EPPO Datasheet: *Lymantria mathura*

Last updated: 2023-07-13

IDENTITY

Preferred name: *Lymantria mathura*
Authority: Fabricius
Taxonomic position: Animalia: Arthropoda: Hexapoda: Insecta: Lepidoptera: Erebidae
Other scientific names: *Lymantria aurora* Butler, *Lymantria fusca* Leech, *Lymantria mathura aurora* Butler, *Lymantria mathura subpallida* Okano, *Ocneria mathura* (Moore), *Porthetria mathura* (Moore)
Common names: pink gypsy moth, rosy gypsy moth
view more common names online...
EPPO Categorization: A2 list
view more categorizations online...
EPPO Code: LYMAMA

more photos...

Notes on taxonomy and nomenclature

Some authors consider subspecies, i.e. *L. mathura aurora* from Japan, the Republic of Korea and the Russian Far East and *L. mathura subpallida* from Taiwan (Inoue, 1957; Roonwal, 1979; Kuznetsov, 1999; Chistyakov *et al*., 2016; Taiwan Insects, 2023), but in the present datasheet, they have been provisionally treated as synonymous.

HOSTS

L. mathura is a polyphagous species attacking many species of *Carpinus*, *Castanea*, *Juglans*, *Malus*, *Quercus*, *Shorea*, *Ulmus* and other deciduous trees. Overall, *L. mathura* is known to feed on woody plants from at least 23 families: Anacardiaceae, Apocynaceae, Betulaceae, Celastraceae, Combretaceae, Dipterocarpaceae, Euphorbiaceae, Fabaceae, Fagaceae, Juglandaceae, Lecythidaceae, Lythraceae, Malvaceae, Meliaceae, Moraceae, Myrtaceae, Oleaceae, Pinaceae, Rosaceae, Rubiaceae, Salicaceae, Sapindaceae, Ulmaceae, including approximately 60 woody plant species in nature and has shown the ability to feed on at least 22 other species in laboratory conditions.

In the Russian Far East, its preferred hosts are *Quercus mongolica*, *Quercus dentata*, *Malus mandshurica*, *Juglans mandshurica*, *Lespedeza bicolor*, *Ulmus japonica*, *Salix arbutifolia* (Kuznetsov, 1999; Yurchenko & Turova, 2002; Chistyakov *et al.*, 2016; Kuzmin, 2019). In the wild, larvae were also found feeding on *Alnus japonica*, *Betula costata*, *Betula platyphylla*, *Crataegus maximowiczii*, *Salix* spp. (including *Salix caprea*, *Salix schwerinii*), *Tilia amurensis*, *Tilia mandshurica*, *Populus maximowiczii* (Yurchenko & Turova, 2002). Eggs can be laid on *Betula dahurica*, but after emergence larvae move to *Quercus* spp. and, thus, do not feed on *B. dahurica* (Alekseenko *et al.*, 2009).

In the Russian Far East, the suitability of other plants was tested in the laboratory and results were as follows, from most to least preferred host: *Quercus mongolica*, *Malus mandshurica*, *Cerasus tomentosa*, *Prunus mandshurica*, *Rosa rugosa*, *Juglans mandshurica*, *Crataegus maximowiczii*, *Prunus padus*, *Betula platyphylla*, *Corylus heterophylla*, *Larix gmelinii*, *Abies nephrolepis*, *?bies holophylla*, *Ulmus japonica*, *Tilia amurensis*, *Populus davidiana*, *Acer negundo*, *Acer mandshuricum* (Yurchenko & Turova, 2002). In indoor experiments, neonate larvae did not feed on *Betula davurica* or *Pinus koraiensis*, thus, these plants cannot be considered as hosts (Yurchenko & Turova, 2002).

In India, *L. mathura* is a major pest of *Shorea robusta*. Besides, it can notably damage five other highly susceptible hosts: *Syzygium cumini*, *Acrocarpus fraxinifolius*, *Mangifera indica*, *Quercus incana*, *Terminalia myriocarpa*. In this country, *L. mathura* can damage other 30 woody plant species, which are not present or not recorded as hosts of *L. mathura* in the Russian Far East: *Adina cordifolia*, *Alstonia scholaris*, *Aphanamixis polystachya*, *Artocarpus lacucha*, *Butea monosperma*, *Castanea sativa*, *Duabanga grandiflora*, *Elaeodendron glaucum*, *Ficus benghalensis*, *Grewia sapida*, *Litchi chinensis*, *Mallotus philippinensis*, *Melia azedarach*, *Morus alba*, *Neolamarckia cadamba*, *Pongamia glabra, Prunus cerasoides, Pterygota alata, Quercus leucotrichophora, Quercus serrata, Terminalia anogeissiana, Terminalia arjuna, Terminalia bellirica, Terminalia elliptica, Terminalia pyrifolia* (Roonwal, 1979; Roychoudhury *et al.*, 2020). In India, during outbreaks, eggs were detected on at least 185 species of woody plants from 47 families, including many plant species which are not known to be hosts of *L. mathura;* the list of these plants is given in Roonwal (1979).

