

SIBERIAN FOREST INSECTS: READY FOR EXPORT

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Introduction. Existing publications on Palaearctic insect invaders to North America forests are devoted exclusively to Europe-U.S. comparisons (Niemela, Mattson, 1996). This is understandable from both geographical and historical points of view. But as the history of mankind continues, new economical relations are established which, unfortunately, make new possibilities for the introductions of pests. The recent discovery in New York of a cerambycid beetle *Anoplophora glabripennis* native to Asia (USDA Forest Service, 1996) and the well known "Asian Gypsy Moth Case" (Wallner, 1996) are the reminders that the forests of Northern and Northeastern Asia are an important source of exotic pests. The largest part of this region belongs to the Russian Federation.

The forested territory of Asian Russia could be divided in two parts (Fig. 1): Siberia (from Urals to the Khabarovsk Kray) and the Far East (with administrative units of Khabarovsk and Prymorsky Kray, Amurskaya, Magadanskaya, Kamchatskaya and Sakhalinskaya Oblast'). The forest land of this region spans a wide range of latitudes, elevations, precipitation, and soils. More than 60 percent of forests in Asian Russia grow on the permafrost (Pozdniakov, 1986).

Comparison of the forest composition of Siberia and Northern North America shows that they are similar in type, but differ in species composition. In Siberia 81% of the forested territory is covered with conifers. Nearly all of the conifer forest is composed of six species: *Larix sibirica*, *Larix dahurica*, *Pinus silvestris*, *P. sibirica*, *Abies sibirica* and *Picea obovata*. Larch forests dominate both in area (62%) and in growing stock (52%) (Falaleev, 1985).

Even a brief comparison shows the similarity of Asian Russian forests to that of Northwestern North America. In the Western U.S., 82% of forests are conifers (Powell et al., 1993), but the list of the woody species is slightly longer than that of Siberia and the Russian Far East. Though Siberia and Northern U.S. and Canada are dissimilar at the species level of woody plants, these regions are much more similar on the genus level. There are at least 16 genera of trees found in both areas (e.g. *Abies*, *Alnus*, *Betula*, *Colylus*, *Crataegus*, *Juniperus*, *Larix*, *Picea*, *Pinus*, *Populus*, *Rhamnus*, *Salix*, *Sorbus*, *Tilia*, *Ulmus*, and *Viburnum*). Taxonomic diversity of these genera in Siberia is comparable with those in the different regions of the Northern U.S. and Canada (Table 1).

The taxonomic diversity of forest insects in Asian Russia is comparable with those of boreal zones of Northern America. For example, 218 and 212 species of bark beetles (*Scolytidae*) were reported from Asian Russia and Canada respectively (Danks, 1979; Yanovskiy, 1996).

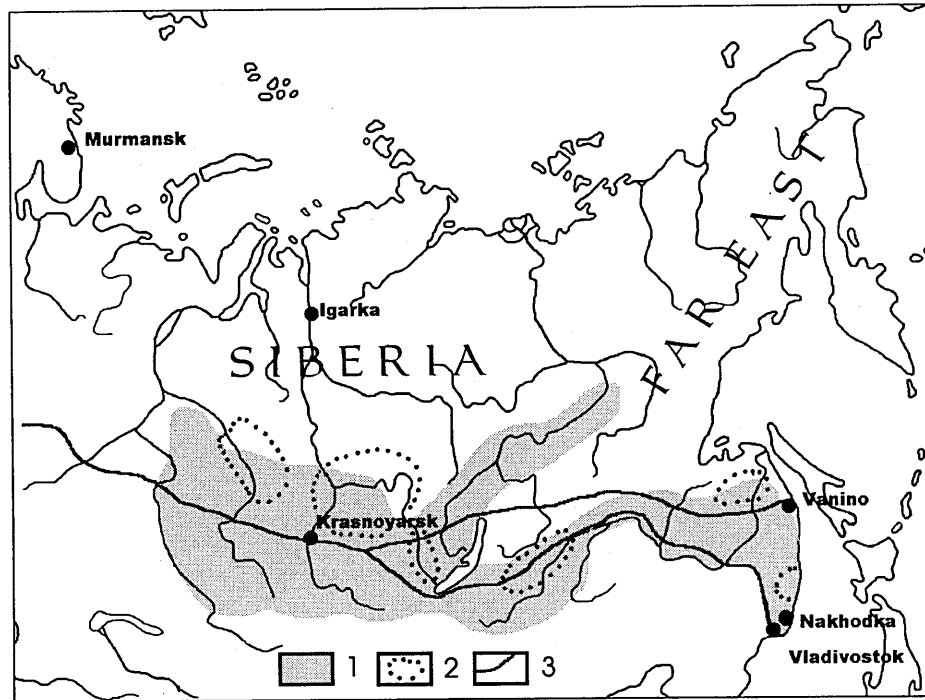


Figure 1. Forest insect injury zones and areas of logging and transportation in Siberia and the Russian Far East.

