***Dendrolimus sibiricus*** **System:** Terrestrial

| Kingdom | Phylum | Class | Order | Family |
|---|---|---|---|---|
| Animalia | Arthropoda | Insecta | Lepidoptera | Lasiocampidae |

**Common name** larch caterpillar (English, China), Siberian moth (English), Siberian coniferous silk moth (English), Siberian lasiocampid (English)

**Synonym** *Dendrolimus superans sibericus* , (Tshetverikov)
*Dendrolimus laricis* , Tschetverikov

**Similar species**

**Summary** The Siberian moth, Dendrolimus sibiricus is a severe pest in regions it inhabits due to its role as a defoliator of conifer trees stands. It is native to Russia and China but has spread outward to other parts of Asia and Europe. The damage the Siberian moth causes to its hosts in its native range results in cascading ecological, economic and social impacts. The risk of the pest being introduced to regions with host species, either by natural or human-related dispersal, is high. While it is likely that the pest may also pose serious risk to European Russia, eastern and central Europe and North America, data suggests that larvae can develop on most European conifers. The distribution of species to the west of the Ural Mountains is prevented by mild winters.

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**Species Description**
Eggs: The eggs are about 2.2 mm in length and 1.9 mm wide giving them an oval shape. They are initially light-green turning creamy-white and finally become darken and spotted (Rozhkov, 1963).\r\n\r\n
Larvae: Larvae are approximately 55 to 70 mm in length, mostly black or dark brown with numerous spots and long hairs (Rozhkov, 1963). The rounded head is brown with a speckled pattern. The dorsum is usually light, silvery, with dark spots on each segment. There are tufts of blue hairs behind the first and second thoracic segments. The second and third segments are marked with blue-black stripes. The dorsal marking of each abdominal segment is hexagonal, and the ventral surface contains a series of fuscous spots (Rozhkov, 1963; EPPO, 2006).\r\n\r\n
Pupae: Pupae are dark brown, 30-36 mm long. The head, thorax, and wing sheaths mat and abdomen are shiny. Wing sheaths reach the fourth abdominal segment. Pupation occurs in cocoons spun with silk, needles and small branches. Cocoon is gray or brownish, 70 x 12 to 15 mm, compact, rough, with inclusion of hairs.\r\n\r\n
Adults: Adult moths are 30-40 mm in length with a wing span of 40-80 mm. Female moths are bigger than males. The adults are yellowish-brown or light gray to dark brown or almost black in color (Rozhkov, 1963). The front wings have two dark transverse bands and a white spot in the centre. The hind wings are the same base color as the forewings, though can be lighter or darker, with no any markings. \r\n\r\n
Please see PaDIL (Pests and Diseases Image Library) Species Content Page: Siberian silk moth *Dendrolimus sibiricus* Chetverikov (Lepidoptera: Lasiocampidae) for high quality diagnostic and overview images

**Notes**
There has been some disagreement over the true identity of this species and its proper scientific name (EPPO, 2006). Most taxonomists have considered the Siberian taxon as a subspecies of the Japanese taxon *D. superans* and used the combination *Dendrolimus superans sibiricus* (Dubatolov & Zolotuhin 1992; Zolotuhin 1995; Chistyakov, 1999). However recent genetic analysis of *Dendrolimus* species allowed separation of *D. sibiricus* and *D. superans* into two different species (Mikkola & Stahls, 2008). Thus, only *D. sibiricus* is reported on in this profile.

**Lifecycle Stages**
Under natural conditions, the moth's life cycle usually requires two to three years, with larvae having from five to seven instars (usually six) ( Boldaruev, 1969; Rozhkov, 1963 ). An 15:9 h L:D photoperiod generates diapause in this species (Geispitz, 1957 ) and diapausing larvae overwinter once or twice (Boldaruev, 1969; Rozhkov, 1963). In the pest's range, most adults appear and lay eggs in the middle of June to the beginning of July. In the first year, larvae develop to the third or fourth instar before coiling up in the litter and overwintering. They emerge in early spring of the next year and feed extensively to complete their development in June (Rozhkov, 1963). However many larvae also enter into a 'summer diapause' (i.e. a period of slow development of the third- to fifth-instar larvae in the tree crowns) and overwinter in the forest floor in the fourth or fifth instar to complete their development in the third year (Baranchikov & Kirichenko, 2002). Such a complex life cycle requires 5 to 11 months of active larvae development.

