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SOILS

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UNKNOWN FORESTS OF WEST SIBERIA'S.

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ABSTRACT

The main feature of landscapes in the West Siberia's taiga is a high level of waterlogging, therefore the role of forests there is modest. The area occupied by forests is almost equal, and sometimes is even smaller than the area of swamps [1].
Until now the nature of West Siberia has remained unexplored in the botanical respect. "Blank Spots" are located in the north-east and east parts.
The goal of this work is to study forests along small rivers of West Siberia's north-east. Changes in the flood-lands' landscape and in the type of vegetation along rivers' flows are defined by the decrease of the base level, by the change of river-bed's and flood-plain's processes, but not by zonal climate factors, which is typical for flood-lands of rivers flowing in the meridional direction.
During field expeditionary research, rare biocoenoses of Abies sibirica Ledeb., Pinus sibirica Du Tour, Larix sibirica Ledeb. have been described. The main research methods used were geobotanical descriptions and their statistical processing. In analysis we used the ecologo-phytocoenotic method of vegetation studies.
In the years of research (1995-2013), typical associations were discovered and rare biocoenoses were described. Distinctive features of these biocoenoses are the structure of forests and floristic composition which are not typical for the most part of West Siberia. Among them are: Laricetum sibiricae vaccinioso-parviherbosum (union Dicrano-Pinion Libb. 1933, order Cladonio-Piceetalia K.-Lund 1967, class Vaccinio-Piceetea Br.-Bl. in Br.-Bl., Siss. et Vlieger 1939), Pinetum sibiricae magnoherboso-oxalidosum (union Vaccinio-Piceion Br.-Bl., Siss. et Vlieger 1939, order Vaccinio-Piccinio-Piceetea), Abietetum sibiricae mixtoherboso-oxalidosum (union Vaccinio-Piceion Br.-Bl., Siss. et Vlieger 1939, order Vaccinio-Piceetalia Br.-Bl. 1939 em. K.-Lund 1067, class Vaccinio-Piceetea), and others [2].
The biocoenoses have a rich floristic composition and distinguish themselves by a high productivity – up to 400-450 metric centners per hectare. All forests fall into the category of the unique ones in the biological sense. The obtained data also has allowed to enlarge the list of higher vascular plants, discover rare ones and determine the necessity to create conservation areas.
Nowadays majority of researchers prefer remote research which allows to perform a large amount of work quickly and with good quality. But modern technologies do not allow to perform complete descriptions of forest biocoenoses and evaluate their features. The authors of this article propose the material that was obtained during expeditions, and this is a significant contribution. Researchers might be able to contribute to the creation of a system to monitor forests of West Siberia [3, 4].

Keywords: vegetation, forest, floodplain, flora, productivity.

INTRODUCTION

In the middle of the 20th century, botanists started to explore and describe the territory of Western Siberia and taiga forests. The researchers V.B. Sochava (1953) and G.V. Krylov (1961) described common features characterizing the geographical distribution of forest vegetation [4]. They presented the data on the southern, central and some northern parts of Western Siberia. However, north eastern and eastern parts of Western Siberia remained unexplored. The research work by V.B. Sochava et al. [1] provides the information on the southern taiga regions, whereas G.V. Krylov's research describes the distribution patterns of forest vegetation.

This paper presents the data on forest associations that are not typical of the eastern part of Western Siberia. The forests here contain such plant species that are characteristic of the European taiga.

Currently, the described forests show some traces of the past climatic changes that occurred in the Holocene. Those forest areas that remained unaffected by glaciers retain certain features of the European taiga [5].

STUDY AREA

The study area included the floodplain of the Vakh River, which is the right tributary of the boreal Ob River, and its tributaries, the Sabun and the Kolik-Egan.

The Vakh River is 1124 km long, with the catchment area of 76.7 thousand km^2. The river rises in the watershed basins of the Ob and the Yenisei and flows into the Ob River 1720 km away from its mouth.

The Vakh River basin contains circa 2450 streams, lakes and swamps.

The changes occurring in the floodplain landscape and vegetation result from the decrease in the erosion base level and changes in the types of channel and floodplain processes rather than from the effect of the zonal climatic factors, which is so typical for floodplain of rivers flowing meridionally.

