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Forests of the Angaro-Chunsky interfluve (Krasnoyarsk region)

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Abstract. The territory of the Angaro-Chunsky interfluve is located in the south-western part of the Central Siberian Plateau in the southern taiga subzone. The paper presents a review of forest vegetation studies in the region, which is represented by dark coniferous (*Abies sibirica*, *Picea obovata*, *Pinus sibirica*), light coniferous (*Larix sibirica*, *Pinus sylvestris*) and small-leaved (*Betula pendula*, *Populus tremula*) forests. The classification of forests of the Angaro-Chunsky interfluve is based on the ecological-phytocenotic classification of forests of V N Sukachev.

1. Introduction

According to the "Geobotanical zoning of the USSR" [1], the territory between the rivers belongs to the Eurasian conifer-forest (taiga) region. Most of it (eastern part) is located in the East Siberian subregion of light coniferous forests of the Central Siberian Province, in the belt of green moss larch forests, Chuno-Angarsk District. A smaller part of the territory (western part) is located in the European-Siberian subregion of dark-coniferous forests of the Ural-Altai province, West-Siberian sub-provinces, in the zone of green-moss-dark coniferous forests, in the Yenisei region of the middle mountain ridge.

According to the "Geobotanical Map of the USSR" [2], the following groups of plant formations are located on the territory of the interfluve: dark coniferous, light coniferous, small-leaved forests.

L M Cherepnin in his work "The vegetative cover of the southern part of the Krasnoyarsk Territory and the tasks of its study" [3] based on the works of V V Reverdatto [4] and A Ya Tugarinova [5] relates the study area to the Priangarsky pine-boron area. According to the schematic vegetation map of the Krasnoyarsk Territory [6], the interfluve belongs to the Yenisei (boreal forest) region with pine and (in the south-west) dark coniferous forests.

According to the botanical-geographical zoning scheme of Siberia of L V Shumilova [7] the territory belongs to the Angarsk province, Central Siberian macroprovince.

Based on the scheme of zonal distribution of vegetation of E L Lyubimova [8], performed on the basis of the works of V B Sochava, the study area belongs to the taiga zone of the province of the Yenisei taiga southern subzone.

Based on the division of the Krasnoyarsk Territory into forest vegetation provinces, our territory belongs to the Angarsk province of pine forests [9].

Of all the geobotanic divisions of Central Siberia, the most accurate and reasonable zoning is given by V V Reverdatto [4], in which the territory of the Angaro-Chunsky interfluve belongs to the Chuno-Angara geobotanical region, a sub-circle of pine-larch forests, the Tungus-Angara district of light coniferous dry forests, the province of the Central Siberian plateau. Here, the elevated interstitial spaces



are occupied by spruce-fir taiga, with its share increasing towards the Yenisei ridge. Pine forests are spread along the river valleys of the Karabula, Chun and Angara rivers by a wide coastline. In the Angara-Chun watershed, pine-larch forests are widespread with larch predominating to the north.

The first attempts to classify the vegetation of the southern part of the study area were made by S D Rosing [10] who identified nine types of vegetation. The classification of south-taiga forests of Central Siberia made by L V Popov is of interest [11]. On the basis of the works of B P Kolesnikov [12], who understands the diversity of forests as a set of specific stages of the process of forest formation, L V Popov identifies sixteen generalized series of forest types.

The geobotanical works use the ecological-morphological classification of E M Lavrenko [13], the ecological-phytocenotic classification of V N Sukachev [14] and the phylogenogenetic classification of V B Sochava [15], which are modified due to the peculiarities of the vegetation cover of a specific area.

As it is noted by A V Kuminova [16] "the natural classification of vegetation cover should be based both on the signs of the vegetation itself, ... and on the complex environmental conditions that have a direct impact on its development".

The basis of the classification of the Angaro-Chunsky interfluvial forests is based on the principle of ecological-phytocenotic series of V N Sukachev [14, 17], applied to the classification of vegetation on the right bank of the Yenisei of A V Kuminova [18], Siberian vegetation (Cisbaikalia and Transbaikalia) of G A Peshkova [19], vegetation of the Taishet District of the Irkutsk Region of N S Vodopianova [20].

In addition to our own geobotanical descriptions, we used the following literature data in this work [10, 20, 21, 22, 23, 24, 25].

