The phylophagous of woody plants of genus Ulmus in protective plantings of arid zone

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Abstract. Creating of long-lasting, normally developing plantings on the urbanized territories in the arid zones is difficult. The main tree species are elm (Fam. Ulmaceae – more than 70% of tree composition). They have a high drought and salt tolerance, rapid growth. They are widely used in the creation of artificial forest plantings in steppes and deserts. The main part of the plantations was created in the 50-60 years of 20th century. Today the aging of plants is observing. Trees of this age lose their physiological and decorative potential as well as resistance to pests under intensive anthropogenic impact. At the forest pathology research about 90 % of the plants of elm species of plantings of various types and categories were identified to be in poor condition. Leaf-eating pests play an active role in the deterioration of their sanitary state. Xanthogaleruca luteola (Müller, 1766), Cladius ulmi (Linnaeus, 1758), and Aproceros leucopoda (Takeuchi, 1939) have a special harmfulness as well as the regularity of the local centers among the mass phylophagous of plants of the family. The last two species were discovered in artificial plantations for the first time. The destructive effect of those pests on certain types of elm plants is uneven.

1. Introduction

One of the most important conditions of the functional stability of agrolandscapes and urbolandscapes is the variety of biota inhabiting them [1, 2, 3, 4]. However, environmental problems which aggravated in recent decades, have led to the destruction of biocenotic relations [4, 5, 6, 7]. That has caused the disappearance of a number of organisms and sharp reduction in the number of useful biota. The widespread of herbivorous arthropods which previously had no economic value occurs now. The violation of regulatory mechanisms of ecosystem leads to the formation of a group of pests that relatively small in species, but well adapted to new ecological conditions [6, 8, 9, 10, 11]. The weakening of the natural mechanisms promoted the appearance of new aggressive biotypes of harmful species in ecosystems [5, 8, 9, 12].

The release of environmental stress is possible if the optimal biodiversity is sustained in ecosystems. This state is achieved through the creation of plantations of different functional purpose with the participation of introduced woody plants [1, 2, 9, 7, 12].

The important role in the formation of new communities play local, abundant types of dendrobiots which find optimal conditions for life here [1, 2, 6].
2. Methodics
Research was realized in the arboretum complexes, forest nurseries, forest seed plantations of Federal Scientific Centre of Agroecology, Complex Meliorations and Protective Afforestation of the Russian Academy of Sciences and in plantings of urban areas. Forest pest monitoring was conducted in the plantings of different types and environmental categories with the participation of woody plants of the families Ulmaceae. Reconnaissance surveillance was carried out with the definition of the sanitary status of planting to determine the phylophagous. Detailed oversight was realized to determine the causes of changes in the status of forest plantations and populations of harmful insects.

Gathering of material was carried out using standard techniques (entomological mowing; visual accounting of the insects on the branches of length 0.5 running meter; 100 leaves) during the vegetation period [1, 3, 11]13. The species which damaged more than 50% of the leaves in the crown of woody plants were related to mass pests. Defoliation degree of plants was determined visually according to the basic methodological criteria [14].

3. Results and Discussion
The polyphagous species such as Lymantria dispar (Linnaeus, 1758), Euproctis chrysorrhoea (Linnaeus, 1758), Archips crataegana (Hübner, 1796-1799) и Agapeta hamana (Linnaeus, 1758), Geometra papilionaria (Linnaeus, 1758), Lycia hirtaria (Clerck, 1759), Alsophila aescularia (Denis & Schiffermuller, 1775), Nymphalis polychloros (Linnaeus, 1758) etc. are typical inhabitants of forest ecosystems in arid zone; they were identified to dominate among phytophagous - inhabitants of economically valuable trees and shrubs (52.9% of the species richness). A lot of those insects periodically have outbreaks and they damage the foliage in tree crowns by 70-100%.

The level of the abundance of species of specific communities of dendrobionts in the plantings of different ecological categories varies. Dendrophages which inhabit woody plants of the generic complex Ulmus L. (66 species) are characterized by high taxonomic abundance of communities.

Representatives of four environmental groups participates in the formation of specific communities of arthropods (Fig. 1). Group of pests of generative organs (1-3) and root systems (2-5 species) of plants are characterized by the lowest species abundance. The population of pests of branches and stems (24 species) a few more varied. Pests of assimilation apparatus (17-48 species, 53,1-77,4%), form the basis of the faunal abundance of the population of dendrobionts.

There are animals among them which can be occurred in plantings with high quantity. They form the centers of mass reproduction and cause severe damage.

The research identified complexes of the most numerous species of phylophagous of elm; they are typical for different types of plantings in arid conditions.

Their composition and quantitative abundance in plantings of different natural zones are markedly different (Table 1, 2, 3). More multicast entomocomplexes support the plantings of steppe and semidesert zones. The population of phylophagous the least various in the planting of the dry steppe zone.

