

Pheromone Traps Application Against Bark Beetles (Coleoptera: Scolytidae) In Ili-Alatau Mountains

A. Sagitov¹, N. Mukhamadiev¹, N. Ashikbaev¹, K. Mazarzhanova², Zh. Bolat¹

G. Mendibaeva¹, D. Abzhanbayev¹ (Almati)

¹ Kazakh Research Institute for Plant Protection and Quarantine, Kazakhstan

² S.Seifullin Kazakh AgroTechnical University, Astana, Kazakhstan

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ABSTRACT

Article presents data in monitoring of bark beetles by means of pheromone traps in Ile Alatau Mountains. Main stages of development of the European spruce bark beetle, *Ips typographus* L, and other beetle species were determined, in order to develop control measures against these pests..

1. Introduction

The territory of Kazakhstan has very sparse forest cover. The total area of the state forest fund in Kazakhstan is just over 27.7 million hectares, which cover 4.6% of total land area of the country. Total forest area is 12.3 million hectares, including 1.6 million hectares of evergreen coniferous trees in the family Pinaceae (13.08%). The spruce (*Picea* spp.) covers 1.9 hectares (1.52%) among other conifers.

Forest conditions in Kazakhstan are of particular concern. Forest fire, storms, and insect pests cause great damage to Kazakhstan forest resources. The Tien Shan spruce (*Picea tianschanica*) is an endemic plant to Central Asia, Tien Shan, Ile-Alatau and Zhongar-Alatau that occurs in the mountain coniferous forests 1300-3600 metres above sea level. The 480 hectares of the forest plantations was damaged by a windstorm on May 17, 2011, in Ile-Alatau Mountains (Image 1). According to a preliminary assessment, about 50 thousand significantly damaged spruce trees have been reported sweeping down by hurricane in the Medeu National Park. The Medeu accident is not the only one example of mass destruction of forests by hurricane [1,2].

It is well known that the windfalls and windbreaks cause significant damage to forestry. These natural phenomena contribute to the interruption of the tree roots and thereby weaken their stability, which are the favourable environment for the mass breeding of harmful insects, i.e. stem pests such as bark beetles, longhorn beetles, jewel beetles and horntails. This problem applies especially to mountain forests of Ile-Alatau and Zhongar-Alatau, where trees suffer from stem pests much more. It was established, as windthrow, which is trees uprooted or broken by wind, gets denser, so the pest population in this area increases. Thus, broken trees initially should be cleaned up, in order to interrupt the stem pest

establishment [3, 4]. This is because of the lack of appropriate cleaning events after hurricane in the areas of windthrow that might have disastrous consequences.

Xylophagous insects, such as the six-toothed bark beetle – *Ips sexdentatus* Boern. and the ribbed pine borer - *Rhagium inquisitor* L., which have not been previously inhabited in the Tien Shan Mountains, were detected among windthrown trees. They were probably introduced here through infested wood materials and were established in 1960-70 years of the last century. According to Zh. Ismuhambetov, construction of city infrastructure and industrial facilities in Central Asia, in the South and South-Eastern Kazakhstan was carried out by local forest resources. However, local wood production did not satisfy the increasing demand for wood construction material. Therefore, in order to build the Turkestan and Siberian railway, since 1930 the wood construction materials were imported from Siberia and other places of the former “Soviet Union”. Timber import into Kazakhstan is still essential today [5].

The vast majority of imported timbers were undressed logs and were infected with stem pests. Timber was directly transported into the zone of spruce forests of the Tien Shan Mountain for construction and energy purposes in the 1960-70s of the last century. Imported wood materials left for a long time in the territory of local forests, sometimes for a period up to a year. Thus, it could be the ideal infection source for introduction and acclimatization of exotic insect pest, which were not dwelling before the Tien Shan Mountains.

Problem of infection was raised for the first time by Prof. P. Marikovskiy [6], who witnessed a possible infection source from imported timber that had traces of severe damage of stem pests in the ravine of Bolshaya Almatinka, located in the Ile-Alatau Mountains, Talgar region, which is 25-30 km away from Almaty city.

One of the authors of the study, who studied insect species composition of the Tien Shan spruce forest, also detected the same invader-insects between a period of 1962 and 1964 on wood materials imported for dam construction and for energy source to heat sanatoria, rest houses, pioneer camps in the train stations, such as Bratsk, Tuymen, Yenisei, Asino, and in the zone of spruce forest of the Ile-Alatau Mountains, such as Talgar ravine, Malaya and Bolshaya Almatinka, Large Almaty Lake. Detected invaders were the three species of woodborers, (including long horned beetle *Monochamus* sp., the ribbed pine borer *Rhagium inquisitor* L.), the 15 species of bark beetles, (including the six-toothed bark beetle *Ips sexdentatus* Boern.), and the three species of horntails.