In Japan, *Lymantria mathura aurora* is reported to feed on *Toxicodendron succedaneum, Zelkova serrata* (Inoue, 1957), but most damage occurs on *Malus* spp. (Roonwal, 1979). An indoor study of the suitability of North American, Asian, and European tree species (24 broad-leaved and conifer species) showed that *L. mathura* develops well on most plants of the family Fagaceae regardless of the plant species' origin (Zlotina *et al.*, 1998; Zlotina, 1999). Survival and rate of development on the European species *Fagus sylvatica* and the American species *Fagus grandifolia* were equivalent to those on the Asian species *Quercus variabilis*. Overall, in laboratory tests the survival of *L. mathura*'s larvae (second and third instars) on Fagaceae was higher than on woody plants of other families (Juglandaceae, Betulaceae, Oleaceae, Aceraceae, Pinaceae) (Zlotina *et al.*, 1998; Zlotina, 1999). The survival was relatively high on the American species *Quercus variabilis, Q. alba* and *Q. prinus* (Zlotina, 1999). Other American oaks, such as *Quercus rubra*, *Quercus velutina* and *Quercus palustris* gave moderate survival and supported further development of only a small proportion of larvae. The Asian *Juglans mandshurica*, the American *Juglans cinerea* and the American *Carpinus caroliniana* were similar. On the other studied trees, the American *Juglans nigra*, the European *Alnus glutinosa*, two American *Fraxinus pennsylvanica, F. americana*, and various conifers, survival was poor, and no further development occurred (Zlotina *et al.*, 1998). The females can also oviposit on conifers, but there are no data showing that larvae are able to feed on conifer needles in nature (Zlotina, 1999). In the indoor test, the highest larval survival rate among conifers was observed on Douglas fir, *Pseudotsuga menziesii* (33%) (Zlotina *et al.*, 1998; Zlotina, 1999). Among conifers, which provided the poorest diet for the larvae, 12% of *L. mathura* larvae survived feeding on *Larix laricina*; very low neonate survival (i.e. < 1%) was recorded on *Abies concolor, Pinus strobus* and *Abies fraseri*, and 100% mortality was documented on *Abies balsamea* (Zlotina *et al.*, 1998; Zlotina, 1999).

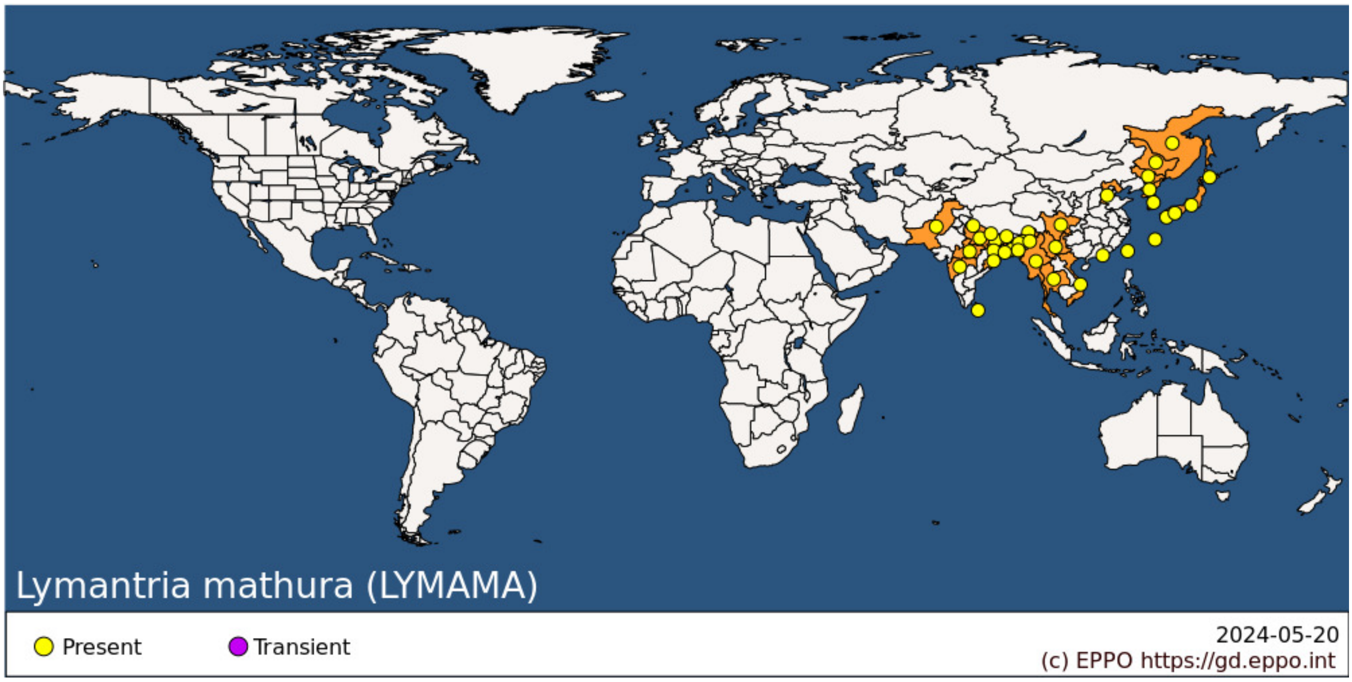
Host list: *Acer mandshuricum, Acer negundo, Acer palmatum, Acrocarpus fraxinifolius, Adina cordifolia, Alnus japonica, Alstonia scholaris, Aphanamixis polystachya, Artocarpus lacucha, Betula costata, Betula dahurica, Betula platyphylla, Butea monosperma, Carpinus cordata, Castanea sativa, Crataegus maximowiczii, Duabanga grandiflora, Elaeodendron glaucum, Ficus benghalensis, Grewia sapida, Juglans mandshurica, Lagerstroemia parviflora, Lespedeza bicolor, Litchi chinensis, Mallotus philippensis, Malus domestica, Malus mandshurica, Mangifera indica, Melia azedarach, Morus alba, Neolamarckia cadamba, Planchonia careya, Pongamia pinnata, Populus maximowiczii, Prunus cerasoides, Prunus mandshurica, Pterygota alata, Quercus dentata, Quercus griffithii , Quercus incana, Quercus leucotrichophora, Quercus mongolica, Quercus serrata, Salix arbutifolia, Salix caprea, Salix schwerinii, Salix sp., Shorea robusta, Syzygium cumini, Terminalia anogeissiana, Terminalia arjuna, Terminalia bellirica, Terminalia calamansanai, Terminalia elliptica, Terminalia myriocarpa, Tilia amurensis, Tilia mandshurica, Toona ciliata, Toxicodendron succedaneum, Ulmus davidiana var. japonica, Zelkova serrata*

