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ECOLOGICAL CONDITION OF OAK PLANTATIONS IN BISHKEK

Экологическое состояние дубовых насаждений в городе Бишкек

Бишкек шаарындагы эмен дарактарынын экологиялык абалы

Abstract: *this article reveals the results of the researches carried out by the author in 2013-2017, examined the species composition of oak trees and their role in the Bishkek ecosystem. Biology and ecology of primary and secondary pest species of oak plantations in urban environment were investigated. And also indicators of damages to oak trees by insect pests in various cities of Kyrgyzstan have been determined.*

Аннотация: *в статье приведены результаты проведенных автором в 2013-2017 годах исследований, рассмотрен видовой состав дубовых деревьев и их роль в Бишкекской городской экосистеме. Исследована биоэкология первичных и вторичных видов вредителей дубовых насаждений в городских условиях. А также определены показатели поврежденности дубовых деревьев насекомыми-вредителями в различных городах Кыргызстана.*

Аннотация: *макалада автордун 2013-2017-жылдардагы Бишкек шаарынын экосистемасындагы эмен дарактарынын орду, түрдүк курамы, жана ал дарактарга зыян келтирүүчү биринчилик жана экинчилик зыянкечтери жана алардын биоэкологиясы жөнүндөгү изилдөөлөр камтыды. Мындан сырткары Кыргызстандын ар кандай шаарларында эмен дарактарынын зыянкеч курт-кумурскалардын таасиринен жабыркоо деңгээлинин көрсөткүчү аныкталды.*

Keywords: *entomology; oak; insect pests; pollution; invasion; ecosystem; bioecology; introduction.*

Ключевые слова: *энтомология; дуб; насекомые-вредители; загрязнение; инвазия; экосистема; биоэкология; интродукция.*

Негизги сөздөр: *энтомология; эмен дарагы; зыянкеч курт-кумырска; булгануу; жуктуруу; экосистема; биоэкология; интродукция.*

Introduction

Oak (*Quercus*) - one of the most valuable breeds of our city. These wood crops are of great economic importance and are a powerful natural protective factor. High growth and ornamental quality, and resistance to unfavorable factors the most important ecological functions, from which it is especially necessary to distinguish water keeping, water regulating, soil-

protective as well as its sanitary and hygienic qualities put it among the main breeds for gardening of city ecosystems [1]. Its high oxygen productivity is superior to other hardwood species to the impact on the environmental sanitation.

Today the state of oak plantings in Bishkek and other cities of the Chui region (Kant, Novopokrovka, Tokmok, Sokuluk, Kara-Balta and others) are critical. This is the result of massive proliferation of harmful insects and adverse environmental factors (cold, droughts, fluctuations of solar activity, environmental pollution, global changes of climatic conditions). Based on the foregoing it can be said that the preservation of these species has become an actual problem of our time.

The purpose of this research is studying of the state and influence of harmful insects on oak plantations, comparing the territories of Bishkek and other cities of Chui region (Kant, Novopokrovka, Tokmok, Sokuluk, Kara-Balta, etc.), Jalal- Abad region (Jalal -Abad, Kerben) and Issyk-Kul region (Balykchy).

Subjects and the methods of research

When determining category of the damage a 6-point scale is used to estimate the condition of trees: 0 – not corrupted, I - II – slightly damaged, III - IV – moderately damaged, V - VI – heavily damaged [5].

For each trial area the percentage of trees of different status categories were determined and the percentage of damage was calculated, then the conclusions on the condition and the degree of weakening of the trees were made.

Results and analysis

Oak belongs to the genus *Quercus* L. and represented by a large quantity of species with very complex and diverse taxonomy. Due to this, up to now it is not precisely determined how many species of oak contains this kind, as well as how many of them there are in the world.

