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COMPREHENSIVE ASSESSMENT OF HERITAGE PARKS' PLANTATIONS OF ZHYTOMYR REGION, UKRAINE

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Abstract

In this article it is considered the current state of heritage parks of the Zhytomyr region. We conducted an ecological, geographical, phytosociological, and taxonomic analysis of trees and shrubs in 6 parks out of 18, according to Kolesnikov, Takhtajan, Vernander and others. In heritage parks, 71 species and 3 varieties of trees and shrubs were revealed, belonging to 44 genera, 20 families, which come from five floristic regions. The most abundant Magnoliophyta family is Rosaceae, which is represented by 21 species (28.2 % of the total number of species). We analyzed the correspondence of woody plants to the conditions of their growth. A lot of species that did not fit soil types were planted in heritage parks. About 20 % of megatrophs grow in soils with low fertility. More than 84 % of the tree species of the parks belong to the Red List of the International Union for Conservation of Nature, and only one species is endangered. The aesthetic evaluation of plantations is low. We recommend cutting diseased and weakened trees and shrubs, also planting highly decorative bio-groups. It is offered a list of trees and shrubs recommended for planting in old parks in the Zhytomyr region.

Key words: aesthetic evaluation, floristic region, woody plants, zonal type of forest conditions.

Introduction

Heritage parks are objects of historical, cultural, and architectural legacy. There are more than 400 old parks in Ukraine (Kuznetsov and Klymenko 2003), 18 of which are located in the Zhytomyr region. A significant part of them was created in the seventeenth and nineteenth centuries.

The old parks of the region are closely connected with events in the life of prominent people of the Russian Empire: an anthropologist, ethnographer, geographer N.N. Miklouho-Maclay, descendants of the Crimean War hero V.I. Istomin, a well-known family of patrons of art Tereshchenko, poet Count Gustav Olizar and others. In this regard, it is important to carry out reconstruction and restoration work, taking into account the intentions of their owners in the past.

In the second half of the twentieth century, in connection with the reconstruction, initiated by the authorities of that time, the structure of many parks has changed significantly. Mostly the work was carried out without taking into account the intentions of their founders. As a result, most

of the objects lost their former landscape appearance. Quiet and calm in their functional purpose, the old parks were reformed into culture and recreation parks. Attractions, children's and sports grounds were installed on their territory (Markov 2015).

Today in Ukraine, architects are mainly engaged in the restoration of parkland, the main attention is paid to the restoration of architectural objects (buildings, fountains, arbours, etc.). At the same time, the overall historical appearance of the park is narrowed, because the main material of the architectural composition of the historical park is vegetation according to the Florence Charter (1982).

To carry out the reconstruction and restoration of plantations, it is first necessary to conduct an inventory of the composition of trees and shrubs, to assess their current condition. Issues on the restoration of plantings of historical landscape gardening objects are considered in the works of Kucheriavyi (2017), Rubtsov (1974, 1977), Kuznetsov and Bahatska (2011), Klymenko (2012), Dudyn and Bahatska (2012) and others.

A succession of plants of old parks is generally not investigated. There is no information about the taxonomic composition of vegetation, the compliance of plants with their environmental conditions, as well as the aesthetic value of landscape ensembles.

The aim of the work is a comprehensive analysis of woody plants of 6 ancient parks of the Zhytomyr region (Yulino, Miklouho-Maclay, Korostyshivskyi, Vilkhivskyi, Turchynivskiy and Chervonskiy), assessment of their compliance with environmental conditions, and aesthetic assessment of parks.

Material and Methods

Materials for the study were collected during 2015–2018. The taxonomic composition of trees and shrubs was studied by route surveys not only following the existing paths, plants were determined using atlases and reference books (Rubtsov 1974, Brodovich and Brodovich 1979, Kokhno et al. 2002). The distribution of trees and shrubs by ecological groups was carried out according to Kolesnikov (1974). The geographical analysis was performed by the botanical-geographical division of the world according to Takhtajan (1987).