GEOGRAPHICAL DISTRIBUTION

L. mathura is an East Palearctic species (Epova & Pleshanov, 1995), or Priamursko-Manchurian species (Dubatolov & Dolgikh, 2009). In Russia, the species is known in several regions of the Russian Far East: Amur Oblast, Jewish Autonomous Oblast, south of the Khabarovsk Krai, Primorsky Krai (Barbarich & Dubatolov, 2012; Kuzmin, 2019), where it co-occurs with the related species *Lymantria dispar* and *L. monacha* (Alekseenko *et al.*, 2009; Kuzmin, 2019). *Lymantria mathura aurora* was also recorded in the Kuril Islands (Inoue, 1957). Since 2012, the eastern border of *L. mathura* in the Russian Far East expanded from the southern part in Amur Oblast (i.e. from Obluchie) towards the western part of the region to the settlement Shimanovsk, from 49°N, 131°E to 52°N 127°E (i.e. 4 degrees westwards) in eight years, whereas in the south of the region prevalence of the species went from occasional to common (Kuzmin, 2019).

L. mathura is also known from several East Asian countries (Inoue, 1957; Lee & Lee, 1996; Kuznetsov, 1999; Pogue & Schaefer, 2007; Molet, 2012; Chistyakov *et al.*, 2016; Kuzmin, 2019; Roychoudhury *et al.*, 2020; Kaustubh *et al.*, 2022).

Overall, *L. mathura* lives in cool, temperate to warm climates with seasonal rainfall and dry periods and it is associated with temperate broadleaf and mixed forests, tropical and subtropical dry broadleaf forests, and tropical and subtropical moist broadleaf forests (Molet, 2012).



EPPO Region: Russia (Far East)
Asia: Bangladesh, China (Hebei, Heilongjiang, Jilin, Sichuan, Xianggang (Hong Kong), Yunnan), India (Arunachal Pradesh, Assam, Bihar, Jharkand, Madhya Pradesh, Maharashtra, Meghalaya, Nagaland, Odisha, Sikkim, Tripura, Uttarakhand, Uttar Pradesh, West Bengal), Japan (Hokkaido, Honshu, Kyushu, Ryukyu Archipelago, Shikoku), Korea Dem. People's Republic, Korea, Republic, Myanmar, Nepal, Pakistan, Sri Lanka, Taiwan, Thailand, Vietnam

BIOLOGY

Outbreaks of *L. mathura* usually occur once in 4 years, a little earlier than or together with outbreaks of *Lymantria dispar* (Epova & Pleshanov, 1995). The behaviour and the life cycle of *L. mathura* are similar to those of *L. dispar*, and in particular to those of the Asian form (with ?ying females) (Yurchenko & Turova, 2002).

The species biology is well studied in the Russian Far East (Zlotina, 1999; Yurchenko & Turova, 2002; Alekseenko *et al.*, 2009) and India (Roonwal, 1979; Roychoudhury *et al.*, 2020). *L. mathura* is a univoltine or bivoltine species. In India, it has two generations: a summer generation takes place from April to October, an overwintering generation from September to June (Roonwal, 1979). Diapause happens at the egg stage (Roonwal, 1979).

Females lay eggs in masses protected by felt-like covering (Roonwal, 1979; Kuznetsov, 1999), usually in hidden places under bark scales or in crevices making them difficult to detect (Pavlovskii & Shtakelberg, 1955; Maslov *et al.*, 1988; Yurchenko & Turova, 2002). One female may lay 50–1 200 eggs, as observed in India (Roonwal, 1979), 493–580 in the outbreaking population in Primorsky Krai (Russian Far East) (Yurchenko & Turova, 2002). During an outbreak, eggs are oviposited on many woody plants, which do not necessarily sustain further development of the pest (Roonwal, 1979), including conifers (Zlotina, 1999). In Primorsky Krai, females often lay eggs on the bark cracks of *Betula dahurica*, but after emergence larvae crawl up the tree crown and spread on silk threads that can be carried by the wind (ballooning) to find and feed on *Quercus* spp., rather than stay on *B. dahurica* (Yurchenko & Turova, 2002; Alekseenko *et al.*, 2009). In the Russian Far East, egg masses of *L. mathura* have been found on several occasions on ships by Canadian and American phytosanitary inspectors (Zlotina, 1999; Zlotina *et al.*, 1999; Mastro *et al.*, 2021).

