Trip Report on Assistance to Mongolian Ministry for Nature and Environment for the Control of Forest Defoliators

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Larch Mortality caused by *Dendrolimus superans sibericus*
Khan Khentii Special Protection Area
Assistance to Mongolian Ministry of Nature and Environment for the Control of Forest Defoliators

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Abstract

In the fall of 2003, the USDA Forest Service assisted the Food and Agriculture Organization of the United Nations in training and operations for the control of severe outbreaks of forest defoliators in Mongolia. Unseasonably cool temperatures delayed insect development and treatment was postponed until 2004. The Forest Service Forest Health Protection International Activities Team funded a return trip to assist in treatment operations and to gather information on potential invasive pest species.

Background

Severe insect pest infestations in forests and urban trees are causing increasing concern both in terms of loss of valuable forest resources and also to the changing face of the urban landscape. Since 1980, 101,100 hectares (250,000 acres) of forest have been damaged due to insects and diseases. The volumes of most economically valuable tree species such as pines and larch are decreasing year by year due to insect pests and diseases. The pine forests of Tuj, Range of Arangat (Selenge aimag) and Duurlig (Khartii aimag) (Figure 1) have already been destroyed by insect damage and wildfire. Many of these forest stands have now reverted to birch forests (Betula sp.)

Figure 1. Forest type map for northern Mongolia. Aimags are shown in insert map.
Forests play an essential role in the protection of soil and water quality and economic productivity. Forests of Mongolia cover 12.9 million hectares (31.9 million acres) of area which is only 8.2 % of whole country. FAO has evaluated Mongolia as one of the poorest forest resource countries.

Pest outbreaks historically occur approximately every 10-12 years with increasing intensity. In recent years, the drought conditions have contributed to a reduction in time between cyclic outbreaks. Pest incidence is affected by climatic conditions compounded by wildfires, logging damage, and permafrost, which all weaken the trees and make them more susceptible to insect infestation. Main forest pests include: *Dendrolimus superans sibiricus*, *Orgya antiqua*, *Erannis jacobsoni*, *Zeiraphera griceana*, *Dasychira abietis*, *Dendroctonus micans*, * Ips subelongatus*, *I. sexdentatus*, *I. typographus*, *Tomius minor*, *T. pinipeda*, *Monochamus*, *Urocerus*, *Sirex spp.*

Recently, many forested areas of Khan Khentii Protected Area (KKPA) such as Terelj National Park have been destroyed by *Dendrolimus superans sibiricus*, (Siberian caterpillar). In Onon-Balj National Park in Khan Khentii Protected Area (KKPA), the birth place of Genghis Khan, infestations of *Lymantria dispar* (Asian gypsy moth) are causing severe damage.

Because of these infestations there is a reduction of forest quality and negative ecosystem changes are occurring. It is predicted that there will be a huge environmental catastrophe in Khan Khentii Protected Area, if this trend is not reversed. There is increased concern about the impact of these forest pests in this cultural heritage area.

It was estimated that more than one million hectares (2.47 million acres) of larch and to a lesser extent pines; in Khan Khentii, Bogd Khan Protected Area, in the city zone areas, and in 10 Aimag (Provinces) were affected by Siberian Caterpillar. In 2003, northern forest areas including Selenge, Tuv, Khentii, Dornod, Arkhangai and Bulgan experienced rapidly increasing populations.

Surveys carried out in 2002 indicate that 30,000 hectares, mainly Larch (*Larix sibirica*), in KKPA needed immediate treatment to prevent critical losses and a further 15,000 hectares (37,000 acres) in the mountainous zone surrounding Ulaanbaatar.

**Pests**

*D. sibiricus* is a destructive pest of conifers which is widespread on the Asian continent. This insect not only destroys the trees but also causes health problems for humans due to allergic reactions from hairs, particularly children living close to affected trees. Recently there has been a comparable outbreak of *D. sibiricus* in the northern forests of North Korea and in eastern Russia.

Attempts to control this insect are complex due to the nature of the terrain and to the close proximity of infested areas to population centers on the outskirts of Ulaanbaatar. Control measures must be tailored around the urban areas to avoid any spray drift. The high winds and extremes of temperatures also complicate control strategies and coupled with the unusual and complex life cycle of this pest makes it very difficult to control.

The full life cycle usually takes two years. In southern parts of the natural range, however, one generation can develop in a single year, whereas, in northern regions, the completion of a generation can sometimes take three years. Drought, increasing population density, and other factors not well understood cause some of the larvae to have a shorter, 2 calendar-year life cycles. As a result, the adults of two generations emerge simultaneously and the population increases sharply. Competition for food may extend development time of the larvae and may also increase the number of instars.

