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EUROPEAN CONIFERS AS HOST PLANTS FOR NEONATE LARVAE OF THE SIBERIAN MOTH – A POTENTIAL INVASIVE SPECIES TO EUROPE

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Abstract

The performance of the Siberian moth Dendrolimus superans sibiricus Tschtkrvk. was estimated on potential host trees from Central Europe on the basis of relative growth rates and survival of their first instar larvae. Larix decidua appeared to be the most suitable host, followed by Abies alba, Abies nordmannian, and Picea abies, respectively. The needles of Pinus silvestris and Pinus nigra proved to be poor substrates for larval development. A new potential host plant, Pseudotsuga menziesii, appeared to be highly favorable for the pest larvae.

Keywords: Siberian moth, survival and growth of larvae, European coniferous species

1. Introduction

The Siberian moth Dendrolimus superans sibiricus Tschtkrvk. (Lepidoptera, Lasiocampidae) is the main pest of coniferous species in Northern Asia (Rozhkov 1963; Baranchikov et al. 1997). The moth dramatically damages thousands of hectares of forests (Baranchikov & Kondakov 1997). Weakened and stressed trees are subject to the attack of secondary pests, which finally results in forest death and its subsequent predisposition to fires (Furyaev 1966; Isaev et al. 1988). In its’ natural habitat, the Siberian moth feeds on coniferous species belonging to a few genera of the Pinaceae family, such as Larix, Abies, Pinus and Picea (Rozhkov 1963). The pest life cycle comprises two to three calendar years with the larvae overwintering once or twice. Eggs are laid by the end of June – the beginning of July and the larvae moult to the third or fourth instar before overwintering in the forest floor. They emerge in early spring and continue feeding extensively to complete their development in the same summer. However, the larvae may also enter into summer diapause and over-winter in the forth or fifth instar to complete their development during the third year (Baranchikov & Kirichenko 2002).

The Siberian moth is distributed over a huge territory of Russia; it is now found from the coasts of the Okhotsk’ and the Japanse seas to the Urals (Rozhkov 1963). Recent records of the moth west of the Urals fuelled the hypothesis of its’ possible invasion into Europe in the near future (Gninenko & Orlinskii, 2002). Based on these recent records the species has been declared as a quarantine pest for EPPO-member countries (EPPO 2005; but see Baranchikov et al. 2006). However, so far there are no reports on the suitability of conifers from Central Europe for the Siberian moth (EPPO 2005). The data provided here will be useful to assess the invasion risk and prognosis of damage to European forests. In this study we evaluated whether European coniferous tree species could serve as host plants for the Siberian moth. Here we report on survival and growth rates of the first instar larvae of the pest on European conifers. Neonate larvae of several Lepidopteran species are the most sensitive to food quality
(Slansky & Scriber 1985), thus this instar may be the critical one for the performance of the pest populations.

2. Materials and methods

The Siberian moth neonates were reared in the insectary of the Department of Crop Sciences (Georg-August University, Goettingen, Germany) in July-August 2006. The material was collected in the larch forest of Kaa-Khemsky Forestry (Republic of Tyva, Russia) in the middle of June 2006. The first instar larvae, hatched 10\textsuperscript{th} - 14\textsuperscript{th} July, were placed in groups of five in plastic Petri dishes (diameter : height = 9 cm : 1.5 cm) and were reared at 22±2°C, 50-55% relative humidity, and a photoperiod of 16:8 (L:D). Keeping neonates in groups corresponded to their habit in nature (Kirichenko & Baranchikov, 2004a). Fifteen groups were reared on each of the seven host plants till all larvae stopped feeding before molting to the second instar. We used the needles of conifers in this experiment which are common for Central Europe and provide a main commercial interest: Larix decidua P. Mill., Abies alba Miller, Abies nordmanniana (Steven) Loudon, Picea abies (L.) Karst., Pinus silvestris L., Pinus nigra Arnold, and the introduced Pseudotsuga menziesii (Mirbel) Franco. Branches of these tree species, all found in the forest and botanical gardens of the University, were cut and immediately placed in a cold dark chamber. These branches served as a source of needles for larval rearing and were changed every third day. Larvae were inspected daily: food not consumed and faeces were removed and new needles added. Larvae were always provided with more needles than they could consume. We monitored survival, larval growth and period of feeding (T). Larvae were weighted individually at the beginning of the instar (W1) and at the time when they stopped feeding (W2) before molting to the next instar. The larvae were weighted on an electronic balance with an accuracy of 0.1 mg. These data were transformed to the absolute dry weight.

