Forest pathology studies of transboundary territories in Asian Russia

T I Morozova, I N Egorova and V I Voronin
Siberian Institute of Plant Physiology and Biochemistry, SB RAS, Irkutsk, 664033 Russia

E-mail: bioin@sifibr.irk.ru

Abstract. A number of cross-border national parks have been established in the border areas of Russia. On the basis of the studies carried out, it is possible to outline a number of current forest pathology challenges facing the national parks. A full picture of sanitary state of the forest can only be obtained by detailed special surveys. It is necessary to organise monitoring of insects and phytopathogenic fungi on permanent touristic routs and model sites. When determining the situation with forest pathology in a vast region, a systematic approach is required. It includes a consistent study of the composition of pathogens, the selection among them of species causing epiphytotics, identification of their biological and ecological characteristics, assessment of the ecological and economic significance, a study of factors that increase the harmfulness. This makes it possible to determine the range of pathogens to be monitored, to identify forest areas with the highest probability of disease outbreak.

1. Introduction
The study area is a large transboundary territory in southern Asian Russia and northern Mongolia, much of which belongs to the southern Siberian mountain system. The area lies in the interior of the Asian continent. From west to east, this inland mountain system extends from the plains of western Siberia to the ridges of the Pacific coast; to the west and north, it is separated from neighbouring countries by clear natural boundaries, generally aligned with the ledges of peripheral mountain sections above the surrounding plains. The eastern boundary runs from the confluence of the Shilka and the Argun rivers to the north, to the Stanovoi Range, and then to the upper reaches of the Zeya and the Maya rivers. The state border between Russia and Mongolia is used as the southern boundary. We study the natural boundaries of the Altai mountain systems, including the Mongolian Altai, Khangai, the Khubsugul vicinity, the Selenga midlands, and the Khentei-Chikoi highlands.

Attention to the study of mountain areas in different regions of the world is steadily increasing due to their economic potential. In particular, the Altai-Sayan mountain region is among 238 ecoregions of the world, the study and protection of whose nature is essential for the conservation of the planet' biodiversity [1]. It is a crucial task to conduct comprehensive research and monitoring of the state of components of the environment, including the monitoring of forest plantations. These studies become especially important under conditions of increasing anthropogenic pressure on vegetation due to the need to eliminate and predict the consequences of ecosystem disturbances.

The ecosystems of the region under consideration are under long-term anthropogenic impact, especially intensively over the last 300 years. A number of studies have shown that strong
anthropogenic impact on forest ecosystems can lead to systemic weakening of forest stands. One of the most important factors determining the condition of forests is phytopathogenic fungi and insect pests [2]. However, this group of pathogens is poorly studied in some regions, including the territories of Tunka National Park, some northern regions of Mongolia, and south-eastern Altai.

2. Results and Discussion
We surveyed areas bordering Mongolia from Zabaikalsky Krai to south-eastern Altai, with special attention to the Sokhondinsky Reserve, which is part of the Transbaikalia forest pathology area. In this area, we identified species that are local breeding grounds for mass reproduction of pine-eating insects, dendrophagous species [3]. In a reconnaissance survey of the Sokhondinsky Reserve, we identified 76 species of insects and 10 species of phytopathogenic fungi affecting forest plants. 9 phyllophagous insect species causing significant damage to forests and 8 species of trunk pests have been identified in the area of the “Istoki Amura” protected area. Numerous outbreaks of Altai larch longhorn beetle were noted. In previous years, an outbreak of Lymantria dispar reproduction was recorded [4].

In the 1990s, a joint Russian-Mongolian complex biological expedition was conducted in Mongolia, during which two groups of insect pests with 16 species were identified as well as a list of over 200 species of macromycetes in the taiga and forest-steppe cenoses of the Khentii, high mountains of the Eastern Sayan (Khubsugul aimag). Reconnaissance forest pathological surveys were conducted in 2010 and 2014 in Gorkhi-Terelzh, Bogd-Khaan (Manzushir), Gobi-Gurvan-Saikhan-Yol national parks with Yelyn-Am reserve (Grif Valley) in Gobi Altai, and “Istoki Amura” protected area [5]. We identified over 30 species of phytopathogenic fungi that damage trees.