Neonate larvae of the first generation usually appear in April (in India) or the first half of May (in the Russian Far East) and continue to hatch for around 20 days (Roonwal, 1979; Zlotina, 1999). For the ?rst 3–5 days, they neither spread out nor feed (Zlotina, 1999; Yurchenko & Turova, 2002). They remain in a dense group on the felt-like covering of egg-masses (Roonwal, 1979; Yurchenko & Turova, 2002). The feeding period covers May, June and July. Larvae feed first on buds, then on leaves, preferring to stay on leaves and not on branches; some can damage young shoots and flowers (Roonwal, 1979). The most active feeding is observed in the evening and at night (Roonwal, 1979). During outbreaks, the pest population level may reach more than 1000 larvae per tree (Roonwal, 1979). The possibilities for wind dispersal of *L. mathura* neonate larvae are greater than those of *L. dispar* because of their smaller weight (Zlotina, 1999; Zlotina *et al.*, 1999). In the indoor experiments, neonate larvae of *L. mathura*s howed a higher tendency to disperse than those of Asian gypsy moth, *L. dispar asiatica* (Zlotina, 1999). In both species, the spread of neonate larvae happens mostly between 12:00 to 17:00 (Zlotina, 1999).

In summer and overwintering generations, larvae undergo from 5 to 6 instars (Roonwal, 1979). Male larvae usually have 5 instars and females 6 instars (Roonwal, 1979; Yurchenko & Turova, 2002). Larval development lasts 50–60 days in India (Roonwal, 1979), 70-80 days in the Russian Far East (Yurchenko & Turova, 2002). According to Roonwal (1979), larval are gregarious. In India, pupation was documented in groups of 40-50 individuals in debris at the base of trees. According to other observations in India (Roychoudhury *et al.*, 2020), pupation takes place in a leaf fastened with a few strands of silk. In the Russian Far East, larvae do not stay together for pupation, i.e. they pupate singly in thin cocoons between the leaves or on branches (Kuznetsov, 1999; Yurchenko & Turova, 2002). Pupal development lasts 12–18 days in India (Roonwal, 1979), 14–16 days in the Russian Far East (Kuznetsov, 1999). In India, moths emerged from the end of July to the third week of October and laid eggs from early August to the end of October (Roonwal, 1979). The flight period starts at the end of July in India and in August in the Russian Far East (Roonwal, 1979; Yurchenko & Turova, 2002).

In the second generation in India, eggs are laid in autumn (early September to mid-October) and develop quickly; larvae take about six weeks to develop and pupate. The emerged adults lay darker eggs. Eggs diapause from four to five months and hatch during the next spring (April). The minimum period for this overwintering generation is about seven months. The various stages of the second generation can be observed in the field for nearly 10 months, i.e. from early September to the end of June next year (Roonwal, 1979).

Both males and females are strong fliers, active at night and attracted to light (Roonwal, 1979; Yurchenko & Turova, 2002). After oviposition females are sluggish, they do not fly away when disturbed but slowly move away (Roonwal, 1979). During outbreaks, pest population levels drastically increase, and it has been observed that over 300 moths (males and females) could be caught in 10 min in a light trap (Chelysheva & Orlov, 1989; cited by Yurchenko & Turova, 2002). Notably, the activity hours of *L. mathura* differ from those of *L. dispar asiatica* and *L. monacha*: from 01:00 till 3:00 for the first species versus. 23:00 – 1:00 and 3:00 – 5:00 for the last two, respectively (Wallner *et al.*, 1995).

Two components of the pheromone of *L. mathura*, Z,Z,Z-3,6,9-nonadecatriene 1 and its monoepoxide Z,Z-(9S,10R)-9,10-epoxy-3,6-nonadecadiene 4a, were identified (Oliver *et al.*, 1999). The study of flight of *L. mathura* towards lights, as well as inspection of ships for the presence any stage of the pest was done under the American-Russian Monitoring Project in the South of Primorsky Krai (Zlotina, 1999; Zlotina *et al.*, 1999; Yurchenko & Turova, 2002; Mastro *et al.*, 2021).

L. mathura is attacked by many natural enemies: hymenopteran egg parasitoids, hymenopteran (mainly *Apanteles* spp.) and dipteran (mainly *Tachinidae*) larval parasitoids, dipteran pupal parasitoids (mainly *Tachinidae* and *Sarcophagidae*). Caterpillars are often infested by nematodes and nuclear polyhedrosis viruses. Natural enemies play a very important role in pest suppression (Lewis *et al.*, 1984; Chelysheva & Orlov, 1986; Lee & Lee, 1996). An extensive outbreak of *L. mathura* in 1953 in India collapsed in 1954 due to a polyhedral virus disease which killed about 99% of larvae and pupae of the pest (Roonwal, 1979).

DETECTION AND IDENTIFICATION

Symptoms

Inspectors should pay attention to egg masses on any products imported from East Asia (Molet, 2012). Defoliation of host trees is usually very spectacular, and the presence of larvae is easily detected (Yurchenko & Turova, 2002). Adults have robust morphological characteristics that distinguish the species from other representatives of the genus *Lymantria* (Arimoto & Iwaizumi, 2014).

Morphology

Eggs

Eggs are roundish, from 0.86 x 0.92 mm (minimum size) to 1.13 x 1.19 mm (maximum size), laid in masses containing more than 400 eggs in 3 or 4 layers (Kuznetsov, 1999; Lee & Lee, 1996). One female may lay 50–1 200 eggs, as observed in India (Roonwal, 1979). The size of the egg-mass varies from to 0.5 x 1 mm to 6 x 15 mm (Roonwal, 1979). The egg-masses are covered by a one-millimetre thick felt-like covering comprising long white silken hairs (Roonwal, 1979), and hairy scales from the end of the female's abdomen (Kuznetsov, 1999). The morphology of eggs and egg-masses of *L. mathura* is highly similar to that of other Asian species of the genus *Lymantria*; thus, cannot be used for distinguishing the species.

