Lymantria monacha

Scientific Name
Lymantria monacha L.

Synonyms:
Noctua heteroclita Müller
Bombyx eremita Hübner
Bombyx niger Freyer
Liparis monacha var. oethiops de Selys-Longchamps
Psilura transiens Thierry-Mieg
Lymantria monacha niger Krulikovsky
Lymantria monacha eremita Krulikovsky
Lymantria monacha forma transiens Lambillion
Lymantria monacha forma flaviventer Krulikovsky
Lymantria monacha forma gracilis Krulikovsky
Lymantria monacha forma brunnea Stipan
Lymantria monacha forma kuznezovi Kolossov
Lymantria monacha chosenibia Bryk
Lymantria monacha matuta Bryk
Lymantria monacha lateralis Bryk
Lymantria monacha idae Bryk
Lymantria monacha neirai Agenjo
Lymantria monacha ceballosi Agenjo

Figure 1. *Lymantria monacha* adult female (Image courtesy of Petr Kapitola, State Phytosanitary Administration, Bugwood.org)

Figure 2. *Lymantria monacha* adult male (Image courtesy of DAFF Archive, Bugwood.org)

Common Names
Nun moth, black arched moth, tussock moth

Type of Pest
Caterpillar

Taxonomic Position
Class: Insecta, **Order**: Lepidoptera, **Family**: Lymantriidae

Reason for Inclusion
Additional Pest of Concern List (2013)

Pest Description
Eggs: Eggs are spherical with a slight concavity in the middle and a diameter of approximately 1 mm (Keena et al., 1998). Initially orange-brown in color, they "later turn brown with an opalescent shine" (Keena et al., 1998).

Larvae: “Newly hatched larvae are approximately 4 mm [approx. $^{3}/_{16}$ in] long, tan in color, turning black in 24 hours. Larvae are not particularly distinctive until they reach [the] third instar, when the orange head with black freckles and tan, green, or dark gray colored bodies become evident. When mature, larvae are 30-40 mm [approx. 1 $^{3}/_{16}$ to 1 $^{9}/_{16}$ in] long and difficult to find since their color conceals them on the bark” (Wallner, 2000).

Figure 3. *Lymantria monacha* larva on *Picea abies* (Norway spruce) (Image courtesy of Daniel Adam, Office National des Forêts, Bugwood.org).

Pupae: “The nun moth pupa is reddish brown and shiny with light colored hair clumps and measures 18 to 25 mm [approx. $^{11}/_{16}$ to 1 in] long” (Keena et al., 1998). This species does not have a cocoon (Keena et al., 1998).

Adults: “The forewings of nun moths can vary from the characteristic chalk-white, decorated with numerous dark transverse wavy lines and patches, to dark brown with black flecks…hind wings are generally gray-brown with minute dark or light patches, or both, at the edge. The nun moth female has a wingspan of 45 to 55 mm [approx. 1 $^{3}/_{4}$ to 2 $^{3}/_{8}$ in], and the male, a wingspan of 35 to 45 mm [approx. 1 $^{3}/_{8}$ to 1 $^{3}/_{4}$ in]” (Keena et al., 1998).

Biology and Ecology:

Adult flight occurs from mid-July to the beginning of September (depending on geographical location) with most activity occurring after midnight (Keena et al., 1998). Females usually perch on trunks and attract males (Keena et al., 1998). This pest is nocturnally active with males flying at night (Carter, 1984). Mated females lay eggs in clusters of about 40 in either bark crevices or underneath lichens on bark and may fly to other locations when laying additional egg clusters (Keena et al., 1998). Adults do not feed and live from 10 to 14 days (Novak, 1976).