M. Golenkin and N. Kobranov (1931) indicate that the number of oak species exceeds 200. V.F. Ovsyannikov (1931) reported that the genus *Quercus* contains more than 300 species and varieties, and F.L. Shepotev (1949) and G. Hegyi (1925) think that there are more than 200. A. Camus (1936-1939) described in details the 292 species of oak, as well as many subspecies and hybrids. According to V. N. Sukachev (1938) only in the Caucasus, there are 17 species of oak. V. P. Maleev and S.Y. Sokolov indicate that the genus *Quercus* has about 600 species [13].

Oak (*Quercus*) is the introduced species in our country. The first trees of petiolate oak (дуба черешчатого) appeared here in the late XIXth century (1881-1895) since the bookmark in Frunze (now Bishkek) Karagachevaya Grove and the Oak Park. Organization of the Botanical Garden in the capital (1937) made it possible to experience the culture in a variety of species of this genus, and by 1978 at the Botanical Garden 33 kinds and oak form different geographical regions of the world were successfully introduced. [1]and 19 species of oak successfully grow here today. They belong to two sections subgenus *Erythrobalanus* Spach and 4 sections of the subgenus *Lepidobalanus* Endl. (Table 1)

Table 1. Species composition of oak trees in Bishkek

Subgenus	Section	Forms
I. Erythrobalanus Spach.	<i>1.1. Section Phellos Loud.</i>	<i>Quercus imbricaria</i> Michx.
	<i>1.2. Section Rubrae Loud.</i>	<i>Q. borealis</i> Michx. f.
2. Lepidobalanus Endl.	<i>2.1. Section Cerris (Spach.) Oerst.</i>	<i>Q. serrata</i> Thunb.
		<i>Q. castaneifolia</i> C. A. M.
	<i>2.2. Section Cerridopsis Maleev</i>	<i>Q. macranthera</i> Fisch. et Mey
	<i>2.3. Section Dentatae C.K. Schneid.</i>	<i>Q. dentata</i> Thunb.
	<i>2.4. Section Eulepidobalanus Orst.</i>	<i>Q. hartwissiana</i> Stev.
		<i>Q. robur</i> L.
		<i>Q. macrocarpa</i> Michx.
		<i>Q. erucifolia</i> Stev.
		<i>Q. pubescens</i> Willd.
		<i>Q. mongolica</i> Fisch.
		<i>Quercus acuminata</i>
		<i>Q. imeretina</i> Stev.
		<i>Q. longipes</i> Stev.
<i>Q. petraea</i> Liebl.		
<i>Q. muehlenbergii</i> Engelm.		
<i>Quercus variabilis</i> Bl		

The oak plantations have a high transpiring ability. Their evaporated moisture is 20 times higher than the area occupied by them, greatly increasing humidity and reducing the temperature of air. And also they significantly reduce the rate of air masses, i.e. promote horizontal and vertical airing (aeration) leading to an improvement in the composition of

air. Foliage of woody plants reduces noise in residential and industrial areas for 2-2,5 times. Besides, the oak plantings clean (clear) the city air from dust, significantly reduce the concentration of harmful gases in the air [8].

Thus, the preservation of oak and other trees is very important for optimization of the urban environmental landscaping.

Unfortunately, today the Bishkek oak plantations are in depressing condition. There is a small number of publications devoted to the study of the reasons of the oak weakening. Measures for pest control and restitution of oak plantings are not developed.

Let us consider in more detail this phenomenon on the example of Bishkek and other cities of Chui region (Kant, Novopokrovka, Tokmok, Sokuluk, Kara-Balta, etc.), Jalal- Abad region (Jalal- Abad, Kerben) and Issyk-Kul region (Balykchy).

The vegetation in Bishkek city is under strong anthropogenic pressure and is subjected to chemical, physical, biological and integrated effects (pollution of water and air, violation of irrigational system, pollution of soil, temperature and water regime of air and soil, its chemical and physico-mechanical properties, contamination by toxic substances, the presence of underground utilities and structures, the influence of asphalt pavement of roads and streets, excessive recreational exposure, additional lighting to gardens later in the evening and at night, mechanical damage to plantations) [6]. All these factors lead to the weakening of trees, and appearance of the primary and secondary insect pests, which strike oak phytocenosis and thus causing the disruption of the ecological balance, water regime, light and temperature conditions of the plantations.