Larva

The neonate larvae are able to produce silken threads and spread by ballooning on air currents (Zlotina, 1999). The neonate of *L. mathura* are lighter than those of Asian relative species *Lymantria dispar* (0.51 vs. 0.65 mg on average) (Zlotina, 1999). Larvae go through five-six instars (Roonwal, 1979). In the 6th instar, sexual dimorphism becomes noticeable: female larvae are longer 70-85 mm vs. males 60-65 mm. In late instar larvae, head is brown to grey, body is black with many tiny white spots, pro- and mesothorax with a transverse brown streak at the distal edge; 9th abdominal segment has a pair of conspicuous dorsal white spots; legs and pro legs are reddish brown, the latter with a large black patch externally (Roonwal, 1979). According to Roychoudhury *et al.* (2020) the larva is ashy in colour with yellow bands across the thorax, abdomen with rows of papules bearing tufts of long hairs, and the head has two long plumes of hair on either side; male larva reaches 50 mm length, female 90 mm. Overall, larvae are camouflaged, matching the colour of the bark of tree trunks; making them difficult to detect, especially when they do not move (Roonwal, 1979). A detailed description of all larval instars is given in Roonwal (1979).

Pupa

Pupa is from pale to dark brown, about 20-36 mm long, with pronounced sexual dimorphism. The female pupa is paler, larger and heavier than male pupa: 30-36 mm length, 10-14 mm width and 0.88 g weigh vs. 15-25 mm length, 6-8 mm width and 0.14 g weight (Roonwal, 1979).

Adult

Adults of *L. mathura* are clearly sexually dimorphic. Males: antennae strongly pectinate, yellow-grey with black segments; head and thorax yellow-grey with grey strokes; abdomen yellow with bundles of grey hairs on tergites; ventral side of abdomen and thorax yellow; forewing white with grey transversal stripes and an orbicular round spot (situated next to the reniform spot), yellow veins and yellow-grey fringe; hindwings dull, grey-yellow, with light yellow fringe; upper side yellow, uncoloured, sometimes slightly pinkish (Arimoto & Iwaizumi, 2014). Females: white-pink; hindwings, abdomen, base of antennae, legs and tops of veins on front wings pink; other parts of the body pinkish; forewings pink with white longitudinal strokes along veins and an orbicular oval spot; wing pattern similar to that of *L. dispar;* head and notum with light strokes (white and grey); valva with three appendixes and acute distal top; 9th segment with subunci. Male wingspan 40–50 mm, female wingspan 70–90 mm (Arimoto & Iwaizumi, 2014).

The species could be discriminated from other Asian species of the genus *Lymantria* by the yellow background colour of the hindwing in males and pink hindwings in females, and male genitalia by the tegumen with lateral process, deeply divided valve with conspicuous dorsal and ventral processes, and ventrally fused valves (Arimoto & Iwaizumi, 2014). A detailed description of male and female morphology can be found in Pogue & Schaefer (2007) and Arimoto & Iwaizumi (2014).

Detection and inspection methods

The presence of larvae can be detected by chewing damage on leaves with untouched thicker veins (Roonwal, 1979). Adults (both males and females) are attracted to light; phosphor mercury lamps attract more individuals than highpressure sodium lamps, with a peak activity for *L. mathura* from 01:00 to 03:00 a.m. (Wallner *et al.*, 1995). Furthermore, to detect the species, traps (milk-carton traps or wing traps) with the synthetic pheromone, or lure can be used in ports of entry and adjacent forest areas (Savotikov *et al.* 1995; Wallner *et al.*,1995; Gries *et al.*, 1999; Oliver *et al.*, 1999; Molet, 2012).

DNA barcoding (i.e. sequencing of the mitochondrial gene COI) allows reliable differentiation between *L. mathura* and other *Lymantria* species, including the nearest neighbour *Lymantria flavida* (4% interspecific divergence) and 13-17% difference with 18 other *Lymantria* species tested, including *L. dispar* (European and Asian forms), *L. monacha* etc. (Ji *et al.*, 2023).

PATHWAYS FOR MOVEMENT

L. mathura can spread naturally by flight of adult moths. All stages of the life cycle can be transported on plants moving in trade, particularly plants for planting and cut branches. Eggs may be associated with wood with bark of different trees (not only of host species) or in crevices on other articles (vehicles including boats, packaging material, containers, etc.). Egg masses are small and well hidden, which makes them dif?cult to detect. Neonate larvae can spread by using silken threads and ballooning on air currents (Zlotina, 1999). During outbreaks especially, larvae may be associated with bark or contaminate other commodities. The introduction of the related Asian gypsy moth, *Lymantria dispar*, to North America is believed to have happened through airborne dispersal of neonates from ships that had been infested in the Far Eastern ports of Russia (Zlotina *et al.*, 1999). The egg masses of *L. mathura* were also intercepted on the ships in the same port underlining the risks of long-distance dispersal and accidental international introduction (Zlotina *et al.*, 1999; Mastro *et al.*, 2021).

PEST SIGNIFICANCE

Economic impact

In East Asia, *L. mathura* is one of the most important defoliators of deciduous trees (especially *Quercus*, *Malus*, *Juglans*) (Roonwal, 1979; Yurchenko & Turova, 2002; Kuzmin, 2019). Its outbreaks usually occur over large areas and often result in significant defoliation of forests. Pest damage does not usually kill trees but lead to significant loss of vigour (Kurnetsov, 1999; Yurchenko & Turova, 2002). Mass outbreaks of *L. mathura* are known in the Russian Far East since 1881 (Graeser, 1888; cited by Yurchenko & Turova, 2002). In some forest stands, defoliation of *Quercus* reached 90% in 1978 (Chelysheva & Orlov, 1986; cited by Yurchenko & Turova, 2002). In the Republic of Korea, an outbreak of *L. mathura* in chestnut plantations was especially heavy in 1992 (Lee & Lee, 1996). Important damage also occurs in orchards, e.g. of apple, leading to loss of fruit yield. In particularly Japan, *L. mathura* notably defoliates apple orchards (Pogue & Schaefer, 2007). In India, it is a major tree defoliator, with periodic outbreaks resulting in the decline of overall growth and host plants, reduction in yield or total crop loss in fruit crops, or even tree death (Roonwal, 1979). In the Sal-forest of Jharkhand (India), *L. mathura* heavily damages *Shorea robusta*, an ecologically and economically important tree, commonly used for timber (Kaustubh *et al.*, 2022).