Figure 3. Damage caused by *L. monacha* (Image courtesy of Landesforstpräsidium Sachsen Archive, Bugwood.org)

The development of the embryo is completed in two to six weeks and then overwinters in this stage (Keena et al., 1998). Eggs can overwinter repeatedly and still produce viable offspring (USDA-APHIS, 2010). Hatching usually occurs toward the end of April in central Europe and in May in more northern regions

(Novak, 1976). Larvae require new foliage to survive and if unavailable, first and second instars will disperse by wind on silken threads (Wallner, 2000; Keena et al., 1998). First instar larvae on spruce feed primarily on newly flushed needles but can consume male flowers if hatching occurs before bud break; first instar larvae on pine feed entirely on male flowers (Jensen, 1991). Larvae develop for the next 2 ½ months, going through five to seven instars (Keena et al., 1998). Pupae attach to the tree with pupation taking 8 to 14 days (Novak, 1976). In the United Kingdom, larvae are present from April to July; larvae pupate from July to August; and adults are present from August to September (Carter, 1984).

Figure 4. Damage caused by *L. monacha* (Image courtesy of Landesforstpräsidium Sachsen Archive, Bugwood.org)

Damage

Larval feeding damage includes holes in leaves and missing leaf tissue (Wallner, 2000). Feeding activity of the larvae can lead to serious defoliation of host plants. In Poland, defoliation of pines led to reduction in annual tree growth (Beker, 1996). Heavily infested trees can be killed.

Mated females lay eggs in clusters of about 40 in either bark crevices or underneath lichens on bark (Keena et al., 1998), but they may be difficult to see due to their color (USDA-FS, 1991).

Figure 5. Damage caused by *L. monacha* (Image courtesy of Landesforstpräsidium Sachsen Archive, Bugwood.org)

Pest Importance

L. monacha is considered a serious defoliator of several genera of trees (Gries et al., 2001), specific species include *Picea abies* (Norway spruce) and *Pinus sylvestris* (Scots pine) (Novak, 1976). Epidemic populations can lead to severe defoliation and lead to tree death. Outbreaks have occurred

throughout Europe, causing defoliation and death of trees (Gries et al., 2001). Carter (1984) states that *L. monacha* is a sporadic but serious pest of conifers. Periodically, populations can build to epidemic proportions, causing extensive damage (Carter, 1984).

During the last century, serious outbreaks have occurred throughout Europe, the largest of which occurred in Poland from 1978-1983 (Schöherr, 1985). This pest infested over 2 million hectares of forests, accounting for about ¼ of forests in Poland (Schöherr, 1985).

This pest is also considered a significant pest in Russia and parts of Asia where it principally attacks spruce, larch, and fir (USDA-FS, 1991).

Known Hosts

This species primarily feeds on needles and male cones of conifers but can also develop on deciduous trees and shrubs (Kenna, 2003). Hosts are from USDA-FS (2009) unless otherwise noted.

Primary hosts:
Abies firma (Japanese fir), *Larix cajanderi* (cajander larch), *Larix leptolepis* (Japanese larch), *Picea abies* (Norway spruce), *Picea ajanensis* (yeddo spruce), *Pinus koraiensis* (Korean pine), and *Pinus sylvestris* (Scots pine).

Good hosts:
Abies alba (white fir), *Betula ermanii* (erman's birch), *Betula pendula* (European white birch), *Fagus sylvatica* (European beech), *Larix decidua* (European larch), *Larix gmelinii* (Dahurian larch), *Malus domestica* (apple), *Picea jezoensis* (yezo spruce), *Picea sitchensis* (sitka spruce), *Pinus contorta* (lodgepole pine), *Pseudotsuga menziesii* (Douglas fir), *Quercus robur* (English oak), *Quercus sessilis* (sessile oak), and *Vaccinium myrtillus* (whortleberry).