**Habitat Description**
*Dendrolimus sibiricus* may be closely associated with biomes characterized as: boreal forests, temperate grasslands, temperate broadleaf and mixed forests and temperate coniferous forests (Davis, French & Venette, 2005). The pest attacks either stressed (i.e. drought) or healthy trees (Rozhkov, 1965; CFIA, 2006). Outbreaks have been reported in five-needle pine, fir, larch and spruce forests (Boldaruev, 1955; Rozkov, 1963; Baranchikov, Kondakov & Petrenko, 2001). However, occasional damage on two-needle pine stands that are typically avoided by moth cannot be ruled out (Epova, 1999).\r\n\r\n
Outbreaks vary in size and extent depending on factors including population density, dispersal behaviour, forest type, and host availability (Boldaruev, 1955; Rozkov, 1963; Davis, French & Venette, 2005). In Siberia maximum mortality of forests caused by outbreaks is observed at elevations of approximately 200 meters and minimum mortality at about 300 meters. This may reflect preferable altitudes of Siberian moth outbreak. The insect inhabits latitudes higher than the historical northern limit of severe outbreaks, but the potential for catastrophic outbreaks is limited by cold climate conditions (Kharuk, Ranson & Fedotova, 2007).

**Reproduction**
Females oviposit an average of 150-400 eggs and a maximum of 800 eggs (Rozhkov, 1963; EPPO, 2006; CFIA, 2006). Eggs are laid soon after mating singly or in clusters on needles or thin twigs, mainly in the lower part of the crowns. During outbreaks eggs are laid throughout the tree and also on bushes, grass, logs and rocks (Rozhkov, 1963; CFIA, 2006). The incubation of eggs takes 9 to 22 days (Rozhkov, 1963; Davis, French & Venette, 2005).

**Nutrition**
*Dendrolimus sibiricus* exclusively damages conifers from Pinaceae family (Boldaruev, 1969; Rozkov, 1963; Kirichenko & Baranchikov, 2007). The conifers from other families: Taxaceae and Cupressaceae are inedible for the larvae (Kirichenko *et al*., 2008). Host plant suitability for the larvae is genus-specific and does not depend much on the host species which the pest develops on in natural range (Kirichenko & Baranchikov, 2007, 2008). \r\n\r\n
The suitability of host plant genera decreases in order: *Larix*, *Abies*, five-needle *Pinus* spp., *Picea* to two-needle *Pinus* spp. (Kirichenko & Baranchikov, 2007). Larvae typically feed on foliage in the crown of trees. First instar larvae damage the edges of needles while older larvae consume entire needles (Baranchikov, 1987) and may also eat the basis of buds, young cones and also bark of the first year shoots.\r\nIn regard to the European conifers, *Larix deciduas*, and to North American conifers, *Abies grandis*, *Pinus strobes* and *Pseudotsuga menziesii*, are the most suitable host plants for the insect, resulting in the highest larval survival and growth rates (Kirichenko *et al*., 2008; Kirichenko, Baranchikov & Vidal, 2009). Douglas fir *P. menziesii* is an entirely new host for the pest as genus *Pseudotsuga* does not exist in the natural range of the moth (Kirichenko *et al*, 2008). The larvae are also able to damage conifers from genera *Cedrus* and *Tsuga*, which do not occur in the pest's range (Kirichenko *et al*., 2008).

**General Impacts**
The potential impact by *Dendrolimus sibiricus* within an infested area is high, including direct damage to coniferous plantations and forests resulting in wood losses, environmental damage to natural forests resulting in their death over large areas and social damage to people living in damaged areas (Furiaev, 1966; Baranchikov, Kondakov & Petrenko, 2001; Orlinskii, 2001). Outbreaks of the pest incite a disruption of the continuum of forest succession by causing significant mortality in the overstory and understory conifers causing the abortion of the future seed crop (Buck, 2008).Within its natural range, the moth has caused serious damage to thousands of hectares of forests (Baranchikov & Kondakov, 1997). During the last outbreak alone, in 1999–2002 in the Republic of Yakutia (Russia), more than 8 million hectares of larch stands were damaged (Vinokurov & Isaev, 2002). Weakened and stressed trees are attacked by secondary pests, which ultimately results in forest death and subsequent predisposition to fires (Furiaev, 1966; Isaev, Rozhkov & Kiselev, 1988).