Assessment of soil fertility was carried out according to the method of Vernander et al. (1951). Sod podzol, soddy gley sandy loam, and clayed sand soils are characterized by a small depth of the humus horizon (up to 25 cm) and low humus content (0.85 %). Grey forest podzolized clayed soils relate to soils with low fertility. Their upper layers are poor in organic and mineral colloids having a sprayed structure (Vernander et al. 1951).

The relationship between climate and types of forest conditions necessitated the creation of a forest typological classification of climates, which is based on the soil-hydrological classification of Alekseev-Pogrebnyak (Herushynskyi 1996). To determine the relationship between climate and types of forest conditions, Vorobiov (1953) proposed the empirical formula (1) used in our work.

$$W = \frac{R}{T^\circ} - 0{,}0286 \times T^\circ, \qquad (1)$$

where: W is an indicator of climate humidity; R is precipitation for the warm period, mm; T° is the sum of positive temperatures to estimate the amount of heat,

°C. The values of *R* and *T*° are average monthly from April to November.

Monthly average plus temperatures and monthly average precipitation are borrowed from the official website of the Ukrainian Hydrometeorological Center (2020).

Analysis of rare species was conducted according to the lists of the International Union for Conservation of Nature (IUCN) and the Red Book of Ukraine (Shaparenko and Shaparenko 2002). The IUCN Commission has developed the following categories for species survival: Extinct (EX), Extinct in the Wild (EW), Critically Endangered (CR), Endangered (EN), Vulnerable (VU), Near Threatened (NT), Least Concern (LC), Data Deficient (DD), Not Evaluated (IUCN 2020). The categories of the Red List of Ukraine are extinct (0), endangered (I), vulnerable (II), rare (III), unspecified (IV), unknown (V), and recovered (VI) (Shaparenko and Shaparenko 2002).

Aesthetic assessment of parklands was carried out on a three-point score scale of Kucheriavyi (2017). This scale has 2 parts: taxation and emotional (were provided by the authors). The first part takes into account landform, soil moisture, growth class, new growth, species composition and density of grass, stand age, forest density, clutter up the territory, signs of soil erosion, soil compaction. The second part takes into account crown closure, depth of perspective, the convenience of movement, colour scheme, wood texture, and shade density.

We selected research objects according to the geobotanical principle (Kuznetsov and Klymenko 2003). Of the 18 old parks of the Zhytomyr region, we chose six of them, which are located in various geobotanical areas, have a large area, and are less explored (Fig. 1).

Results and Analysis

Taxonomic analysis

Based on the collected materials and their analysis, the following was established: in heritage parks were revealed 71 species and 3 varieties of trees and shrubs belonging to 44 genera, 20 families (Table 1).

Pinophyta has 2 families Pinaceae and Cupressaceae, which are represented by four (5.6 %) and two (2.8 %) species of trees and shrubs, respectively. The first family includes *Pinus sylvestris* L., *Pinus nigra* Arn., *Picea pungens* Engelm. and *Picea abies* L. *Thuja occidentalis* L. and *Juniperus sabina* L. belong to the second family.

The most abundant Magnoliophyta family was Rosaceae, which is represented by 21 species (28.2 % of the total number of species). These include *Armeniaca vulgaris* Mill., *Cerasus avium* (L.) Moench., *Cerasus vulgaris* Mill., *Chaenomeles japonica* (Thunb.) Lindl., *Crataegus kyrtostyla* Fingerh, *Malus sylvestris* (L.) Mill., *Pyrus communis* L., etc. Family Salicaceae is represented by 8 species (11.3 %) and one variety: *Salix alba* L., *Salix alba* 'Vitellina Pendula', *Salix babylonica* L., *Salix caprea* L., *Salix fragilis* L., *Salix pentandra* L., *Populus alba* L., *Populus nigra* L. and *Populus tremula* L. The next in the number of representatives of the family, which has 6 species (8.5 %) and one variety, is Fabaceae. They are *Robinia pseudoacacia* L., *Genista tinctoria* L., *Gleditschia triacanthos* L., *Laburnum anagyroides* Med., *Chamaecytisus ruthenicus* (Fisch. ex Vorosch.) Klask, *Caragana arborescens* Lam. and *Robinia pseudoacacia* 'Decaisneana'. Representatives of Aceraceae count 6 species (8.5 %): *Acer platanoides* L. and *Acer*