The field studies of the Vakh River were conducted in the period from 1995 to 2014.

RESEARCH METHODS AND MATERIALS

Here we present the results of our research of the floodplain vegetation at the Vakh River and some lower reaches of its tributaries conducted during four field seasons (2010-2014). The floodplain vegetation were described at cross topo-environmental profiles, whereas upland vegetation were described on the ledges above the floodplain terrace overlooking the river and at the floodplain remnants.

Basic research methods of our study included geobotanical descriptions and statistical processing [5]. Work performed within the project №15-44-00028 «r-ural a».

We have used the eco-phytocenotic method for studying vegetation during the analysis.

Totally, we have conducted 876 descriptions, 78 of which used for this study.

RESULTS AND DISCUSSION

We have observed *Caricetum sibiricae vaccinio-parviherbosum* on flat elevated and well-drained surfaces in the central zone of the floodplain or in the transition from the riverbed to the center part in the upper reaches of the Vakh River only. Usually they are located as a strip between red bilberry and small grass pine forests and small grass and red bilberry cedar forests in the upper segment parts. They occur in the locality characterized by the short period of land submerge during the river flood, moderate sedimentation, and loamy and cryptopodzol soils.

The stand composition is 7Л2К1С+П [*Translator's note: in the Russian formulae Л stands for Larch, К – for Cedar, С – for Pine, П – for Fir (Abies)*], the crown density is 0.7. The tree layer contains two canopies. The first canopy is 22 (18-24) m tall, with the average diameter of *Larix sibirica* amounting to 34 (28-42) cm. The second canopy, with the crown density of 0.3, is composed of *Pinus sibirica*, *Abies sibirica*, *Picea obovata Ledeb.* The canopy height is 17 (14-18) m. The productivity class is IY, the timber reserves amount to 200 (180-350) m^3 per 1 ha.

The understory is composed of *Abies sibirica*, *Pinus sibirica*, *Picea obovata*. It is thin, up to 2 thousand per ha, 2-3 m tall.

The shrub layer contains *Sorbus sibirica Hedl.* (Y_2), *Rosa acicularis Lindl.* (IY_2), *Swida alba (L.) Opiz* (II_2), *Lonicera pallasii Ledeb.* (II_2), *Duschekia fruticosa (Rupr.) Pouzar* (II_2) with a small admixture of *Ribes rubrum* (I_1), *Rubus idaeus* (I_2), up to 1.5 m tall, and has an average total projective cover of up to 9%.

The average total projective cover of the herbaceous and shrub layer is uniform and rather tall and amounts to 56% (40-65). The dominant species include small taiga species of *Maianthemum bifolium (L.) F.W. Schmidt* (Y_3), *Linnaea borealis L.* (Y_2), *Trientalis europaea L.* (Y_2); *Vaccinium vitis-idaea L.* (Y_4). *Pyrola rotundifolia L.* (Y_2), *Orthilia secunda (L.) House* (IY_2), *Gymnocarpium dryopteris (L.) Newm.* (Y_3), *Calamagrostis obtusata Trin.* (IY_2), *Equisetum pratense Ehrh.* (IY_2), *Solidago virgaurea L.* (III_2) belong to a high constancy class. High constancy species are in association with tall taiga herbs, such as *Heracleum dissectum Ledeb.* (I_2), *Veratrum lobelianum Bernh.* (I_2), *Dryopteris carthusiana (Vill.) H.P. Fuchs* (I_2), *Athyrium filix-femina (L.) Roth* (I_2). Totally, the layer contains 36 species. *Laricetum sibiricae vaccinioso-parviherbosum* contains more of tall taiga herbs, because larch forests of this type are found in more mature soils.