Occasional hosts:
Acer platanoides (Norway maple), *Carpinus betulus* (European hornbeam), *Corylus avellana* (hazelnut), *Evonymus europeus* (spindle tree), *Frangula alnus* (glossy buckthorn), *Fraxinus excelsior* (European ash), *Juniperus communis* (common juniper), *Picea pungens* (Colorado spruce), *Pinus banksiana* (jack pine), *Pinus nigra* (Austrian pine), *Pinus strobes* (white pine), *Populus nigra* (Lombardy poplar), *Pyrus domestica* (pear), *Quercus rubra* (northern red oak), *Rubus idaeus* (European raspberry), *Sorbus aucuparia* (European rowan), *Tilia cordata* (small-leaved linden), *Tilia platyphyllos* (large-leaved linden), and *Ulmus laevis* (European white elm).

Chinese hosts (quality not specified):
Abies fabri (faber's fir), *Abies nephrolepis* (Manchurian fir), *Carpinus cordata* (heartleaf hornbeam), *Corylus heterophylla* (Asian hazel), *Fagus longipetiolata* (south Chinese beech), *Juniperus chinensis* (Chinese juniper), *Keteleeria fortunei*

(fortune's keteleeria), *Malus pumila* (paradise apple), *Picea asperata* (dragon spruce), *Pinus armandii* (Chinese white pine), *Pinus densiflora* (Japanese red pine), *Populus davidiana* (Chinese aspen), *Prunus armeniaca* (apricot), *Pseudotsuga sinensis* (Chinese douglas fir), *Quercus aliena* (Oriental white oak), *Quercus glandulifera* (Korean oak), *Salix humboldtiana* (pencil willow), *Sorbus alnifolia* (Korean mountain-ash), *Tilia tuan* (tuft leaved lime), *Tsuga chinensis* (Chinese hemlock), *Ulmus pumila* (Siberian elm), and *Ulmus macrocarpa* (large fruited elm).

Keena (2003) looked at 26 North American species and 8 introduced Eurasian tree species to test survival and development of *L. monacha*.

Suitable hosts included seven conifers: *Abies concolor*, *Picea abies*, *P. glauca*, *P. pungens*, *Pinus sylvestris* with male cones, *P. menziesii* variety *glauca*, and *Tsuga canadensis*, and six broadleaf species: *Betula populifolia*, *Malus x domestica*, *Prunus serotina*, *Quercus lobata*, *Q. rubra*, and *Q. velutina*.

Intermediate hosts included four conifers: *Larix occidentalis*, *Pinus nigra*, *P. ponderosa*, *P. strobus*, and *Pseudotsuga menziesii* var. *menziesii*, and six broadleaf species: *Carpinus caroliniana*, *Carya ovata*, *Fagus grandifolia*, *Populus grandidentata*, *Quercus alba*, and *Tilia cordata*.

Hosts that ranked poor included: *Acer rubrum*, *A. platanoidies*, *A. saccharum*, *F. americana*, *Juniperus virginiana*, *Larix kaempferi*, *Liriodendron tulipfera*, *Morus alba*, *Pinus taeda*, and *P. deltoids* (Kenna, 2003).

Pathogens Vectored

This pest is not currently known to vector any pathogens or other associated organisms, but damage by this pest can "increase the risk of attack by other insects, notably bark beetles (Grijpma, 1988)" (Wallner, 2000).

Known Distribution

Armenia, Austria, Azerbaijan, Belarus, Belgium, Bosnia and Herzegovina, Bulgaria, China, Corsica, Czech Republic, Denmark, Estonia, Finland, France, Georgia, Germany, Greece, Hungary, Italy, Japan, Kazakhstan, Korea, Latvia, Lithuania, Macedonia, The Netherlands, Norway, Poland, Portugal, Romania, Russia, Slovenia, Spain, Sweden, Switzerland, Turkey, Ukraine, United Kingdom, and Vietnam (EPPO, 2007; Li et al., 2001; Ostrauskas, 2001; Jürivete et al., 2000; Gninenko, 1993; Waterhouse, 1993; Dzutevski and Cakar, 1955; Brammanis, 1940).

Potential Distribution within the United States

This pest is currently not known to occur in the United States. A population was reported in New York in the early 1900s (Holland, 1905), but this population seems to have died out.

