



# Revegetation of Dark Coniferous Taiga at the Site of Second Growth of Light Coniferous-Leaf Woods in the South-Eastern Pre-Baikal

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## Abstract

Zonal and height belt differentiations of the environmental parameters determine forms and types of forest changes while forming natural systems of any hierarchy. Under the conditions of climate changes, shifting of natural (geographical) environments or height belts as definite environments is possible, with the structural differentiation of the whole biosphere. Determination of consequences of such changes is a problem for modern biogeography, biocenology, geobotanics and ecology as for knowledge systems on vegetation formation and development under concrete physical geographical conditions. According to this case we are presenting the results of the study of the forest development in some areas of Lake Baikal basin. It was observed that the dark coniferous taiga is forming everywhere on the site of the second growth of the light coniferous-leaf woods due to secular forests dynamics, to climate changes and partly to decrease of anthropogenic impact for last decades in the region.

## Keywords

South-Eastern Pre-Baikal, Dark Coniferous Taiga, Second Growth of Light Coniferous Leaf Woods, Revegetation

**Subject Areas:** Biogeography

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## 1. Introduction

Regions, which can be basins of any large river or surroundings of a closed water body (a lake) comprising dif-

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ferences in spatial, structural and dynamic organization of natural system are suitable models for studies of all the diversities and all different directions of changes in the biosphere on the background of climate dynamics. Subjects of such studies can be forests forming within a definite natural zone or a height belt. Revealing the peculiarities of spatial and temporal variability in the forest structure is especially important in modern trends of environmental studies, where it is necessary to obtain bulk information (quantitative and qualitative parameters) aimed to forecast of direction of vegetation development on the background of regional climatic fluctuations.

The aim of our studies is to reveal the structural and dynamical organization as well as the spatial and temporal variability of forests on Lake Baikal near-shore territories, which are included in the water protection zone of the lake. The peculiarities of the structure, dynamics and spatial variability of transitional forests between height belts, at the boundary of forests and mountain tundra in some areas of the Eastern Pre-Baikal adjacent to Lake Baikal water protection zone were study before as well [1]-[4].

## 2. Research Areas, Methods and Materials

The studied area comprised the territory of the South-Western pre-Baikal, its near-shore part, from southern to northern branches of Khamar-Daban Ridge. The situations of key sites were as follows: N51°28'161" - E104°48'959"; N52°29'658" - E104°52'797"; N51°58'36" - E106°21'819". We described there in details the structure of phytocenoses reflecting modern trends of formation of forests in the water protection zone of this part of Lake Baikal basin.

The studied area, according to the map of land use in the south of East Siberia [5] belonged to the lands of water protection zone. According to the ecological zonation of Baikal natural territory [6], it is included as well to water protection zone of the lake itself. According to correlational ecological-phytocenotic map [7], the phytocenoses on the considered territory were represented by the second growth of birch (*Betula pendula*)-aspen (*Populus tremula*) groups on the place of forests consisting of fir (*Abies sibirica*)-cedar, (*Pinus sibirica*) bilberry (*Vaccinium myrtillus*)-short grasses, green mosses (*Dicranum polysetum*, *Polytrichum juniperium*, *Hylocomium splendens*, *Ptilium crista-castrensis*) and cedar (*Pinus sibirica*), cedar (*Pinus sibirica*)-spruce (*Picea abovata*), undershrub (*Vaccinium vitis-idaea*, *Vaccinium uliginosum*, *Ledum palustre*)-green mosses (*Dicranum polysetum*, *Hylocomium splendens*) in moderately cold humid habitats. Depending on the ecotope conditions, the composition of plant species and composition of the tree species forming the forests varied by their quantitative parameters within the cenoses. There were as well relatively swamped sites, where increase and abundance of trees species at the undergrowth stage (from 5 to 15 y.o.) were observed as well.

The studies had been performing for several years during different vegetation periods by method of field geobotanical survey with geobotanical descriptions and using of topographic maps to connect the sites to the network of geographical coordinates.

## 3. Results

The performed studies revealed some peculiarities of phytocenoses structure reflecting modern trends in formation of vegetation in the south-eastern part of Pre-Baikal. The characteristic listed below characteristics of forest cenoses, in our opinion, represented the peculiarities of the organization of cenoses at modern stage of vegetation formation both in the studied area and in the whole region.