The following species is observed sporadically: *Actaea erythrocarpa Fisch.* I_1; *Cacalia hastata L.* II_1; *Chamaenerion angustifolium (L.) Scop.* I_1; *Filipendula ulmaria ssp. denudata (J. Presl & C. Presl) Hayek* I_1; *Goodyera repens (L.) R. Br.* I_1; *Lilium pilosiusculum (Freyn) Miscz.* I_2; *Luzula pilosa var. macrocarpa (Buchenau) B.Boivin* I_2; *Paris quadrifolia L.* II_1; *Ranunculus repens L.* I_1; *Ribes glabellum (Trautv. & C.A. Mey.) Hedl.* I_1; *Rubus idaeus L.* I_2; *Veratrum lobelianum Bernh.* I_2; *Vicia cracca L.* I_1; *Viola epipsila Ledeb.* II_2.

The moss layer is composed of 12 species and has an average total projective cover of 60%. It is composed of *Pleurozium schreberi (Brid.) Mitt.* (Y_4), *Dicranum polysetum Sw. ex Mlchx.* (Y_3), *Hylocomium splendens (Hedw.) Br.* (IY_4), *Ptilium crista-castrebsis (Hedw.) De Not.* (III_2), Mnium sp. (I_2). Totally, the layer contains 5 species.

Totally, all layers contain 59 species.

In accordance with the ecological and floristic classification, this association can be attributed to the union of Dicrano-Pinion Libb. 1933, order of Cladonio-Piceetalia K.-Lund 1967, and class of Vaccinio-Piceetea Br.-Bl. in Br.-Bl., Siss. et Vlieger 1939 (Taran, 1993a) [6].

We have observed *Pinetum sibiricae magnoherboso-oxalidosum* in the central zone of the floodplain in well-drained upland areas. They occur in the locality characterized by the short period of land submerge during the river flood, poor sedimentation, and sabulous or loamy, latent podzol, clayed and wet soils.

The stand composition is 7К2Е1П+Б [*Translator's note: К stands for Cedar, Е – for Spruce (Picea), П – for Fir (Abies), Б – for Birch*], the crown density is 0.8. The tree

layer contains two canopies. The first canopy's crown density is 0.7, the stand composition is 8К1Е1П+Б [*Translator's note: К stands for Cedar, Е – for Spruce (Picea), П – for Fir (Abies), Б – for Birch*]. The second canopy's crown density is 0.2, with dominant species of *Abies sibirica* and *Picea obovata* mixed with *Betula concinna Gunnarss.* The second canopy contains no *Pinus sibirica*. *Pinus sibirica* is 23 (18-24) m tall, with the average diameter of 35 (20-50) sm. The timber reserves amount to 380 (270-420) m^3 per 1 ha. The productivity class is III.

The understory is composed of *Abies sibirica*, *Pinus sibirica*, *Picea obovata*. It is thin, stunted, uniform, up to 3 m tall.

The shrub layer has 13% average total projective cover. It is composed of *Sorbus sibirica* (Y_3), *Swida alba* (Y_2), *Duschekia fruticosa* (IY_2), *Lonicera pallasii* (IY_2), *Ribes rubrum* (II_2), *Rosa acicularis* (II_1) with a small admixture of *Padus avium Mill.* (I_2). The shrubs are up to 1.5-2.5 m tall. Totally, the layer contains 7 species.

The herbaceous and shrub layer has a rather high average total projective cover of 67% (45-75) and it is mostly composed of small taiga herbs, such as *Maianthemum bifolium* (Y_3), *Trientalis europaea* (Y_2), *Linnaea borealis* (Y_2), *Orthilia secunda* (Y_2), *Pyrola rotundifolia* (Y_2), *Gymnocarpium dryopteris* (Y_4), *Equisetum pratense* (IY_4), *Rubus arcticus* (III_2), *Viola epipsila* (IY_2), and *Calamagrostis obtusata* (Y_3). These associations always contain *Oxalis acetosella* (IY_3) and tall floodplain forest herbs like *Cacalia hastata* (III_2), *Aconitum septentrionale Koelle* (IY_2), *Thalictrum flavum L.* (IY_2), *Atragene sibirica L.* (III_1), *Dryopteris carthusiana* (III_2), *Solidago virgaurea* (IY_2). From the floristic point of view, this association is quite diverse, the herbaceous and shrub layer is composed of 40 species and all of them have a high constancy class (only 6 species are observed sporadically).