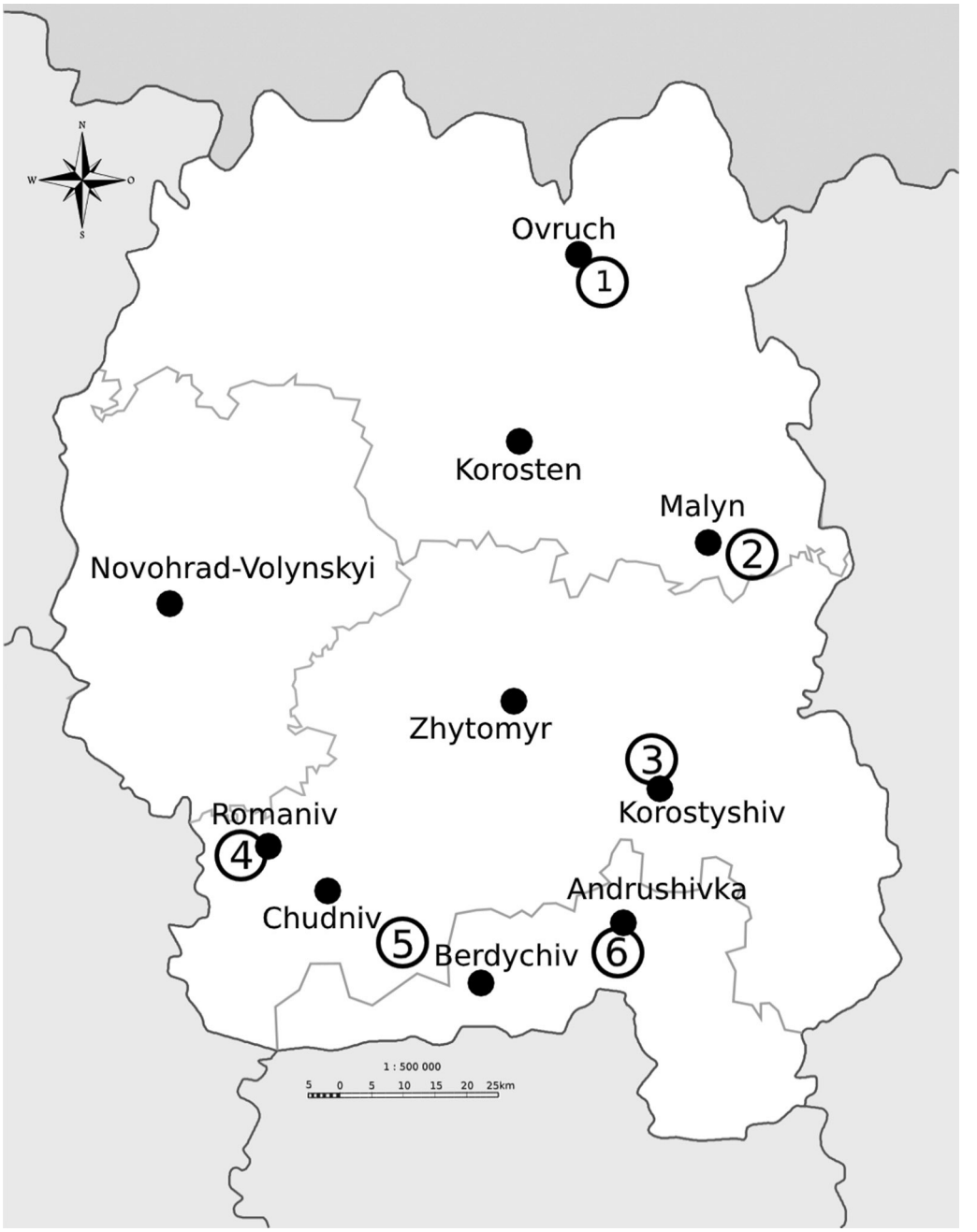

Fig. 1. Scheme of location of objects of research on the map-scheme of Zhytomyr region.

Parks: 1 – Yulino, 2 – Miklouho-Maclay, 3 – Korostyshivskyi, 4 – Vilkhivskyi, 5 – Turchynivskiy, and 6 – Chervonskiy.

negundo L. identified in all studied parks, in some parks found *Acer campestre* L., *Acer pseudoplatanus* L., *Acer saccharinum* L. and *Acer tataricum* L. Representatives of other families occupy less than 5 %.

Table 1. Systematic structure of woody plants of heritage parks of Zhytomyr region.

Families	Genera		Species		Varieties, hybrids	Parks					
	n	%	*n*	%	*n*	Yulino	Miklouho-Maklay	Korostyshivskyi	Vilkhivskyi	Chervonskiy	Turchynivskiy
Pinophyta											
Pinaceae Lindl.	2	4.5	4	5.6	-	+	+	-	+	-	-
Cupressaceae F. Neger	2	4.5	2	2.8	-	-	+	+	-	-	+
Magnoliophyta											
Aceraceae Lindl.	1	2.3	6	8.5	-	+	+	+	+	+	+
Berberidaceae Torr. Et. Gray	1	2.3	1	1.4	-	-	+	-	-	-	-
Betulaceae Agardh	4	9.1	4	5.6	-	+	+	+	+	+	+
Caprifoliaceae Juss.	3	6.8	3	4.2	-	+	-	-	-	-	-
Celastraceae Lindl.	1	2.3	2	2.8	-	-	+	-	-	-	-
Fabaceae Juss.	6	13.6	6	8.5	1	+	+	+	+	+	+
