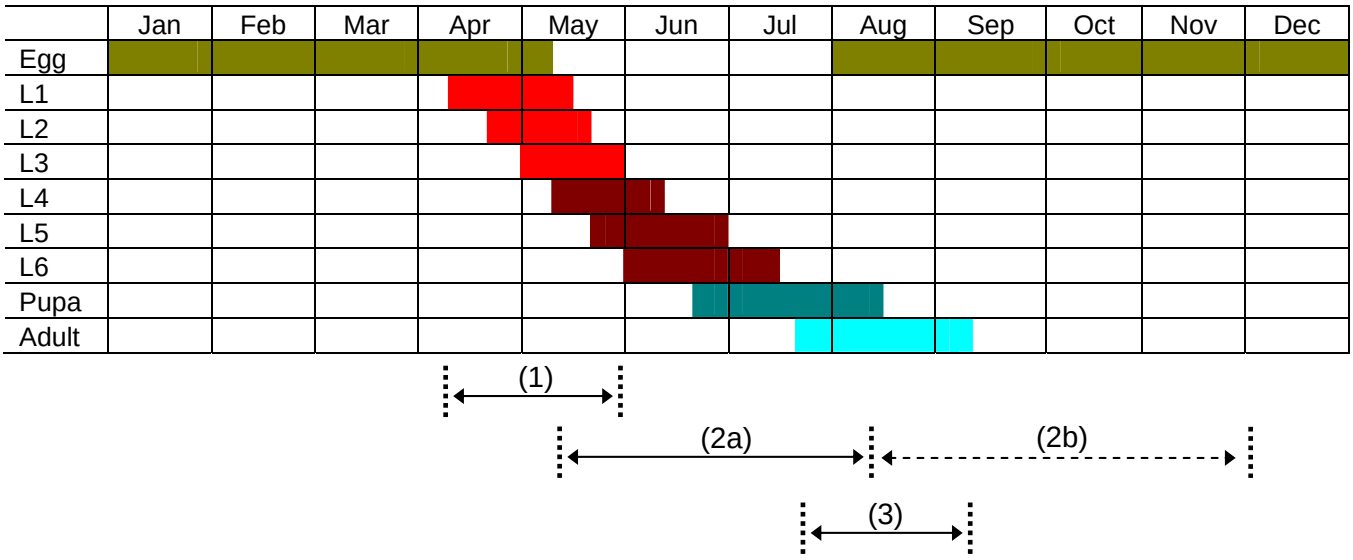
Forest Research

Forestry Commission

Survey and intervention in relation to different phases of the oak processionary moth life cycle.

To be used in conjunction with statutory notices served under the Plant Health (Forestry) Order 2005, as amended, and with more detailed advice on control, nest removal and use of protective clothing: Appendix 1 (revised 2011)

Life cycle of oak processionary moth (OPM): note that the timings of the various stages are approximate, reflecting the relative lack of precise information on larval and pupal development under British conditions, and also seasonal and local variation. In some years, L1 may appear in mid April and L4 by the first week of May. The stages are described in more detail in the Forest Research leaflet on OPM (http://www.forestresearch.gov.uk/pdf/fr_advice_note_oak_processionary_moth.pdf/$FILE/fr_advice_note_oak_processionary_moth.pdf).



(1) Insecticide application period: target larvae up to 1cm long

(2a) Main survey and nest management period

(2b) Follow-up surveys in autumn for late developing nests

(3) Pheromone trapping for males

Egg stage: This is the most difficult stage to survey for as the eggs are laid in batches on a twig, but in the absence of detailed information on typical egg hatch periods in Great Britain, a search of branches for egg masses during the winter months is recommended. Any egg batches found can then be marked for regular inspection from late March onwards and used as indicators of egg hatch and appearance of the first stage larvae, which are the primary targets for insecticide applications.

Larval stage: The larvae pass through six stages (instars) during their development and get progressively bigger from one stage to the next. Two different strategies are recommended in relation to larval size, as size influences the susceptibility to insecticides, the risk of tree damage and irritation from the larval hairs.

Stages L1-L3:

The most effective method of controlling OPM is to apply insecticides against the early stage (L1-L3) larvae. The first three larval stages are the most susceptible to the insecticides approved for use against OPM, especially the biological and growth regulating insecticides (*Bacillus thuringiensis* and Dimilin) that have a lower overall environmental impact. Fourth stage and older larvae also remain mainly within their silken nests during the day where they are protected from chemical sprays

OPM larvae are very small when they hatch (around 2mm long) and are still less than 1 cm long by the time they reach the third stage. As a rule of thumb therefore, insecticide applications will be most effective when applied to larvae smaller than 1 cm. The majority of larvae will have reached this size by the end of May (by mid May in warmer years).

