Plant Communities of Economically Valuable Forest-Forming Species of the Orenburg Region

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Abstract. The article provides an analysis of their sinusial structure, the species composition of vascular plants of the Ural River floodplain within the steppe zone is studied in detail. For the first time, a classification has been carried out for the study area and a phytocenological characteristic of all tree-shrub vegetation has been compiled; patterns of ecological-dynamic changes in the types of floodplain forests are revealed. It has been established that the Tilia cordata and Quercus robur formations are quite rare for the territory of the Orenburg region. The growth class of oak forests is assessed in grades II – IV, and linden forests in grades III. Two groups of types of oak forests are characteristic of the floodplain of the study area: blackberry oak and lily of the valley oak. Linden associations are represented by two-tier plantations. Tilia cordata dominates in the first tier, Ulmus laevis and Quercus robur form the second tier. A decrease in the floodplain area under Quercus robur and Tilia cordata on the territory of the Ilek and Tashlinsky forestries was noted. Phytocenoses are transformed by replacing Quercus robur formations with Ulmus laevis formations.

Key words: natural vegetation, floodplain forests, oak forests, linden associations, anthropogenic transformation

1. Introduction
The territory of the Orenburg region belongs to sparsely forested areas. Often, the floodplain is almost the only habitat of natural woody vegetation. Therefore, given the important role of forests in protecting the environment and their fulfillment of water protection, anti-erosion, hygienic and other special functions, which are of great importance in the conditions of arid climate, their deep and comprehensive study is necessary. Orenburg Forests are rare plant communities that provide shelter for many rare and endangered plant species such as Quercus robur L. and Tilia cordata Mill [1-3].

2. Problem Statement
An increasing anthropogenic load leads to disruption of the formed natural complexes. Floodplain forests and meadows, as well as the river itself, are increasingly used by man for economic purposes [4, 5]. The emerging environmental situation is exacerbated by the powerful industrial potential in the river basin, especially in the chemical, oil and gas industries. In this regard, it is important and necessary to study the preserved sections of forest vegetation, their current status and recovery trends under conditions of the termination of anthropogenic impact [6-8].
3. Research Questions
On the basis of a geobotanical study of floodplain forests, a detailed analysis of their sinusial structure was carried out, the species composition of vascular plants of the floodplain of the Ural River within the steppe zone was studied in detail. For the first time, a classification has been carried out for the study area and a phytocenological characteristic of all tree-shrub vegetation has been compiled; patterns of ecological-dynamic changes in the types of floodplain forests are revealed.

4. Purpose of the Study
Give an ecological-phytocenotic characterization of floodplain oak forests and linden forests of the Orenburg region.

5. Materials and methods
Geobotanical studies of woody-shrubby vegetation were carried out according to generally accepted methods. When isolating and studying the types and associations of floodplain forests, the biogeocenological principle of V.N. Sukachev and his definition of the type of forest [9]. In order to study the forest growing conditions, geobotanical profiles were laid that dragged from the edge of the river to the point of transition of the terraced part of the floodplain to the first floodplain terrace with level surveying with simultaneous registration of plant associations [10].

The study of forest types was carried out on trial plots. In order to more fully characterize the floodplain forest, trial plots were tied, if possible, to leveling passages. The size of the trial plots is at least 0.25 ha (50x50 m) [11].

Among the objects examined, the following were studied: tree stand, undergrowth and natural regeneration, undergrowth, grass cover, soil conditions, and features of forest growing conditions of the floodplain. When describing the vegetation, a detailed analysis of the sinusial structure of the phytocenosis was performed.

At typological sites, a continuous enumeration of trees was carried out. The age of the trees was calculated by annual rings on the saw cuts, with subsequent refinement in the forest tax reference book. In office conditions, growth class and stand density were determined. Natural regeneration was taken into account at the registration sites of 1 m² (1x1m) in size, the number of which depends on the uniformity of seedlings and undergrowth distribution, in the amount of not less than 5 pieces. Accounting and description of renewal were carried out in the established form. The life state of the undergrowth was characterized by its division into healthy, oppressed and damaged [12].

For undergrowth, the following indicators were established: its closeness, species composition, abundance, maximum and prevailing heights, sub-tiers.