**Management Info**
Preventative Measures: To prevent introduction of *Dendrolimus sibiricus* by international movement of commodities; plants for planting and cut branches of host plants from the infested areas should be free from soil according to OEPP/EPPO. In addition, such commodities could originate in a pest-free area, 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 to destroy contaminating insects (EPPO, 2006). \r\n
Chemical: Adult males can be captured using pheromone traps containing specific pheromones (Klun *et al*., 2000; EPPO, 2006). \r\n
Biological: Under non-outbreak conditions, natural enemies of this species (the egg parasitoids *Telenomus tetratomus*, *Ooencyrtus pinicola* and *Trichogramma dendrolimi*, the larval and pupal parasitoids *Masicera sphingivora*, *Blepharipa schineri* and *Rhogas dendrolimi*, the microorganisms *Bacillus dendrolimus*, *Bacillus thuringiensis*, *Beauveria vassiana*, polyhedrosis viruses and some other viruses) play an important role in the regulation of its population density (Kolomietz, 1962; Boldaruev, 1969; EPPO, 2006).

**Pathway**
All stages of the life cycle of *Dendrolimus sibiricus* can be transported on plants moving in trade, particularly plants for planting and cut branches (EPPO, 2006).

**Principal source:**

**Compiler:** National Biological Information Infrastructure (NBII) & IUCN/SSC Invasive Species Specialist Group (ISSG)

**Review:** Dr. Yuri Baranchikov and Dr. Natalia Kirichenko, Department of Forest Zoology, VN Sukachev Institute of Forest, Siberian Branch of Russian Academy of Sciences.

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## ALIEN RANGE

**[1]** CENTRAL ASIA
**[1]** KAZAKHSTAN
**[1]** MONGOLIA
**[1]** POLAND
**[1]** JAPAN
**[1]** KOREA, REPUBLIC OF
**[1]** NORTHERN ASIA

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Gninenko, Yu. I.; Sidel nik, N. D., 2003. The Siberian moth *Dendrolimus sibiricus* in Yakutia in the 20th century. Lesovedenie.(6). November-December 2003. 71-73.

**Summary:** Abstract: Analysis of *Dendrolimus sibiricus* outbreaks in larch forests conducted on the basis of literature data showed the influence of crown defoliation on the state of these stands. Repeated strong damage of crowns was found to lead to decline and death of trees. A single strong damage of crowns is reverse and does not destroy larch stands.

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**Summary:** Abstract: Problems on creating a system of forest entomological monitoring based on integration of existing information flows and the data obtained by using remote methods are considered. A scheme of the forest entomological monitoring approved in Krasnoyarsk Territory to predict and control the numbers of the most dangerous pests in boreal forests, *Dendrolimus sibiricus* and *Monochamus urussovi* Fisch., is suggested.