Stages L4-L6 and pupae:

The main method of control for larger larvae and pupae is to manually remove and destroy the larvae and their nests, either by using professional vacuum equipment or by removing the nests by hand. Larvae spin bigger silken nests and spend more time within these nests during the day as they grow larger. Eventually, the larvae moult to the pupal stage, again within the nest. By this stage the nest tends to be tougher and usually brown in colour (whitish when first formed), containing cast skins and shed hairs. Removing nests immediately after they are discovered will reduce further damage to trees and minimises risks from dislodging the irritating hairs. However, delaying nest removal until the larvae have completed feeding and have moulted to the pupal stage increases the chances of destroying all of the larvae/pupae within the nests.

Large, old nests need to be removed with considerable care, as indicated in the operational safety advice, to reduce the exposure of operatives to the hairs, which are inevitably shed, especially from the cast skins adhering to the nests. During this phase of the life cycle, larvae may also be seen massing on the trunks and branches of trees and moving in the characteristic nose to tail processions that give the moth its common name.

Removing larvae and nests manually, by vacuum equipment or by hand, can be very effective in reducing OPM populations, but this method alone is unlikely to lead to eradication, because it may not be possible to find and locate every last larvae and pupae. Eradication of OPM is most likely to be achieved by a combination of methods which includes correctly timed applications of insecticide that treat the whole of the tree canopy.

Adult stage: Adults emerge and fly from around the middle of July to early September. Males are strong fliers, the females less so. Deployment of pheromone traps, baited with the female sex attractant pheromone of OPM, will provide an indication of population size and distribution. However, the traps only capture males and, since they are strong fliers, it is uncertain whether the distribution of captures in the traps is an accurate reflection of the local distribution of the breeding population of the moth. Consequently, captures soon after initial adult emergence will tend to provide the most accurate measure of the distribution of OPM in the local area.

Appendix 1: Treatments and Minimum Health & Safety Requirements for Management of Oak Processionary Moth (OPM) Larvae (Caterpillars) and Removal of Larval Nests
(revised May 2011)

Personal Protective Equipment

Operators controlling Oak Processionary Moth (OPM) (*Thaumetopoea processionea)* larvae (caterpillars) or removing larval nests not only require Personal Protective Equipment (PPE) to minimise exposure to the chemical pesticide being applied, but must also have PPE that will prevent skin and eye contact, or inhalation, of the highly irritating hairs from the larvae. These hairs are about 0.2mm long and barbed, and they contain an urticating toxin, a protein, exposure to which can cause intense skin irritation and asthmatic-type symptoms. These symptoms may be more severe in some people than in others and can be long-lasting, and repeated exposure may lead to a disproportionate increase in the severity of symptoms due to sensitisation.

OPM larvae possess irritating hairs from the 2nd moult onward, although it is the full-grown larvae that carry most hairs. The dorsal surface of these larger larvae carries patches of tens of thousands of the small hairs. The hairs are easily detached when the larvae are handled or disturbed, dispersing on air currents, especially in dry conditions. The silk nests produced by the larvae on the trunk and branches of the host tree, in which the larvae moult and eventually pupate, also contain dense concentrations of hairs that retain their toxicity for many months.

Minimum PPE for controlling larvae or removing nests shall include:

PPE	Protection	Standard
Face mask	to prevent inhalation	Filtering half mask FFP2 or FFP3 (European standard EN149: 2001), disposable, to protect against particles.
Goggles	to protect eyes	Goggles complying with European standard EN166 and either code 4 or code 5[1].
Disposable spray suit	to prevent skin contact	An impermeable protective suit suitable for insecticide spraying will also protect against the larval hairs[2].
Gloves	to prevent skin contact	Robust water and chemical resistant gloves, as used for spraying operations.
Boots	to prevent skin contact	Water proof and chemical resistant rubber boots, as used for spraying operations.
Climbing equipment for reaching nests high in a tree	to prevent falling	Ropes and harnesses used for climbing can retain hairs and, therefore, should only be handled with protective gloves. They should also be bagged after use and maintained solely for the purposes of removing nests.

Particular care must be taken when removing and cleaning contaminated PPE following a control operation – contact with wet skin must be avoided.

