Plant communities with *Ulmus japonica* (Rehd.) Sarg. in Eastern Transbaikalia

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Abstract. The article presents the data of long-term studies of communities with *U. japonica* in Eastern Transbaikalia, in particular, the results of anatomical studies, floristic, ecological and biological, biomorphological and arealogical analysis of the flora of elms.

The problem of biodiversity conservation is one of the main research areas. One of the main tasks is a comprehensive analysis of ecosystems, their preservation and maintenance in their natural state. The elms – the communities with domination of *Ulmus pumila* L., *U. macrocarpa* Hance, *U. japonica* (Rehd.) Sarg. – are relict and are of particular interest as representatives of nemoral vegetation [2, 3]. On the territory of Eastern Transbaikalia they survived as a trace which the once were the continuous extension of deciduous forests of the Tertiary period. The study of the floristic composition, ecology and phytocenology of the elms is interesting both theoretically and practically. The elms are of great value for elucidating the issues of the evolution and history of the formation of flora and vegetation not only in the region, but in general for the eastern sector of the Palaearctic.

*U. japonica* – a common, Japanese, valley elm – is a summer-green deciduous tree. The plant is a tree 15-20 m tall or a large shrub – 3-4 m tall. The trunks are light grey; the bark of the branches is grayish-brown, often with cork outgrowths. The buds are bare. The leaf petioles are 2-9 mm long. The leaves are in-oviform, with a gradually drawn-out pointed tip and with an unequally wedge-shaped base, twice or thrice toothed along the edge, 1.5-9.5 (12) cm long and 1.5–3.5 (5) cm wide, almost bare, from below with a tuft of hairs at the base of secondary veins. The latter almost do not branch (dichotomize). The flowers are bisexual on very short peduncles, in bunches. The samaras are 1.2–1.7 cm long, 5–7 mm wide, in-oviform, with a seed at the base of the upper notch [2]. In Eastern Transbaikalia it is found along the valleys of the Argun, Shilka and Chikoy rivers.

The distribution of *U. japonica* is mainly associated with mesophilic forest formations. The formation of the structure of plant organs is in direct dependence to the living conditions. To reveal the ecological adaptation of *U. japonica*, we studied the structure of the mesophyll, the thickness of the cuticle and the epidermis, since these indicators are informative in order to identify the adaptability of plants to environmental conditions.

*U. japonica* is an East Asian species that grows along river and springs valleys, in bush thicket. The leaf of this species is mesomorphic with a thin leaf blade, dorsoventral. The cells of the upper and lower epidermis are the same in outline with small differences in size: the upper ones are slightly larger than the lower ones, they are of elongated form. The cell walls of the epidermis are almost even. The cuticle and trichomes are absent. The stomatal apparatus is of an anomocytic type. The mesophyll...
is composed of 2–3 rows of palisade tissue cells underlying the upper epidermis and of two rows of loose spongy tissue cells with a large number of intercellular spaces. The cells of spongy tissue are of elongated oval shape. The conductive bundle of a semi-lunar shape is surrounded by 1–2 rows of mechanical tissue.

The analysis of the anatomical structure of the *U. japonica* leaf reflects the adaptation to the conditions of existence. So the distribution of stomata on the surface of the leaf blade has an adaptive meaning and depends on the illumination. In *U. japonica*, which grows in conditions of sufficient moisture, the stomata are located both on the upper and lower sides of the leaf.

The adaptation of plants to various environmental conditions is also manifested in the structure of the mesophyll. The species of the genus *Ulmus* are characterized by the dorsoventral type of mesophyll. According to M G Buinova, N K Badmaeva, L K Bardonova [1], the differentiation of the mesophyll into columnar and spongy tissue is noted with increased radiation and indicates xeromorphism. The excess in volume of palisade tissue over spongy one is also a sign of xeromorphism. The large number of intercellular spaces in the spongy tissue in *U. japonica* indicates the mesomorphic nature of this species.