1 – area of most severe outbreaks; 2 – primary areas of logging; 3 – Trans-Siberian railroad.

Only 90 species of insects are of real economical importance in the forests of Siberia and the Far East (Baranchikov, Montgomery, 1996). The main folivores are: *Dendrolimus superans*, *Lymantria dispar* and *Zeiraphera griseana* on *Larix*; *Lymantria monacha* (Fig. 2) and *Bupalis piniarius* on *Pinus*; *D.superans* on *Abies* and *Choristoneura murinana* on *Picea*. The major wood borers are: *Ips cembrae* and *Xylotrechus altaicus* on *Larch*; *Ips sexdentatus* and *Tomicus piniperda* on *Pinus*; *Monochamus urussovi* on *Abies*; and *Ips typographus* on *Picea*. The following three species are the most widespread and destructive:

Fir sawyer beetle (*Monochamus urussovi* Fisch.) is a transpalearctic species occurring in coniferous forests from Finland to the Pacific Ocean (Fig. 2). The insect infests nearly all species of *Pinaceae* but the firs (*Abies*) are most heavily damaged. The beetle vectors the phytopathogenic fungus *Ceratocystis* sp. During their feeding on the crown, the adult beetles remove strips of bark and infect branches with the fungus spores. The developing fungus kills tiny branches on the periphery of the crown, weakens the tree and reduces resin flow. This makes oviposition and larvae development of the beetle more successful. To our knowledge fungus is pathogenic only for fir species. In Siberia, *M. urussovi* is frequently found on birches (*Betula*), but causes little damage to it.

The life cycle of *M. urussovi* typically lasts for 2 years. The beetles fly from late May or early June through September. A female lays eggs under the bark, one at a time; eggs hatch in 16 to 30 days. From the second instar and up to pupation the larvae gnaw tunnels in the wood. Winter is usually spent in the larval stage. Before pupation, larvae form pupal chambers in the wood, separated from

the surface by a thin layer of bark and wood where they pupate. The pupal phase lasts from 4 to 5 weeks; adults emerge by gnawing a round hole 6 to 12 mm in diameter through the bark.

Table 1. Number of tree species per woody plant genus in Siberia and Northern United States and Canada (Data from Koropachinskiy, 1983; Elias, 1980; introduced species not included).

Plant Genera	Siberia	Alaska	Western Canada	North-western U.S.	Eastern Canada	North-eastern U.S.	Northern North America
Abies	1	-	3	5	1	1	8
Alnus	5	2	4	4	1	3	7
Betula	8	1	2	2	5	6	7
Cornus	2	1	2	3	2	4	6
Craetagus	4	-	2	2	6	11	12
Juniperus	5	1	2	3	1	1	4
Larix	3	1	2	3	1	1	3
Picea	2	3	4	3	3	3	7
Pinus	3	-	6	9	2	8	17
Populus	6	3	3	4	4	5	8
Prunus (Padus)	1	-	3	3	4	8	10
Rhamnus	4	-	1	2	-	2	3
Salix	11	8	14	13	10	12	25
Sambucus	1	-	1	1	2	2	4
Tilia	1	-	-	-	1	2	2
Ulmus	4	-	-	-	3	5	5
Euonymus	2	-	-	1	-	1	2

M. urussovi is one of the most destructive pests of firs in Northern Asia. The pest increases its number in *Abies* forests damaged by defoliating insects, fires and windfalls. Having infested the damaged parts of the forest, the beetle population becomes dense enough to attack, weaken and kill

healthy stands. By attacking healthy fir stands dense beetle populations can maintain outbreak levels indefinitely, causing the death of fir forests over enormous areas. In the late 1950's in the Tomsk Oblast' (Western Siberia), the pest destroyed 2 million m³ of fir wood stock. This caused the collapse of forest enterprises in that region for years and previously planned construction of a railway was delayed significantly slowing the industrial development of the whole area. In 1971-1976, an outbreak of *M. Urussovi* destroyed 300,000 hectares of fir forest in Krasnoyarsk Kray in the Central Siberia (Isaev et al., 1988).