Kharuk Viacheslav I., Kenneth J. Ranson & Elena V. Fedotova, 2007. Spatial pattern of Siberian silkmoth outbreak and Taiga mortality. Scandinavian Journal of Forest Research, 2007; 22: 531 536
**Summary:** Abstract: The latest catastrophic Siberian silkmoth (*Dendrolimus superans sibiricus* Tschetw.) outbreak occurred in central Siberia during 1994 1996. The relationship between forest stand mortality from insects and topographic features (azimuth, elevation, slope steepness) was analyzed based on a high-resolution digital elevation model, a pest damage map and Terra/ MODIS data. It was found that pest-induced forest mortality patterns depend on topographic features. Before the outbreak the major part of host forest species was found within the elevation zone of 150 500 m. After the outbreak, surviving darkneedle stands were found mainly at elevations higher than 400 m. The greatest damage was observed at elevations between 210 and 320 m, whereas maximum mortality was observed at elevations of about 200 m and minimal mortality at elevations of 300 m. With respect to slope steepness, maximum damage for all categories was observed for slopes of 5 208. Slightly damaged stands were most common at low slope angle (about 58 or less), whereas the highest proportion of stands with high tree mortality was found on steeper slopes. With respect to azimuth, insect damage is mostly uniform, with a small increase in damage on the south-west-facing slopes. The spatial pattern of the silkmoth outbreak can provide a basis for prioritizing Siberian silkmoth outbreak monitoring.
Kharuk, V. I.; K. J. Ranson, A. G. Kozuhovskaya, Y. P. Kondakov and I. A. Pestunov., 2004. NOAA/AVHRR satellite detection of Siberian silkmoth outbreaks in eastern Siberia. International Journal of Remote Sensing, 20 December, 2004, Vol. 25, NO. 24, 5543&#65533;5555
**Summary:** Abstract: During 1993&#65533;1996, in central Siberia, a silkmoth (*Dendrolimus superans sibiricus* Tschetw.) infestation damaged approximately 700 000 ha of fir, Siberian pine and spruce stands. Temporal (1995&#65533;1997) Advanced Very High Resolution Radiometer (AVHRR) images were used for pest outbreak monitoring of this event. Damaged stands were detected, with heavy (50&#65533;75% dead and dying trees) plus very heavy (w75%) levels of damage classified. Summer and winter images were used for delineation of the northern border ofthe region of pest outbreaks. The Siberian taiga insects were classified with respect to their harmfulness to forests, based on the frequency of outbreaks, the size of the damaged territory, and the available food sources based on forest type.
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**Summary:** Abstract: The data on the post-fire dynamics of soil properties in foci of Siberian moth (*Dendrolimus sibiricus*) outbreaks are considered. The burning of forests previously damaged by Siberian moth is found to induce losses of carbon (75%) and nitrogen (about 50%) from the forest titter. At the same time, the total potassium and phosphorus contents increased by 3.2 times, concentrations of their mobile forms, by 4.3 and 12.3 times, respectively. In the first two months, the favorable effect of fire of physicochemical properties of soils was registered. A significant transformation of biological pocesses in the organic horizon of soils was registered after fire. In this horizon, the abundance of microarthropods and mite population were reduced by hundreds of times.
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**Summary:** Abstract: About 40 spp. of pine caterpillars infesting conifers and broad-leafed trees were collected in China. They belong to 4 genera: *Dendrolimus*, *Cyclophragma*, *Hoenimnema* and *Metanastria*. These 6 spp. cause serious forest damage: *D. superans* (Butler) (= *D. sibiricus* Tsch.), distributed in the northeastern provinces and northern Sinkiang; *D. tabulaeformis* Tsai et Liu, in northern China; *D. spectabilis* Butler, in the provinces around the Gulf of Pohai; *D. punctatus* (Walker), in southern China; *D. latipennis* Walker, in Yunnan Province and *D. kikuchii* Matsumura, in southern China. Each species has its own preferred host trees, i.e., *D. punctatus* prefers *Pinus massoniana*, *D. spectabilis* to *P. densiflora et al*. Synecological relationships for the outbreak center of pine caterpillars were summarized. Integrated control of pine caterpillars requires species identification and surveys on distribution and outbreak centers, bionomics and pest forecasting, forest management for the prevention of the pest population growth, biological control for caterpillar population suppression and application of chemical insecticides in urgent situations.
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Gninenko, Yu. & V. Yu. Kryukov., 2007. Siberian Moth in Forets of the European Part of Russia. National Centre For Agrarian Sciences. Plant Science, 44, 256?258 2007, Sofia
**Summary:** Abstract: *Dendrolimus sibiricus* is widespread in coniferous forests of Siberia, northern-east China, northern Mongolia and northern Korea. The penetration of this species into coniferous forests situated to the west of Ural that was registered at the beginning of the 20th century resulted in its appearance in last years in central regions of the European part of Russia. In the article there are data allow to come to conclusion that also in the future the phytophagan will move to the west and extend its natural habitat. Keeping the same speed it can appear in forests of Belorussia, Baltic and Finland