2. Results and discussion

Forests are the dominant type of vegetation on the Angaro-Chunsky interfluvial; they are a combination of communities of different groups of formations: light coniferous, dark coniferous and small-leaved forests. The advisable species are pine (*Pinus sylvestris*, *Pinus sibirica*), larch (*Larix sibirica*), spruce (*Picea obovata*), fir (*Abies sibirica*), birch (*Betula pendula*), and aspen (*Populus tremula*).

It is believed that the indigenous coniferous forests in the area are dark coniferous forests, which due to constant disturbances (fires, logging, etc.) have been replaced by light coniferous forests [20, 21, 22, 23]. However, L V Shumilova [7] notes that in the basin of the river "it is absolutely impossible to notice the tendency of replacing the pine back to dark conifer plantations, and this area represents the historically established pine zone formed at the beginning of the Holocene". G A Peshkova [19] also claims that light coniferous forests on the Central Siberian Plateau represent a zonal type of vegetation.

Class of formations - coniferous forests.

The group of formations is light coniferous forests.

Light coniferous forests and restoration series of light coniferous formations dominate the territory. They are distributed along the valleys of large (Angara, Chun) and medium (Karabula, Mura) rivers, where they are warmer and drier, preferring dry sandy and sandy-loamy soils, and are also located on steep or middle steepness of light, especially stony, hillsides. The edificators are *Pinus sylvestris*, *Larix sibirica*.

Formation - pine (*Pinus sylvestris*).

Over a large area pine forests form both pure stands and mixed with larch, birch and aspen, they are largely disturbed by logging and fires. Ground fires do not lead to the complete destruction of pine stands and these forests are often restored without the participation of birch or aspen [26]. However, on the site of deforestation and abandoned agricultural lands, aspen-birch grass series dominated as a result of overgrowing, and occupying the largest areas.

Associations: cowberry-bearberry-lichen pine (*Pinus sylvestris* – *Arctostaphylos uva-ursi* + *Vaccinium vitis-idaea* – *Cladonia rangiferina*), pinewood greenberry-lingonberry (*Pinus sylvestris* – *Vaccinium vitis-idaea* – *Pleurozium schreberi*), pine-rose wild rosemary-blueberry (*Pinus sylvestris* – *Vaccinium myrtillus* + *Ledum palustre* – *Pleurozium schreberi*), pine-tree (with birch) wide-grass-green moss (*Pinus sylvestris* + *Betula pendula* – heteroherbae – *Pleurozium schreberi*), pine-tree (with larch) grass-green moss (*Pinus sylvestris* + *Larix sibirica* – heteroherbae – *Pleurozium schreberi* +

Hylocomium splendens), pine forest alder-cowberry-grass (*Pinus sylvestris* – *Duschekia fruticosa* – *Vaccinium vitis-idaea* + heteroherbae), pine-tree (with birch) blue-and-gray grass (*Pinus sylvestris* + *Betula pendula* – heteroherbae + *Vaccinium uliginosum* + *Spiraea media*), pine-tree (with larch) grass and grass (*Pinus sylvestris* + *Larix sibirica* – heteroherbae).

Formation - larch (*Larix sibirica*).

Pure larch forests are rare, and occupy the slopes of the northern exposure, more moist and with less heated soils, the largest of their areas are concentrated in the north of the study area. Mostly larch forests are found with the participation of pines.

Associations: larch grass-shrub (*Larix sibirica* – *Spiraea media* + *Sorbus aucuparia* – heteroherbae), larch (with pine) cowberry-grass (*Larix sibirica* + *Pinus sylvestris* – heteroherbae + *Vaccinium vitis-idaea*), larch (with pine) shrub-green moss (*Larix sibirica* + *Pinus sylvestris* – fruticis – *Hylocomium splendens*), larch forest (with pine) grass-green moss (*Larix sibirica* + *Pinus sylvestris* – heteroherbae – *Hylocomium splendens*).

The group of formations is dark coniferous forests.

Dark coniferous forests are confined to habitats characterized by high humidity of air and soil. These are river floodplains, as well as elevations and their gentle slopes, where the thermal regime is more favorable due to surface temperature inversions [27]. An important role is also played by the richness of the soil with mineral nutrition elements (spruce and fir trees like rich soils). Dark coniferous forests are relatively widespread in the western part of the Angaro-Chun interfluve [21]. The edificators are *Picea obovata*, *Abies sibirica* and *Pinus sibirica*.

