

REPLACEMENT OF DOMINANTS OF FOREST FORMING SPECIES IN PRE-BAIKALIAN AND TRANS-BAIKALIAN FORESTS (The Baikal Region)

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ABSTRACT

Found out the structural-dynamic organization and trends in light-coniferous forests development under different physical-geographic conditions in some areas of the Baikal Region. In light-coniferous forests consisting of larch (*Larix sibirica*) and pine (*Pinus sylvestris*) with inclusion of birch (*Betula platyphylla*) and aspen (*Populus tremula*) of different typology in subordinate synfolia there are such dark-coniferous species as cedar (*Pinus sibirica*), sometimes spruce (*Picea obovata*). Cedar dominance in the undergrowth was revealed everywhere, while occurrence of modern forest-forming species such as pine and larch counts only several specimens. Cedar is often considerably represented on the places of burnings and cuttings, which took place in different years, where a timber stand of small-leaf trees species (birch, aspen) formed together with their underwood. Due to this fact, we can suppose that the probability of replacement of dominant from light-coniferous species to dark-coniferous component in the light-coniferous forests of the studied area is rather high. Presence in the soil cover of plants species characteristic for mixed light-coniferous – dark-coniferous forests can confirm the existence of potential for the developments of dark-coniferous taiga on the background of probable decrease of pyrogenic factors and of cuttings of different form and intensity in the region. By many factors, the forests in the studied area where forest-forming trees species are replaced are indicators of modern changes in the forests structural-dynamic organization on the background of dynamics of natural-climatic factors in the Baikal Region. It is found out that in the subordinate synfolia of light-coniferous forests in South-Eastern Pre-Baikal and South-Western Trans-Baikal, initial stage of dark-coniferous taiga is found out.

Key words: forest-forming species, dominants, light-coniferous forests, dark-coniferous taiga, South-Eastern Pre-Baikal, South-Western Trans-Baikal.

INTRODUCTION

The problem of the state assessment and changes forecast in vegetation (in particular, in forests) is a basis of modern biogeographic, geobotanical and ecological studies. Main task is a study of spatial-temporal self-organization of vegetation reflecting practically all changes in the environment for a concrete time period. It is necessary for it to synthesize different aspects of their studies rather than a simple detailed analysis of separate environmental systems components and elements (Alekseev et al., 2001; Blaubeurg, Yudin, 1973). At this approach, a forest cenosis is

considered as a system, which forms and develops as a unit and forms mutually conditioned links of matter-energy exchange with systems of other hierarchical level and ecological processes (Bolshakov et al., 1993; Voronov, 2002; Shmalgauzen, 1961; Maksimov, 1989). Approaches in finding out long-term trends in forests development are at present at different stages of development. Main task of such studies is finding out age, position and role of all forest forming synfolia (cenotic structures) in successional systems currently. It is necessary for this to reveal the peculiarities of forests composition and structure on the background of climate variations and anthropogenic impact with determination of periods of homeostasis in environmental systems of any hierarchy (Armand, Kushnareva, 1989). Optimal values of formation of forest cenoses typological diversity on the position of primary ones (Sochava, 1979) depend on the amount of environment resource and on the degree of its stability. The mechanisms of optimization of forests diversity are consequently due to ecological and evolutionary processes occurring in the environment of a concrete territory. The dynamics of forests development during last decades on the background of climate variability in continental-regional scale reflects modern trends of their formation under different physical-geographic conditions as well in the Baikal Region. Due to this fact, timely correction of determination of successional variations vector in the forests becomes very important at the modern stage of the monitoring of vector of their development. In this case, finding out actual state, degree of primary forests transformation, trends in their development in a spatial-temporal aspect on the background of climate variation are aims of their status forecast – way to reconstitution of conventionally primary (Sochava, 1979) cenoses or to formation of secondary components at different temporal distances.