There are some issues with PPE that may only be resolved with experience[1,2]:

[1] Code 4 goggles have indirect ventilation (slits at the side) and this might result in some exposure to the larval hairs. Code 5 goggles have no ventilation, but may mist up. Should goggles and a half mask prove inadequate for preventing exposure to the hairs, particularly around the face, then a full hood with respirator (fitted with particle filters) might be necessary. This is more restrictive for the operator.

[2] There are potential problems with paper suits in that they cannot be washed down effectively after work, and removing the suit when it is dry may release hairs into the air that could then irritate the skin and eyes or be inhaled. Also experience has shown that they rip easily, especially when worn by tree climbers. A full water-proof suit, which can be washed down after each control operation, is likely to be more appropriate, but such suits are very hot to work in for any length of time.

It is very important that operatives are monitored for symptoms of ill health caused by exposure, and that these are reported immediately to line management and/or to medical practitioners, and action taken to prevent further exposure. Any person who develops sensitivity after exposure, should not take any further part in control operations, either against the larvae or to remove nests. Any person who develops sensitivity will not be permitted to take any further part in control operations being carried out under Statutory Notice.

Insecticide control of young larvae

The following products are listed in the UK Pesticides Guide 2012 published by the British Crop Protection Council and CAB International as being approved for professional use against caterpillars on outdoor amenity vegetation. This includes OPM (and brown-tail moth) in amenity situations. Other products, marked *, are also listed as being approved for professional use on amenity vegetation by the Health and Safety Executive (HSE) and Chemicals Regulation Directorate (CRD) (formerly Pesticides Safety Directorate, PSD). **However, the status and availability of chemicals may change from year to year, so it is important to check the manufacturer's label to ensure that there is approval for the use intended.**

Active ingredient	Product	Main Supplier	Comments
Bacillus thuringiensis (BT) var kurstaki	DiPel DF DiPel DF *	Interfarm UK Fargro Ltd	Biological agent. It is recommended that a follow up spray is carried out after 7-10 days. (See below)
Diflubenzuron	Dimilin Flo Dimilin Flo* Dimilin 25 WP*	Certis Chemtura	Growth regulator. Approved for amenity vegetation & hedges. Follow up spray after 2 weeks also recommended. Very toxic to aquatic organisms
Deltamethrin	Bandu Decis Decis Protech Delta-M 2.5 EC Agriguard Deltamethrin* Agrotech Deltamethrin* Cleancrop Decathlon* Landgold Deltaland* Milentus Deltamethrin* Delta-M 2.5 EC Routeone Deltam10 *	Headland Bayer CropScience Bayer CropScience AgChem Access Agriguard Agritech-Trading United Agriproducts Teliton Milentus BV MAC Albaugh UK	Fast acting, but broad spectrum pyrethroid insecticide. Extremely dangerous to fish and other aquatic life. High risk to bees

BT and diflubenzuron are most effective against the very young (1st-3rd stage) larvae and therefore timing of application is crucial. Larvae hatch from the eggs between mid April and early May, and the young larvae will be present at least through to mid May.

NB: there are very limited data on the timing of larval development in GB and how development might vary between years; it is recommended, therefore, that interested parties locate and monitor egg batches in the field to provide early warning of egg hatch in the spring.

BT and diflubenzuron are often favoured for control of pests because of their specificity against moth caterpillars and their relatively low environmental impacts. However, a single application of BT or diflubenzuron is not always fully effective. Where the objective of control is to eradicate OPM completely, then a second, follow-up spray should be applied after either 7-10 days (BT) or 2 weeks (diflubenzuron). In other circumstances, where the objective of control is to suppress OPM numbers,

or where the first application of the pesticide has been particularly effective, then a follow-up spray is probably not necessary.

Deltamethrin is less selective, but kills on contact and is fast acting. It might be a more appropriate insecticide to use for the more mature larvae that have become less susceptible to BT and diflubenzuron. However, deltamethrin is highly toxic to bees and aquatic life and particular care must be taken when using this product (and diflubenzuron) on or near flowering plants or near water bodies (see product label).