Pest invasion through wood importation could cause substantial damage to the Tien Shan Mountains. However, in the 1960s of the last century the Council of Ministers of the Kazakh SSR declared special order that prohibited the importation and storage of timber, infested with pests and infected with pathogens, to forest territory or nearby territories of the State Forest Funds. Unfortunately, almost half a century later, it can be stated with confidence that the above mentioned special order was not successfully implemented, as the quarantine insect pests are detecting in the area of the windthrow today.

The Kazakh Research Institute for Plant Protection and Quarantine (KazRIPPQ) was considering the possibility of risks of future pest invasion of the above mentioned quarantine insect species through imported timber from the windthrow areas and their establishment in the spruce forests of Almaty city and other nearby territories. Therefore, the KazRIPPQ appealed to the appropriate authorities of the Republic of Kazakhstan to follow the quarantine rules.

According to our view, there are several circumstances that lead to the possible invasion and establishment of the “new pests”. First of all, coniferous plant species, such as spruce, pine, fir, and larch have common pest problems, e.g. bark beetles, longhorn, horntails and stem borers. For example, insect pest composition of Scots pine (*Pinus sylvestris* L.) planted in many regions of the Tien Shan Mountain shares common pest problem with the Tien Shan spruce [7, 8]. Secondly, the insect pest species composition of the Tien Shan spruce consists of the 63 species, whereas on the Siberian spruce dwelling the 170 species of herbivores that indicate to the presence of available ecological niches on the local conifers [8]. Under these circumstances, there is a reason to conclude that the Tien Shan spruce has a great potential of pest establishment from the Siberian coniferous species. Moreover, some of the invaded pest species able to well-adapt and flourish in the new environment compared to their place of origin, where their development constrained with their natural enemies and environmental conditions.

After a half-century of prediction of P. Marikovski [6] regarding risk to the Tien Shan spruce forest, eventually today his prediction has become a real problem. Nowadays the overall concept of plant protection is changing. The main objective of a pest management strategy is not a total pest eradication, but control of pest population under economic threshold. Forest restoration, preservation and sustainability are emphasised for a self-sustaining forest ecosystem in order to control the mass reproduction of insect pests. Only the complex of appropriate tools and techniques based on extensive knowledge about forest ecosystem can help towards achieving this goal. One of the main components of the concept called the Integrated Pest Management (IPM) is the application of pheromone traps. Insects use pheromones to mark territories around nests, intra- and interspecies communication, direction of the food items, and to provide meeting of the opposite sex.

The concept of the IPM is based on accurate information about insect populations. Information regarding the population ecology can be obtained by using pheromone traps. The IPM strategy is based on the application of the most selective means of pest control. Pheromones enable us directly control pests without affecting other beneficial organisms in the forest ecosystem. Moreover, pheromones as volatile compounds easily can be distributed into the space and have any traces on the treated area [9].

Advantages of pheromone traps application were highlighted since Soviet times as in the “Guidelines for the application of pheromones for monitoring and protection of spruce against bark beetle” [10]. Nowadays the pheromone traps application is still essential and reflected in the “Guidebook for localization and liquidation of outbreaks of harmful organisms” [11].

Europe has much more experience in dealing with pests by using pheromones. A.M. Maslov has done the extensive literature review regarding analysis of this topic called “Spruce drying up due to European spruce bark beetle, *Ips typographus* L., and the integrated pest control” [12].

In Norway, the 600 000 pheromone traps, which had the mean number of insects caught per trap of 4 700-7 400, were applied. Overall, the 2.9 trillion beetles in 1979, and the 4.5 trillion beetles in 1980 were trapped by means of pheromones that significantly decreased damage caused by the European spruce bark beetle.

In Sweden, in order to control the spruce bark beetle the common agronomic activities, such as a sanitation cutting of trees, use of trap trees or trap logs, and even the insecticide application (the insecticide lindane) were carried out by 1978. The pheromone application started in 1978 (30 000 pcs), and were applied annually: in 1979 – 316 880 pcs, in 1980 – 336 720 pcs, in 1981 – 335 448 pcs, in 1982 – 119 564. Population of the spruce bark beetle dropped to normal levels of abundance in 1983, so the installation of pheromones was stopped this year.

In Germany, the 100 000 pcs of pheromone traps were applied annually between the same period against the European spruce bark beetle.

A. D. Maslov concludes his study with the following expression: « International evaluation of the pheromone traps application against the European spruce bark beetle stated that chemical substances, which influence to the behavioural features of bark beetles, is not a panacea, but valuable attributes of an integrated pest management in combination with proper agronomic and forestry methods...» [13].



