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RESEARCH ARTICLE

BIOECOLOGICAL PECULIARITIES AND *EX-SITU* CONSERVATION OF SPECIES *PTEROCARYA PTEROCARPA* PROTECTED BY GLOBAL AND NATIONAL "RED LIST" AT BATUMI BOTANICAL GARDEN

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ABSTRACT

The article analyzes the composition and conservation significance of the plants protected by the global and national "Red Lists" in the specific diversity of the Ajara floristic region. The article discusses the peculiarities of growth-development and reproductive biology of the plants of the tertiary period relict species of wingnut - *Pterocarya pterocarpa* growing at the Batumi Botanical Garden, protected by the International Union of Conservation of Nature (IUCN), Georgian "Red Book" and Georgian "Red List". The study of the development biology and elaboration of the effective methods of propagation is the basis for elaboration and implementation of conservation measures for *ex situ* – in the Batumi Botanical Garden, and *in situ* – in the natural Colchis conditions – conservation.

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INTRODUCTION

The region of the Caucasus is one of the 34 "hotbeds" characterized by large biodiversity and abundance of endangered ecosystems (15-17). There are about 6 350 species registered in Caucasian flora. About 900 species of the flora are endemic ones (600 Caucasia, and 300 Georgian endemics). 161 species of rare and endangered plants are included into the "Red List" of Georgia. 56 species protected by the Georgian "Red List" have statuses of different categories of protection, out of which 52 species are angiosperms and 4 species are gymnosperms (15-17).

Out of the Georgian "Red List" woody species, there are 22 species of diverse protection status in the Ajara region. They are: *Arbutus andrachne L. (EN), Astragalus sommieri Freyn. L. (VU), Betula medwedewii Regel. (VU), Buxus colchica Pojark. (VU), Castanea sativa Mill. (VU), Celtis australis L. (VU), Daphne albowiana Woronow ex Pobed. (EN), Epigea gaultherioides (Boiss. & Bal.) Takth. (VU), Juglans regia L. (VU), Laurus nobilis L. (VU), Osmanthus decorus (Boiss. & Bal.)Kaspligil. (VU), Ostrya carpinifolia Scop. (EN), Pterocarya pterocarpa (Michaux) Kunth ex Iljins (VU), Quercus imeretina Stew. ex Woronow (VU), Quercus hartwissiana Stev. (VU), Quercus pontica C. Koch. (VU), Rhododendron ungernii Trautv. (VU), Rhododendron smirnowii Trautv. (VU), Salix kikodseae Goerz. (EN), Staphyllea colchica Stev. (VU), Taxus baccata L.(VU),Ulmus glabra Huds.(VU).* The markers used in the Georgian "Red List" have the same meaning that is indicated in the explanation of the International Union for Conservation of Nature (IUCN) Red List Categories and Criteria (IUCN Red List Categories and Criteria, Version 3.1, 2001) as well as the recommendations of the IUCN for regional and national Red Lists (IUCN Guidelines for National and Regional Red List, 2003).

Ajara is situated in the far south-western part of Georgia and occupies the farthest southern coast of the Black Sea littoral. Geographically it covers the following 41°26[1] – between 41°54[1] NL და 41°33[1] - 42°35[1] AL. According to the longtime meteorological observations of the Batumi Botanical Garden Station, the coastline between the river Chakvistskali estuary and the Green Cape, 200 m above sea level, is characterized by highly humid and warm subtropical climate. Abundance of atmospheric precipitation (annual total 2400-2700) is mainly preconditioned by intensive condensation caused by interaction of humid air from the Black Sea and coastal zone mountainous relief. The average temperature fluctuates between 13-14,4 °C,

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average temperature in January is 4-6 °C whereas in August - 22- 23 °C. Absolute maximum temperature reaches 38-40 °C while absolute minimum temperature can fall to -8 °C. It seldom snows and when it does the height of snow never exceeds 10 cm. Relative air humidity fluctuates between 70-82%. The average wind speed is 4,6 m/sec and maximum – 39 m/sec (2, 3).

The results of the anthropogenic impact on the natural flora diversity are increased day by day owing to which many species become rare or extinct. Introduction of global, national and regional status species in botanic gardens, creation of their collections and ex-situ conservation provide reintroduction bases (in-situ) for the species included into "Red Lists" and "Red Books" of different countries, for the purpose of their complex study and restoration of natural populations.