Both pines and spruces are distributed throughout North America making primary host material readily available if introduction were to occur.

Pathway

Both males and females are strong fliers and can disperse up to 3.5 km (2.2 mi), while first and second instar larvae can move through wind dispersal (Wallner, 2000).

Long distance movement is mainly by human-mediated movement of egg-masses (Wallner, 2000). Egg masses can move through international trade on container crevices, pallets, and ships (Kenna, 2003), as well as unprocessed logs, crates, and dunnage with large strips of bark in place (Wallner, 2000). The egg stage lasts several months and is tolerant of temperature and moisture extremes which increase the likelihood of the pest moving through international trade (USDA-FS, 1991).

Females in the family Lymantriidae can pupate on a multitude of surfaces (USDA-APHIS, 2010), allowing *L. monacha* to be spread from an initial introduction easily through man-moved material.

Survey

CAPS-Approved Method*:

The CAPS-approved method is a trap and lure combination. The trap is a paper delta trap with 2 sticky sides. Both lure combinations are effective for 84 days (12 weeks).

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

Paper Delta Trap, 2 sticky sides, Brown
Paper Delta Trap, 2 sticky sides, Green
Paper Delta Trap, 2 sticky sides, Orange

There are two lure options. The Lure Product Names are:

Lymantria monacha Lure, 3 Compound,
Lymantria monacha Lure, 1 Compound

IMPORTANT: The three-component lure inhibits *Lymantria dispar dispar* (European gypsy moth); therefore, this lure should be used for surveys in areas with established European gypsy moth populations to reduce large catches of European gypsy moth.

In addition, the three-component lure has been shown to have higher nun moth captures in European populations. Therefore, the three-component lure may be more effective at detecting moths coming from European populations (i.e., in the Eastern United States and other areas along this pathway of introduction).

The one-component lure should only be used in areas without established European gypsy moth populations. The one-component and three-component lures are equally effective at detecting Asian populations; therefore, the one-component lure is acceptable for use in states that would expect the pathway of nun moth to be from Asia.

Lance (2006) states that *L. monacha* traps should not be assembled at the same time and space as *L. dispar* lures. They should also be transported separately to prevent cross contamination as *L. monacha* lure components are potent inhibitors of male *L. dispar*.

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

Method Notes: The lure (a flex tube or laminate dispenser) should be stapled to the inside of the trap on the non-sticky area.

Trap should be used with ends open. Trap color is up to the State and does not affect trap efficacy.

Do not place lures for two or more target species in a trap unless otherwise recommended.

*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/.

Survey Site Selection:
"In Europe, *L. monacha* is most notably a pest of Norway spruce, *Picea abies*, and Scots pine, *Pinus sylvestris,* but the species has a very broad host range and does well on many additional hosts, including (among others) larches, oaks, maples, birches, and a variety of fruit trees" (Lance, 2006).

Trap Placement:
Hang traps from branches of host trees (Lance, 2006).

Literature-Based Methods:
Trapping:
Adults are attracted to artificial lights and have been observed in port areas in the Russian Far East (Kenna et al., 1998; Wallner et al., 1995). Eggs can be found on containers, pallets, and ships meaning that this species has a high potential of moving through commerce (Keena et al., 1998).

The New Pest Response Guidelines for Lymantriidae suggests using both trapping and visual survey methods to increase effectiveness (USDA-APHIS, 2000). High risk trapping areas can include port areas and certain inland areas

(areas with high host levels or host disposal and areas with high travel to and from areas where the pest is established, among others) (USDA-APHIS, 2000). Other sites that have a high risk of having *L. monacha* artificially introduced are nurseries, campgrounds, State and Federal parks, and other tourist attractions, among others (USDA-APHIS, 2000). Traps listed for *L. monacha* include light, 3D, and sticky delta traps (USDA-APHIS, 2000). Pheromone trap attractiveness is listed as 200 meters; they should be placed near hosts and serviced approximately every two weeks (USDA-APHIS, 2000).