The oak plantations are damaged by a huge number of pests and diseases. Among the most common pests that damage the foliage are: 5 species of Bombycidae, 5 species of Noctuidae, 6 species of Geometridae, 8 species of Nepticulidae, 8 species of Symphyta, 2 species of Psyllidae, 11 species of Cynipoidea, 2 Tortricidae, 5 species of Curculionidae, 2 species of Adelgidae, 5 species of Aphidoidea. Buds and flowers hurt 12 species of Cynipoidea. Acorns are hurt by 2 species of Tortricidae, 3 species of Curculionidae and 1 type of Cynipoidea. The trunk and branches are damaged by 8 species of Scolytinae, 7 species of Cerambycidae, 3 species of Siricidae, 2 species of Lyctidae, 1 species Anobiidae, 3 species of Buprestidae, 1 type of Platypodinae and 1 type of Cossidae [6].

In our conditions, the most common and dangerous pests of oak are primary pests: *Profenusapygmaea* (Klug, 1814), *Lymantriadispar* L., *Malasomaneustria* L., *Euproctischrysorrhoea* L., *Operoptherabrumata* L.,

Erannis defoliaria Cl., secondary pests: Scolitus intricatus Ratz., Aeolesthes sarta Sols and a fungal disease - farinose dew.

Among the pests of oak plantings the most malware is secretly living pest of oak leaf-mining. These pests have a hidden lifestyle, while staying in plant tissues, which makes it difficult to fight with them, because they are in the external environment for a short time. They inhibit the plants, reducing photosynthetic surface of the leaves, causing premature abscission of the leaves (mid-August), degrade the aesthetic value of the plantings.

The **oak leaf -mining Sawfly** - monifah. These insects dwell only oak, and bring significant damage eating plates of leaves thereby reducing the photosynthetic area of the leaves. They are able to give short-term outbreaks and damage oak stands to a great extent on large areas. Massive damage of these sawflies even kill trees.

Imago of Profenusapygmaea of a small size (to 5 mm) and live for a short time (not more than 2 weeks). Moth flight occurs in late April — early May. Males are not found, they are extremely rare or there are none at all. Females choose leaves of a certain age for a oviposition. Profenusapygmaea submerge eggs under the epidermis of the lower side of the sheet, develop (according to our data) in 14-17 days. Mines on the leaves of the oak become visible in late May — early June. Larvae at hatching from the eggs do not go to the surface of the leaf, but bite into it.

Profenusapygmaea is an obligate miner, the complete larval development of which takes place inside the leaf blade. The larvae of the Profenusapygmaea use only easily digested leaf tissues and do not eat the epidermis, the cuticle and tissues of the vascular bundle, that is why their development is much faster than that of the free-living phyllophagous.

The shape of Profenusapygmaea is irregular, often pear-shaped, upside, clearly visible and not masked by any special twists and folds of the leaf and can take from % to $\frac{1}{4}$ of the leaf area, sometimes the whole surface.

In urban oak plantations the level density of populations of leaf-mining the foliage of woody plants insects in recent years has been at a constant and relatively high level. During the spring and summer time periods they represent a great threat to the condition of the oak plantings [7].

The high number of the Profenusapygmaea on oak trees is noted in Bishkek, Kant, Tokmok, Sokuluk, Kara-Balta and Kerben. And in IssykKul area the oak leaf-mining Sawfly is seen singly or not at all. Such fluctuation of number is bound to air temperature, the air temperature and the land weather is higher, the number of the wrecker is higher and vice versa.

Lymantria disparis L. is one of the important objects of the control services of forest protection in several countries of Eurasia, North America and Africa. The larvae can damage more than 300 species of plants [3].

Biology and ecology of the *Lymantria disparis* is well researched and includes many of the writings of [2, 4].