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**Summary:** Abstract: The spatial structure of *Dendrolimus sibiricus* populations at landscape and biocoenotic levels has been studied. Interrelationships and the level of variability in structural and dynamic characters of aboriginal populations in the period between outbreaks have been revealed. Mosaic distribution of population numbers is considered as a characteristic feature of many forest insects. Specificity of the spatial structure is explained not only by heterogeneity of the environment, but biological and ecological peculiarities of eruptive and prodromic species of forest insects. Lability of the spatial structure is shown to be of adaptive feature for providing an optimal use of ecological niches. It reduces competition to a minimum keeping informational and functional relations between intrapopulational groups occupying reservations of different type.
Isaev A.S., Rozhkov A.S. & Kiselev V.V., 1988. Fir Sawfly beetle *Monohamus Urussovi* (Fisch). Nauka, Novosibirsk. (in Russian).
Kirichenko, Natalia; Stefan Vidal, Yuri Baranchikov., 2006. European conifers as host plants for neonate larvae of the Siberian Moth a potential invasive species to Europe. IUFRO Working Party 7.03.10 Proceedings of the Workshop 2006, Gmunden/Austria
Kirichenko N.I. & Baranchikov Y.N ., 2007. Appropriateness of needles of different conifer species for the feeding and growth of larvae from two populations of the Siberian moth. Russian Journal of Ecology. 38. 198-203.
Kirichenko, N. I.; Baranchikov, Yu. N., 2008. The determination of needle loss under partial defoliation of forest stands by the Siberian moth (*Dendrolimus sibiricus*). Lesovedenie.(4). JUL-AUG 2008. 68-72.
**Summary:** Abstract: The results of experimental assessment of food norms for Siberian moth larvae reared on needles of Siberian larch (*Larix sibirica*), Siberian fir (*Abies sibirica*), Siberian pine (*Pinus sibirica*), Siberian spruce (*Picea obovata*), and Scots pine (*Pinus syvestris*) are discussed. The food norms may be corrected on the basis of the data on the larva mortality only in the case of high larva dieback in the older aged groups. The relationships between the larva mass and the food mass consumed may be directly used for the determination of the food norm for Siberian moth affected each of the Siberian coniferous species
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**Summary:** Abstract: The performance of young larvae of the potentially invasive Siberian moth *Dendrolimus sibiricus* Tschtv. has been studied for the first time on the native and exotic coniferous species which are widely distributed and of considerable commercial value in Europe. *Picea*, *Abies*, the introduced *Pinus* species (five-needle pine only), and species from the exotic genera *Pseudotsuga* and *Cedrus* (all Pinaceae) are found to be suitable hosts for pest development. Two-needle pines and species from non-native *Tsuga* (also Pinaceae) are poor hosts in terms of larval performance though they may support growth of neonates (most sensitive to food quality). Coniferous species from other families: Taxaceae and Cupressaceae are inedible for the pest. The fact that the Siberian moth is able to survive and develop on all the tested genera of Pinaceae and that some of them constitute two thirds of the European forests underline how harmful this defoliator could be in the case of its introduction into European countries.
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**Summary:** Abstract: The data collected in the Siberian Uvals ( 63 degree N and 73 degree E) confirm that the West Siberian Lowland territory is not uniform for outbreaks of needle- and leaf-eating insects. Southwards from the isoline of the optimal heat-moisture ratio (according to D. I. Abramovich, 1952) the outbreaks of *Dendrolimus sibiricus*, *Lymantria dispar*, *L., monacha*, *Bupalus piniarius* and some species of sawflies arise periodically in large areas. These pests are very dangerous for forests. Northwards from this isoline the mass reproduction of lepidopterans is made difficult or impossible. Sawflies (*Diprion pini*, *Pristiphora erichsoni*, *Croesus septentrionalis* and *Caliroa annulipes*) penetrate up to the polar circle and in ecotones of the Siberian Uvals form centers of reproduction. There is no essential damage of forest there
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Krasnoshchekov, Yu. N; Vishnyakova, Z. V., 2003. Changes in properties of soils in foci of Siberian moth (*Dendrolimus sibiricus*) outbreaks. Pochvovedenie.(12). December 2003. 1453-1462.
**Summary:** Abstract: The experimental data on the transformation of properties of soddy-deeply podzolic soils and raw humus burozems under fir forests defoliated by the Siberian moth *Dendrolimus sibiricus* are analyzed. In the first two months after the addition of Siberian moth excrements to the forest litter, the population of all ecological-trophic groups of microorganisms was shown to increase by 13 times, that of ammonifying phototrophs and microorganisms, taking part in humus mineralization, by 42 and 9 times, respectively. The leaching of water-soluble carbon from litters in forests defoliated by the Siberian moth was by 2126% higher than that from litters of control ones. A year later, it was reduced to 14%. The content of exchangeable hydrogen and total acidity decreased, and the degree of base saturation increased. Within 56 years after the Siberian moth invasion, the transformation of physicochemical, chemical, and microbiological properties of soils was specified by succession development of the plant cover.