The moss layer has 43% (35-50) average total projective cover. It is represented by 7 species, with *Rhytidiadelphus triquetrus (Hedw.)* (Y_4), *Hylocomium splendens* (Y_4), *Pleurozium schreberi* (Y_4), *Brachythecium sp.* (IY_2) as the dominant ones.

Totally, the layers contains 59 species, 52 of which are vascular plants.

This kind of association is less common than red bilberry and small grass cedar forests and we have described it in the upper reaches and in the middle of the Vakh River. It occupies small areas on the ridges in the central part of the segment, mostly on the slopes leading to dead channels.

In accordance with the ecological and floristic classification, such tall sorrel grass and cedar forests can be attributed to the union of Vaccinio-Piceion Br.-Bl., Siss. et Vlieger 1939, order of Vaccinio-Piccinio-Piceetea Piceetalia K.-Lund 1967, and class of Vaccinio-Piceetea Br.-Bl. in Br.-Bl., Siss. et Vlieger 1939 (Taran, 1993).

Piceetum obovatae myrtilloso-oxalidosum forests are observed in the central zone and terrace near floodplain in well-drained upland areas. They occur in the locality characterized by the short period of land submerge during the river flood, poor or medium sedimentation, and sabulous or loamy wet soils with the traces of clay.

The stand composition is 8Е1К1Б+П *[Translator's note: Е stands for Spruce (Picea), К - for Cedar, Б – for Birch, П – for Fir (Abies)]*, the crown density is 0.8. The layer is 22 (20-24) m tall on average, the average diameter of *Picea obovata* is 32 (28-34) sm. The timber reserves amount to 110 m^3 per 1 ha. The productivity class is III. The layer is composed of two canopies.

The first canopy's crown density is 0.6. It is 13 m tall and it is composed of *Picea obovata* and *Abies sibirica*. The second canopy is also composed of *Picea obovata* and *Abies sibirica*, with the crown density of 0.2.
The understory is thin and stunted. It is composed of *Picea obovata* and *Betula pubescens*.
The shrub layer has 25% average total projective cover. It is mostly composed of *Sorbus sibirica* (Y_3) with admixture of *Duschekia fruticosa* (III_3), *Padus avium* (II_4), *Lonicera pallasii* (II_3), *Swida alba* (II_3), *Ribes nigrum* (II_1), *Ribes rubrum* (II_1), *Rosa acicularis* (II_1). The layer is 1.5-2.5 m tall and contains 8 shrub species.
The herbaceous and shrub layer has a rather high average total projective cover of 35% (30-45). The following species are dominant: *Maianthemum bifolium* (IY_2), *Trientalis europaea* (Y_1), *Linnaea borealis* (IY_2); *Oxalis acetosella* (IY_2), *Rubus arcticus* (III_4), and *Gymnocarpium dryopteris* (III_4). In such associations we often observe *Pyrola rotundifolia* (IY_2), *Orthilia secunda* (IY_2). The floodplain species include *Calamagrostis langsdorffii (Link) Trin.* (IY_2), *Equisetum pratense* (III_2), *Cacalia hastata* (II_1), *Veratrum lobelianum* (II_1), *Thalictrum flavum* (II_1). Totally, the layer is composed of 24 species.
The following species occur sporadically: *Athyrium filix-femina* (I_2); *Cacalia hastata* (I_1); *Filipendula ulmaria* (I_1); *Lycopodium annotinum L.* (I_1); *Poa palustris L.* (II_1); *Ranunculus repens* (I_1); *Ribes nigrum* (I_1); *Viola palustris* (III_2).
The moss layer has 39% average total projective cover. It is mostly represented by green mosses, such as *Pleurozium schreberi* (Y_4), *Polytrichum commune* (IY_2), *Hylocomium splendens* (III_4), *Dicranum polysetum* (II_4). Totally, the layer is composed of 4 moss species.
The total number of species in the association amounts to 41.
Bilberry and sorrel grass spruce forests present a rare association. We have described only 4 associations of this kind occurring in the middle reaches of the river. In two cases, these associations occur in the former cedar forests.

