The larch forest of the “Bastak” State Nature Reserve (Jewish autonomous region)

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Abstract. The article presents the information about the current state of the larch forests of the “Bastak” State Nature Reserve. The area, ecological and cenotic conditions of growth are determined, the classification of the studied plant communities is presented, a brief description of the forest structure is given. The current state of the larch forests of the “Bastak” State Nature Reserve can be assessed as fairly stable. Currently, larch forests occupy within 25% of the forested area. The most widespread area is occupied by lowland larch forests (94%). Mountain larch forests are derived plant communities formed after forest cutting in fir-spruce forests.

1. Introduction

The “Bastak” State Nature Reserve is the only federal specially protected natural area (SPNA) located in the territory of the Jewish Autonomous Region (JAR). It was established by the decree of the Government of the Russian Federation No. 96 of 28.01.1998. The Bastak Reserve consists of two cluster plots, namely, “Central” which is located in the northeastern part of the JAR, north of the administrative center of the region, the City of Birobidzhan, and “Zabelovsky” which is in the eastern part of the JAR. It is located in three municipal districts including Birobidzhansky, Obluchensky and Smidovichi. The total area of the reserve is 128055 ha.

The surface of the territory of the “Bastak” Reserve is represented by two types of relief: mountainous (in the north and in the center of the cluster “Central”) and plain (in the south of the cluster “Central” and the entire territory of the cluster “Zabelovsky”).

The territory of the Bastak Reserve is characterized by an ultracontinental climate with distinct manifestations of monsoon processes. The long-term average annual air temperature is +1.7 °C, which is the norm for areas of moderate monsoon climate. January is the coldest month of the year, with an average monthly temperature of −21°C. The warmest month of the year is July, the average monthly temperature of which was +21°C. The average annual precipitation falling in the territory of the reserve is 931 mm, which is higher than the norm indicated in the literature (600–800 mm) [1]. The humidification regime of the territory is characterized by a pronounced seasonality. The greatest amount of precipitation falls during the warm period, when from 36% to 75% of all precipitation fell. The most abundant precipitation falls in July–August (these months account for from 15% to 63% of the total
precipitation), the minimum amount of precipitation is typical for January–February (0.2–9 % of the total precipitation). The average multi-year date for establishing a stable snow cover is November 10. The average snow cover height for the winter is 22 cm in open spaces and 19 cm in the forest. In general, since 2016, there has been a tendency to a decrease in the height of snow cover both in open spaces and in the forest [2].

The low temperature in winter and the low power of the snow cover contribute to the deep freezing of the soil, reaching 150–200 cm, which worsens the growing conditions of plant communities.

Most of the territory of the Bastak Nature Reserve (75881.7 ha) is represented by forests that are diverse in conditions of growing and species composition. They are mainly represented by plantings with a dominance of Korean pine Pinus koraiensis Siebold et Zucc. (5071.8 ra), ayan spruce Picea ajanensis (Lindl. et Gord.) Fisch. ex Carr. and Siberian spruce P. obovata Ledeb. (4125.8 ha), Cajander larch Larix cajanderi Mayr (10019.1 ha), Amur linden Tilia amurensis Rupr. (3286.8 ha), Mongolian oak Quercus mongolica Fisch. ex Ledeb. (8249.2 ha), flat-leaved birch Betula platyphylla Sukacz. (14571 ha), trembling poplar Populus tremula L. (4965.1 ha) and a number of other tree species. A significant area (48430.8 ha) is occupied by swamps and other non-forest vegetation groups. One of the key indicators of the sustainability of forest ecosystems is the forest cover of the territory. According to the materials of the forest management, the total forest cover of the reserve territory is 56 %. The forest cover is extremely uneven in the district forestry, amounting to 96 % in Mountain, 61 % in Ikurinsky, 39 %, in Razdolensky, and 29 % in Zabelovsky [3].

The purpose of this work is to characterize the current state of the larch forests of the Bastak Nature Reserve. To achieve this goal, it is necessary to solve the following tasks:

1. Defining the ecological and cenotic conditions for the growth of larch trees within the boundaries of the “Bastak” State Nature Reserve
2. Identifying the main dominant of tree stand and structure of the tree layer of the phytocenoses studied.