The duration and effect of outbreaks also depend on the forest type. Outbreaks in fir and five-needled pines result in defined focal areas with very high densities of larvae that defoliate trees for 2 or 3 years in succession before the outbreak collapses. Tree mortality is nearly 100 percent in many stands. Outbreaks in larch forests are more prolonged but cause less tree mortality. However, coupled with the prolonged drought of recent years, extensive mortality of larch has occurred (Figure 3).
This pest is a serious threat to neighboring forests and to human health (skin irritant). The European and Mediterranean Panel on Plant Protection (EPPO) have recognized that this pest has all necessary characteristics of a quarantine pest for the European part of the EPPO region.

The target insect for immediate control is *D. sibericus* (Figures 4 - 7). Where *Lymantria dispar* (Figures 8 - 13), also threatens important forest resources this insect is also targeted.

Continuous attempts have been made by the Mongolian government to control the pest outbreaks but the vast areas, lack of trained personnel, limited facilities, financial constraint, and poor equipment made this very difficult to implement. In 2001 the mini-

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**Life Stages of Dendrolimus superans sibericus.**

*Figure 3. Mortality of larch stand caused by D. superans sibiricus.*

*Figure 4. Eggs laid on larch foliage*

*Figure 5. Late instar larvae overwinter in forest litter.*

*Figure 6. Sixth instar larva*

*Figure 7. Cocoons spun in defoliated larch*
Life Stages of *Lymantria dispar* - Asian Gypsy Moth

Figure 8. Female (right) and male gypsy moths

Figure 9. First instar larvae emerging from egg masses laid in rock outcrops.

Figure 10. Second instar larva

Figure 11. Third instar larva

Figure 12. Fourth instar larva

Figure 13. Tachinid fly and fourth instar gypsy moth larva
The minimum estimated area needing treatment was 400,000 hectares (988,000 acres) but funds were only available to treat 10,000 hectares (24,700 acres). Local production of *Bacillus thuringiensis* (biological pesticide) kept costs down, but production was limited and it was uncertain if there was regular quality testing and the product’s potency is unknown. Application technology prior to 2003 relied on outdated, hydraulic equipment. In 2003, FAO purchased modern spray equipment allowing the use of ultra low volume applications which are more cost effective and efficient in product delivery.

**Current Pest Management Conditions**

Currently, there is an expertise gap in aerial application. There are insufficient qualified personnel working in Mongolia on forest health issues, and there are no Non-Government Organizations or private companies, which carry out pest management activities. Two specialists from Geoecology Institute under Academy of Science carry out basic pest research in Mongolia. Also two specialists work for the Forest Management Center of the Ministry of Nature and Environment who carry out supplementary studies and control activities against insect pests.

In 2003 the USDA Forest Service assisted FAO in training in forest Integrated Pest Management, including insecticide application technology for both backpack (Figure 14) and aerial spraying. The FAO project (TCP/MON/2902) assisted the country by providing biopesticide and the necessary spray equipment, both for aerial and ground application. Two An-2 aircraft (Figure 15) were outfitted with Micronair AU-5000 atomizers and new booms. Four Ciferalli backpack sprayers fitted with Micronair AU-8000 atomizers were also purchased for urban and small forest stands. A limited amount of biological insecticide (22,000 liters of Foray 76B), sufficient to spray the most heavily infested high value forest, was purchased. Additional funds were provided to cover fuel costs for spray operations. During our visit in 2003, two training sessions were held to cover various aspects of integrated pest management practices for forest managers and technicians.

Due to the early onset of cool weather in the fall of 2003, insect development was delayed. This resulted in an early hibernation in the forest litter of late instar *Dendrolimus* larvae. Although some insects completed development and laid eggs, these did not develop. However, *Lymantria dispar* was able to complete development and lay eggs in the fall.

To assist forest managers in completing the aerial application portion of the project, a return trip in June of 2004 was made. The purpose was to provide technical assistance in use of the new spray equipment and get more information on life cycles of both *D. superans sibiricus* and the Asian variety of *L. dispar*.

**Figure 14. Micronair AU800 and Cifarelli backpack sprayer.**

**Figure 15. Antonov An-2 aircraft used for aerial application. Two An-2’s were fitted with new Micronair spray systems provided by FAO.**
Field Visits

Initial trips to access insect development were made to the Khan Khentii Special Protection Area north of Ulaanbaatar. This area encompasses several different management zones. It is equivalent to a National Park and includes wilderness areas. The larch stands are heavily impacted by both *D. superans* and *L. dispar* in 2003. Figure 16 shows the typical damage to larch stands. Larvae (Figure 17) were in late instars and were beginning to pupate. This development varies from published life cycles from Russia and conditions that currently exist in North Korea where 3rd instar larvae were present. Due to the late larval stage it was decided that spraying for *D. superans* would be put on hold until late July when appropriate early instar larvae will be present.

A second field trip to the Tov aimag area (200 km north of Ulaanbaatar) was made to visit and Asian gypsy moth infestation. The larval stages were in 2nd and early 3rd instars. Four forest stand totaling 2000 hectares were selected for aerial application. While visiting this site the birch forests near inhabited areas were being ground treated with backpack sprayers.