The fact that OPM larvae live in the canopies of large oak trees, particularly in parks and built-up areas, will mean that spraying operations will have to be targeted at tall, mature trees, very frequently in areas where the public have access, along roadsides and between buildings. Applying insecticides to tall trees is very difficult and coverage is not always satisfactory. There is evidence that OPM larvae congregate toward the tops of trees, particularly during the early part of the season, and it is important that sufficient insecticide reaches the very top of the canopy. Motorised sprayers tend only to deliver insecticide up to about 8m and tractor mounted sprayers are unlikely to reach higher than 15-20m. Consequently, full coverage of large trees may only be possible using hydraulic platforms (MEWPs, cherry-pickers). Working at height poses particular H&S problems and will impose constraints on the selection of PPE and control options. **This work, therefore, should only be carried out by appropriately qualified and trained operators. When control is being carried out under Notice, then this work shall only be permitted to be carried out by appropriately trained and qualified operators.**

Chemical insecticide control of mature larvae

BT and the growth regulating insecticides are less effective against older (4^{th}-6^{th} stage) larvae, whereas deltamethrin can still be applied, provided there is good coverage and spraying takes place while larvae are outside the nests. Therefore, deltamethrin is the preferred insecticide for dealing with older larvae, should the decision be made to continue with attempting to treat them directly, rather than removing the larvae or nests.

Older larvae congregate on the larger branches and trunk of the tree during the day, notably when they are about to form nests, and therefore spraying for older larvae needs to be directed as much to these areas as to the canopy, bearing in mind that the larvae must be outside the nests to be exposed to the insecticide spray.

More information on the behaviour of OPM larvae, particularly when and where they feed and at what times they aggregate on the stem, could increase the efficiency of insecticide application and might improve control.

A problem reported in France concerns large numbers of dead and dying 5^{th}-6^{th} instar larvae falling from trees that were recently sprayed with insecticide. This occurred at a picnic and camping site, and the result was increased contact between people and the larval hairs, which led to much greater health problems than had occurred before the larvae were disturbed to the point where the campsite had to be closed. A similar problem with fallen larvae has occurred in the UK after spraying larvae with deltamethrin. Therefore, if it is decided to apply insecticide against the larger L4-L6 larvae, it is recommended that access to the area around the treated trees is restricted for some time after spraying, to ensure that the majority of dead larvae have fallen from the trees and while assessments are made of the potential need to dispose of the fallen larvae. It might be useful to lay a sheet beneath the trees to collect any larvae that fall from the canopy. Alternatively, larvae can be cleared from the ground using vacuum equipment (see below).

Removal of larval nests

The aggregation nests spun up by the larvae on the main branches and trunks of oak trees contain many hairs and pose a very significant health risk, either through direct contact with the nest material

or through the release of hairs as the nests break up and disintegrate. The nests are quite persistent and experience in mainland Europe shows that they remain a hazard for up to 12 months or more until the hairs degrade through decay.

Destroying the nests during May and June, at the appropriate time of day, will kill the larvae in the nests, and destroying nests between late-June and the end of July should kill the pupae. Targeting nests containing pupae is likely to be the most effective strategy because there will be no further dispersal of larvae to the foliage to feed and, consequently, all the remaining life stages will be removed before emergence of the next adult generation.

The most efficient and safe method for removing larval nests (and groups of larvae) is to use commercial vacuum equipment: see FC Plant Health SOP9 “Removal of Oak processionary Moth material by professional vacuum cleaner”. Vacuum equipment is especially useful where larvae and nests need to be removed rapidly because there is a particular risk of human contact with the hairs, and when operated from a MEWP, the equipment can be used to remove and destroy nests visible in the upper canopy of large oak trees that are beyond the reach of conventional tree climbing techniques.

Alternatively, larval nests may be removed by hand. Although there will be variation in local practice during nest removal, it is recommended that wherever practicable the nests are removed intact by first covering the nest with a plastic bag and then carefully pulling the nest off, which is then retained within the bag. The bag should be sealed immediately and placed inside a second bag. Any remaining fragments of nest that could contain hairs can be destroyed by topical application of a flame source. Use of a flame source directly to intact nests is not recommended since this will destroy the outer layers which could allow larvae or pupae inside to fall out.

Manual nest removal, by vacuum equipment or by hand, cannot completely eradicate OPM, but it has the advantage of not affecting populations of other non-harmful insects and from an environmental point of view may be considered more acceptable. However, OPM nest material is classified as hazardous waste and its transport and destruction is regulated. Current practice is to destroy the material by burning it at a licensed incinerator or by burying it deeply in the ground at an approved land-fill site. Information on the transport and disposal of OPM material can be obtained from the FC Plant Health Service (Tel: 0131 314 6414; email: plant.health@forestry.gov.uk)

This Guidance Note was prepared by Forest Research.

NB: Before using any pesticide product always read the manufacturers instructions on the label (including any accompanying leaflet) carefully and apply the product for the use, and at the rate and by the method recommended, paying particular attention to all aspects of safety.

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