

# Fir-spruce and lime-fir-spruce forests of Vyatka-Kama biome

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**Abstract.** During the preparation of map “Biomes of Russia” in broad-leaved-coniferous forests belt of the Eastern Europe Vyatka-Kama biome was substantiated. This territory is allocated for the first time at such a high level. Formations of fir-spruce and lime-fir-spruce forests occupy a central position in the vegetation cover of the biome and largely determine its specificity. As the result of ecological-morphological classification 7 groups of associations and 17 associations of vegetation have been determined.

## 1 Introduction

Broad-leaved-coniferous forests of Eastern Europe belong to the most controversial in their rank and attribution to a particular chorologic units. Using the biome concept of biosphere organization the map “Biomes of Russia” was developed in the department of biogeography of Lomonosov Moscow State University [1]. During map preparation and justification of biogeographic boundaries in it, special attention was paid to the hemiboreal forests of European Russia. Based on research [2] two biomes – Smolensk-Privolzhsky and Vyatka-Kama – were substantiated in broad-leaved-coniferous forests belt of the European part of Russia. Key indicators for establishing their boundaries were: biotic diversity - floristic (faunistic) and cenotic - and bioclimatic aspects (mean annual temperatures, sum of biologically active temperatures > 10 °C and average annual precipitation).

The Vyatka-Kama biome is situated in the middle Volga basin and its largest left tributary, the Kama. Distinguished in it are the Zavolzhie rudimentary elevation, the Vyatka Uval and the Vyatka-Kama interfluvium in the east (parts of the Nizhny Novgorod and Kirov regions and the Republics of Mari El, Tatarstan and Udmurtia) and the left bank of the Kama with the Tulva Upland and the spurs of the Ufa Plateau (parts of Perm region, Udmurtia, Bashkortostan, Sverdlovskaya region). This territory is allocated for the first time at such a high level.

Woodland coverage of Vyatka-Kama biome reaches 51%, but differs significantly in the western (40-45%) and eastern parts (60-65%). Among forests, the fir-spruce (*Abies sibirica* Ledeb., *Picea x fennica* (Regel) Kom., *P. obovata* Ledeb.) and lime-fir-spruce (*Tilia cordata* Mill.) forests and their derivatives, which account for more than 83% of the wooded area, are absolutely dominant in the area occupied. Lime-fir-spruce forests are to a

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certain extent unique for this biome and in many respects determine its specificity. At the same time, almost 60% of the territory falls on derivative forests with a predominance of birch (*Betula pendula* Roth., *B. alba* L.) and aspen (*Populus tremula* L.). Spruce (1.2%) and broadleaf-spruce (1.8%), pine (*Pinus sylvestris* L.) (5.4%) and broadleaf-pine (3.9%), oak (*Quercus robur* L.) (0,7%) and lime (2.5%) forests are also presented. Not more than 2% of the territory is occupied by bogs.

## 2 Materials and methods

Formations of fir-spruce and lime-fir-spruce forests occupy a central position in the vegetation cover of the biome and largely determine its specificity. As a part of the work to justify the boundaries of biomes using the ecological-morphological classification approach [3, 4], an assessment of the diversity and distribution of fir-spruce and lime-fir-spruce forests was made. It was based on the original field research materials (more than 100 plots), vegetation maps and published data. As the result 7 groups of associations and 17 associations of vegetation have been determined.

## 3 Results and discussions

### 3.1 Fir-spruce forests

Fir-spruce forests are widespread in the biome. They occur from the northern part of the Vetluga basin to the eastern boundary of the study area, along the watersheds and on the slopes of river valleys on sandy loamy and loamy podzolic and sod-podzolic soils. Fir is located here near the western limit of its distribution. In the west, it does not form pure forests – the predominant breed is spruce, and the participation of fir does not exceed 0.1-0.4 of stand composition. To the east its share increases up to 0.3-0.6 (0.7), while the fir-spruce forests themselves begin to predominate over the spruce forests. At the same time, the consideration of fir-spruce forests apart from spruce forests is due, first of all, to the fact that together with fir in the addition of these forests, a number of siberian species are essential. In the area of research fir-spruce forests are one of the leaders in the formation of forest cover, and the territory of the Priuralie, along with the Pechora basin, is the main arena of their spread. Also, similar types are known from the Urals and the extreme west of Siberia [5, 6].