Accounting and description of the grass cover were also carried out at registration sites. Previously, the general appearance of the grass cover, its physiognomic features depending on the growing season were noted, then the degree of projective cover was taken into account, which was established by eye and expressed as a percentage. The species composition of the grass cover was very carefully determined. Unknown plant species were placed in a herbarium under conventional names or numbers for subsequent determination.

The participation of species of the grass layer was determined by taking into account the abundance on the Drude scale. In addition, the average height of the grass cover, the degree of uniformity of the distribution of plants, the general state of their growth and development, and also the effect of floods on these processes were determined [13].

Herbarium material was determined using multi-year reports. The nomenclature of plants is given in accordance with modern requirements [14-19].

6. Experiment
The oak forests of the Ural floodplain are a heterogeneous group of associations differing in the composition and structure of the phytocenoses formed by them, which together make up the floodplain oak formation.

In the ecological ranks of the floodplain forests, *Quercus robur* is characterized by habitats flooded for a period of about three weeks, and on average for 6-10 days. Oak seedlings and undergrowth
tolerate flooding no higher than 50 cm and no more than 10-12 days. Young and middle-aged *Quercus robur* trees withstand alluvium falling asleep at the bottom of the trunks, while maintaining their viability. In old age, *Quercus robur* flood resistance decreases. Oak forests occupy predominantly elevated positions (banks of oxbows, manes, elevations) of the central and terrace floodplains, where drainage conditions are better and the duration of flooding is not particularly long.

The reduction of oak forests and the shift of the border of their distribution in the floodplain from 49° 40'N 51° 15'N is not only the result of the deterioration of the forest-growing conditions of the floodplain, but also the prolonged ruthless extermination of this breed by humans, as well as grazing in floodplain forests, leading to the death of undergrowth.

The population of *Quercus robur* in the floodplain usually occurs under the canopy of elm trees and shrubs, which facilitate the competition of this breed with grassy meadow vegetation and protect *Quercus robur* from adverse climatic conditions. In the floodplain of the Ural River, oak forests are mainly of overgrown origin; in this regard, they are characterized by worse development and productivity. Seed regeneration of *Quercus robur* in the floodplain is unsatisfactory. Seed regeneration of *Quercus robur* in the floodplain is unsatisfactory. The flowers and acorns of this oak often die from late frosts.

The growth class of oak forests is rated in grades II – IV, with a slight improvement in the growth class of stands to grades I and I. A slight decrease in the productivity of oak forests from north to south is due to a change in climatic conditions in the direction of increasing dryness. In the south, the degree of violation of oak forests by human activities is also increasing. On average, the fullness of oak groves is 0.5–0.7.

Two groups of types of oak forests are characteristic of the floodplain of the study area: blackberry oak and lily of the valley oak. The latter are more common in the Ural floodplain. Floodplain oak forests, in comparison with oak forests on the watershed and in the mountains, are characterized by a somewhat depleted and more uniform composition. Plants characteristic of meadows make up a significant proportion in the grass cover.

Blackberry oak forests (*Quercus robur – Rubus caesius*) are widespread in high sections of the central floodplain with a short-rate regime on thick flood-plain meadow sandy soils. The forest stand in the oak forest has a crown density of 0.5–0.6, represented by one or two tiers. The second tier, as a rule, is occupied by *Ulmus laevis*. The forest stand in the oak forest has a crown density of 0.5–0.6, is represented by one or two tiers. The second tier, as a rule, is occupied by *Ulmus laevis*. Sometimes *Acer negundo* is mixed with it, forming a third tier. In Blackberry oak forest the growth class of *Quercus robur* is rated in grade III. Average height 16 m.

The shrub layer is represented by *Rosa majalis* - sol - sp, *Lonicera tatarica* – sol, *Prunus spinosa* – sp, found on the edge of the forest. Under the forest canopy, usually *Frangula alnus* – sol.