Fagaceae A. Br.	1	2.3	2	2.8	-	+	+	+	+	+	+
Hippocastanaceae Torr.	1	2.3	1	1.4	-	-	+	+	+	+	+
Juglandaceae Lindl.	1	2.3	2	2.8	-	-	-	+	-	+	+
Moraceae Dc.	1	2.3	2	2.8	-	-	-	+	-	-	+
Oleaceae Lindl.	2	4.5	4	5.6	-	-	+	+	+	+	+
Rosaceae Juss.	13	29.5	20	28.2	1	+	+	+	+	+	+
Salicaceae Lindl.	2	4.5	8	11.3	1	+	+	+	+	+	-
Sambucaceae Link.	1	2.3	1	1.4	-	+	+	+	-	+	+
Tiliaceae Juss.	1	2.3	1	1.4	-	+	+	+	+	+	+
Ulmaceae Mirb.	1	2.3	2	2.8	-	+	+	+	+	+	+
Viburnaceae Dum.	1	2.3	1	1.4		+	-	-	-	-	-
Vitaceae Juss.	1	2.3	1	1.4	-	+	+	+	+	+	+
Total	44	100.0	71	100.0	3						

In the 1960s and 1980s, the local authorities of the USSR reconstructed the plantations of most of the ancient parks of Ukraine, including Zhytomyr region. Unfortunately, the planting of trees and shrubs was unsystematic and rarely relied on scientific research. Table 2 lists the plants that have been planted or have settled themselves, and in our opinion do not correspond to the creative ideas of the authors of old parks, because there are non-indigenous species. *Acer negundo* L. and *Acer pseudoplatanus* L. are potentially invasive.