Abietetum sibiricae mixtoherboso-oxalidosum are found in the central zone of the floodplain on low ridges between shifts or in the downstream end of the river elbows where they replace birch forests with langsdorffii miscellaneous herbs. Usually they are located as strips and occupy small areas. They occur in the locality characterized by the moderate period of land submerge during the river flood, severe sedimentation, and loamy, clayed soils, with spotted humus in the upper horizon.
The stand composition is 7П2К1Б+Е [*Translator's note: П stands for Fir (Abies), К – for Cedar, Б – for Birch, E - for Spruce (Picea)*], the crown density is 0.7. The tree layer is 19 (17-22) m tall, with the average diameter of Abies sibirica amounting to 25 (22-28) cm. The trees here are 100-130 years old, the productivity class is III, the timber reserves amount to 210 (150-300) m^3 per 1 ha. The layer is composed of two canopies. The first canopy's crown density is 0.5, the second one's is 0.2. The second canopy, 13 m tall, is composed of *Abies sibirica*, *Picea obovata*, *Pinus sibirica*, *Betula pubescens*.
The understory is thin and stunted. It is composed of *Abies sibirica*, *Picea obovata*, *Pinus sibirica*, up to 7 (4-7) m tall.
The shrub layer is composed of *Sorbus sibirica* (Y_2), *Swida alba* (IY_3), *Rosa acicularis* (III_2), *Lonicera pallasii* (III_2), *Duschekia fruticosa* (II_3), with some admixtures of *Ribes rubrum* (I_2), *Ribes nigrum* (I_2), *Rubus idaeus* (I_2), *Padus avium* (I_1), *Salix viminalis L.*

(I_1). The layer's average total projective cover amounts to 17%. The shrubs are 1.5 – 3 m tall. Totally, the layer is composed of 10 shrub species.

The herbaceous and shrub layer has 44% average total projective cover and it quite diverse in terms of species composition, as it contains 36 species. The following small taiga herbs are dominant: *Maianthemum bifolium* (Y_3), *Trientalis europaea* (Y_2) *Linnaea borealis* (II_2); *Gymnocarpium dryopteris* (IY_2), *Oxalis acetosella* (III_2); tall herbs include *Veratrum lobelianum* (IY_2), *Aconitum septentrionale* (III_2), *Actaea erythrocarpa* (II_2), *Diplazium sibiricum (Turcz. ex G. Kunze) Kurata* (II_2); floodplain species include: *Calamagrostis langsdorffii (Link) Trin.* (III_3), *Equisetum pratense* (III_3) *Solidago virgaurea* (III_2).

The following species are observed sporadically: *Calamagrostis canescens (Web.) Roth* (I_2); *Equisetum sylvaticum L.* (I_1); *Filipendula ulmaria* (I_2); *Galium boreale L.* (I_1); *Goodyera repens* (I_1); *Hieracium umbellatum L.* (I_1); *Lilium pilosiusculum* (I_1); *Lycopodium annotinum* (I_1); *Poa palustris* (I_2); *Ribes nigrum* (I_2); *Rubus idaeus* (I_2); *Rubus saxatilis L.* (I_2); *Veronica longifolia L.* (I_2); *Viola palustris L.* (I_2).

The moss layer is composed of green mosses and has 40% (25-50) average total projective cover. The layer is composed of circa 11 moss species, of which the following are dominant: *Rhytidiadelphus triquetrus* (IY_4), *Brachythecium sp.* (IY_3), (III_2), *Climacium dendroides* (III_2), *Hylocomium splendens* (III_4).

Totally, the association is composed of 62 plant species.

Miscellaneous sorrel grass fir forests are mostly found in the upper reaches of the river. In accordance with the ecological and floristic classification, such forests can be attributed to the union of Vaccinio-Piceion Br.-Bl., Siss. et Vlieger 1939, order of Vaccinio-Piceetalia Br.-Bl. 1939 em. K.-Lund 1067 and class of Vaccinio-Piceetea (Taran, 1993b) [7].

CONCLUSIONS

These four types of forest association we have observed are unique, as their structure and composition are close to the European forests. The associations are mostly located on the right bank of the Vakh River.

The capability of these forests is more than one and a half times higher than the average one in the area.

These forests occur sporadically in elevated areas, 100 meters and more above sea level.

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