The grass is thick, has a projective cover of 60-70% and an average height of 35-40 cm. Forest species are represented by: *Rubus caesius* - cop, *Aristolochia clematitis* – sol, *Solidago virgaurea* – sol, *Viola ambigua* – sol, *Heracleum sibiricum* – sol, *Galium boreale* – sol. Closer to the forest edge, meadow species are typical: *Bromopsis inermis* – sol-sp, *Sonchus palustris* – sol-sp, *Carex melanostachya* – sp, *Stachys palustris* – sol, *Lycopus exaltatus* – sol, etc. There are many weed species in the forest: *Xanthium strumarium* – sol, *Amaranthus retroflexus* – sol, *Ecballium elaterium* – sp, *Solanum nigrum* – sol, *Atriplex sagintata* – sol, except *Urtica dioica*, since in the Ural floodplain it occurs only under the forest canopy. Of the vines, *Solanum dulcamara* – sol and *Humulus lupulus* – sp.

In the Blackberry oak forest in the first tier, *Populus nigra* at the age of 60 years and individual trees of the shrinking *Quercus robur* are noted. This, as well as the absence of *Quercus robur* undergrowth, indicate that the environmental conditions necessary for the normal growth of this tree species have changed for the worse. At the same time, the presence of good undergrowth of smooth elm (380 ind./ha, aged 10-14 years) indicates a possible change in oak groves by elm trees.

Blackberry oak with viburnum (*Quercus robur - Viburnum opulus – Rubus caesius*) with a crown density of 0.4–0.5 was noted on the mane of the central floodplain, on floodplain meadow soils. The height of *Viburnum opulus* reaches 4.5 m, stand density is 0.8. At the edge of the forest is mixed with: *Prunus spinosa* – sp, *Rosa majalis* – sol, *Lonicera tatarica* – sol and *Ribes nigrum* – sol.
The grass cover is sparse, with a projective cover of up to 20% and an average height of 35 cm. Here dominate: *Rubus caesius* – cop, *Urtica dioica* – sp, *Convallaria majalis* – sp. At the edge of the forest: *Heracleum sibiricum* – sol, *Rumex confertus* – sol, *Lythrum salicaria* – sol, *Veronica longifolia* – sol, *Calamagrostis epigeios* – sol, *Lycopus exaltatus* – sol, *Pteridium aquilinum* – sol, *Silene silaus* – sol. It is abundant in *Humulus lupulus*, which braids trees and shrubs, reaching 5-7 m in height.

The absence of *Quercus robur* undergrowth and the abundant *Ulmus laevis* undergrowth (up to 1200 ind./ha, with an average height of 7 m, aged 10-15 years) and the blackberry elm forest, located in the immediate vicinity of the oak grove, indicate that in the case of *Quercus robur* felling he will be replaced by *Ulmus laevis*.

One of the modifications of blackberry oak forests is nettle oak forest, located in the central floodplain south of Utvinka village on floodplain-alluvial soils enriched with excrement of birds nesting here.

In the shrub layer, single specimens of *Viburnum opulus* are found. In the shrub layer, single specimens of *Viburnum opulus* are found. Herbage is plentiful, 70-80 cm high and projective cover 70-75%. Dominated by *Urticadioica* - cop2. The subdominant is *Glechoma hederacea* – cop1, *Rubus caesius* – is not numerous. *Aristolochia clematitis* – sol, *Stachys palustris* – sol, *Calystegia sepium* – sol, *Agrostis albiida*, *Humulus lupulus* are found in the herbage.

*Quercus robur* is also missing here. There is undergrowth of smooth elm (139 ind./ha, with an average height of 4-5 m, aged 6-7 years), but it is not as plentiful as in previous cases.

Kirkason oak forest (central floodplain) (*Quercus robur – Aristolochia clematitis*) grows on the slopes of manes, 4.5-6.5 m high in the central floodplain. Overgrown oaks at the age of 70 years have the lowest growth class - V. The tree stand is a two-tier, as in previous forest types, represented by *Quercus robur* and *Ulmus laevis*. The degree of closure of crowns is 0.5. Of all the oak forests, this type of forest is the least productive.

The shrub layer is sparse, represented by: *Rhamnus cathartica* – sol, *Frangula alnus* – sol, *Crataegus sanguinea* – sol.