For the first time in Mongolia, blue spruce Picea obovata Ledeb. var. coerulea Malysch. was discovered in the Bogd-Khaan national park. Reconnaissance surveys of cryptogams organisms (terrestrial algae, micromycetes, macromycetes) and insect pests have been conducted in several areas of the Altai Republic [6]. During forest pathology surveys in Kosh-Agachsky, Ulagan and Shebalinsky districts in the valleys of Boguty, Dzholin, and Yustyd rivers in 2015-2016, mass reproduction of Asian gypsy moth subspecies – Lymantria dispar asiatica Vnukovskij was observed. As a result of preliminary studies, 14 species of insects and 35 species of phytopathogenic fungi were found in this area. It was found that in forests weakened by recreational load, the degree of forest stand damage increases. Forest pathology studies of forests in Krasnoyarsk Krai were carried out in Yergaki and Stolby nature parks. 39 species of conifer pathogens and 19 species of trunk rot pathogens have been registered in the studied areas [7].

As a result of long-term surveys conducted in 1987-2009, more than 150 species of parasitic fungi on tree species were discovered on the territory of the Podlemorye Nature Reserve. Some of them under certain forestry conditions are capable of causing massive damage to stands, accompanied by significant ecological changes and economic losses. Based on the accumulated information on the features of pathogen biotopes, their number and harmfulness in natural conditions, a map of forest pathology situation (1:2,500,000) has been published in the Ecological atlas of the Irkutsk region [8]. Such maps will allow forestry organizations to focus their attention on areas with the greatest threat of forest pathology and thereby increase the effectiveness of forest protection.

At present, more than 300 species of fungi parasitizing on tree and shrub species have been registered in the Baikal region. In particular, about 100 species of tree crown-damaging micromycetes have been recorded. We have studied the dendrophilic mycoflora of Baikal Siberia in most detail. Lists of phytopathogenic fungi noted on all major species growing in Baikal Siberia have been published [2, 9, 10]. In the last decade, fungal epihytotics of species not previously massively noted in our region have occurred in this region, such as epihytotics of scleromorphosis, a mass infestation of pine in different areas of the Baikal mountains. Cases of pine-twig blight diseases, root rot, scleroderma, bacteriosis of tree species have also become more frequent. It affects not only coniferous but also deciduous species. Birch, aspen, elm, poplar, apple tree, and bird cherry are susceptible to damage. It is accompanied by mass reproduction of insects – aphids, moths, silkworms.
The recently emerged bacterial damage of dark coniferous forests in the Baikal region, which has not been previously noted here, we conditionally called “new” diseases [12]. In weakened forests, the negative impact of microfungi and insect pests is very likely to increase. A significant decrease in the level of atmospheric moisture in these forests, which may lead to their mass desiccation, poses a particular danger [11].

3. Conclusion
Based on the studies carried out, a number of current forest pathology tasks can be outlined [5]. A full picture of the sanitary state of the forests can only be obtained by detailed special surveys. It is necessary to organise monitoring of the number of insects and phytopathogenic fungi on permanent routes and model sites.

When determining the forest pathology situation in a vast region, a systematic approach is required. It includes a consistent study of the composition of pathogens, the selection among them the species causing epiphytotics, clarification of their biological and ecological characteristics, the evaluation of environmental and ecological characteristics.

It enables determining the range of infectious agents that are subject to forest pathology surveillance, to identify forest areas characterized by the highest probability of disease outbreaks [14].