Mikkola, Kauri; Stahls, Gunilla., 2008. Morphological and molecular taxonomy of *Dendrolimus sibiricus* Chetverikov stat.rev. and allied lappet moths (Lepidoptera : Lasiocampidae), with description of a new species. Entomologica Fennica. 19(2). JUN 13 2008. 65-85.
**Summary:** Abstract: The populations of the well-known forest pest, *Dendrolimus sibiricus* Chetverikov, 1908 stat.rev., were sampled in the European foothills of the Ural Mountains, Russia. *D. sibirieus* is a species distinct from the Japanese taxon *D. superans* (Butler, 1877). Another taxon from the Southern Urals, taxonomically close to *D. pini* (Linnaeus), is described here as *D. kilmez* sp.n. The synthetic female pheromones prepared for *D. pini* and *D. sibiricus* attracted equally well all three taxa present, and thus cannot be used to identify these species. The Ural populations of *D. sibiricus* show differences in external appearance, and as already in the 1840s Eversmann indicated that the species had caused local forest damage, *D. sibiricus* must be a long-established species in the Ural area. Thus, natural spreading westward of the pest is not to be expected. The five *Dendrolimus* species of the northern Palaearctic and the male genitalia are illustrated, and the distinguishing characters are listed. Two *Matsumura* lectotypes are designated.
Mikkola K. & Stahls G., 2008. Morphological and molecular taxonomy of *Dendrolimus sibiricus* Chetverikov stat.rev. and allied lappet moths (Lepidoptera: Lasiocampidae), with description of a new species. Entomologica Fennica. 19. 65-85.
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**Summary:** Abstract:Nine percent of global forest resources is located in Siberia, Russia. Statistics on composition of forest stands, standing volume, and forecasted logging volumeplanned cut area in Siberia are presented. The authors state that the current planned cut area is twice beyond a sustainable level. Data on forest fires in 1991-2000, *Dendrolimus sibiricus* infestations, timber harvesting in 1960-2000 are presented. The authors argue that transfer of forestry to a sustainable model needs to be linked to an economic reform, development of a forestry model which is both environmentally and economically sustainable, efficient spending and investment. Use of GIS [geographical information systems] in forest management is emphasised. The principal future trends in forest management are identified as scientifically justified zoning and reforestation, complex evaluation of forest resources (taking into account both environmental and economic factors), and development of felling systems based on environmental conditions.
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Vetrova, V. P.; Isaev, A. S; Pashenova, N. V.; Konstantinov, M. Yu., 1998. Estimation of threat of *Monochamus urussovi* outbreak in dark coniferous stands damaged by *Dendrolimus sibiricus* in the Lower Angara River region. Lesovedenie. 0(3). May-June, 1998. 58-67.
**Summary:** Abstract: Dynamics of *Monochamus urussovi* numbers and propagation infection through it in dark coniferous stands damaged by *Dendrolimus sibiricus* in the Lower Angara River region was investigated in 1994-1996. Formation of *Monochamus urussovi* primary loci in the stands completely devoid of needles because of *Dendrolimus sibiricus* was registered. Relations between occupation of stands by *Monochamus urussovi* and the time and degree of their defoliation were revealed. A suggestion of realizing the first stage of the outbreak due to migration of beetles to damaged stands and transition of populations to the stage of maximum (1998) is made based on the analysis of the xylophage numbers dynamics. In the loci an epidemic level of distributing fungi by *Monochamus urussovi* was observed.
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