Table 2. List of trees and shrubs in parks planted after 1960.

Species	Parks					
	Yulino	Miklouho-Maklay	Korostyshivskyi	Vilkhivskyi	Turchynivskiy	Chervonskiy
Acer negundo L.	+	+	+	+	+	+
Acer pseudoplatanus L.	-	-	+	-	-	-
Alnus glutinosa L.	+	+	-	+	+	-
Armeniaca vulgaris Mill.	-	+	-	-	+	-
Cerasus avium (L.) Moench.	-	-	-	-	+	-
Cerasus vulgaris Mill.	-	+	-	-	+	-
Malus domestica Borkh.	+	+	+	+	+	+
Populus nigra L.	-	+	+	+	+	-
Populus tremula L.	+	+	-	+	+	-
Prunus divaricata Ledeb.	-	+	-	+	+	+
Prunus domestica L.	+	-	-	+	+	-
Pyrus communis L.	+	+	+	+	+	+
Robinia pseudoacacia L.	+	+	+	+	+	+
Viburnum opulus L.	-	+	-	-	-	-

These species of plants were practically not planted in the parks at the beginning of the XX century, and if they were planted, then in small quantities (Regel 1896). Today, most of these species are dominant (*Acer pseudoplatanus* L., *Alnus glutinosa* L., *Populus nigra* L., *Populus tremula* L., *Robinia pseudoacacia* L.).

Geographical analysis

According to geographical analysis, the species of dendroflora of parks come from Boreal and Mediterranean zones, which included 5 floristic regions (Fig. 2).

The most widespread are species originating from the Circumboreal floristic region. There are 32 taxa (43 %). These are species that grow naturally in Europe, the Caucasus, Siberia, Alaska and Northern Sakhalin: *Juniperus sabina*, *Picea abies*, *Pinus nigra*, *Acer platanoides*, *Acer tataricum*, *Aesculus hippocastanum* L., *Betula pendula* Roth., *Caragana arborescens*, *Lonicera caerulea* L., *Malus sylvestris*, *Sorbus aucuparia* L. and others.