A number of cross-border national parks, along with China, Mongolia and Kazakhstan, have been organised in areas bordering Russia. Based on our research, we have identified a number of topical forest pathology challenges facing the national parks [13]. Surveys should be conducted from the Khentii-Chikoi highlands to Altai across the northern territory of Mongolia. A complete picture of the sanitary state of forests can only be obtained by detailed special surveys.

It is necessary to organize monitoring of the number of insects and phytopathogenic fungi on permanent routes and model sites. In determining the forest pathology situation within a vast region, a systematic approach is required, which includes a study of the pathogens composition, the identification of species causing epiphytotics, clarification of their biological and ecological characteristics, assessment of ecological and economic significance, identification of factors that increase the harmfulness. This makes it possible to determine the range of infectious agents that are subject to forest pathology surveillance, to identify forest areas characterized by the highest probability of disease outbreaks [14].

Acknowledgements
The work was supported by the Ministry of Science and Higher Education of the Russian Federation, the grant for implementation of large scientific projects on priority areas of scientific and technological development (the project “Fundamentals, methods and technologies for digital monitoring and forecasting of the environmental situation on the Baikal natural territory”, No. 13.1902.21.0033).

References
[1] Olson D M and Dinerstein E 2002 Ann. Missouri Bot. Gard. 89 199-224
[2] Pleshanov A S and Morozova T I 2009 Micromycetes of Siberian fir and atmospheric pollution of forests (Novosibirsk: “Geo”) p 116
[3] Epova V I and Pleshanov A S 1995 Zones of harmfulness of insect phytophages of Asian Russia (Novosibirsk: “Nauka”) p 147
[4] Morozova T I and Berezhnykh E D 2010 A brief review of dendrophilic entomofauna and phytopathogenic fungi of Sokhondo State Reserve Proc. of Int. Conf. “Conservation of irrational use of animal and plant resources” (Irkutsk: Irkutsk State Academy of Agriculture Press) pp 470-4
[5] Morozova T I 2010 Forest pathology surveys in the international projected special protected area “The Amur Rivers” Proc. of Int. Conf. “Ecological consequences of biosphere processes in the ecotone zone of South Siberia and Central Asia” 2 (Ulaanbaatar: Bambi San) pp 63-5

[6] Morozova T I and Egorova I N 2017 Reconnaissance forest-pathological survey in the Republic of Altai Proc. of the II All-Russian Conf. “Problems of study and conservation of the plant world of Eurasia” (Irkutsk: IG SB RAS Press) pp 75-7

[7] Morozova T I 2016 Phytopathological survey of the “Ergaki” Nature Park Proc. of the All-Russian Sci. and Practical. Conf. “Intensification of Forestry in Russia” (Krasnoyarsk: IL SB RAS) pp 135-6

[8] Morozova T I, Pleshanov A S and Epova V I 2004 Atlas of the Irkutsk region: environmental conditions of development (Moscow, Irkutsk: IG SB RAS, ROSKARTOGRAFIA) pp 81-4

[9] Morozova T I and Tkacz B 1997 Amer. Phytopatol. Soc. 77-9

[10] Petrov A N 1991 The flora of macromycetes of Pribaikalye (Novosibirsk: Nauka) p 81

[11] Voronin V I, Morozova T I, Stavnikov D Y, Nechesov I A, Oskolkov V A, Buyantuev V A, Mikhailov Yu Z, Govorin Y V, Seredkin A D and Shuvarkov M A 2013 Forestry 3 pp 39-41

[12] Voronin V I, Sofronov A P, Morozova T I, Oskolkov V A, Sukhovolsky V G and Kovalev A V 2019 Geography and Natural Resources 4 56-65

[13] Morozova T I 2015 Forest pathology surveys in the national parks of Mongolia Proc. Int. Conf. “Ecosystems of Central Asia in modern conditions of socio-economic development” 2 (Ulaanbaatar) pp 489-91

[14] Morozova T I and Voronin V I 2019 Multiyear forest pathology monitoring in the Baikal region and identifying the causes of mass forest damage (Irkutsk: IG SB RAS Press) p 118