2. Materials and methods

The authors determined the growing conditions of the larch forests of the Bastak Reserve, identified the species composition of plant communities in them, and determined the taxational characteristics of the stand during a route survey of the forests of the reserve. The density of routes made it possible to cover almost the entire array of larch forests. During the route survey, geobotanical descriptions of 20 m x 20 m sample areas were completed. The plots that are relatively homogeneous in terms of ecological conditions and floral composition are selected for the description. When describing communities, the following information and dimensions are collected: 1). Geographical location; 2). Geomorphology; 3). Description of the stand (total density of canopies (TDC), average height of the stand, species composition, and the total cover (TC) in %, height, and diameter for each species of tree; 4). Description of the undergrowth (species composition, height of the undergrowth of each tree species and its quantity is estimated in pcs/ha); 5). Description of the undergrowth (TC in %; for each species of shrubs the average height and the cover in % are collected ); 6). The description of the grass layer includes drawing up a complete species list, determining the total cover of the grass layer and each species in %, the average height of each species in meters) [4, 5]. The boundaries of the larch forests of the Bastak Reserve are drawn in the ArcMap 10.4.1 program on the basis of multi-season satellite images of Landsat-8, which are freely available via the Internet. We downloaded 11 multi-channel images in the amount of 11 pieces. In QGIS 3.3, the downloaded images were combined into a single color image with a combination of 5-4-3 colors (red, green, blue) and exported to jpeg format. We used the materials of the forest management (2011) and the data of the State Forest Register (as of 01.01.2021) to correction the area of growth of various types of larch forests.
3. Results and discussion
The edifier of the larch forests of the Bastak Reserve is the Kayandera larch Larix cajanderi Mayar. In the reserve, the studied phytocenoses grow only in the «Central» cluster in the territories of the Mountain, Ikurinsky and Razdolnensky forestry districts (Fig. 1). These plant communities grow both in the mountainous part of the specially protected natural area and on the plain, and, therefore, they are divided into mountain and plain. The total area of growth of larch trees within the «Bastak» Reserve is 15109.1 ha.

We have noted mountain larch forests in the upper reaches of the Big Sorennak, Bastak, Kirga and Ikura rivers. In these plant communities, slope and valley larch forests are distinguished. Slope larch trees grow on fairly steep slopes (slope steepness 20–30°) and narrow watersheds. The soils in the studied communities are strongly stony light-brown permafrost. According to the forest management materials, these plant communities, belong to shrub larch forest (forest type Lsh), green-mossed larch forest (Lgm) and rhododendron larch forest (Lr), and according to the ecological and floral classification, they are attributed to the association Aceri tgmentosi–Laricetum cajanderi Krestov et al. 2009 of the union Abieti nephrolepidis–Piceion jezoensis Song, 1991 of the order Abiety veitchii–Piceetalia jezoensis Miyawaki et al. 1968 of the class Vaccinio–Piceetea Br.-Bl. in Br.-Bl. et al. 1939 [3, 6]. The studied formations are characterized by a simple structure. The floral composition significantly coincides with the vegetation of spruce forests of a specially protected natural area, which allows one to conclude that these plant communities are derived from the spruce forests of the Bastak Reserve. The tree stand is two-layered.

![Figure 1. Map of the larch forest distribution in the territory of the Bastak Nature Reserve](image)

Legend
- 1 - slope larch forests, 2 - mountain valley larch forests,
- 3 - moss larch forests, 4 - herbaceous larch forests
The first layer is of weak density of canopy (TDC is 50 %) formed by Larix cajanderi Mayr and Betula platyphylla Sukacz., the second is dominated by Picea ajanensis (Lindl. et Gord.) Fisch. ex Carr. and Abies nephrolepis (Trautv.) Maxim. (TC up to 60 %). The shrub layer is rare (TC up to 15 %), represented by the Rhododendron dauricum L., Sorbaria sorbifolia (L.) A. Br., Actinidia kolomikta (Maxim.) Maxim., Philadelphus tenuifolius Rupr. et Maxim., Spiraea salicifolia L., Spiraea media Franz Schmidt and other species. The grass layer is rare (TC up to 10 %), represented by small grasses (Linnaea borealis L., Maianthemum bifolium (L.) F. W. Schmidt, Oxalis acetosella L., Trientalis europaea L.), in combination with ferns (Pseudocystopteris spinulosa (Maxim.) Ching, Leptomorum amurenseis (Christ) Tzvel.) and Calamagrostis langsdorffii (Link) Trin.. The moss cover is well developed (TC up to 90 %), consisting of Hylocomium splendens (Hedw.) Bruch et al., Pleurozium schreberi (Brid.) Mitt., and mosses of the genus Sphagnum. The total area of growth is 837.4 ha.