MATERIAL AND METHODS

The studies of modern structural-dynamic forests organization from viewpoints of their dominants composition in a timber stand were performed at two polygons including three key sites. First polygon is in the Olkha R. basin (South-Eastern Pre-Baikal), second one is in the Orongoy R. basin (foothills of Khamar-Daban Ridge, South-Western Trans-Baikal). Main studies method was field geobotanical survey (Field ..., 1964; Field ..., 1976; Methods ..., 1996) at key (model) sites reflecting zonal characteristics of forest vegetation. The obtained geobotanical descriptions were grouped on the base of structural-dynamic and cenotic characteristics of forests of concrete types of their habitats. Plants species composition in the cenoses was conformed with existing flora keys (Flora ..., 1979; Flora ..., 1987-2003; Summary ..., 2005), and mosses names were specified according to the key by L. V. Bardunov [15]. The areas of studies done are shown on the schematic map with red circles and on the spatial picture (inset) – with red markers with numbers (see Fig.1).

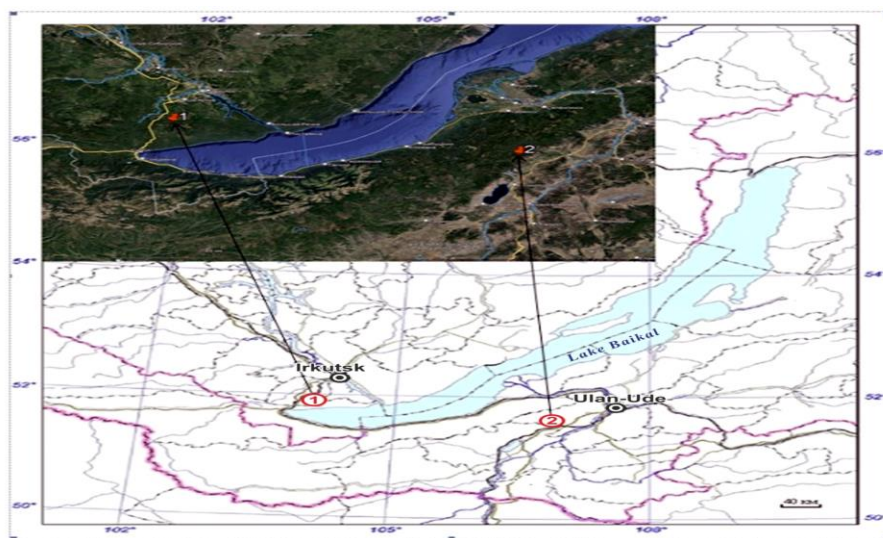


Figure 1. The studied areas (polygons 1 and 2) are marked with figures in red circles on the schematic map and with red markers with numbers of the space picture (inset). Polygon 1 – the Olkha R. basin (South-Eastern Pre-Baikal) and polygon 2 – the Orongoy R. basin (South-Western Trans-Baikal).