The relative growth rate of the larvae was calculated as: RGR = (ln W2 - ln W1)/T, mg/mg/day. Survival (%) was computed as a mean percentage of surviving larvae in all Petri dishes for each host plant. Data on RGR on different host plants were analysed by one-way ANOVA (Turkey HSD, Bonferroni tests) (SigmaPlot 10.0); larval survival was tested using a Binominal test (Statistica 6.0).

3. Results

We found that Siberian moth neonates were able to moult to the second instar on all European coniferous species tested. However, the survival and relative growth rates of the first instar larvae were affected to a large extend by the host plants they were fed with (Fig. 1). Larvae displayed the highest survival, up to 95%, and the highest relative growth rates (about 0.34 mg/mg/day) on larch. Larvae that were fed with needles of Pseudotsuga menziesii exhibited a similar survival, although their growth was reduced by 40% as compared to those fed with larch. The lowest larval survival was found on Pinus nigra (9%) and Pinus silvestris (30%), respectively (Fig. 1A). Surviving caterpillars gained much less body weight within the same time period (Fig. 1B). Larvae fed with spruce and fir exhibited lower survival and growth rates as compared to larvae fed with larch; however these parameters were still higher as compared to pine species.
4. Discussion and conclusion

Our results indicate that with regard to the European conifers tested so far, *Pinus silvestris* and *Pinus nigra* are the poorest hosts for the Siberian moth neonates. In contrast *Larix decidua* is the most suitable host plant, resulting in the highest larval survival and growth rates. The remaining conifers tested (*Abies alba, Abies nordmanniana, Picea abies*) are of an intermediate value; they are poorer hosts as compared to larch but more suitable hosts as compared to pine species. So far the exact ranking of firs and spruce species with regard to their suitability for the larvae and subsequently maintaining moth populations is not clear. More detailed studies are needed on the development of later instars larvae (not yet completed).

![Figure 1. Survival (A) and relative growth rates, RGR, (B) of the 1st instar larvae of Siberian moth on different European coniferous species. Bars indicate means ± SE. Different letters above bars denote significant differences at the 0.05 level (Binominal test; Turkey HSD, Bonferroni tests).](image)

Douglas-fir, *Pseudotsuga menziesii*, deserves a special attention. This conifer is widely spread in Western Canada and the USA and has been introduced to Central Europe more than a half century ago where it has become the commercially most important non-indigenous tree species (Essl, 2005). Our experiments demonstrated that the Siberian moth is able to develop on this tree. The first instar larvae exhibited unexpectedly high survival rates close to that on the most favorable host, larch, and the growth rates were comparable to the ones on firs and spruce. It will be interesting to understand, how the Siberian moth larvae are able to cope with these different food qualities. We need more detailed analyses with regard to food consumption and utilization within all larval stages. These data have been collected in subsequent experiments will be discussed in the forthcoming papers (in preparation).

In conclusion, the suitability of coniferous host plants for the neonates of the Siberian moth in Central Europe is in agreement with results obtained in the natural habitat of the pest in Siberia. The suitability of North Asian host plants for this defoliator decreases from larch *Larix sibirica* Ledeb., fir *Abies sibirica* Ledeb., five-needles pine *Pinus sibirica* De Tour., spruce *Picea obovata* Ledeb., to Scots pine *Pinus silvestris* L., respectively (Boldaruev 1969, Kirichenko & Baranchikov 2004b). Within the actual homerange of the moth widespread outbreaks typically occur in larch forests and, to a lesser extend, in Siberian fir and Siberian pine stands, whereas spruce and Scotch pine are rarely defoliated. This could mean, that,
when accidentally introduced to Central Europe, the Siberian moth could become invasive in forests dominated by *Larix decidua* and could also become a pest on the newly introduced host plant, *Pseudotsuga menziesii*. The 2 Needles pines (*Pinus nigra*, *P. silvestris* and other pine species not tested so far) will be less prone to intensive defoliation by this species. Nevertheless, the recent outbreaks of the Siberian moth in Scots pine forests of Transbaikalia (Epova 1999) indicate that occasional damage on unfavorable tree species cannot be ruled out. This should be taken into account in risk assessment procedures.

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