Formation - fir (*Abies sibirica*).

Associations: fir-tree silver grass (*Abies sibirica* – heteroherbae – *Hylocomium splendens* + *Pleurozium schreberi*), fir-tree (with spruce) sour-grass-green moss (*Abies sibirica* + *Picea obovata* – heteroherbae + *Oxalis acetosella* – *Hylocomium splendens* + *Pleurozium schreberi*), silver fir-tree (with spruce) (*Abies sibirica* + *Picea obovata* – heteroherbae – *Pleurozium schreberi*), silver fir (with cedar) green moss (*Abies sibirica* + *Pinus sibirica* – *Ptilium crista-castrensis* + *Hylocomium splendens*).

Formation - spruce (*Picea obovata*).

Associations: spruce forest grass (*Picea obovata* – heteroherbae – *Hylocomium splendens*), spruce (with larch and Siberian pine) horsetail-green moss (*Picea obovata* + *Pinus sibirica* + *Larix sibirica* – *Equisetum pratense* + *Equisetum sylvaticum* – *Hylocomium splendens*), spruce (with cedar) wide-grass-green moss (*Picea obovata* + *Pinus sibirica* – heteroherbae – *Ptilium crista-castrensis* + *Hylocomium splendens*), spruce (with Siberian pine) lingonberry-grass grass-green moss (*Picea obovata* + *Pinus sibirica* – heteroherbae + *Vaccinium vitis-idaea* – *Ptilium crista-castrensis* + *Hylocomium splendens*), spruce (with larch) blueberry-green moss (*Picea obovata* + *Larix sibirica* – *Vaccinium uliginosum* – *Ptilium crista-castrensis* + *Hylocomium splendens*).

Class of formations - deciduous forests.

The group of formations is small-leaved forests.

Small-leaved forests are significantly inferior in coniferous area. They appear in the zone of intensive human economic activity and in the absence of anthropogenic and pyrogenic intervention, a transition to conifers is planned. Edifiers of small-leaved forests are *Betula pendula*, *B. pubescens*, *Populus tremula*.

Formation - hanged-birch (*Betula pendula*).

Associations: birch forest (with aspen) short-toed-large grass (*Betula pendula* – heteroherbae + *Brachypodium pinnatum*), birch forest (with cedar and fir) green moss (*Betula pendula* + *Pinus sibirica* + *Abies sibirica* – *Hylocomium splendens* + *Pleurozium schreberi*), birch forest grass (*Betula pendula* – *Calamagrostis obtusata* + heteroherbae – *Pleurozium schreberi* + *Polytrichum commune*), kostyanikovo-iriso-cereal birch forest (*Betula pendula* – *Poa nemoralis* + *Rubus saxatilis* + *Iris ruthenica*), birch grass sedge (*Betula pendula* – *Carex cespitosa* + heteroherbae).

Formation - fluffy-birch (*Betula pubescens*).

Associations: birch forest (with spruce) grassy sedge (*Betula pubescens* + *Picea obovata* – *Carex caespitosa* + heteroherbae).

Formation - aspen (*Populus tremula*).

Associations: horn-stick aspen (*Populus tremula* – *Calamagrostis arundinacea* + *Brachypodium pinnatum*), spindle-horsetail aspen (*Populus tremula* – *Calamagrostis arundinacea* + *Equisetum pratense*).

3. Conclusion

The territory of the Angaro-Chunsky interfluvium is located in the southwestern part of the Central Siberian plateau in the southern taiga subzone, belongs to the Chuno-Angarsky geobotanical region, the sub-zone of pinewood forests, the Tungus-Angara district of light-coniferous dry forests, in the province of the Middle-Siberian plain. Forest vegetation of the region is represented by various groups of formations. Light coniferous forests (*Larix sibirica*, *Pinus sylvestris*) are the predominant and most diverse group of formations. Dark coniferous forests (*Abies sibirica*, *Picea obovata*, *Pinus sibirica*) forests, despite being indigenous, have a limited distribution. Small-leaved (*Betula pendula*, *Populus tremula*) forests arise in places of anthropogenic and pyrogenic disturbance of vegetation cover.

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