Outbreaks of *L. mathura* have often been reported at the same time as those of *L. dispar*, increasing the impact of the latter. Most authors believe, nevertheless, that *L. mathura* is not as important as *L. dispar* (which is present in Europe) (Maslov, 1988; Gninenko & Gninenko, 2002). Indeed, in the Russian Far East, the areas of *L. mathura*'s outbreaks are not as large as those known for *L. dispar asiatica*, nevertheless, its impact on broadleaf forests in Primorsky Krai in notable (Alekseenko *et al.*, 2009).

Control

Signi?cant control efforts (mainly treatments with chemical, bacterial and viral preparations) against *L. mathura* are undertaken during years of outbreaks in Russia. Usually, these measures are similar to those used against *L. dispar* (Maslov *et al.*, 1988; Yurchenko & Turova, 2002). Forecasting of population development is possible by trapping *L. mathura* adults in light traps and analysing weather conditions. Pheromones have been developed for monitoring and control purposes. The concentration of epoxy compounds, i.e. (c)-mathuralure and (–)-mathuralure] at a 1 : 4 ratio showed to be the best to attract males to pheromone traps (Gries *et al.*, 1999). It is important to note that field experiments in Japan have shown that *L. mathura* was not trapped by disparlure designed for the related species *L. dispar*, *L. monacha*

(Oliver *et al.*, 1999). However, in field experiments conducted in China, pheromone traps containing (+)-disparlure attracted males of *L. mathura* even in low density population (Odell *et al.*, 1992). For *L. mathura* control, it is recommended to use pheromone traps at the beginning of the flight period, i.e. before the end of July (Odell *et al.*, 1992).

In India, larvae of *L. mathura* are heavily parasitised by Hymenoptera (undetermined chalcids and a braconid, *Apanteles* sp.) and Diptera (undetermined tachinids) but pupae are less parasitised (tachinids) (Roonwal, 1979). In India, polyhedral virus disease (Baculoviruses) rapidly spreads in outbreaking *L. mathura*'s populations and causes significant mortality of larvae (Roonwal, 1979). In the Russian Far East (Primorsky Krai), 28 species of tachinid parasitoids from three subfamilies (Exoristinae, Tachininae, Dexiinae) were detected on the representatives of Lymantriidae, including *L. mathura* (Markova & Manchela, 2013). Parasitoids play a significant role in suppressing *L. mathura* populations (Markova & Manchela, 2013). In the Republic of Korea, a total of nine parasitoid species and two pathogens attacking larvae and pupae were documented, with *Cotesia melanoscela* (Ratzeburg) (Hymenoptera: Braconidae) the dominant larval parasitoid and *Brachymeria lasus* (Hymenoptera: Chalcididae) the dominant pupal parasitoid which caused about 28.6% mortality in 1992 (Lee & Lee, 1996). Overall, combined mortality caused by nuclear polyhedrosis virus (NPV) and a fungus (*Beauveria* sp.) resulted in the death of more than 60% of *L. mathura*'s larvae in the Republic of Korea (Lee & Lee, 1996). Simultaneously, the parasitoids, the virus and the fungus have shown high efficiency to control *L. mathura*: in the Republic of Korea, in 1993 altogether they caused 99.9% mortality, which led to the collapse of the host population the following year (Lee & Lee, 1996). At least in the Republic of Korea and the Russian Far East, *L. mathura* share the parasitoids and NPV with *L. dispar* (Lee & Lee, 1996; Lewis *et al.*, 1984; Markova & Manchela, 2013). NPV extracted from *L. mathura* collected in China showed similar activity against *L. dispar* as the virus extracted from *L. dispar* (Lewis *et al.*, 1984). Biocontrol options also include spraying a water solution of the bacterium, *Bacillus thuringiensis* (B.t.) var. *kurstaki* 1% (Roychoudhury *et al.*, 2020).

Phytosanitary risk

L. mathura is considered to be an important defoliator of deciduous forests and orchards in countries where it occurs (Roonwal, 1979; Maslov *et al.*, 1988; Lee & Lee, 1996; Yurchenko& Turova, 2002). It is very likely to be able to establish in many EPPO countries, particularly in those that are in the centre of the region. Its major host species (*Fagaceae*) include several key oaks species in Europe, for instance, *Q. robur,Q. petraea*. The related species, *L. dispar* is present in Europe and also causes damaging outbreaks. The evidence from the Far East suggests that *L. mathura*, which is expanding its range in Amur Oblast, is competing and displacing *L. dispar* in the region (Kuzmin, 2019). Because of *L. dispar*, most *Lymantria* spp. are regarded as potentially dangerous pests in continents where they do not occur, and their presence in Europe could cause additional problems with export trade. Overall, human-mediated long-distance spread from East Asia (i.e. with transport and commodities), attractiveness to light, wind dispersal of young larvae, relatively long survival of neonate larvae without food after emergence, wide polyphagy suggest that the phytosanitary risk is relatively high (Gninenko Yu & Gninenko M, 2002). *L. mathura* is considered to pose a high risk to North American forests (Zlotina *et al.*, 1998, 1999; Zlotina, 1999).