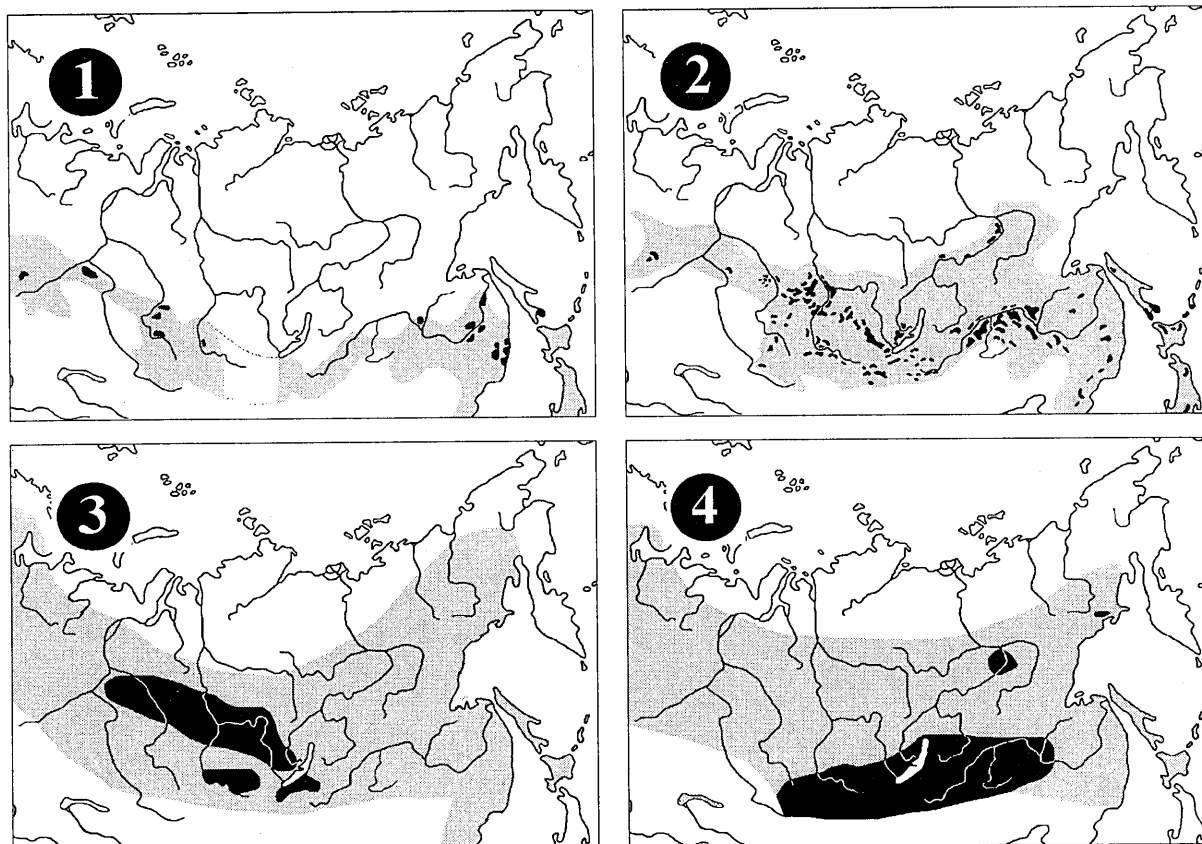


Figure 2. Distribution (grey) and areas of economic importance (black) of some forest insect pests of Northern Asia: 1 – *Lymantria monacha*; 2 – *Dendrolimus superans*; 3 – *Monochamus urussovi*; 4 – *Ips cembrae*.

Larch bark beetle (*Ips cembrae* Heer) is known in Russian literature as *Ips subelongatus* Motschulsky. It is a transpalearctic species occurring from Europe to Japan (Fig. 2). In Siberia it attacks all species of larch, spruce (*Picea*) and pine, but larch is the principal host on which outbreaks occur.

The pest has 2 generations per year in the southern regions of Siberia where the yearly sum of temperatures above 10 C° is more than 1500 and the frost-free period lasts more than 2.5 months. The adult beetles hibernate, mostly in the litter, then emerge from late May to early June, attack trees and lay eggs. Larval and pupal stages occur from June to early July. First generation beetles emerge and attack trees in July. The larval and pupal stages occur from late July to mid-August. New adults start emerging in mid-August. They feed on the same tree if the previous density was not too high, or migrate to neighboring trees. In Europe, *I. cembrae* adults have been recorded

feeding in tree crowns, much like the bark beetles of the genus *Tomicus*. Such crown feeding has not been recorded in Siberia.