RESULTS

The studied area – polygon 1 (the Olkha R. basin, South-Eastern Pre-Baikal; N 51°59.450' – E 103°59.176') is situated in South Siberian mountain area, Upper Angara swamp-steppified-subtaiga province, where there are mountain taiga forests consisting of pine, grasses and shrubs underwood (Landscapes ..., 1977). The vegetation of the studied area and its adjacent environment (see Fig. 1-1) is represented with pine and pine-larch cowberry – motley grasses forests, often with marsh tea and blueberry and duschekia underwood and with their reconstitution series consisting of aspen and birch (Vegetation ..., 1972). According to ecological-phytocenotic correlational map, those phytocenoses are related to low- and middle-mountain pine and larch-pine forests, mainly sustainably secondary ones with undershrubs, grasses and green mosses with fragments of primary dark-coniferous timber stands (Correlation ..., 1977; Atlas ..., 1993; Map of ..., 1988). According to the obtained geobotanical descriptions, the vegetation of this area is represented with forests consisting of pine (*Pinus sylvestris* L.) and larch (*Larix sibirica* Ledeb.) with inclusion of cedar (*Pinus sibirica* Du Tour), spruce (*Picea obovata* Ledeb.), Asian white birch (*Betula plathyhylla* Sukacz.), aspen (*Populus tremula* L.), cowberry (*Vaccinium vitis-idaea* L.), sedge (*Carex macroura* Meinsch.), green mosses (*Hylocomium splendens* (Hedw.) B.S.G., *Climacium dendroides* (Hedw.) Web. et Mohr.), *Pleurozium schreberi* (Brid.) Mitt of different age forming one vertically closed canopy and growing everywhere in the Olkha R. basin. The second synfolium of such forests consists of pine (*Pinus sylvestris* L.), larch (*Larix sibirica* Ledeb.) and cedar (*Pinus sibirica* Du Tour). The third synfolium of the timber stands consists of cedar (*Pinus sibirica* Du Tour), spruce (*Picea obovata* Ledeb.) and fir (*Abies sibirica* Ledeb.), while pine (*Pinus sylvestris* L.) occurs as single specimens. The undergrowth is everywhere dominated by cedar (*Pinus sibirica* Du Tour) from 3-5 to 15-18 y.o. (the amount is 700-900 pieces/ha depending on a position in the relief. There are in the undergrowth (seldom) fir (*Abies sibirica* Ledeb.) and spruce (*Picea obovata* Ledeb.) 10-12 y.o. In the undergrowth of these forests, presence of modern forest forming species - pine (*Pinus sylvestris* L.) is represented by single specimens up to 10 y.o. In drier habitats, there are such shrubs as duschekia (*Duschekia fruticosa* (Rupr.) Pouzar), blueberry (*Vaccinium uliginosum* L.), marsh tea (*Ledum palustre* L.), seldom - meadowsweet (*Spiraea media* Fr. Schmidt). The soil cover is represented by undershrubs as simple synusia of huckleberry (*Vaccinium myrtillus* L.) and cowberry (*Vaccinium vitis-idaea* L.). There are such taiga motley grasses as bush grass (*Calamagrostis epigeios* (L.) Roth, northern twinflower (*Linnaea borealis* L.) as well as club-mosses – stiff club-moss (*Lycopodium clavatum* L.) and juniper club-moss (*Lycopodium juniperoideum* Sw.). Mosses are represented with such species as *Polytrichum juniperinum* Hedw., *Dicranum polysetum* Sw., *Pleurozium schreberi* (Brid.) Mitt., *Hylocomium splendens* (Hedw.) B.S.G., *Climacium dendroides* (Hedw.) Web. et Mohr), they are edifiers of soil cover in light-coniferous – dark-coniferous forests. Probably, in this Pre-Baikalian area an initial stage of formation (with replacement of forest forming trees species) of dark-coniferous taiga is fixed at present (see Fig. 1-1).



Figure 1-1. Forests consisting of pine (*Pinus sylvestris* L.), larch (*Larix sibirica* Ledeb.), inclusion of birch (*Betula plathyhylla* Sukacz.), undergrowth of cedar (*Pinus sibirica* Du Tour), participation of cowberry (*Vaccinium vitis-idaea* L.) and green mosses (*Polytrichum juniperinum* Hedw., *Dicranum polysetum* Sw., *Pleurozium schreberi* (Brid.) Mitt.).

On the burnt sites made in different years, the forests reconstitute (reconstitution succession) with dominating in main synfolium of birch (*Betula plathyhylla* Sukacz.) with pine (*Pinus sylvestris* L.) and larch (*Larix sibirica* Ledeb.). The structural-dynamic organization of the forests in this Pre-Baikalian area is characterized by replacement of forest forming trees species due to secular forests dynamics on the background of climate (mainly