In Bishkek the *Lymantria disparis* has one year generation. Butterflies of *Lymantria disparis* is characterized by a pronounced sexual dimorphism: males and females look different. The wingspan of the male is 45 mm, antennae plumose, wings are dark grey or brownish-grey with dark stripes. The female is larger than the male and lighter in color, wingspan of about 75 mm, with thread-like antennae and the thick abdomen.

Time of flying the *Lymantria disparis* begins in early May, the duration is 2.5 months. Females can mate with males shortly after emerging from the pupae. After mating, the ability to attract males fastly disappear. The female begins egg laying 2-3 days later after hibernation.

The detailed description of the Gypsy moth eggs is found in researches of V. Benkevich [2].

The output of the caterpillars from the eggs begins when the average weekly temperature exceeds 10°C and maintained for 2-3 weeks. The output of the tracks coincides with the period of leafing on their main prey species. In conditions of Bishkek output of the tracks begins with the second decade of May-first decade of June. For caterpillars of *Lymantria dispar* typical 4 or 5 molts. Males have five instars, females six. Before each molt the caterpillar stops moving and eating. The total duration of life of the caterpillars ranges from 40 to 60 days.

The doll of *Lymantria dispar* is matte, dark brown or almost black, covered with rusty-brown hair length from 1.8 to 3.07 cm. Healthy pupa is very active, reacts to the slightest touch, making the lower end of the abdomen an undulating motion. The pupal stage lasts from 10 to 12 days.

Malasomaneustria L. is a butterfly of the family of the lappet moth, pest of pome and stone fruit crops, and many forest species. The female butterflies are ochre-yellow or reddish-brown, extent of wings of 3.5 - 4.4 cm; on the front wings there is a dark transverse band edged with pale stripes, on the hind wings the same figure expressed not sharply. Males are distinguished by smaller size (wingspan of their wings is 2.6 - 3.3 cm) and well-defined combed antennae. A dark-colored butterflies dominate the beginning of the outbreak.

Eggs are laid off by a close spiral around thin branches. The eggs are upright, shaped like a truncated cone, tapering somewhat to the base. They

are so tightly glued to each other dark-grey secretions of the accessory genital glands of the females that are visible only the tops of the eggs, testicles are dark-grey, 1,3X0,8 mm in size, their structure is fine-grained, the upper roller of them is porcelain-white, winter with developed caterpillars inside.

Adult caterpillars are of 4,5 – 6,0 cm, bluish-grey, with the same color of head, on the sides there are orange black-striped strips. There are the rarely located bunches of blackish hairsprings on a spinal side, and light-brown hairsprings thickly grow above feet and there is a dark fleshy wart on eleventh tergite.

Dolls are to 2,5 cm long, dove-coloured-brown, with the bright orange edges of sternites and some tergites. The rounded top of cremasters is not armed, but its slopes, and also sides and partly tergites of the 8th and 10th segments are covered with reddish tiny hooked and simple bristles. 9th and 10th segments are extended. Cocoons are disposed among the clamped mulberry leaves, often there are few cocoons in one nest of pupation. At mass reproductions cocoons can be found on fences, buildings, usually at corners [3]

Operophterabrumata L., Erannisdefoliaria Cl. are butterflies of different size with wide wings and thin slender body, a caterpillar is naked, with two pairs of pectoral feet, at a movement bending the body pulling up the back-end to front. The dolls have no cocoons.

Male of *Operophterabrumata* has a wingspan of 20 - 25 mm, female with rudimentary wings does not fly. Front wings of male are yellow-grey with dim wavy and transversal bars, back wings whitish-grey. Flying starts in October and lasts 40 - 50 days. Most intensive fly come in 6 - 10 days after its beginning and proceeds 17 - 19 days. Sometimes flying lasts till January. There are cases when single pupas overwinter and butterflies took off only in spring. Maximum activity of butterflies occur in the twilight, the males fly to the light.