Projective cover of grass cover 80-90%. The average height is 25-30 cm. *Aristolochia clematitis* dominates. From forest species also grow: *Galium boreale* – sol, *Agrimonia pilosa* – sp, *Viola cannina* – sol, *Viola elatior* – sol, *Rubus caesius* – sol, *Humulus lupulus*. Meadow species are represented by such species as: *Calamagrostis epigeios* – sol- sp, *Thalictrum simplex* – sol, *Carex melanostachya* – sol-sp, *Lycopus europaeus* – sol, *Lythrum salicaria* – sol, *Plantago major* – sol, etc. The share of forest species in the grass cover is 30%, the share of meadow species is 57%. A steppe species (*Linaria vulgaris, Asparagus officinalis, Sedum telephium*) accounts for 13% of the share. 9 species from the recorded have already been found in blackberry oak forest.

Renewal submitted by *Quercus robur*. The growth of seed oak is 278 ind./ha, 15 m high at the age of 1-2 years. Occasionally, 10-year-old *Ulmus laevis* undergrowth is 4 m high, 3-4 cm in diameter.

At higher short-level floodplains, blackberry and kirkazon oak forests are replaced by forest types dominated by lily of the valley.

The most common type in the *Quercus robur* formation is the lily of the valley oak forest (*Quercus robur - Convallaria majalis*). Oak forests of this type are confined mainly to higher rarely flooded floodplain areas and are located along the banks of oxbows and their gentle slopes, most often of northern and north-western exposure. The soils occupied by this type of forest are floodplain meadow thick.

Lily of the valley oak forest is represented by seed and overgrown stands. One-tire tree stand, composed of *Quercus robur*, sometimes mixed with *Populus tremula, Populus alba, Ulmus laevis, Acer negundo*. One-tire tree stand, composed of *Quercus robur*, sometimes mixed with *Populus tremula, Populus alba, Ulmus laevis, Acer negundo*. However, the accompanying *Quercus robur* tree species do not form a pronounced tier, except for *Ulmus laevis* and *Acer negundo*. The age of the oak is 70-80 years, the crown density is 0.6. Growth class with a grade of III-V prevail. Growth class with a grade of III-V prevail. The growth class of preserved sites of seed origin are evaluated I and I*. The undergrowth of medium frequency, the density of its canopy - 0.4-0.5. On the fringe of the forest grow - *Lonicera tatarica* - sol, *Prunus spinosa* - sol, *Spiraea crenata* - sol, *Viburnum opulus* -
un. Such species are occasionally found under the forest canopy – *Crataegus sanguinea* and *Rosa majalis*, *Cerasus fruticosa* - sol, *Frangula alnus* - sp.

Forest cop of semi-decomposed leaves covers the soil with a dense layer with a thickness of 3-5 cm. Grass cover is sparse, projective cover is 50-60%. Its composition is dominated by forest species - *Convallaria majalis* (cop1, cop2), *Aristolochia clematitis* (sol-cop) and *Rubus caesius* (sol-cop1). Often, but not very profusely, *Humulus lupulus* – sol, *Urtica dioica* – sol, *Thalictrum minus* – sol, *Galium boreale* – sp-sol are found. Rare species: *Chelidonium majus* – sp, *Polygonatum odoratum* – sp, *Melica nutans* – sol, *Cucubalus baccifer* – sol, *Adenophora lillifolia* – sol, *Campanula bononiensis* – sol, *Scrophularia nodosa* – sol, *Solidago virgaurea* – sol, *Chaerophyllum prescottii*, etc. 55% of the total number of species noted in the described type of oak forests are found in one association. Of the marsh species, *Euphorbia palustris* is rarely found. The proportion of meadow species is 51% (41). Of these, with abundance were noted: *Agrostis alba*, *Calamagrostis epigeios*, *Oberna behen*, *Vicia cracca*, *Phragmites australis*, *Taraxacum officinale*, *Sonchus palustris*, *Galium aparine*, *Carex melanostachya*, *Solanum dulcamara*, *Sanguisorba officinalis*, *Lysimachia nummularia*, etc. The proportion of steppe species is 22% (18), meadow-steppe species prevail in this group: *Trifolium hibridum* – sp, *Erigeron canadensis* – sol, *Lavatera thuringiaca* – sol, *Medicago falcata* – sol, *Melilotus albus* – sol, *Chaeroppyllum prescottii*, *Silairsilaus* – sol, *Filipendula vulgaris* – sol, etc. Trees and shrubs are plentifully braided by *Humulus lupulus*.