Analysis of the quantitative abundance of the main species of dendrobionts demonstrated a strong dependence of this indicator on the environmental conditions of regions. During the transition from steppe to dry steppe the number of important pests in plantations was reduced on 70.5-85.2 %. but the number of pests increases 7.3 - 30.9 times with the movement into the semi-desert zone. More clearly, this tendency appears among arthropods which inhabit roadside and recreation and landscaping areas. due to specific environmental conditions (pollution of environment, microclimate, etc.). But identification of the exact causes of this phenomenon requires a detailed study.
Figure 1. Structure of community of dendrobionts of plants of generic complex of Ulmus L.

Table 1. Traits of the composition and abundance of the main phyllophagous of elm in plantings of the steppe zone, specimens / units of account.

| Family and genus of arthropods | Kind of plantings                      | Dendrological collections | Field protective | Roadside | Recreation and landscape |
|--------------------------------|----------------------------------------|---------------------------|------------------|----------|--------------------------|
| Cicadellidae                   |                                        |                           |                  |          |                          |
| Oncopsis scutellaris Fieb.     |                                        | 3.5±0.2                   | 9.9±0.1          | 12.7±0.2 | 28.2±0.6                 |
| Curculionidae                  |                                        |                           |                  |          |                          |
| Polydrosus inustus Germ.       |                                        | sporadic                  | 10.7±0.3         | 14.2±0.1 | 17.9±0.2                 |
| Tenthredinidae                 |                                        |                           |                  |          |                          |
| Aproceros leucopoda Hart.      |                                        | 1.5±0.03                  | 68.1±0.9         | 64.2±0.5 | 4.7±0.06                 |
| Cecidomyiidae                  |                                        |                           |                  |          |                          |
| Physemocercis ulmi Kieffer     |                                        | sporadic                  | 16.2±0.3         | 19.7±0.08| 7.3±0.2                  |

A fact of significant differences in taxonomic composition of the groups of major phyllophagous in different types of plantings in different natural areas requires attention. So, common species in roadside, recreation and field protecting planting in the steppe zone are Polydrosus inustus (Schoenh, 1834) and Physemocercis ulmi (Kieffer, 1909). Here Aproceros leucopoda (Takeuchi, 1939) and Cladius ulmi (Linnaeus, 1758) [11, 12, 15-18] were discovered for the first time. Local outbreaks of those pests was noted in the Southern and Eastern districts of Samara region. Larvae of the first generation of sawflies destroyed about 85% of the leaves in the crown of trees in field protective plantings. The foliage was completely destroyed in separately standing elms and in row 3-4-row roadside plantings.
Table 2. Traits of the composition and abundance of the main phyllophagous of elm in plantings of the dry steppe zone, specimens / units of account.

| Family and genus of arthropods | Kind of plantings | Dendrological collections | Field protective | Roadside | Recreation and landscape |
|-------------------------------|-------------------|---------------------------|----------------|----------|------------------------|
| Aphididae                     | Tetrameura ulmi L. | 2.6±0.09                  | 22.3±1.1        | 8.9±0.1  | 5.8±0.3                |
| Tortricidae                   | Peronea boscana F. | sporadic                  | 17.6±0.2        | 6.3±0.1  | 4.8±0.3                |
| Notodontidae                  | Dicranula ulmi Schiff. (units / 1 running meter) | sporadic | 24.1±0.9 | 23.6±0.2 | -                     |

Table 3. Traits of the composition and abundance of the main phyllophagous of elm in plantings of the semi-desert zone, specimens / units of account.

| Family and genus of arthropods | Kind of plantings | Dendrological collections | Field protective | Roadside | Recreation and landscape |
|-------------------------------|-------------------|---------------------------|----------------|----------|------------------------|
| Cicadellidae                  | Cicadella viridis L. | 4.7±0.2                  | 3.1±0.01        | 14.2±0.6 | 59.5±3.1               |
| Aphididae                     | Colopha compressa Koch. | 2.7±0.6                  | 7.1±0.03        | 29.2±0.8 | 5.3±0.2                |
| Aphididae                     | Tetrameura ulmi L. | 6.4±0.5                   | 22.3±0.9        | 8.8±0.1  | 3.0±0.04               |
| Chrysomelidae                 | Galerucella luteola Mull. | 10.7±0.5                 | 227.6±0.5       | 158.9±1.2 | 95.1±1.5              |
| Cecidomyiidae                 | Janetiella lemei Kieffer | 2.8±0.1                  | 29.5±0.3        | 32.9±0.7 | 16.5±0.2              |
| Aphididae                     | J. nervicola Kieffer | 5.3±0.06                 | 14.2±0.4        | 21.2±0.3 | 9.0±0.5                |
| Eriophyidae                   | Eriophyes filiformis Nal. | 3.1±0.04                 | 23.5±0.7        | 10.2±0.1 | 8.1±0.3               |
| Eriophyidae                   | E. ulmicola Nal.  | 5.9±0.1                   | 44.9±0.3        | 9.7±0.5  | 7.7±0.1               |

Sawflies caused significant damage of elms in multibreed multifunctional plantings of tight construction as well as in arboretum. The amount of damaged leaves in the crown was about 45-57%, respectively. *U. pumila* was damaged by pest significantly.