After leaving the pupae the females climb trees and lay eggs near the buds and internodes, cracks and irregularities of the bark of thin branches, along the whole length of the crown, and also on the cortex of the trunk. The female lays one or two eggs, or in groups of 10-20. Female fecundity is very changeable.

Erannisdefoliaria Cl. Male has a wingspan of 30 -40 mm, the female is wingless. The front wings of the male are brown the female is dark yellow. Biologically is close to the *Operophterabrumata*. Flight in September - October and overwinter in the egg stage, the tracks appear in April – May,

of a year generation. Polyphage. It prefers oak and fruit trees. It often occurs in conjunction with the previous species.

Eggs are light green, pistachio color, in 6 - 10 days after laying of eggs they become orange. Before hatching of caterpillars the eggs become grey-violet. Caterpillars are large, from grey till yellow-brown color, have all typical signs of the family. Dolls are red-brown, bright, differ on a cremaster.

Primary insects usually attack outwardly healthy trees. Especially dangerous are outbreaks of mass reproduction of primary pests that last for several years and cause repeated eating of oak tree foliage. The weakened trees are exposed to a complex of secondary stem pests.

S. intricatus Ratz. is found throughout the oak habitats. Occasionally settled on a hornbeam, chestnut, birch, maple and other species, but their threat is not listed. Populates mostly dying young oaks around the trunk and in older trees, avoids thick crust and populates their middle part, the top and branches. Uterine transverse passages are simple, short. Flight of beetles in June, after which they are within 10 - 12 days extra feed in the crowns of perfectly healthy oaks. For this the beetles are introduced into thin terminal branches at the points of their articulation. Initially, they make superficial bites and only a few days later completely penetrate deep into the branches, making their stroke length of about 0.5 cm. Oviposition in the second half of June-July. They hibernate in the stage of larva, pupate in the spring of the following year at the end of April-May, of one year generation. [3].

Aeolesthesarta Sols. widely distributed in Central Asia, including Kyrgyzstan, where causes great damage to many tree species, especially growing in the urban conditions settings of oaks, poplars, white acacia, walnut, etc. Beetle with a length of 28 - 47 mm, dark grey-brown, with silvery hairs on elytra.

Flying is from late April to mid-June. Females lay one egg in crevices and recesses of the bark of trunks of trees of all ages, mostly old. Only one female lays up to 270 eggs.

After hatching, the larvae dig under the bark, feed on the inner bark at first, then navigate tortuous passages, strongly affects sapwood, and are moving in the wrong oval cavity, dramatically crashing into the phloem and the cork bark. In the fall the larvae go deep into wood and winter there, and the next year continues to progress. First it is laid down, then bends sharply hooked and directed upwards, parallel to the surface of the barrel. Young beetles appear in late summer and overwinter in the tunnels. Generation of two

years. *Aeolesthes sarta* attacks externally healthy, still quite viable trees and gradually leads them to death.

It is important to note leaf-eating group of insects, the most numerous ones. Their damage quickly becomes evident as leaf-eating insects roughly devour the leaves, eating holes in them.

Eventually we can conclude that primary pests lead to disruption of the normal functioning of trees and shrubs, the decline of their productivity and other valuable properties in the first place – decorative. In addition, severe damage by primary insects leads to the inevitable move their insects that will entail drying of skeletal branches and death of the whole plant. It is important to note that the affected trees and shrubs fall before the time foliage, and plants with damaged wood become brittle, why during a strong wind or snowfall the branches of these plants break off easily, which can lead to accidents or casualties.

The emergence of pests in urban green spaces is closely related to the mistakes of carrying out measures to care for them, and also neglect of carrying out scheduled maintenance work. Trees and shrubs in urban environment is a means of protecting the population from negative impact of a surrounding medium, and affected plants cope with this role much worse. And the lack of attention to regulating the numbers of most insects through regular trimming of trees and shrubs, rejuvenation of old plantations, processing soil cover can annihilate all landscaping work in the city.