There are only 5 weed species: *Arctium lappa* – sol, *Cannabis sativa* – sol, *Erigeron Canadensis* – sol, *Kochia scoparia* – sol and *Lactua seriola* – cop. 16 species out of 76 were previously found in blackberry oak forest.

Under favorable conditions, lily of the valley oak forest expands due to other types of forests; as a result, oak forests are formed: blackberry-lily of the valley, kirkason-lily of the valley, or lily of the valley-kirkason, lily of the valley-celandine. The most frequent transitions at the border of lily of the valley and blackberry oak forests. In this case, the outcome of the competition for the habitat is decided in favor of *Convallaria majalis*, which has significant stability and exposure to the root systems of the stand.

Lily of the valley oak forest is the most stable type of oak forest in the Ural River floodplain. On the slopes of the terrace floodplain and the floodplain terrace in the lily of the valley oak forest, the role of the shrub layer is significantly increased: *Ribes nigrum*, *Viburnum opulus*, *Padus racemosa*, *Frangula alnus*, *Euonymus verrucosa*, *Corylus avellana*, *Cerasus fruticosa*, *Lonicera tatarusa*, *Cotoneaster melanocarpus*, *Spiraea crenata*, *Chamaecitisus ruthenicus*, *Amigdalus nana*, *Rhamnus catharhica*, *Caragana frutex*.

Depending on the composition of the shrub layer, we distinguished species of oak forest: shrub-lily of the valley, hazel-lily of the valley and viburnum-lily of the valley.

Compared to *Quercus robur*, *Tilia cordata* tolerates flooding much better during floods, especially at a young age. However, even after prolonged floods, it usually retains the ability to resume vegetatively. Linden forest and individual trees occupy elevated areas in the floodplain, subject only to short-term flooding.

Linden associations are represented by two-tier plantations. *Tilia cordata* dominates in the first tier, *Ulmus laevis* and *Quercus robur* form the second tier. *Tilia cordata*, aged 70, has a growth class of grade III.

*Tilia cordata*, aged 70, has a growth class of grade III. Individual *Quercus robur* trees, 10 m high and 45 cm in diameter, have the lowest IVa growth class. The youngest was seed elm at the age of about 40-45 years. Stand density 0.94. Crown density 0.6. Linden is in excellent condition, bears fruit. There is no shrub layer. Occasionally, *Prunus spinosa* is found at the edge of the forest.

Grass cover is very thin. Its projective cover is 30%. It is composed of *Rubus caesius*, *Aristolochia clematitis*, *Lysimachia vulgaris*, *Urtica dioica*, *Glechoma hederaeae*, *Galiumboreale*. The dominant species is *Convallaria majalis*. *Bidens tripartita*, *Inula britannica*, *Plantago major*, *Lycopus europaeus* and *Convolutus arvensis* grow on the edge of the forest. *Arctium lappa*, *Atriplex sagittata*, *Sonchus arvensis* and *Matricaria perforata* grow here from the weed species. The average height of the grass stand is 10-15 cm.
The renewal of *Tilia cordata* overgrown totals 722 ind./ha, 1-1.5 m high at the age of 2-3 years. *Quercus robur* is renewed by seed, but very poorly (52 ind./ha, 0.6 m high, aged 2-3 years). *Ulmus laevis* renews slightly better (138 ind./ha, 1.5-2 m high, 3-5 years old).

7. Conclusion

Formations *Tilia cordata* and *Quercus robur* are quite rare for the territory of the Orenburg region. In the flora of the studied territory, we noted 8 species included in the list of rare and endangered plant species of the Orenburg region. Most of these species are represented in the *Quercus robur* formation, in such types as celandine oak, lily of the valley oak, hazel-lily of the valley oak, shrub-lily of the valley oak, shrub-lily of the valley aspen. At the same time, a decrease in the floodplain area under *Quercus robur* and *Tilia cordata* on the territory of Ilek and Tashlinsky forestries was noted.

Substitution of the *Quercus robur* formations with the *Ulmus laevis* formations is noted [20, 21].

In order to restore, preserve the genetic fund, increase productivity and enrich the quality composition, linden forests and viburnum-lily of the valley oak forests must be protected and organized protected objects of extractive reserve type; to ensure the restoration and protection of oak forests of hazel-lily of the valley, shrub-lily of the valley, celandine.

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