Fir-spruce greenmoss forests - the most widespread group of fir-spruce forests of the Priuralie, the most represented in its northern half. They are confined to territories with a predominance of moraine and eluvial-deluvial loams and clays with sod-strongly podzolic and podzolic soils.

As part of the stand, in addition to spruce and fir, there is an admixture of birch, aspen, lime, less often – pine. Oak and lime are noted in the regrowth. In a rare undergrowth are represented: *Frangula alnus* Mill., *Sorbus aucuparia* L., *Juniperus communis* L., and also *Lonicera caerulea* L. In the grass and shrub layer, the followings are common: *Maianthemum bifolium* (L.) F. W. Schmidt, *Trientalis europaea* L., *Vaccinium myrtillus* L., *V. vitis-idaeae* L., *Oxalis acetosella* L., *Pyrola rotundifolia* L., *P. minor* L., *Gymnocarpium dryopteris* (L.) Newm., *Carex rhizina* Blytt ex Lindbl.. In a sparse moss cover, *Pleurozium schreberi* (Brid.) Mitt., *Hylocomium splendens* (Hedw.) Bruch et al., *Dicranum* sp., etc. predominate.

Fir-spruce haircup-moss (*Polytrichum commune*) forests are spread slightly, mostly to the west of Vyatka, and occupy a variety of depressions with poor drainage and sod-podzolic gley soils. In their stand, the role of birch and pine is quite noticeable. The

herbaceous and shrub layer is usually very sparse and is represented by: *Vaccinium myrtillus*, *Equisetum sylvaticum* L., *Molinia caerulea* (L.) Moench, *Carex nigra* (L.) Reichard, etc. The moss cover is dominated by *Polytrichum commune* Hedw.

Fir-spruce grass forests are occupied by a few swamped old valleys in the floodplains of small rivers and the bottoms of ravines. The stand of the alder (*Alnus glutinosa* (L.) Gaertn) and birch is inherently significant. Characteristic is the participation in the undergrowth of species of Euro-Siberian distribution – *Lonicera caerulea* and *Swida alba* (L.) Opiz, as well as *Atragene sibirica* L.. In the high grass stands there are: *Filipendula ulmaria* (L.) Maxim., *Valeriana officinalis* L., *Cirsium palustre* (L.) Scop., *Matteuccia struthiopteris* (L.) Todaro, *Glyceria maxima* (C. Hartm.) Holmb., *Cacalia hastata* L., etc.

Fir-spruce nemoral forests are confined to watershed spaces with the richest (in particular, sod-carbonate) soils (in the east of the biome), as well as parts of river valleys (mainly in the west of the biome). This is one of the most important groups that characterize the vegetation cover of the whole region. The stand is characterized by a noticeable admixture of birch and aspen and a pronounced second tier of lime with the participation of maple (*Acer platanoides* L.) and elm (*Ulmus glabra* Huds.). In the undergrowth sometimes there is abundant *Sorbus aucuparia*, but mostly it comprised of nemoral species – *Lonicera xylosteum* L, *Corylus avellana* L., *Euonymus verrucosa* Scop.. For the grass and shrub layer is characterized by the participation of boreal, including Siberian, species (*Oxalis acetosella*, *Linnaea borealis* L., *Carex digitata* L., *Trientalis europaea*, *Aconitum septentrionale* Koelle, etc.) and nemoral Euro-Siberian species (*Aegopodium podagraria* L., *Pulmonaria obscura* Dumort., *Stellaria holostea* L., *Galium odoratum* (L.) Scop., *Paris quadrifolia* L., etc.).

Various authors [7, 8] repeatedly stressed complex and multifaceted nature of the vertical structure of this forests in which an alternation in tiers formed species having different origin. Thus, the tier of European nemoral species alternates with the tier of Euro-Siberian taiga species. All this indicates the "borderline" nature of these forests, which in their way are "transitional" from the East European to the Priuralie and the Urals.

### 3.2 Lime-fir-spruce forests

Lime-fir-spruce forests are one of the outstanding features of this biome. They are predominant over the Kama - in Priuralie. Significant massifs are presented in the Vyatka-Kama interfluvium. Most of these forests are associated with mesopodzolic, rarely - gray forest soils formed on eluvial-diluvial loams and clays indigenous Permian rocks. Brought forth near the extreme north-eastern distribution limits of broad-leaved trees and their companions, these forests are characterized by an increase in the composition of all the layers of the role of Siberian species and, in part, lime, reduced the role of a maple, an increase of cover herbs (especially - tall and ferns) and a decrease in participation shrubs.