![Figure 16. Defoliation and mortality in Larch stand.](image1)
![Figure 17. Sixth instar D. sibericus larva defoliating larch](image2)

The insecticide, Foray 76B had been in storage in an unheated warehouse since last fall (Figure x). Winter temperatures had reached a low of -30° C during the winter in Ulaanbaatar. As expected there was separation of the suspension fluids within the barrels, but the biological activity should have only diminished by 10 percent during cold storage. Product solids had settled within the containers, but agitation of the barrel by rolling and shaking aided in remixing the content. The spray aircraft do not contain a recirculation system, which would assist in the agitation of the spray material. We recommend that a nurse tank be used and the content recirculated with the loading pump prior to loading the aircraft. Emptied barrels should be checked after emptying into the nurse tank for the presence of solids in the bottom. If present, a small amount of water can be used to free the content and this can be added to the final spray mixture.

The spray equipment had been removed from the aircraft and stored indoors during the winter. We inspected the Micronair VRU settings and blade angles to insure that equipment was in the same configuration set during calibration trials held in 2003. The pump on the An-2 is wind driven, but does not have adjustable blades to alter pressure. To reduce the pressure, the pump fan’s diameter was reduced by grinding down the blade length. Calibration of the system to obtain the recommend 3 L/ha application rate is done by varying VRU settings of the individual Micronairs.

In preparation for the treatment project, training in the use of hand-held GPS units was conducted in the field and at the airport for the pilots. The Slow the Spread project several surplus units for field use. The Lat/Long coordinates were obtained for the treatment areas, and were entered into hand-held GPS units to be used in the aircraft. Pilots were trained in the entering of waypoints and the use of the units to assist in locating treatment areas selected by the ground survey crews. This would help in reducing flight times and ensuring that the correct stands are treated.
And now the bad news.

In a joint venture with a Russian company, the spray planes were recently outfitted with newer higher performance engines. Prior to our arrival, these aircraft were used for a grasshopper control program in the western part of Mongolia. The Russian company failed to inform the Mongolian company that these new engines required high octane aviation fuel (110 octane). The old engines used standard 93 octane. This lower octane was used for the treatment program. The end result was that all four spray aircraft engines were damaged. The aircraft were grounded until a Russian engineer could oversee repairs. He would arrive in about 10 days.

In two weeks the gypsy moth larvae would be in late instars and we recommended not treating, and to save the Foray for D. superans later this summer, when early instars of this insect would be present.

We were able to do backpack treatments in shelter belt areas in the Khan Khentii Special Protection Area (Figure 18). The selected stands were located along stream banks. Due to the heavy amount of grazing in the area from various livestock herds, protection of these riparian areas is very important to control erosion.

To evaluate spray droplet size and coverage, water sensitive spray cards were hung in tree crowns. Coverage from the backpack sprayers was very good, with very high droplets per square centimeter and very fine droplets (Figure 19). Volume median diameter of the spray was approximately 100 µm in size.

**Recommendations**

Treatment of *Dendrolimus superans sibericus* should be timed when the majority of the larvae are in second instar or early third. Given current conditions, this would be sometime in early August. Reports from Mongolia indicate that the aircraft have now been repaired and are ready when needed.

Good documentation of life stage development and measurements should be conducted. Such information can be used by field crews to assist in treatment timing. A similar card (Figure 20) is used in gypsy moth treatments in the east to insure application in made to optimum life stage - majority of insects are in second and early third instars. Since outbreaks occur about a decade apart, such documentation can help future managers.

After reinstalling Micronair spray equipment on the aircraft, check to insure that all AU-5000 blade angles are set to 35 degrees. This setting will provide the smallest droplet size for the low volume application.  

Foray 76B was stored over the winter in an unheated warehouse. Winter temperature as low as -30°C were recorded. This 'cold storage' should not affect the potency of the material, but some separation of fluids and settling of solids within individual containers will occur. Prior to loading, the 50 liter barrels should be vigorously agitated. The contents of the barrels should be poured into a nurse tank and agitated. A small amount of water can be added to the barrels if sediment is present in the container. This sediment will contain useful Btk product, and can be added to the tank. Mixing can be by manual stirring or by use of the loading pump to recirculate the Foray within the nurse tank.

The aircrafts are not plumbed with a return line from the pump, so there will not be any internal agita-
tion in the aircraft's spray tank. It is important that good mixing be made prior to loading of the aircraft.

Foray 76B has some detergent actions and will loosen any scale or dried material within the aircraft's spray system. The aircraft are not outfitted with filter screens, so there may be the possibility of clogging of the Micronair VRU. The flow rates of individual units should be monitored during the initial loads to check that the calibrated flow rate is maintained. A reduction in flow rate is an indication of a blocked Micronair unit. Clogging will typically occur at the outer ends of the spray booms. Pilots should be informed to check for changes in spray discharge appearance from individual units during treatment and report any abnormal pattern.

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Figure 20. Field card used to time gypsy moth control in eastern US.

High resolution images of insects found in this report and others are available at www.forestryimages.org