humidity) variability during last decades. As these Pre-Baikalian areas, according to ecological zoning of Baikal Natural Area (Ecological ..., 2002), are among regions of intensive nature management, the revealed vector of forests development will depend on the degree of impact of these or those forms of forest usage on these territories in the whole. The studied area - polygon 2 (includes two key sites) – the Orongoy R. basin (South-Western Trans-Baikal) is situated in South Siberia mountain region, Khamar-Daban mountain taiga – depression province (Landscapes ..., 1977), where pine (*Pinus sylvestris* L.) and larch (*Larix sibirica* Ledeb.) mountain-taiga forests of South Siberia formations, Ural-Siberia formations fratria formed (Vegetation ..., 1972). According to ecological-correlational map (Correlation ..., 1977), the vegetation of the studied area represents units of low, somewhere middle mountain pine and larch-pine forests with motley grasses. The vegetation (Atlas ..., 1993) of the studied area and of its adjacent environment is characterized by development of taiga light-coniferous forests expanding along the slopes of different expositions and consisting of larch (*Larix sibirica* Ledeb.) and pine (*Pinus sylvestris* L.) with larch (*Larix sibirica* Ledeb.), including grasses, cowberry (*Vaccinium vitis-idaea* L.) and Daurian rhododendron (*Rhododendron dauricum* L.). According to land usage system (Map of ..., 1988), the studied area is in the zone of lands of State Forestry Fund aimed for exploitation. According to the map of ecological zoning (Ecological ..., 1002), the area territory is related to mountain-taiga piedmont-slope middle and low mountain, piedmont landscapes used nowadays for basic and applied forests usage within the buffer zone. According to the atlas (Atlas ..., 2021, p. 124), the vegetation in the studied area is characterized as a weekly disturbed one with moderately stable cenoses sustainability. The forests of the key site 1 (N 51°35.824' - E 106°42.650') on the polygon 2 (see Fig. 1-2) and its adjacent environment are characterized by development of light-coniferous taiga. There are everywhere their secondary components with formed pine (*Pinus sylvestris* L.) –birch (*Betula platyphylla* Sukacz.) forests with inclusion of larch (*Larix sibirica* Ledeb.). As for the undergrowth of a light-coniferous forest consisting of pine (*Pinus sylvestris* L.), birch (*Betula platyphylla* Sukacz.) and including larch (*Larix sibirica* Ledeb.), green mosses (*Dicranum polysetum* Sw.) and sedge (*Carex macroura* Meinsh.), it is dominated by cedar (*Pinus sibirica* Du Tour) up to 10-12 y.o. (from 300 to 500 pieces/ha). Modern forest forming species in the undergrowth – pine and larch are presented as single specimens. Presence of post-fire brushwood and fire damage on pines and larches trunks suggest fires of different intensity during different years. This is also suggested by a considerable occurrence of birch (*Betula platyphylla* Sukacz.) and aspen (*Populus tremula* L.), which often dominate in timber stand structure.



Figure 1-2. A forest consisting of pine (*Pinus sylvestris* L.), birch (*Betula platyphylla* Sukacz.) and aspen (*Populus tremula* L.) with inclusion of larch (*Larix sibirica* Ledeb.). The undergrowth is dominated by cedar (*Pinus sibirica* De Tour) with single specimens of spruce (*Picea obovata* Ledeb.).

Presence of dark-coniferous trees species in the structure of light-coniferous forests may suggest an initial stage of development of light-coniferous – dark-coniferous taiga. This may be due to secular dynamics (with replacement of forest forming trees species) of zonal forests development. However, such anthropogenic factors as cutting and burning during different years and of different intensity constrain such processes considerably. This is characteristic for the whole Western Trans-Baikal including the studied area. The forests of the key site 2 (N 51°35.925' - E 106°42.729') of the polygon 2 are represented by forests consisting of birch (*Betula platyphylla* Sukacz.), pine (*Pinus sylvestris* L.), underwood of Daurian rhododendron (*Rhododendron dauricum* L.), green mosses (*Dicranum polysetum* Sw., *Abitinella abietina* (Turn.) Fleisch., *Polytrichum commune* Hedw., *Rhytidium rugosum* (Hedw.) Kindb., *Hylocomium splendens* (Hedw.) BGS), motley grasses (*Pyrola asarifolia* Michaux., *Carex macroura* Meinsh.) with cowberry (*Vaccinium vitis-idaea* L.) at flattened slopes of different expositions (see Fig. 1-3). The soil cover in these forests includes sedge (*Carex macroura* Meinsh.), liver-leaf wintergreen (*Pyrola asarifolia* Michaux.), cowberry (*Vaccinium vitis-idaea* L.) with synusia of mosses (*Dicranum polysetum* Sw., *Abitinella abietina* Turn.) Fleisch., *Polytrichum commune* Hedw., *Rhytidium rugosum* (Hedw.) Kindb., *Hylocomium splendens* (Hedw.) BGS; this is characteristic for a polydominant light-coniferous taiga of a zonal type. However,