Image 1. View of the windthrow area in Gorelnik in 2012, Medeu, Almaty

2. Material and methods

The spruce bark beetle monitoring was carried out by utilizing two different types (barrier and triangle) of the pheromone traps called *Ips vabot* – A, produced in Belarus and Moldova. The traps made in Moldova showed higher efficacy. Flight season of beetles was recorded when an average temperature was 180 C, the end of April – beginning of May. Installing pheromone traps occurred between a periods from 20th of April until 10th of July in the blocks No. 12 and No. 13, as well as in plantations of the age of four class of Malaya Almatinka forestry. Total quantity of pests trapped in the pheromones that has individual numbers was counted every 7-12 days. In addition, dispensers were replaced every 35-40 days.

In 2014, pheromone traps were installed at different altitude levels in the Medeu National Park: block No. 13 at an altitude H1630, N43009.644, E007002.869; blocks No. 4 and 5, in the Mohnatka field at an altitude H1776, N43009.524, E077003.176 and at an altitude H1778, N43009.961, E077002.986; blocks No. 6 and 7, in Chimbulak, No. 57 H2395, N43002.067, and E007004.750.

Pheromone trap installation process occurred on the 4th of April at the “Mohnatka” field in Medeu, in coordinate H1778, N43009.961, E077002.989; and in Chimbulak at the blocks No. 12 and No. 13, as well as in plantations of the age of 4 classes at the height of an adult’s breast. Beetle’s flight season was recorded in the second and third decades of April during the flowering stage of dandelion plant. The mass of flying of beetles was observed at an average temperature of 180 C, the end of May – beginning of June.

Research field works were carried out in the Medeu National and Ile-Alatau State National Parks, whereas laboratory works were conducted at the the Kazakh Research Institute for Plant Protection and Quarantine. The general methodology guideline in forest protection was used to fulfil a project report.

In order to register population development rate of stem pests, in particularly bark beetles, round shaped traps with diameter 50 cm (for small sized forest pests $d=30$ cm, for longhorn beetles $d=1$ m), were placed inside of tree stems with moderate infection [15, 16].

Visual assessment of the stem pest infestation enabled us to divide into different categories according to a degree of plant weakening at the experimental sites during the monitoring. The forest evaluation was performed using a visual and recognition, as well as route methods. The main tasks of a recognitional evaluation are: to detect on time a pest pressure that have negative effect on forest; to establish the main infection sources of future forest pest and disease outbreaks at the early stage of their development; to estimate degrees of tree damage and a relative mean size of dried trees. In particular, visual assessment methods of pest detection rely on key diagnostic features, such as pest and disease

presence, severity of pest damage, a weakening of plant conditions and other related features of negative forest health conditions.

After conducting visual and recognitional evaluation, afterwards a route assessment follows that register trees according to their pathological features. As a result, there were six categories of spruce tree infestation. Among these categories, mainly categories 2, 3 and 4 (2- weak trees, 3- very weak trees, 4- drying trees) were detected during our route evaluation. The main causes of these weak, very weak and drying trees, including infested with stem pests, were also visually determined [17].

3. Results

Insect pests trapped in the pheromones were the following species: Family of bark beetles (Ipidae), including the lineate bark beetle (*Triptodendron linatum* Ol.), European spruce bark beetle (*Ips typographus* L.), Hauser's bark beetle (*Ips hauseri* Reitt.), bark beetle (*Ips duplicatus* Sahalb.), six-toothed spruce bark beetle (*Pityogenes chalcographus* L.), Baikal bark beetle (*Pityogenes baicalicus* Egg.), Kyrgyz bark beetle (*Pityophtorus kirgicus* Pjat.); Longhorns, including spruce woodcutter (*Tetropium Staudingeri* Pic.), Ribbed pine borer (*Rhagium inguisitor* Z.) and the Tien Shan horntails (*Sirex tianshanicus* Sem.). All above-mentioned pests pose potential hazard in subsequent years for both healthy and attenuated spruce plantations in the conditions of the Ile-Alatau.

The highest quantity of beetles were registered in August, when the 865 pcs of insects were collected, including the 610 pcs (53%) of *Ips typographus* L., the 99 pcs (30%) of *Ips hauseri* Reitt., the 115 pcs (11%) pitted engraver, and 11 pcs (3%) longhorns, as well as 30 pcs (3%) of other insects, including bugs, opiliones, click beetles (Image 2).