The systematic structure of the elms flora is characterized by high heterogeneity, which is expressed in a relatively high species richness, by a high percentage of the participation of single-species families, as well as a high percentage of the participation of leading families. The basis of the elms flora in Eastern Transbaikalia is made up of angiosperms, numbering 173 species (98.8%), among which the dicotyledonous of 145 species (81% of the total number of angiosperms) predominate, monocots include 31 species (19%). The participation of spore plants is minimal (1.7%). In communities with *U. japonica*, the first place is occupied by the *Rosaceae* family (20.0%). The second place is taken by the *Asteraceae* family (10.0%), the third – *Fabaceae* (8.5%). The families *Lamiaceae* and *Scrophulariaceae* are absent (table 1).

| №  | Family           | Elms with *U. japonica* % | rank |
|----|------------------|---------------------------|------|
| 1  | Asteraceae       | 10.0                      | 2    |
| 2  | Rosaceae         | 20.0                      | 1    |
| 3  | Poaceae          | 6.0                       | 4–5  |
| 4  | Fabaceae         | 8.0                       | 3    |
| 5  | Liliaceae        | 4.0                       | 6    |
| 6  | Ranunculaceae    | 6.0                       | 4–5  |
| 7  | Caryophyllaceae  | 2.0                       | 7    |
| 8  | Lamiaceae        | -                         | -    |
| 9  | Apiaceae         | 6.0                       | 4–5  |
| 10 | Scrophulariaceae | -                         | -    |
| 11 | Cyperaceae       | 2.0                       | 7    |
|    | Total (%)        | 64.0                      |      |

Table 1. Correlation of the main families in the flora of the elms with *U. japonica*.

Total species: 50

More than half of all families in all elms is characterized by the minimum species richness, from 1 to 3 species, which is typical for floras developing in harsh conditions of existence. The share of small-species genera accounts for 30.0%, 70.0% of genera are single-species.

A small percentage of the participation of xerophytes (10.0%) and petroxerophytes (6.0%) – in the flora of the elms with *U. japonica* – indicates their confinement to river valleys in the territory of Eastern Transbaikalia (table 2).

| Ecological group          | Number of species | % of the total |
|---------------------------|-------------------|----------------|

Table 2. Correlation of ecological groups in the flora of the elms with *U. japonica*.
Mesoxerophytes  33  66.0
Xerophytes    5    10.0
Petroxerophytes  3    6.0
Mesophytes    6    12.0
Succulents    2    4.0
Hygrophytes   1    2.0
Total species:  50

At the same time, in the elms with *U. japonica* the dominant species are chiefly of mesophilic nature (*Maianthemum bifolium* (L.) F. W. Schmidt, *Trifolium repens* L., *Urtica angustifolia* Fisch.ex Horneman, etc.).

A rather high percentage of participation of species of mesophytic nature is explained by the microclimatic conditions of cenoses. In addition, this can be explained by the physical and geographical position of Eastern Transbaikalia, which is limited from the influence of the humid air masses of the Pacific and Atlantic oceans. It indicates the continentality of the elms flora and its mountainous character.

The analysis of the diversity of biomorphs (table 3) showed the predominance of herbaceous polycarpics (80.0%) over woody and semi-woody forms (15.8%) in the flora of elm trees.

**Table 3. Correlation of life forms in elms with *U. japonica.***

| Life form                          | Number of species | % of the total |
|-----------------------------------|-------------------|----------------|
| Woody                             |                   |                |
| Trees                             | 3                 | 6.0            |
| Shrubs                            | 10                | 20.0           |
| Total:                            | 13                | 26.0           |
| Semi-woody                        |                   |                |
| Semi-shrubs                       | –                 | –              |
| Small semi-shrubs                 | –                 | –              |
| Total:                            | –                 | –              |
| Terrestrial grassy polycarpics    |                   |                |
| Rod-rooted rosetteless            | 10                | 20.0           |
| Rod-rooted half-rosette           | 6                 | 12.0           |
| Rod-rooted rosette               | 2                 | 4.0            |
| Short rhizomed                    | 10                | 20.0           |
| Short rhizomed                    | 5                 | 4.0            |
| Bulbous                           | –                 | –              |
| Pillar-forming                    | 1                 | 2.0            |
| Tuberous                          | –                 | –              |
| Liana                             | 1                 | 2.0            |
| Total:                            | 35                | 60.0           |
| Monocarpics                       |                   |                |
| Annuals                           | –                 | –              |
| Biennials                         | 2                 | 4.0            |
| Perennials                        | –                 | –              |
| Total:                            | 2                 | 4.0            |

In elms with *U. japonica*, the first place is shared by rod-rooted rosetteless and short-rhizomed polycarpics (20% each). The high percentage of participation of short-rhizomed plants in the flora of elms (20.0%) confirms the forest nature of these communities, because this group of plants is drawn towards meadows and grassy forests.
We used the scheme proposed by L I Malyshev and G A Peshkova [4] to analyse the ecological and geographical structure of the elms of Eastern Transbaikalia. The species of the forest floristic complex dominate in elms with *U. japonica*, which emphasizes the more mesophytic growing conditions of these communities (table 4).