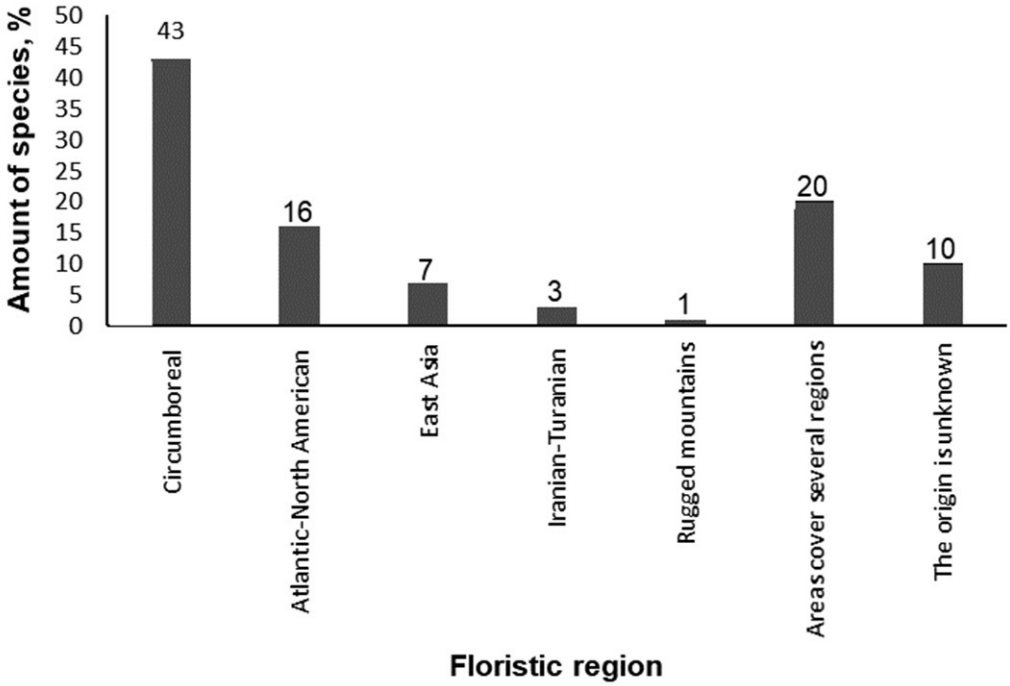

Fig. 2. Distribution of woody plants in parks by floristic regions.

The next place is occupied by species native to the Atlantic-North American floristic region (12 taxa). The natural range of these plants covers the area from the Atlantic coast of North America to the Great Plains and from the Gulf Coast to the southern regions of Canada. These are *Thuja occidentalis*, *Acer negundo*, *Acer saccharinum*, *Fraxinus pennsylvanica* Marsh., *Fraxinus lanceolata*, *Gleditschia triacanthos*, *Juglans nigra*, *Padus serotina*, *Parthenocissus quinquefolia*, *Physocarpus opulifolius*, *Quercus rubra,* and *Robinia pseudoacacia*.

There is a group of plants which ranges cover several floristic regions. *Pinus sylvestris*, *Cerasus avium*, *Corylus avellana* L., *Prunus divaricata* Ehrh.*,* and *Rosa canina* L. belong to Circumboreal and Iranian-Turanian floristic regions. *Acer campestre*, *Berberis vulgaris* L., *Populus tremula* and *Salix alba* belong to Circumboreal and East Asia floristic regions.

A geographical analysis revealed a group of plants whose origin is unknown. These are *Cerasus vulgaris*, *Malus domestica* Borkh., *Malus prunifolia* Borkh., *Prunus domestica* L., *Robinia pseudoacacia* 'Decaisneana', *Salix alba* 'Vitellina Pendula' and *Spiraea vanhouttei* Zabel.

Ecological analysis

When assessing the state of green spaces of old parks, one should take into account the exactingness of tree and shrub species for certain growing conditions. According to the ecological principle of creating a composition, each plant bears the imprint of the geograph-

ical and climatic conditions in which this species was formed. Inconsistency of growing conditions with the needs of plant development is reflected in their appearance. Most plants reveal ornamental qualities completely only in certain conditions. In this regard, we analysed the correspondence of trees and shrubs of old parks in the region to their needs for land fertility (Table 3) and soil moisture (Table 4).

In terms of species, megatrophic plants growing on poor soils in the parks Yulino, Miklukho-Maklay, and Korostyshivskyi, prevail over oligotrophic plants (Table 3). We believe that in these parks, to create bio-groups, it is necessary to select plant species that will maximize their ornamental qualities on poor soils. Grey forest podzolized clayed type of soil is characteristic of Chervonskiy park (Table 3). Here we observe the dominance of plant species that do not require rich soils for their development and growth.

Chernozem-loess and degraded chernozem have sufficiently high fertility. According to the Table 3, the percentage of megatrophs and oligotrophs is distributed in favour of the first.

The zonal climate of forest conditions affects only the formation of loamy soils. All other soil types are intrazonal (Yulino, Miklukho-Maklay, and Korostyshivskyi parks). That's why we determined the zonal type of forest conditions for Vilkhivskyi, Turchynivskiy, and Chervonskiy parks, which are located in the south of the Zhytomyr region.

Table 3. Correspondence of woody plant species to soil conditions.