1) Vegetation of key site, the Osinovka River basin (N51°28'161" - E104°48'959") was represented by second growth of motley grasses (*Calamagrostis epigeios*, *Carex macroura*, *Equisetum sylvaticum*, *Rubus arcticus*)—undershrubs (*Vaccinium myrtillus*, *Vaccinium vitis-idaea*, *Vaccinium uliginosum*) in birch forests (*Betula pendula*, *Betula fruticosa*). The second layer consisted of Siberian spruce (*Picea abovata*) and cedar (*Pinus sibirica*) under 35 y.o. The undergrowth of these forests was everywhere rich in cedar (*Pinus sibirica*) with spruce inclusion (*Picea abovata*). The underwood was formed by *Duschekia fruticosa* with inclusions of mountain pine (*Pinus pumila*). It was necessary to notice here that second growth of parvifoliate forests with undergrowth with prevailing cedar (*Pinus sibirica*) with inclusion of Siberian spruce (*Picea abovata*) were rather widely represented at mouths of major part of rivers and creeks within branches of Khamar-Daban Ridge forming the near-shore part of Lake Baikal.

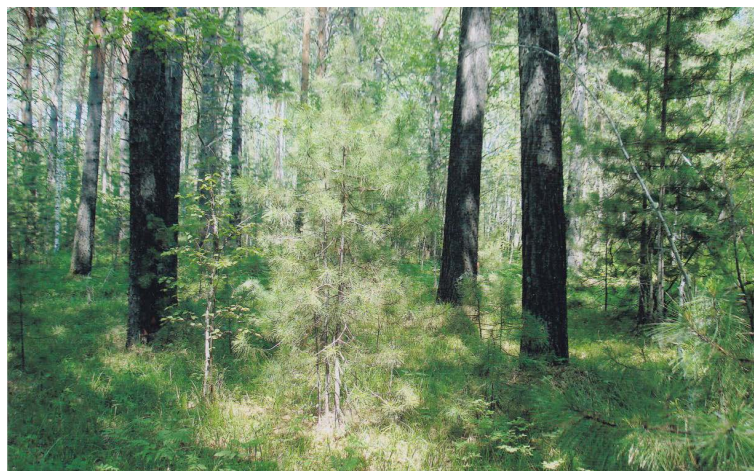
2) The structure of phytocenoses at the key site, the Vydrinnaya River basin (N 52°29'658" - E104°52'797") was characterized by composition of cedar (*Pinus sibirica*)-pine (*Pinus sylvestris*) forests with inclusions of flat-leaved birch (*Betula plathyphylla*) and shrub birch (*Betula fruticosa*) with swamped shrub groups. The second

layer of timber stands was represented by cedar (*Pinus sibirica*), Siberian fir (*Abies sibirica*) and pine (*Pinus sylvestris*). The undergrowth was dominated by cedar (*Pinus sibirica*). Small sites were recovered by sphagnum (magellanian, spiculate, auctifoliate and brown sphagnum) bogs with inclusions of *Cassiope cricoides*, *Andromeda polifolia*, *Rubus arcticus*. Among them there were sprouts and undergrowth of cedar (*Pinus sibirica*) under 10 y.o. and some specimens of trees of 35 - 40 y.o.

The boundary of timber stand and boards of swamped territories in the first layer of forest cenoses are occupied by cedar (*Pinus sibirica*) and flat-leaved birch (*Betula plathyphylla*), the undergrowth including cedar (*Pinus sibirica*) and Siberian fir (*Picea abovata*). There were as well mountain pine (*Pinus pumila*) and goldish rhododendron (*Rhododendron aureum*) with inclusion of *Vaccinium myrtillus*, *Vaccinium vitis-idaea*, synusially-*Veratrum lobelianum*. There was as well *Ledum palustre* together with *Cassiope cricoides*. The soil cover was dominated by such mosses as *Dicranum polysetum*, *Polytrichum juniperium*, *Hylocomium splendens* with inclusion of *Ptilium crista-castrensis*. The cenoses of such structure were adapted mainly to depressions in cleavages forming an apron of a macro-slope of Khamar-Daban Ridge extending from the southern margin (the Slyudyanka river basin) to its north-eastern part (the Bol'shaya River basin).