presence of cedar (*Pinus sibirica* Du Tour) and spruce (*Picea obovata* Ledeb.) of different age (up to 60-80 y.o.) in the 2nd synfolium of such forests may indicate an initial stage of formation of light-coniferous – dark-coniferous taiga. This is confirmed by the fact that the undergrowth everywhere includes cedar, seldom – spruce up to 5-7 y.o. (amount from 300 to 500 pieces/ha). Here presence of pine in the underground as of main modern forest forming species is single.



Figure 1-3. Birch (*Betula platyphylla* Sukaczju) – pine (*Pinus sylvestris* L.) forests with rhododendron (*Rhododendron dauricum* L.) and undergrowth of cedar (*Pinus sibirica* De Tour). Initial stage of formation of light-coniferous – dark-coniferous forests.

The studied area (polygon 2, key sites 1, 2) are characterized by development of forests with considerable structural-cenotic reconstructions in their organizations due to replacement of forest forming trees species during recent decades. We have to notice that during a long period (since the middle part of last century), the forests in Pre-Baikal and Western Trans-Baikal were effected anthropogenically – there were large cutting and periodic fires of different degree and intensity. On the cut and burnt sites of these forests, light-coniferous forests consisting of pine and larch were replaced by groups of secondary small-leaf trees (birch, aspen). However, dominance of a dark-coniferous species in the undergrowth, such as cedar (with inclusion of spruce) with plants species in the soil cover characteristic for mixed light-coniferous – dark-coniferous forests suggests an existing potential for the development of a dark-coniferous taiga. This will be possible without fires during at least 30-50 years but this is very problematic due to increased anthropogenic impact during recent decades – non-controlled cutting and burning in the whole region. Taking into account existing criteria of satisfactory reconstitution of cedar (1000 pieces/ha and more) for Baikalian mountain forest area (Ministry of ..., 2020; Order of Ministry ..., 2022), the revealed quantitative ratios of cedar in the light-coniferous forests undergrowth in the studied area up to 700-900 pieces/ha (for the polygon 1) and up to 300-500 pieces/ha (for the polygon 2) allow to suppose a high probability of development of a dark-coniferous taiga in the studied areas. We have to notice that similar trends in forests development with replacement of dominant forest forming species from light-coniferous to dark-coniferous components were revealed before as well in other areas of Pre-Baikal and Trans-Baikal (Sizykh, 2005; 2019). Probably, such trends in forests development are of regional scale.

CONCLUSION

- The forests in the studied area, in the Olkha R. basin (polygon 1, South-Eastern Pre-Baikal) are represented by pine timber stands with inclusion of larch and birch. In the 2nd synfolium, there are cedar (*Pinus sibirica* Du Tour) and spruce (*Picea obovata* L.) of different age. The undergrowth of light-coniferous forests is dominated by cedar (with inclusion of spruce) everywhere. Increase of dominant positions of dark-coniferous trees species suggests a trend of dominants replacement in the forests of this Pre-Baikalian area.
- Common feature of the forests in the studied area – in the Orongoy R. basin (polygon 2, key sites 1 and 2, South-Western Trans-Baikal) and in its adjacent environment, where light-coniferous forests formed, is the initial stage (succession) of the development of mixed light-coniferous – dark-coniferous forests with a probable further development of a dark-coniferous taiga. This is suggested by dominance of cedar (*Pinus sibirica* Du Tour) in the undergrowth, while presence of pine (*Pinus sylvestris* L.) of a modern forest forming species is represented by single specimens. Secular dynamics with dominants replacements in forests development on the background of climate variability during recent decades will result in variation of structural-dynamic organization of forest vegetation in the whole Baikal Region.

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