The same can be said about the wingnut species - *Pterocarya pterocarpa (Michaux.) Kunth. ex Iljins.,* growing in the Batumi Botanical Garden. Wingnut/walnut - *Pterocarya pterocarpa* was included into the Georgian "Red Book" in 1982. In 1998 in was estimated by the International Union of Conservation of Nature (IUCN) as the category of Least Concern LC- ver.2.3 IUCN. The citations of the "Red List" evaluation describes as the main dangers for the species forest cutting, cattle pasturing and cultivation of agricultural cultures (Firsov, 1998).

In 2006 wingnut was included into the Georgian "Red List" in accordance with the Order # 303, 2 May, 2006 by the President of Georgia. It acquired the national protection status of Vulnerable VU - D2. The basis for the inclusion into the document is the fragmental area, cutting, intensive farming application of the lowland and river bank forests. The species is protected in the reserves of Lagodekhi and Kolkheti and restrictions of Alazani and Rioni. For the complete protection of the species it is necessary to pronounce to the preserved grove habitats as restricted areas, conduct control over population state and prohibit massive cutting, as well as *ex-situ/in-situ* conservation in botanic gardens.

MATERIALS AND METHODS

The object of the research is the relict species of wingnut - *Pterocarya pterocarpa* (Michaux.) Kunth. ex Iljins, protected by the International Union of Conservation of Nature (IUCN – 1998), Georgian "Red Book" (1982) and Georgian "Red List" (2006). The literary sources mostly provide the information about systematic, morphology, distribution and in-situ protection of wingnut - *Pterocarya pterocarpa* (Abashidze I. 1959; Memiadze V. 1970; Gavasheli G. 1987; Firsov G., 1998; Stuchlik L., Kvavadze E., 1998; Gagnidze R., 2005; Yilmaz M. 2014, etc.). The biology of the species in culture, seasonal development and comparative analysis in natural habitats are all studied by the scientists and researchers of the Georgian National Botanical Garden (Aseishvili *et al*., 2011). However, the ontogenesis and peculiarities of reproduction biology are studied in a less degree. Therefore, the practical value of the research is the study of bioecological peculiarities of wingnut - *Pterocarya pterocarpa* (Michaux) Kunth. ex Iljins protected by global and national "Red List", in controlled areas, elaborate protection-restoration measures in south Colchis (Ajara), mobilize sowing and planting materials on the obtained results and elaborate active reintroduction measures in natural populations.

RESULTS AND DISCUSSION

Wingnut - *Pterocarya pterocarpa (Michaux) Kunth. ex Iljins.,* synomym: *Juglans pterocarpa* Michx. Belongs to the family - *Juglandaceae Lindl*. According to the data of Species Survival Commission SSC of the International Union for Conservation of Nature (IUCN) "Red List", for today the worldwide study has been conducted on 19 varieties of 7 genera of the *Juglandaceae* family. Wingnut is included among them (15-17).

Genus Wingnut Pterocarya Kunth. combines 6 species that are spread in subtropical or warm, temperately monsoon climatic zones. *Pterocarya pterocarpa (Michaux) Kunth ex Iljins.* is a rare relic species of the tertiary period. It is important for the study of the history of flora and is very interesting as a decorative and paint plant.

It is naturally distributed in Turkey (South Anatolia), Azerbaijan (Talish, Zakatala and Shemah), Russian Federation (Dagestan-River Samur estuary), Armenia, Iran, and Ukraine. In Georgia it is distributed in the western part of the Colchis lowland: Abkhazia, Samegrelo. Imereti, Guria, and in Eastern Georgia - in Inner Kartli, in Kakheti – Alazani Valley. In Ajara it is wildly spread in river-bank humid valleys from coastal plains to lower mountain belts, 600-700 m above sea level; in Kintrishi gorge – Zeraboseli, Chakhati, tskhemvana, Chakvistavi gorge, Gonio, Ochkhamuri, Ureki (14).

Pterocarya pterocarpa (Michaux) Kunth ex Iljins. is a monecious tree of 25- 30 m height and 1-1,5 m diameter of stalk. The bark of a young plant is light-grey and later becomes dark-grey, broken in length. The leaves are arranged in turns, longish-oval, jagged, naked on both sides or with white fuzzes on lower part, in vein corner. Accarpelous and carpellate flowers are gathered in amentum inflorescence. Accarpelous flowers have short stem, carpellate flowers are subpetiolas arranged in distance on a stem. The fruit is a two-wing nut that ripens in September-October and enters generative stage after 15 years. It is wind-resistant, light and warm-loving, frost resistant – bears -25 °C, lives for 250 years (13).