Park	Soil type	Plants trophotopes, %		
		Oligotrophic	Mesotrophic	Megatrophic
Yulino	sod podzol sandy loam	8.0	68.0	24.0
Miklouho-Maklay	soddy gley sandy loam	13.8	67.2	19.0
Korostyshivskyi	soddy gley clayed sand	20.0	56.7	23.3
Vilkhivskyi	chernozem-loess	12.9	64.5	22.6
Turchynivskiy	degraded chernozem	8.6	62.9	28.6
Chervonskiy	grey forest podzolized clayed	22.2	63.0	14.8

Table 4. Correspondence of park woody plants to humidification conditions.

Parks	Indicator of climate humidity (W)	Zonal type of forest conditions	Plants hygrotopes, %		
			Xerophyte	Mesophyte	Hygrophyte
Vilkhivskyi	1.6	slightly moist	6.5	87.0	6.5
Turchynivskiy	2.6	moist	5.7	88.6	5.7
Chervonskiy	2.6	moist	11.1	88.9	0.0

Table 4 shows the climate humidity calculation results and correspondence of park woody plants to humidification conditions.

Mesophytes are predominant. These plants grow under moderate conditions of moisture. In general, the plant assortment of the studied parks meets humidification conditions.

Phytosociological analysis

The studied parks have the status of parks, the monuments of landscape art, so it is important to identify rare species of woody plants. The phytosociological structure is represented in Table 5.

Table 5. Phytosociological structure of protected woody plants of parks.

Red list	Rarity category	Species number	Species %
International Union for Conservation of Nature	CR	2	2.8
	EN	1	1.4
	VU	2	2.8
	NT	1	1.4
	LC	48	67.6
	DD	6	8.5
	Total	60	84.5
Red Book of Ukraine	III	1	1.4
	Total	1	1.4

Aesthetic evaluation

The aesthetic assessment of the parks is given in Table 6.

Table 6. Aesthetic assessment of parks.

Parks	Assessment of signs, the average score			Aesthetic value class
	Taxation	Emotional	Average score	
Yulino	1.88	1.99	1.94	3
Miklouho-Maclay	1.87	2.11	1.99	3
Korostyshivskyi	2.01	2.01	2.01	2
Vilkhivskyi	1.93	1.96	1.95	3
Turchynivskiy	1.89	1.86	1.88	3
Chervonskiy	1.92	1.89	1.91	3

Table 6 shows that the studied parks have the lowest class of aesthetic assessment, only the Korostyshevsky park has second class. Some sections of the Miklukho-Maklay, Chervonsky and Turchinovsky parks have a second class of aesthetic value, but most territories are represented by a third class.

Discussion

None of the studied parks has the highest class of aesthetic value because care for parkland is almost not carried out. Also, during park reconstruction, plant species that did not fit soil types were planted there, like *Picea abies*, *Acer platanoides*, *Alnus glutinosa*, *Fraxinus excelsior*, *Laburnum anagyroides* Medik., *Populus tremula* L., *Quercus robur* L., and others.

When developing reconstruction projects, it is first of all necessary to eliminate the above mentioned disadvantages, thereby increasing the class of aesthetic value of parks. To increase the class of aesthetic value of parks, we recommend providing a reconstruction of the parklands. When carrying out works on the planting of trees and bushes it is necessary to provide a selection of a range of plants according to their demanding conditions of moistening and soil fertility (Table 7).

Table 7. Recommended list of plants for planting in old parks of Zhytomyr region.