In the poorly drained valleys of the mountain rivers in their upper reaches, as well as in the lower parts of the gentle slopes, we registered small areas of mountain larch forests. According to the forest management materials, these plant communities belong to the larch-spruce (LE forest type), and according to the ecological and floral classification, they are assigned to the association Filipendulo palustre-Laricetum cajanderi Krestov et al. 2009 of the union Abieti nephrolepidis-Piceion jezoensis Song, 1991 of the order Abieti veitchii-Piceetalia jezoensis Miyawaki et al. 1968 of the class Vaccinio-Piceetae Br.-Bl. in Br.-Bl. et al. 1939 [3, 6]. Plant communities grow on sod-podzolic-gley or sod-alluvial-oged soils. The phytocenoses studied are characterized by a rather complex structure. The stand is diverse, and is mainly two-layered. The first layer is slightly closed (TDC is 30 %), formed by Larix cajanderi Mayr, Betula platyphylla Sukacz., Populus tremula L. and Populus maximowiczii A. Henry, the second layer is dominated by Alnus hirsuta (Spach) Fisch. ex Rupr., there are Picea ajanensis (Lindl. et Gord.) Fisch. ex Carr., Abies nephrolepis (Trautv.) Maxim., Salix schwerini E. Wolf, Acer tegmentosum Maxim. (TC up to 30 %). The shrub layer is quite dense (TC up to 30 %), grows in curtains, Sorbaria sorbifolia (L.) A. Br., Rhododendron dauricum L. prevail among the shrubs, Betula ovalifolia Rupr, Betula fruticosa Pall., Vaccinium uliginosum L., Ledum palustre L. are extremely rare. The grass layer is dense (TC up to 70 %), represented by Calamagrostis langsdorffii (Link) Trin., various types of sedges forming tussocks (Carex schmidtii Meisn., C. appendiculata (Trautv. et Mey.) Kuk., Carex rhynchophylla C. A. Mey.), Filipendula palustre (Pall.) Maxim., Aruncus dioicus (Walt.) Fern., Angelica dahurica (Fisch.) Benth. et Hook. fil. ex Franch. et Savat., Calacila hastata L., Athyrium monomachii (Kom.) Kom., Naumburgia thyrsiflora (L.) Reichenb., Caltha membranacea (Turcz.) Schipcz., Aconitum umbrosum (Korsh.) Kom., Atragene ochotensis Pall. and other species. The total area of growth of this type of forests is 107.9 ha.