Identification

CAPS-Approved Method*:

Morphological. Adults should be identified by a taxonomist with expertise in the Lymantriidae family.

Literature-Based Methods:

Asian populations consist of white color morphs with black spots. While melanistic (darker) forms which are frequently found in Europe (Keena et al., 1998), are absent (Gries et al., 2001). Descriptions of the different life stages can be found in Pogue and Schaefer (2007).

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Easily Confused Pests

This species is similar to *Lymantria dispar* (gypsy moth) (Keena et al., 1998). Females of *L. monacha* have "narrower abdomens and extremely long ovipositors" which can be used to distinguish them from female *L. dispar* (Keena et al., 1998). If the male has either white on the wings or black flecks on the forewings then it is *L. monacha*. *L. dispar* males have characteristic wavy lines (Keena et al., 1998).

"First instar of the nun moth [*L. monacha*] can be distinguished from the first instar of the gypsy moth [*L. dispar*] by the presence of a series of small, paired, black protuberances along the center of the back…The hairy larvae have a white patch on each side of their back near the head…and may also have a light patch in the middle of the back farther down the body…unlike gypsy moth larvae" (Keena et al., 1998).

"Beginning with the third instar, the larval heads of the nun moth [*L. monacha*] and gypsy moth [*L. dispar*] can be differentiated by the patterns of dark spots and stripes on their heads…the two single large glands in the middle of the larva's back near the posterior end are orange in the nun moth [*L. monacha*] and red in the gypsy moth [*L. dispar*] …the stripe down the middle of the larva's back is brown to black in the nun moth [*L. monacha*] and white to yellow in the gypsy moth [*L. dispar*]. The pairs of hairy mounds on the back of the nun moth larva [*L.*

monacha] are all bluish, while those of the gypsy moth [*L. dispar*] are blue-violet near the head and red on the rest of the body" (Keena et al., 1998).

L. monacha is also similar in appearance to *Panthea coenobita* (Bejer, 1988) but can be distinguished from one another from presence of ocelli and tufts of scales on the posterior side of the thorax which are found on *P. coenobita* (CABI, 2011).

L. monacha has previously been misidentified as *L. minomonis okinawaensis* (from Okinawa) (Kishida, 1987).

Commonly Encountered Non-targets

Because the ends of the delta traps are left open, non-target organisms (both invertebrates and vertebrates) can enter the traps and potentially remove captured moths or become trapped themselves (Lance, 2006).

The one component lure may also trap *Lymantria dispar* (gypsy moth), *L. obfuscata* (Indian gypsy moth), and *L. concolor*. Some *L. mathura* may respond as well (Lance, 2006).

References

Bejer, B. 1986. Outbreaks of nun moth (*Lymantria monacha* L.) in Denmark with remarks on their control. Anzeiger für Schädlingskunde Pflanzenschutz, Umweltschutz 59: 86-89.

Bejer, B. 1988. The nun moth in European spruce forest, pp. 211–231, In A. A. Berryman (ed.). Dynamics of Forest Insect Populations: Patterns, Causes, Implications. Plenum Press, New York.

Beker, C. 1996. The diameter at breast height increment in pine stands of older age classes. Sylwan. 140(1): 81-91.

Brammanis, L. 1940. A survey of the forest pests in Latvia [Latvijas mezu kaiteklu apskats] [abstract]. Mezkopja darbs un zinatne (1-2): 257-340.

Carter, D. J. 1984. Pest Lepidoptera of Europe with Special Reference to the British Isles. Dordrecht, Dr. W. Junk Publishers.

Dzutevski, B. and L. Cakar. 1955. The mass appearance of *L. monacha* in the beech forests of Macedonia [abstract]. Zastita Bilja 32: 55-60.

EPPO. 2007. PQR database (version 4.6). Paris, France: European and Mediterranean Plant Protection Organization. www.eppo.org.

Gninenko, Y. I. 1993. Features of the use of virus preparations for forest protection [abstract]. Lesnoe Khozyaĭstvo 6: 48-49.