Species	Parks					
	Yulino	Miklouho-Maclay	Korostyshivskyi	Vilkhivskyi	Turchynivskiy	Chervonskiy
Abies balsamea Mill.	-	-	-	+	+	+
Abies fraseri Poir	-	-	-	+	+	+
Abies nordmanniana Spach.	-	-	-	-	+	+
Abies sibirica Ledeb.	-	+	+	+	+	+
Chamaecyparis pisifera Endl.	-	+	+	+	+	+
Ginkgo biloba L.	-	+	+	+	+	+
Juniperus communis L.	+	+	+	+	+	+
Juniperus sabina L.	+	+	+	+	+	+
Larix gmelinii Rupr.	-	+	+	+	-	-
Larix decidua Mill.	+	+	+	+	+	+
Larix laricina K.Koch	+	+	+	-	-	-
Larix sibirica Ledeb.	+	+	+	+	-	-
Picea engelmanni Parry ex Engelm	-	-	+	+	+	+
Picea marianna Mill.	-	-	+	+	+	+
Picea rubens Sargent	-	-	+	+	+	+
Pinus pumila Regel	-	-	-	+	+	+
Pinus strobus L.	+	+	+	+	-	-
Taxus baccata L.	-	-	-	+	+	+
Betula ermanii Cham.	+	+	+	+	+	+
Castanea sativa Mill.	-	+	+	+	+	+
Crataegus nigra Waldst. Et Kit.	+	+	+	+	+	+
Fagus sylvatica 'Purpurea'	-	-	-	+	+	+
Fraxinus excelsior 'Pendula'	-	+	+	+	+	+
Gleditsia triacanthos L.	-	-	-	+	+	-
Gymnocladus canadensis L.	-	-	-	+	+	+
Liriodendron tulipifera L.	-	+	+	+	+	+
Phellodendron amurense Rupr.	-	-	-	+	+	+
Prunus virginiana L.	+	+	+	+	+	+
Quercus sessiliflora 'Longifolia Dipel'	-	+	+	+	+	+
Rhamnus cathartica L.	-	-	-	+	+	+
Salix alba 'Splendens'	-	-	-	+	+	+
Sorbus aucuparia L.	+	+	+	+	+	+

The full list of recommended plants can be seen in our work (Markov 2015). We also used the source of the renowned XIX century landscape architect Arnold

Regel to compile this list (Regel 1896).

According to Klymenko (2012), no matter how carefully some landscape nodes of the park were restored, if in its main territory instead of those species that were in the heyday of the park, others will dominate, the reconstruction of the park cannot be considered satisfactory. In our earlier work (Markov 2015) we found out that the main park-forming species are not species-edificators of native forests, but their companions – *Fraxinus excelsior*, *Tilia cordata*, *Acer platanoides*, *Ulmus glabra* and others. Significant areas are occupied by plantations in which none of the species dominates. Dudyn, Bahatska (2012) and Kuznetsov (2011) make the same conclusion. Probably the reason for this is the degradation of plantations that once consisted of edificatory species of native forests.

Thus, for the territories of research parks, which were created based on natural vegetation or artificially, but with the use of edificatory species of local forests and their satellites, phytocoenotic degradation is characteristic. It is the most dangerous for the plantations of ancient parks, as it threatens to replace valuable plantations on a large area with low-value derivatives (Klymenko 2012).

In our opinion, the reasons for the replacement of dominant species are also the unsystematic planting of trees and shrubs during the reconstruction of parks in Soviet times without taking into account the compliance of plants with environmental conditions. As well as the use of fruit plants that are less stable in urban conditions (Table 2). As a result, we have the lowest class of aesthetic evaluation of parklands (Table 6). That's why we recommended a list of plants for planting in old parks of the Zhytomyr region (Table 7).

Conclusions

There are 71 species and 3 varieties of trees and shrubs in heritage parks of the Zhytomyr region. The largest family is Rosaceae – 20 species (28.2 %). Family Salicaceae is represented by 8 species (11.3 %) and one variety. Other families have a share of less than 10 % of species. In general, the taxonomic composition of parks is poor. Most species grow in inappropriate soil conditions. According to the geographical analysis of the parks' woody plants come from Boreal and Mediterranean zones, which included 5 floristic regions**.** This shows that Zhytomyr region belongs to the zone of wide introduced opportunities. One park has a second class of aesthetic value, the remaining five have the third class. To increase the class of aesthetic value of parks we recommend clearing from clutter, felling sick and weakened trees and shrubs, planting trees and bushes, which are represented in our work.

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