*Tetrameura ulmi* (Linnaeus, 1758) and *Acleris boscana* (Fabricius, 1794) are common phytophagous of woody plants of genus *Ulmus* in plantations of the dry steppe zone. They are more numerous in protective forest belts (14.8 and 11.6 specimens / accounting units correspondingly). In recreation and landscaping plantings their quantitative abundance was 65-72% and 34-46% and less. In the arboretum *A. boscana* met only in separate trees, its density was 0.2-0.5 specimens / accounting units. Settlements of *T. ulmi* were recorded in trees neighbouring elder. It populated about 85% of leaves in the lower part of the crown.

*Dicranula ulmi* (Denis & Schiffermuller, 1775) dominated in forest belts and massive plantations of different ages, especially in heavily eroded areas. Local foci of the pest were located in the plantings on the right bank of the Volga along the Volga elevation. *Ulmus parvifolia* and *Ulmus laevis* were the main target of that pest. Caterpillars eat away the tissue of leaves, but they left intact the main and lateral veins. Damage of the assimilation apparatus was 95% at the average.

*Xanthogaleruca luteola* (Müller, 1766) had caused maximum damage to elm in plantations of semi-desert zone. The outbreak of that pest continues since 2013.

In these conditions, the elm-leaf beetle damages in three generations, overlapping each other. The
pest populates leaves in the tree crown by groups of 5-8 individuals. The major part of the larvae in the latter stages of development lives single. Individuals of the first generation damage more than 60% of the area of the leaf lamina by the end of May. By the end of the development of the second generation almost all the leaves in the trees are destroyed.

High quantitative abundance of *X. luteola* in different types of plantations is caused by the poor condition of the trees. Plantings were created in the 50-60th years of the last century. Currently, there are more than 80% of highly weakened and drying trees.

A group of subdominant, which is presented by aphids and galls, is quite numerous in these plantings – 141.5 and 117.4 specimens / accounting units. In landscaping plantings, *Cicadella viridis* (Linnaeus, 1758) was characterized by increase in number – 59.5 specimens / accounting units.

Trophic complex of phyllophagous in plants of the dendrological collection of semi-desert region includes representatives of different ecological groups of arthropods. The quantitative abundance of individual species and whole community of that area lower on 69.7-78.8% in common than the same parameter in plantings in other natural zones.

Representatives of the genus *Ulmus* is among the main breeds for protective afforestation in the conditions of arid zone. They differ from other woody plants by higher drought tolerance, salt tolerance and rapid growth. However, at present a strong weakening and drying of the representatives of this kind are recorded in many plantings. Those processes are caused by activity of insects-phyllaphagous.

There is an urgent necessity to develop ecological forecasting, which allows to evaluate the status of protective plantations, to provide further development of the succession process and to plan activities for enhance the biological stability of plantings. That way is realizable if information (primarily) about the peculiarities of the composition and the quantitative abundance of the most important phyllophagous in different types of elm is available. Therefore, we undertook a research of the population by pests of the most common plants of semi-desert zone, such as *U. pumila*, *U. laevis* and *U. foliacea*.

Observations have shown that the quantity of the group of dominants in different species of *Ulmus* varies greatly. Higher levels of those parameters are defined *U. pumila*. The abundance of phyllophagous on other types of elm less than there. *U. laevis* differs that in a greater degree.

Different types of leaf-eating insects respond to species of *Ulmus* as a feed tree incertainly. For example, *X. luteola* and *D. ulmi* accumulate mainly in *U. pumila*. *Physemocecis ulmi* prefers *U. grabra*. Abundance of *Eriophyes ulmicola* (Nalepa, 1898) in *U. pumila* and *U. scabra* practically did not differ, but their density in *U. laevis* decreased 1.3-1.9 times. At the same time, *E. filiformis* (Nalepa, 1898) does not show marked attachment to any species of Ulmus.

4. Conclusions

The specific complex of pests, which is based on leaf-eating insects (53.1-77.4 % of species richness of dendrobionts) is formed in the crowns of tree species of Ulmaceae.

Environmental conditions of the region affect the numerical abundance of the major species of phyllophagous. The number of important pests in plantations is reduced by 70.5-85.2% when move from the steppe to dry steppe, whereas in the direction of the semi-desert zone their number is growing at 7.3… 30.9-times.

*Aproceros leucopoda* Takeuchi. and *Cladius ulmi* L. first discovered in the crowns of tree species of Ulmaceae in roadside, recreational and landscape plantings as well as in field-protecting plantings.

The most abundant species were differed among the population of the insects, such as *Xanthogaleruca luteola* Müller, *Dicraneura ulmi* Den. ett Schiff., *Aproceros leucopoda* Takeuchi, and *Cladius ulmi* L.; they formed local foci in plantations of various types and categories. Their destructive effect varies at the level of 60-100% of destroyed foliage in the crowns of trees.

The abundance of phyllophagous on different types of elm is uneven. *Ulmus pumila* is the most attractive tree for pests. That species acts as a as a feed tree for *Xanthogaleruca luteola* Müller, *Dicraneura ulmi* Den. ett Schiff., *Physemocecis ulmi* Kieffer, and *Eriophyes ulmicola* Nal.
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