PHYTOSANITARY MEASURES

Because of its potential for natural spread, phytosanitary measures may have little effect in countries bordering the present range. Surveys may be conducted in the border areas, using light traps and pheromone traps to detect entry of the pest which would be followed by eradication campaigns. Control measures, which are similar to those used for the related lymantiids (*L. dispar*, *L. monacha*), can also be applied in adjoining infested areas, especially during outbreaks, to limit spread of *L. mathura*. To prevent introduction, plants for planting and cut branches of host plants from the infested areas should be free from soil, according to EPPO (1994). Alternatively, such commodities should originate in a pest-free area, or be produced in protected houses, or fumigated or imported during winter. Wood should be debarked or heat-treated or originate in a pest-free area, or be imported during winter, and isolated bark should be treated against contaminating insects.

REFERENCES

Alekseenko AYu, Brusova EV, Vyvodtsev NV, Gromyko SA, Gukov GV, Gul LP, Efremov DF, Zamaleev VK, Kovalev AP, Kovalev SA, Kolesnikova RD, Koryakin VN, Malokvasova TS, Manko YuI, Morin VA, Nechaev AA, Nikitenko EA, Perevertailo II, Pankratova NN, Pozdnyakova VV, Ryabukhin PB, Sapozhnikov AP, Timchenko VA, Chelyshev VA, Tagiltsev YuG, Turova GI, Shmelev GS, Sheshukov MA & Yurchenko GI (2009) [The current state of the forests of the Russian Far East and prospects for their use] (ed. Kovaleva AP. Far Eastern SRIF, Khabarovsk (RU) (in Russian).

Arimoto M & Iwaizumi R (2014) Identification of Japanese *Lymantria* species (Lepidoptera: Lymantriidae) based on morphological characteristics of adults. *Research Bulletin of the Plant Protection Service of Japan* no. 50, 89-110.

Barbarich AA & Dubatolov VV (2012) [Family Noctuidae - Owlet moths]. In Fauna of Bastak Nature Reserve. BSPU Press, Blagoveshchensk (RU) (in Russian).

Chelysheva LP & Orlov YuM (1986) [On outbreaks of pink gypsy moth and gypsy moth in Primor'e.] *Problemy Ratsional'nogo Lesopol'zovaniya na Dal'nem Vostoke, Trudy Dal'nevostochnogo Nauchno-Issledovatel'skogo Instituta Lesnogo Khozyaistva* no. 28, 125–129. Izdatel'stvo Gosudarstvennogo Komiteta SSSR po Lesnomu Khozyaistvu, Khabarovsk (RU) (in Russian).

Chistyakov YuA, Dubatolov VV & Belyaev EA (2016) [Subfamily Lymantriinae]. *In* Annotated catalogue of the insects of Russian Far East. Vol. II. Lepidoptera. Dalnauka, Vladivostok (RU) (in Russian).

Dubatolov VV & Dolgikh AM (2009) [New records of moths (Insecta, Lepidoptera, Macroheterocera) from the Bolshekhekhtsyrskii Nature Reserve (Khabarovsk suburbs) in 2008 and spring 2009]. *Amurian Zoological Journal* **I** (2), 135-139 (in Russian).

Epova VI & Pleshanov AS (1995) [*The Forest Regions Injured by Phyllophagous Insects in the Asian Russia*]. Nauka, Novosibirsk (RU) (in Russian).

Graeser L (1888) Beitrage zur Kenntnis Lepidopteren. Fauna des Amurlanders. 1Theil. *Berliner Entomologische Zeitschrift* **32**(1), 125.

Gninenko YuI & Gninenko MYu (2002) Little known lymantriids of the Russian Far East – potential for movement to other countries of the Paci?c region. *EPPO Bulletin* **32**, 477–480.

Gries G, Gries R, Schaefer PW, Gotoh T & Higashiura Y (1999) Sex pheromone components of pink gypsy moth, *Lymantria mathura*. *Naturwissenschaften* **86**, 235–238.

Inoue H (1957) A revision of the Japanese Lymantriidae (II) *Japanese Journal of Medical Sciences and Biology* **10**, 187-219.

Ji W, Dou F, Zhang C, Xiao Y, Yin W, Yu J, Kurenshchikov DK, Zhu X & Shi J (2023) Improvement in the identification technology for Asian spongy moth, *Lymantria dispar* Linnaeus, 1758 (Lepidoptera: Erebidae) based on SS-COI. *Insects* **14**(1), 94. https://doi.org/10.3390/insects14010094

Kaustubh K, Joshi R, Hassan SMM (2022) Report of occurrence of *Lymantria mathura* (Lepidoptera: Erebidae) from Saranda Forest Division, Jharkhand, India. *Acta Entomology and Zoology* **3**(1), 30-33. https://doi.org/10.33545/27080013.2022.v3.i1a.61

Kuzmin AA (2019) [Long-term dynamics of the species of the genus *Lymantria* Hübner, [1819] 1816 (Lepidoptera, Erebidae) in the Amur Region]. *Agroforum* no. 7, 56-57 (in Russian).

Kuznetzov VI (1999) [The family Lymantriidae (Liparidae, Orgidae)]. In Insects and mites—pests of agricultural plants (ed. Kuznetsov VI), pp. 279–320. Vol. III (2). Lepidoptera. Nauka, St. Petersburg (RU) (in Russian)

Lee JH & Lee HP (1996) [Parasites and phenology of *Lymantria mathura* in Kyonggi Province, Korea.] *Korean Journal of Entomology* **26**, 393–401 (in Korean).