In the plain part, we have registered moss and herbaceous larch forests. The moss larch forests grow on gently shaded, often concave slopes, in flow-swampy hollows, on wide and flat slopes and in saucer-shaped depressions. According to the forest management materials, these plant communities belong to the following types of larch forests: larch-bagulnik-moss (Lbm), sedge (Lo), blueberry-sphagnum (Lbs), sedge-sphagnum (Lso), and sphagnum (Ls), and according to the ecological and floral classification, they are attributed to the associations Chamaedaphno calyculatea-Laricetum cajanderi Krestov et al. 2009 of the union Ledo palustris-Laricion cajanderi Ermakov in Ermakov et Alsynbaev 2004 of the order Ledo palustris-Laricetalia cajanderi Ermakov in Ermakov et Alsynbaev 2004 of the class Vaccinio-Piceeetae Br. - Bl. in Br. - Bl. et al. 1939 [3, 6]. Plant communities grow on light-brown peat-bog, humus-illuvial, and peat-podzolic-gley soils. The phytocenoses studied are characterized by a fairly simple structure. The stand is mostly single-tiered, and rather sparse (TDC up to 50 %). It is mainly formed by Larix cajanderi Mayr, Betula platyphylla Sukacz., Alnus hirsuta (Spach) Fisch. ex Rupr. The shrub layer is quite dense (TC up to 50 %), and consists of Betula fruticosa Pall. and Betula ovalifolia Rupr., Andromeda polifolia L., Chamaedaphne calyculatea (L.) Moench, Sorbaria sorbifolia (L.) A. Br., Rhododendron dauricum L., Vaccinium uliginosum L., Ledum palustre L., Oxycoccus microcarpus Turcz. ex Rupr., Oxycoccus palustris Pers. and other species. The grass layer is rare (TC up to 20 %), represented by Calamagrostis langsdorffii (Link) Trin., various types of sedges forming tussocks (Carex globularis L., Carex minuta Franch., Carex cespitosa L., Carex schmidtii Meisn.,...
Carex meyeriana Kunth, Carex appendiculata (Trautv. et Mey.) Kuk., Smilacina trifolia (L.) Desf. and other species. A well-developed moss cover (TC up to 90%), consists of various mosses of the genus Sphagnum. The total area of growth of this type of larch forests is 6945.5 ha.

In the above-floodplain terraces, on flat slopes, gently sloping decays, the herbaceous larch forests are growing. These plant communities, according to the materials of forest management, belong to different types of larch forests, namely, shrubby and mixed-grass (Lshm) and larch-oak forests (Lo), and according to the ecological and floral classification, they are assigned to the association Querco mongolicae-Laricetum cajanderi Krestov 2009 of the union Dictamno dasycarpi-Quercion mongolicae Kim ex Krestov et al. 2006 of the order Lespedeza bicoloris-Querctalia mongolicae Krestov et al. 2006 of the class Querco mongolicae-Betuletea davuricae Ermakov et Petelin in Ermakov 1997 [3, 6]. Plant communities grow on sod-podzolic-gley, and brown-podzolic stony soils. The studied phytocenoses are characterized by a fairly simple structure. The stand is mostly two-layered, and closed (TDC up to 80%). It is formed by Larix cajanderi Mayr, Quercus mongolica Fisch ex Ledeb, Betula platyphylla Sukacz and Betula davurica Pall. Shrub layer of medium density (TC up to 30%), consists of Lespedeza bicolor Turcz, Corylus heterophylla Fisch. ex Trautv., Rosa acicularis Lindl., Viburnum sargentii Koehne and other species. The grass layer is thick (TC up to 70%), represented by Calamagrostis langsdorffii (Link) Trin, Pteridium aquilinum (L) Kuhn, Lathyrus komarovii Ohwi, Anemonoides udensis (Trautv et Mey) Holub, Thalictrum filamentosum Maxim, Campanula punctata Lam, Convallaria keiskei Miq, Bupleurum longiradiatum Turcz, Carex falcata Turcz, Carex reventa V. Krecz, Filipendula palmata (Pall) Maxim and other types. The total area of growth of this type of larch forests is 7219 ha.

4. Conclusions

The current state of the larch forests of the “Bastak” State Nature Reserve can be assessed as fairly stable. To date, larch forests occupy within 25 % of the forested area. The most widespread area is occupied by lowland larch forests (94 %). Mountain larch forests are derived plant communities formed after logging in fir-spruce forests. Lowland larch forests are periodically exposed to forest fires. However, the analysis of forest management materials for the period 1969–2011 indicates the stable development of these plant communities: the area of larch forests growth has increased by 2.1 times, and the planting stock has increased by 2.3 times [7]. In addition, the analysis of the reforestation processes that occur in the studied plant communities indicates that in the absence of repeated forest fires and the presence of surviving adult individuals of the Kayander larch, the restoration of larch trees occurs within 5–10 years; in the case the larch trees were completely destroyed, the restoration of the plant community occurs within 20 years [8]. Despite the stable state of the larch forests of the Bastak Reserve, timely implementation of the fire-fighting measures can significantly improve the state of not only the plant communities studied, but also of all natural complexes of the reserve.

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