2003) found that pherocon traps were somewhat more efficient than delta traps and effectively attracted a large number of males when 10 mg of synthetic pheromone was placed in the upper crown of oaks; higher placed traps caught more males. Breuer et al. (2003) found that there was a relationship between the level of infestation and number of moths caught but attractive range is apparently limited.

Gries et al. (2004) found that (Z,Z)-11,13-hexadecadienyl acetate and (Z,E)-11,13,15-hexadecatrienyl acetate attracted a significant amount of moths when used in combination (1:1 ratio), but not individually like previous studies (Quero et al. 2003, Breuer et al. 2003).

Because males are strong fliers, males caught in pheromone traps may not accurately reflect the local distribution of the breeding population (Tree Health Division of Forest Research, n.d.). Males caught soon after emergence provided the most accurate measure of moth distribution in immediate area (Tree Health Division of Forest Research, n.d.).

Adults are also attracted to artificial light and are used to catch both males and females (EFSA 2009).

Key Diagnostics

CAPS-Approved Method*:
Confirmation of *T. processionea* is by morphological identification.

*For the most up-to-date methods for survey and identification, see Approved Methods on the CAPS Resource and Collaboration Site, at http://caps.ceris.purdue.edu/.

Easily Confused Pests

This pest may be confused with *T. solitaria* and *T. pityocampa*, neither of which is currently present in the United States.

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