Lewis FB, Wallner WE & Rollinson WD (1984) Activity of lymantriid NPVs from the People's Republic of China against North American *Lymantria dispar*. *Entomophaga* **29**, 299–302.

Markova TO & Manchela KA (2013) [Tachinidae (Diptera) – parasites of Lymantriidae (Lepidoptera) of Primorye Territory]. *Bulletin of the Orenburg State University* **155**(6), 155–158 (in Russian).

Maslov AD, Vedernikov NM, Andreeva GI, Zubov PA, Krangauz RA, Lyashenko LI & Pavlinov NP (1988) [Guide to Forest Protection Against Pests and Diseases], 2nd edn. Agropromizdat, Moscow (RU) (in Russian).

Mastro VC, Munson AS, Wang B, Freyman T, Humble LM (2021) History of the Asian *Lymantria* species Program: A Unique Pathway Risk Mitigation Strategy. *Journal of Integrated Pest Management* **12**(1), 1–10. https://doi.org/10.1093/jipm/pmab023

Molet T (2012) CPHST Pest Datasheet for *Lymantria mathura*. USDA-APHIS-PPQ-CPHST.

Odell TM, Xu CH, Schaefer PW, Leonhardt BA, Yao DF, Wu XD (1992) Capture of gypsy moth, *Lymantria dispar* (L.), and *Lymantria mathura* (L.) males in traps baited with disparlure enantiomers and olefin precursor in the People's Republic of China. *Journal of Chemical Ecology* **18**, 2153–2159.

Oliver JE, Dickens JC, Zlotina M, Mastro VC & Yurchenko GI (1999) Sex attractant of *Lymantria mathura*. *Zeitschrift für Naturforschung. Section C, Biosciences* **54**, 387–394.

Pavlovskii EN & Shtakelberg AA (1955) [Guide to Forest Pests]. Izdatel’stvo Akademii Nauk SSSR, Moscow–Leningrad (RU) (in Russian).

Pogue MG & Schaefer PW (2007) A review of selected species of *Lymantria* Hübner (1819) (Lepidoptera: Noctuidae: Lymantriinae) from subtropical and temperate regions of Asia, including the descriptions of three new species, some potentially invasive to North America. Forest Health Technology Enterprise Team (US), 221 pp.

Roonwal ML (1979) Field-ecological studies on mass eruption, seasonal life-history, nocturnal feeding and activity rhythm, and protective behavior and coloration in the sal defoliator, *Lymantria mathura* (Lepidoptera: Lymantriidae), in sub-Himalayan forests. *Records of the Zoological Survey of India* **75**, 209-236.

Roychoudhury N, Singh RB & Mishra RK (2020) Occurrence of *Lymantria mathura* in sal forests of Odisha. *Van Sangyan* **7**(10), 27-31.

Savotikov YF, Smetnik AI & Orlinskii AD (1995) Situation of the Asian form of gypsy moth (*Lymantria dispar*) in Russia and in the world. *EPPO Bulletin* **25**, 617–622.

Taiwan Insects. *Lymantria mathura subpallida* Okano,1959. Accessed 22 June 2023 from: http://gaga.biodiv.tw/new23/9408/079.htm (in Chinese)

Wallner WE, Humble LM, Levin RE, Baranchikov YN & Card RT (1995) Response of adult lymantriid moths to illumination devices in the Russian Far East. *Journal of Economic Entomology* **88**(2), 337-342.

Yurchenko GI & Turova GI (2002) [Features of biology, behavior and population dynamics of the rosy gypsy moth unpaired silkworm (*Lymantria mathura* Moore) in the Russian Far East]. In Readings in memory of A.I. Kurentsov, pp.84-95. Dalnauka, Vladivostok (RU) (in Russian).

Zlotina MA (1999) Biology and behavior of *Lymantria mathura* Moore (Lepidoptera: Lymantriidae). Doctoral Dissertations 1896 - February 2014. 5673. Accessed 9 June 2023 from: https://scholarworks.umass.edu/dissertations_1/5673

Zlotina MA, Mastro VC, Elkinton JS & Leonard DE (1999) Dispersal tendencies of neonate larvae of *Lymantria mathura* and the Asian form of *Lymantria dispar* (Lepidoptera: Lymantriidae). *Environmental Entomology* **28**, 240–245.

Zlotina MA, Mastro VC, Leonard DE & Elkinton JS (1998) Survival and development of *Lymantria mathura* on North American, Asian, and European tree species. *Journal of Economic Entomology* **91**, 1162–1166.

ACKNOWLEDGEMENTS

This datasheet was extensively revised in 2023 by Dr Natalia Kirichenko (Sukachev Institute of Forest, the Siberian Branch of the Russian Academy of Sciences, Federal Research Center ‘Krasnoyarsk Science Center SB RAS’ and Siberian Federal University, Krasnoyarsk, Russia) and Stanislav Gomboc (Slovenia). Their valuable contribution is gratefully acknowledged.

How to cite this datasheet?

EPPO (2024) *Lymantria mathura*. EPPO datasheets on pests recommended for regulation. Available online. https://gd.eppo.int

Datasheet history

This datasheet was first published in the EPPO Bulletin in 2005 and revised in 2023. 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.

EPPO (2005) *Lymantria mathura*. Datasheets on pests recommended for regulation. *EPPO Bulletin* **35**(3), 464–467. https://doi.org/10.1111/j.1365-2338.2005.00875.x

Co-funded by the European Union