In Northern Asia, *I. cembrae* is particularly destructive in the larch forests of the south taiga forest-steppe complex. The distinguishing features of these stands are enhanced aridity and high temperatures in summer, the conditions under which *I. cembrae* can produce two generations. When the forest is damaged by factors that kill more than 20% of the trees, the bark beetle can become epidemic and outbreaks occur. During the outbreak it can infest resistant larch forests adjacent to the damaged ones, thus making the losses much greater.

Siberian moth (*Dendrolimus superans sibiricus* Tschtrvk.) is widely distributed in Urals, Siberia, and the Far East (Fig. 2). Outbreaks occur in *Abies sibirica*, *Pinus sibirica*, *Picea* spp. and *Larix* spp. forests, although larvae feed on most conifers in the family *Pinaceae*.

The length of the life cycle varies from two to four calendar years depending on population density. The larvae of the males have 5 to 9 instars, those of the females 6 to 10; typically males have 5 and females 6. The larvae are up to 110 mm long. Moths fly from the end of June to the beginning of August and lay eggs on needles or branches. Commonly two winters are spent in the larval stage; second to third instars and fifth to sixth instars overwinter coiled up, under the forest litter. Pupation occurs from mid-June to late July in cocoons in tree crowns. During outbreaks, a large portion of excessively dense populations has a life cycle of two calendar years and the rest have a three year cycle. As a result, the adults of two generations emerge simultaneously and the population increases sharply. At the depression phase, some portion of the population have a four calendar year life cycle, where three winters are spent as larvae.

D. superans is the major defoliator of coniferous forests in Asian Russia. In the fir-dominated forests of Central Siberia there were 10 outbreaks since 1873, the last 5 were carefully documented. They occurred in 1935-1947, 1950-1959, 1962-1969, 1978-1985 and 1989-1997 defoliating 0.7, 2.6, 0.9, 0.1 and 1.1 million ha respectively. These forests all died, either directly from the defoliation or from the increasing attacks of the fir sawyer beetle or fire. In the South Siberia, *D. superans* outbreaks take place in larch forests. Outbreaks on larch are not as destructive as those on firs because larch is very tolerant to defoliation.

The ways of possible introductions of Siberian forest insects are through the sea ports of Asian Russia. The overall dry cargo shipments through all Russian ports in the year to July 1996 were 34 million tonnes of which 24 million were exports. The largest Russian port is Novorossiysk on the Black sea, handling 16% of all Russian cargo. The northern port of Murmansk represents 8% and combined Far Eastern ports (Nakhodka, Vladivostok, Vostochny and Vanino) represent the largest concentration at 31% of the total Russian capacity. Large amount of cargo shipments, a deficit of manpower, and the complex economic situation in Russia make the task of the Russian Far East Quarantine Service extremely difficult (Gordon, 1996). International cooperation should be enhanced to prevent transmission of exotic organisms. The mutual Russian-U.S. project on monitoring the population level of lymantriid moths in the Far Eastern port areas was started in 1993 (U.S. Department of Agriculture, 1996). It was agreed that insect outbreaks in the nearby forests should trigger mitigation measures.

Trains transport 97 % of all cargo that enters and leaves the port area. The main transport artery of Asian Russia is the Trans-Siberian railroad (Fig. 1). For much of its length, the railroad goes through the areas known as "the zone of forest insect injury" - the area of the most severe outbreaks and forest damage (Epova and Pleshanov, 1996). Open railroad cars with wood and containers are exposed to many kinds of natural infestations during the 2-6 weeks that it takes them to go through Siberia. Currently, lymantriid pest populations are monitored at the Far Eastern ports area, but this activity is not enough. On the vast area from Urals to Pacific Ocean, flying gypsy moth females can freely put eggs on the containers at the railway stations which are brightly illuminated at night. To more efficiently prevent the occurrence of pest insects on cargo we need the entomological information from all of the Siberian zone of potential infestation, as well as port areas.

Mutual efforts between Russia and U.S.A were set on technology and information transfer regarding pest risk assessment and control of potential pests. Besides the lymantriid survey project, mentioned above, efforts were made to access existing scientific information on species of risk and on the methods of their control (U.S.Department of Agriculture, 1991; Wallner et al., 1995; Baranchikov et al., 1996; Baranchikov and Montgomery, in prep.).

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