The composition and structure of these forests are often significantly transformed, mainly by logging. In large areas of the forest reduced at all or replaced by birch, aspen and (significantly less) lime forests.

Lime-fir-spruce high-grass forests are prevalent mainly in the northern part of the Priuralie. They are mainly confined to deep podzolic heavy loamy and brown clay soils of the upper parts of the slopes of hills and watersheds. The stand is composed of spruce, fir, and inferior in height lime, sometimes with an admixture of elm. The undergrowth is rare from *Lonicera xylosteum*, *Frangula alnus*, *Sorbus aucuparia*. Grass cover consists of *Aconitum septentrionale* (almost always - a clear dominant), *Dryopteris expansa* (C. Presl.) Fraser-Jenkins et Jermy, *Oxalis acetosella*, *Dryopteris filix-mas* (L.) Schott, *Stellaria holostea*, *S. bungeana* Fenzl., *Maianthemum bifolium*, etc. In a few sparse moss cover is dominated *Pleurozium schreberi*, *Brachythecium reflexum* (Starke) Bruch et al., etc.

Lime-fir-spruce large-fern forests are confined to the slopes of watersheds and the bottoms of ravines with deeply podzolic heavy loamy soils. The stand is characterized by smaller participation of fir in comparison with the previous group, an admixture of birch and aspen, rarely – pine. *Sorbus aucuparia*, *Lonicera xylosteum* and *L. caerulea* are in the rare undergrowth. Quite a dense grass layer is formed by *Dryopteris expansa*, *Diplazium sibiricum* (Turcz. ex G. Kunze) Kurata, *Athyrium filix-femina* (L.) Roth, *Calamagrostis obtusata* Trin., *Oxalis acetosella*, *Stellaria bungeana*, etc. The moss cover is dominated by *Hylocomium splendens*, *Brachythecium reflexum*.

Lime-fir-spruce nemoral forests are the most common in the biome. They predominate in the area in the Priuralie and occupy significant positions in the Vyatka-Kama interfluve. In general, they are associated with watershed spaces and floodplain slopes with sod-podzolic or brown clayey and loamy soils. The stand is characterized by an increase in the role of fir and lime, often noticeable admixture of elm of rough and aspen, rarely – maple. In the undergrowth are represented *Sorbus aucuparia*, *Lonicera xylosteum*, *Viburnum opulus* L. For the grass and shrub layer the common species are *Aegopodium podagraria*, *Asarum europaeum* L., *Stellaria holostea*, *S. bungeana*, *Brachypodium sylvaticum* (Huds.) Beauv., *Galium odoratum*, *Carex rhizina*, *Lathyrus vernus* (L.) Bernh., *Aconitum septentrionale*, *Cicerbita uralensis* (Rouy) Beauv., etc. The moss cover is usually poorly expressed.

## References

1. G.N. Ogureeva (ed.), *Biomes of Russia. Map M 1: 7 500 000* ("Financial and Organizational Consulting", Moscow, 2016)
2. N.G. Kadetov, *Izv. Samarsk. Nauchn. Centra RAN*, **14**, 1603 (2012)
3. E.M. Lavrenko, *Botan. Zhurn.*, **67**, 572 (1982)
4. A.P. Shennikov, *Introduction to geobotany* (Izd-vo Leningr. Un-ta, Leningrad, 1964)
5. G.A. Voronov, L.M. Trofimova, S.V. Balandin, *Complex fir-spruce forests of the Ural Prikamye* (Izd. Perm. Un-ta, Perm, 2005)
6. L.P. Rysin, Yu.I. Man'ko, S.M. Bebiya, *Fir forests of Russia* (Tov-vo nauchn. izd. KMK, Moscow, 2012)
7. V.V. Alyokhin, *Explanatory note to the geobotanical maps (modern and restored) of the former Nizhny Novgorod province (scale 1: 500 000)* (Perv. Kartogr. f-ka VKT, Leningrad, 1935)
8. S.S. Stankov, *Essays on the physical geography of the Gorky region. 3rd ed., corr.* (Gork. Obl. Izd-vo, Gorky, 1951)