The specific structure of wood vegetation in the urban environment defines possibility of formation of a peculiar specific structure of entomokomplex of dendrophag and their steady populations.

At the same time adaptation and action for decrease of number of wreckers at entomophages are much lower here as parazitoides and predators develop the new habitat much more slowly. Besides in city ecosystems there are adverse conditions for development of a number of species of parasitic and predatory entomophages [3], especially in cases of distribution of invasive types in the urban environment. Thus, particularly in urban plantings the extremely favorable environment for penetration and distribution of stranger or invasive organisms – invayder- is formed. In the course of formation of an ecological niche after establishment of trophic communications, the invayder quite often gives the strong flash of mass manifolding [6].

Different types of wreckers differently damage oak trees. Results of overseeing for 2013-2017 are given in the table 2.

As shown in the table 2, the primary and secondary pests often arrive under the genus **Lepidobalanus** than oaks under the genus **Erythrobalanus** particularly damaged species is the *Q. robur* L., *Q. mongolica* Fisch., *Q. dentata* Thunb., *Q. macranthera* Fisch. et Mey. *Q. longipes* Stev.

Heavily damaged trees are found in all districts of Bishkek, Cant, Tokmok, Sokuluk. Particularly, plants growing along motor roads subject to damage.

It is noteworthy bad condition of the oak trees in Bishkek, having average category of state from shares of the defective trees on the main wreckers of 69%, and in Tokmok, Kant and in Sokuluk their number decreases and the condition of trees is slightly better.

Table 2. The degree of damage of oak trees on points.

The degree of damage points							
<i>Quercus imbricaria</i> Michx.	II	II	-	-	I	I	-
<i>Q. borealis</i> Michx. f.	-	-	I	-	I	I	-
<i>Q. serrata</i> Thunb.	II	I	-	-	II	I	-
<i>Q. castaneifolia</i> C. A.M	III	III	I	I	-	-	-
<i>Q. macranthera</i> Fisch. et Mey	III	IV	I	I	I	I	-
<i>Q. cktata</i> Thunb.	III	I	II	I	II	I	I
<i>Q. hartwissiana</i> Stev.	I	-	I	-	I	I	-
<i>Q. robur</i> L.	VI	III	III	II	II	III	II
<i>Q. macrocarpa</i> Michx.	VI	II	III	I	II	II	I
<i>Q. erucifolia</i> Stev.	V	II	I	I	II	I	I
<i>Q. pubescens</i> Willd.	VI	II	I	I	I	II	-
<i>Q. mongolica</i> Fisch.	IV	I	I	II	II	III	II
<i>Quercus acuminata</i>	V	I	II	I	I	I	I
<i>Q. imeretina</i> Stev.	VI	III	II	-	-	-	I
<i>Q. longipes</i> Stev.	V	III	I	I	-	-	I
<i>Q. petraea</i> Liebl.	I	-	I	-	-	I	-
<i>Q. muehlenbergu</i> Engelm.	III	I	II	I	I	I	-
<i>Quercus variabilis</i> Bl	II	-	II	I	II	II	-

Note: 0 – not corrupted, I-II – slightly damaged, III-IV – moderately damaged, V-VI – badly damaged.

Conclusion

On the basis of the conducted research the species composition of the oak plantings in Bishkek were studied. In the course of work there were identified 19 species and forms of oak introduced from different geographical regions of the globe. They belong to 2 sections of the subgenus **Erythrobalanus Spach.** and 4 sections of the subgenus **Lepidobalanus Endl.**

Species composition, bio-ecology of major pests (primary and secondary) and the degree of damage of oak trees were identified. The insects – phyllophagous, miners and xylophagous and damaging leaves and trunk are of particular danger. The phyllophagous and miners belong to the group of primary pests, as they are the first to populate the plants, weaken them and dramatically reduce the decorative appearance.

These studies can form the basis for improving the state of urban ecosystem, developing a concept and techniques for combating specific pests.

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