**Table 4.** Correlation of belt-zonal groups in the flora of elms with *U. japonica.*

| Floristic complex    | Belt-zonal group | Number of species | % of the total |
|---------------------|------------------|-------------------|----------------|
| Forest              | LCF<sup>a</sup>  | 13                | 26.0           |
|                     | PB<sup>b</sup>   | 10                | 20.0           |
|                     | Total            | 23                | 46.0           |
| Steppe              | MS<sup>c</sup>   | 9                 | 18.0           |
|                     | FS<sup>d</sup>   | 9                 | 18.0           |
|                     | SP<sup>e</sup>   | 4                 | 8.0            |
|                     | DS<sup>f</sup>   | –                 | –              |
|                     | Total            | 22                | 44.0           |
| Azonal              | WB<sup>g</sup>   | 2                 | 4.0            |
|                     | M<sup>h</sup>    | 1                 | 2.0            |
|                     | RB<sup>i</sup>   | 2                 | 4.0            |
|                     | Total            | 5                 | 10.0           |
| High-mountainous or mountainous of general belt | Alp<sup>j</sup> | –                 | –              |
|                     | GAM<sup>k</sup>  | –                 | –              |
|                     | Total            | –                 | –              |
| **Total species:**  |                  | 50                |                |

<sup>a</sup> light coniferous forest.
<sup>b</sup> preboreal.
<sup>c</sup> mountainous-steppe.
<sup>d</sup> forest-steppe.
<sup>e</sup> steppe proper.
<sup>f</sup> desert-steppe.
<sup>g</sup> water-bog.
<sup>h</sup> meadow.
<sup>i</sup> riverbed.
<sup>j</sup> alpine.
<sup>k</sup> hyparctic-mountainous.

The light-coniferous-forest and preboreal species have practically the same percentage of participation within the complex (26.0 and 20.0%, respectively). The second place is occupied by the steppe complex of species, within which the mountain-steppe species share the first – second place with the forest-steppe ones. An insignificant percentage of participation (8.0%) falls on the actual steppe species. The species of the azonal floristic complex rank third (10%).

The predominance of species of the forest floristic complex in the elms proves the forest origin of the communities. The high percentage of participation of the light-coniferous-forest group (26.0%) in the cenoses indicates that the flora of this group corresponds to modern zonal and climatic conditions. The analysis of the elms flora areal (chorological) groups was carried out to identify the role of various floristic centres in the composition of Eastern Transbaikalia (table 5). As a basis we used the scheme of L I Malyshev and G A Peshkova [4].

**Table 5.** Correlation of areal groups in elms formed by *U. japonica.*

| Areal (chorological) group | Number of species | % of the total |
|---------------------------|-------------------|----------------|
Circumpolar or boreal holarctic & 4 & 8.0 \\
American Asian & 1 & 2.0 \\
Euro-Asian & 9 & 18.0 \\
Pan-Asian & 2 & 4.0 \\
North Asian & 7 & 14.0 \\
South Siberian and Mongolian & 4 & 8.0 \\
Central Asian & 1 & 2.0 \\
North East Asian & – & – \\
East Asian & 8 & 16.0 \\
Endemic & – & – \\
Eurosiberian & 4 & 8.0 \\
Manchurian-Daurian & 6 & 12.0 \\
Okhotskaya & 4 & 8.0 \\

A comparative arealogical analysis of the elms showed that the Eurasian group of species occupies the first place in the elms formed by *U. japonica*.

The Eurasian group of species is closely related to species common in the nemoral (preboreal) and forest-steppe zone of the European part of Russia. The high percentage of the Eurasian group indicates that the roots of origin of related species lie in the Tertiary Turgai flora. The second place belongs to the East Asian species, the third – to the North Asian ones. A significant number of species of the same origin with the elms have preserved as a result of the favourable conditions that the elm bushes are able to create under their canopy.

We classify elms from *U. japonica* as forest vegetation, because they are characterized by the dominance of single-trunk trees growing close to each other. The total density of the stand is about 80-90%. The elms form coastal forests with high density (up to 0.9) dominated by single-trunk trees. The forest nature of these cenoses is confirmed by the studies of A S Pleshanov [5]. The undergrowth in such forests is formed by *Ribes nigrum* L., *Rubus sachalinensis* Lev., *Rosa acicularis* Lindley, *Salix rorida* Laksh., *Swida alba* (L.) Opiz. In addition, species of the forest floristic complex dominate here (46.0%), it also indicates the forest nature of these communities.

Thus, in the species of the genus of elm (*Ulmus*) there is a correspondence of ecological and physiological characteristics both with the historical processes of adaptation of relict species of Eastern Transbaikalia and with their modern geographical distribution.

**References**

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