Gries, G., P. W. Schaefrer, R. Gries, J. Liška, and T. Gotoh. 2001. Reproductive character displacement in *Lymantria monacha* from northern Japan? Journal of Chemical Ecology 27(6): 1163-1176.

Gries G., R. Gries, G. Khaskin, K. N. Slessor, G. G. Grant, J. Liška, P. Kapitola. 1996. Specificity of nun and gypsy moth sexual communication through multiple-component pheromone blends. Naturwissenschaften 83: 382-385.

Holland W. J. 1905. The Moth Book, a Popular Guide to the Moths of North America. Doubleday, Page and Company, New York, United States. 479 pp.

Jensen, T. S. 1991. Integrated pest management of the nun-moth, *Lymantria monacha* (Lepidoptera: Lymantriidae) in Denmark. Forest Ecology and Management 39: 29-34.

Jürivete, U., J. Kaitila, T. Kesküla, K. Nupponen, J. Viidalepp, and E. Õunap. 2000. Estonian Lepidoptera Catalogue. Kirjastaja. Tallinn, Estonia. 151 pp.

Keena, M., K. Shields, and M. Torsello. 1998. Nun moth: potential new pest. United States Department of Agriculture, Forest Service, Northeastern Area; NA-PR-95-98, 2 pp.

Kishida Y, 1987. A new subspecies of *Lymantria minomonis* Matsumura (Lymantriidae) from Okinawa I. Japan Heterocerists' Journal, 144: 292-293.

Lance, D. 2006. Guidelines for detection trapping of exotic Lymantriid and Lasiocampid moths. USDA-APHIS-PPQ. pp. 11.

Li, G., X. Zhang, L. Wang. 2001. The use of *Bacillus thuringiensis* on forest integrated pest management. Journal of Forest Research 12(1): 51-54.

Morewood, P., G. Gries, D. Häubler, K. Möller, J. Liška, P. Kapitola, and H. Bogenschütz. 1999. Towards pheromone-based detection of *Lymantria monacha* (Lepidoptera: Lymantriidae) in North America. The Canadian Entomologist 131: 687-694.

Novak, V. 1976. Atlas of Insects Harmful to Forest Trees. Volume 1. Elsevier Scientific Publishing Company. Amsterdam, The Netherlands. 125 pp.

Ostrauskas, H. 2001. Moths in pheromone traps for *Anarsia lineatella* Zll. and *Phthorimaea operculella* Zll. (Gelechiidae, Lepidoptera) in Lithuania. Acta Zoologica Lituanica 11(4): 372-384.

Pogue, M. G. and P. W. Schaefer. 2007. A review of selected species of *Lymantria* Hübner [1819] Including three new species (Lepidoptera: Noctuidae: Lymantriinae). United States Department of Agriculture.

Schönherr, J. 1985. Nun moth outbreak in Poland 1978–1984. Zeitschrift fuer Angewandte Entomologie 99: 73–76.

USDA-APHIS. 2000. New Pest Response Guidelines: Lymantriidae. United States Department of Agriculture, Animal and Plant Health Inspection Service, Plant Protection and Quarantine. 234 pp.

USDA-FS. 1991. Pest Risk Assessment of the Importation of Larch from Siberia and the Soviet Far East. Miscellaneous Publication No. 1495. United States Department of Agriculture. Forest Service.

USDA-FS. 2009. Nun Moth. Accessed February 17, 2011 from: http://www.nrs.fs.fed.us/disturbance/invasive_species/nun_moth/. USDA, FS.

Wallner, W. E., L. M. Humble, R. E. Levin, Y. N. Baranchikov, R. T. Carde. 1995. Response of adult Lymantriid moths to illumination devices in the Russian Far East. J. Econ. Entomol., 88(2): 337-342.

Wallner, W. E. 2000. *Lymantria monacha* Pest Report. Exotic Forest Pest Information System for North America.

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