3) Vegetation of key site, surrounding territory of railway station Posol'skaya (N51°58'036" - E106°21'819") formed forest cenoses consisting of pine (*Pinus sylvestris*)-aspen (*Populus tremula*) with birch (*Betula pendula*). The second layer as well was represented by pine (*Pinus sylvestris*) and birch (*Betula pendula*). As for undergrowth which transited into young growth, it consisted of cedar (*Pinus sibirica*) with inclusion of Siberian spruce (*Picea abovata*) aged 5 - 35 y.o. everywhere, and the presence of pine (*Pinus sylvestris*) is minimal, up to several specimens within cenoses. The soil cover consisted of taiga motley grasses (*Carex macroura*, *Trollius asiaticus*, *Fragaria orientalis*, *Maianthemum bifolium*, *Iris ruthenica*, *Rubus arcticus*) with inclusion of *Pteridium aquilinum*. The role of shrubs-*Vaccinium myrtillus*, *Vaccinium vitis-idaea* and mosses is also noticeable (*Polytrichum juniperium*, *Hylocomium splendens*), as dominant edificators of soil cover characteristic for dark coniferous taiga (*Pinus sibirica*, *Picea abovata*, *Abies sibirica*). It suggested activation those processes of dark coniferous taiga formation on the place of polydominant light coniferous-parvifoliate forests of this Pre-Baikalian territory.

Generally, the trends of forests formation in the south-western part of Lake Baikal near-shore zone is characterized, despite modern cenoses structure, ecotopes conditions and cenoses position, by regrowth of dark coniferous taiga everywhere on the place of second growth of light coniferous-parvifoliate forests and partly on swamped sites up to reforestation of upper reach swamps. On the photographs presented below (Figures 1-3) one can see modern trends of forest formation in the region towards formation of dark coniferous taiga on the place of polydominant light coniferous parvifoliate forests everywhere.



**Figure 1.** Undergrowth of Siberian cedar (*Pinus sibirica*) in polydominant second growth forests with dark coniferous (*Pinus sylvestris*)-parvifoliate (*Betula pendula*, *Populus tremula*) species with an expressed trend to transition of a dark coniferous species (*Pinus sibirica*) into the second layer of the timber stand. The soil cover consisted of taiga motley grasses with inclusion of *Vaccinium vitis-idaea* in the cenoses.





**Figure 2.** Formation of a stable layer (second one) of dark coniferous trees species (*Pinus sibirica*, *Abies sibirica*, *Picea abovata*) in the polydominant forests with light coniferous (*Pinus sylvestris*)-parvifoliata (*Betula pendula*, *Populus tremula*) second growth with trend of increase of the role of taiga undershrubs (*Vaccinium myrtillus*, *Vaccinium vitis-idaea*) and mosses (*Dicranum polysetum*, *Polytrichum juniperium*, *Hylocomium splendens*, *Ptilium crista-castrensis*) in the soil cover everywhere.



**Figure 3.** Polydominant light coniferous (*Pinus sylvestris*)-parvifoliata (*Betula pendula*, *Populus tremula*) second growth forest with the dark coniferous young trees species (*Pinus sibirica*, *Abies sibirica*) in the first stage of the dark coniferous formatting for region.

#### 4. Discussions

Structural and dynamic differences of the forests under different natural conditions were revealed. In connection with mentioned above we can say that the dark coniferous forests are forming not only on the place of the second light coniferous-parvifoliata forest but under the canopy of the zonal light coniferous taiga everywhere around the south-eastern and western coast of Lake Baikal. It was observed for the beginning of the twenty one century at all [8]. Probably it was connected with the climate dynamics during last several decades initiated in the region [9]. For example, in the whole Baikalian Siberia there are as well processes concerning dynamics of increase of snow cover thickness and of maximal snow stocks during last 50 years in taiga zone. A stable in-

crease of main annual temperatures with the rate of 0.2°C - 0.5°C for a 10-year period is noticed. At the same time was observed the decrease of continental characteristics of the climate in the region due to decrease of annual temperature amplitudes. There are trends to relative and multidirectional decrease of mean annual precipitations amount, especially in October-April with a maximum in December [10].

## 5. Conclusions

The second growth of light coniferous-parvifoliate forests formed on the place of ancient cuts and fires of anthropogenic origin during several decades on the background of climatic changes of last century. At present, dark coniferous taiga forms everywhere simultaneously due to secular forests dynamics, to climate changes and partly to decrease of anthropogenic impact, as the vegetation of the studied area is included for a long time in the water protection zone of Baikal natural territory.

Inclusion of all the forests on the littoral, and further of all phytocenoses in small rivers basins flowing into Lake Baikal in the category of water protection ones will impact in a positive way the vegetation playing first of all environment protection function for vegetation cover in the region. This is most important for Lake Baikal under the conditions of modern increase of human activities in the lake near-shore zone on the background of climatic changes in the Baikal Region.

The monitoring of reforestation dynamics of near-shore forests will allow us to quickly obtain the information on the way of their formation to determine further forms and types of vegetation use within its main function-environment protection. Probably, in some cases (e.g., at burnt-out sites), forest reconstitution will be required, as well as creation of additional natural reserve zones within the water catchment basins of Lake Baikal.

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