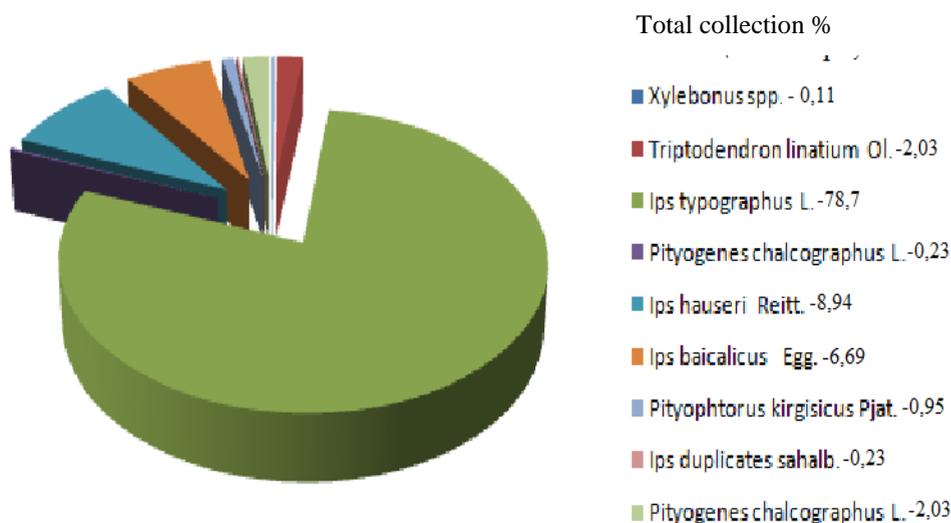


Image 2. Total percentage of bark beetles

Overall, the European spruce bark beetle, *Ips typographus* L. had the highest percentage, which was equal to 78.7%.

According to preliminary examination, the *Ips typographus* L., *I. hauseri* Reitt., *Pityogenes* sp., *Arhopalus rusticus* L. were the well-distributed insect pests, which were the mostly detected on weakened or fallen trees in the territory of wind throw area of Medeu ravine.

In order to confirm the identification of the European spruce bark beetle, samples of this insect sent to Archil Supatashvili, who is a prominent taxonomist of bark beetles and head of Department for

Forest Protection of the Institute of Forestry in Tbilisi, Georgia. The results of pest identification confirmed that it was the same beetle species (Image 3).

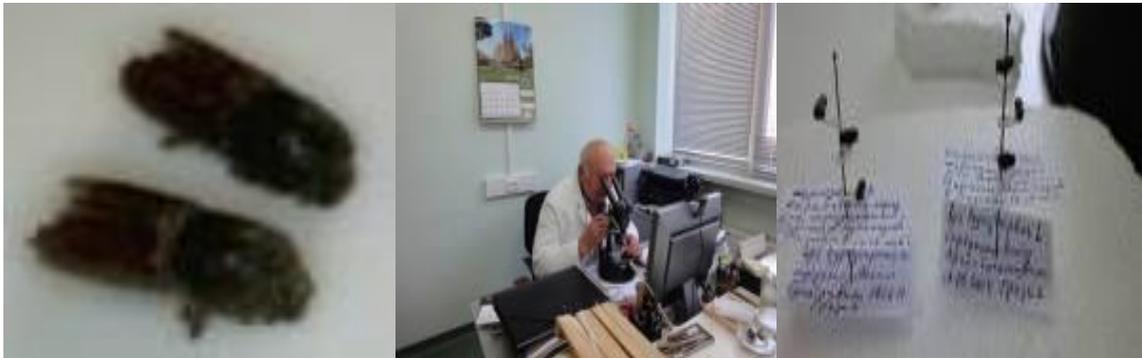


Image 3. Prof. A. Supatashvili and pest identification process, 2013

In order to assess tree conditions of different category, experimental plots with the Tien Shan spruce plantation of third and fourth classes (N=100 trees) were established in the windthrow areas (Gorelnik and block №4) of Medeu, Malo-Almatinka and Butakovka forestry.

As indicated in Table 1, in 2013 fallen trees covered 27-29 percent of total forest territory, while in 2014 it increased up to 50 percent. Xylophagous insects, such as bark beetle, long horn beetles, jewel beetles and weevils, attacked rooted trees. Overall, forest health condition was unsatisfactory and posed risks to other healthy plantations around. This was because healthy trees were under repeated mass attacks by stem pests.

Table 1 – Results of evaluation for forest health condition on the experimental sites in 2013

| Location of monitoring sites | Categories of tree health condition, | | | | Unfallentrees, % | Total number of trees, pcs | Fallen trees, % |
|---|--------------------------------------|----|-----|----|------------------|----------------------------|-----------------|
| | I | II | III | IV | | | |
| Medeu (dam) H- 2200 N-43°09'354 E-077°03'012 | 3 | 22 | 40 | 5 | 70 | 100 | 29 |
| Butakovka H- 2082 N- 43°10'338 E- 077°06'248 | - | - | 65 | 7 | 72 | 100 | 27 |

Trees infested with stem pests are major source of pest invasion. Damaged areas with secondary pests had wind throw trees and their remains (tree stumps, branches, trunks), which were distributed especially in the inaccessible mountainous areas.

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