Wingnut was introduced in the Batumi Botanical Garden in 1939. There are 32 specimens growing in the phytogeographical department of Transcaucasia Humid Subtropics. In this area wingnut forms a habitat in the lowland humid part - *Carpinus caucasica, Fagus orientalis, Tilia caucasica, Rhododendron ponticum, Laurocerasus officinalis, Hedera colchica, Filitis scolopendrium,* etc. together. The height of some specimens exceeds 25 m, with stalk diameter of 60-63 cm. It gives fruit regularly; fullness of the seed is 80%; also gives root sprouts.

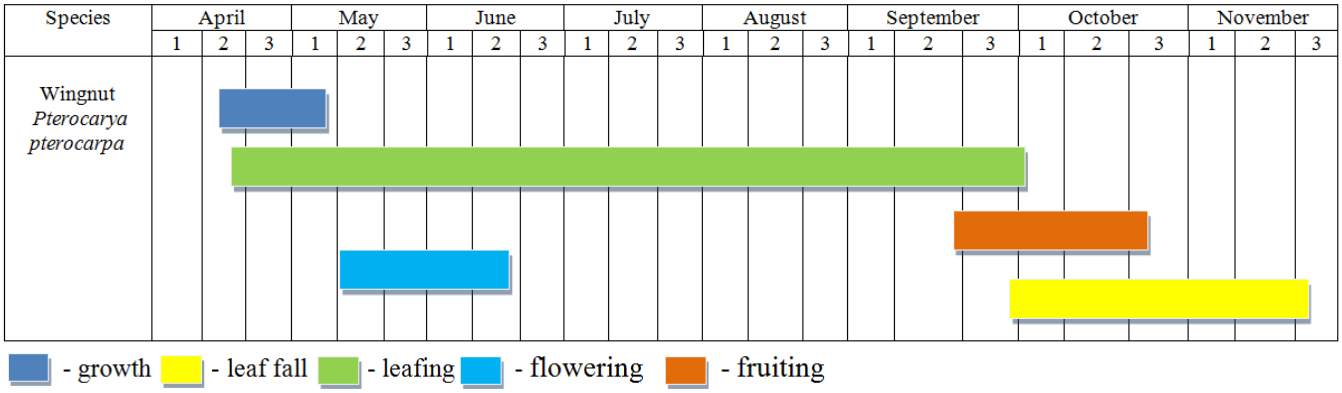
For the purpose of evaluating biological state of wingnut in *ex situ* conditions, we have studied peculiarities of development seasonal dynamics and reproduction biology.

In the conditions of the Batumi Botanical Garden, the vegetation of wingnut - opening of leaf and flower buds, in favorable temperature regime begins simultaneously in late April or early May. Masculine Accarpelous inflorescence develops at the current year sprout roots, while carpellates - in the apical leaf bosom. Their formation finishes in late May. Massive flowering begins in mid June. The fruit is a two-wing nut. The ripening ends in the first half of October. At this time it gets brownish coloring and seed dissemination begins. Leaf-falling starts in the beginning of October and continues rather slowly. The leaves get bright yellow color then. First, the leaves arranged in the peripheries fall and then – apical ones. Leaf-falling ends at the end of November. Table 1 shows the phenospectre of seasonal development of wingnut.

90-day stratification (+5°C) proved to be productive – 75-85%, the sprouts are characterized by high energy.

The study of the vegetative reproduction peculiarities of wingnut was accomplished in the orangery conditions against the specific agrotechnical background. The substrate contained 1 portion humus and 2 portions of sand; humidity – 80%, configuration of grafts – bending 60^0; optimal period for grafting – March, length of grafts 10-15 cm, distance between grafts – 2 cm, regulation of watering – intensive. Elaboration of grafts with rooting stimulators was conducted with indoleacetic acid 0.02%, indolebutyric acid 0,01%, lignohumic 0,05%, potassium permanganate 0,1%, sucrose 5% solutions.

Table 1. Wingnut - *Pterocarya pterocarpa* (*Michaux) Kunth. ex Iljins.* Phenospectre in the conditions of Batumi Botanical Garden



The peculiarities of wingnut reproduction (with seeds and vegetative) have been studied in closed and open soil. The optimal degree of seed ripening, terms of gathering, storage and pre-sowing measures (stratification) have been determined. Sowing was conducted in two versions: 1) sowing of seeds collected in autumn; 2) sowing of stratified seeds collected in autumn in early spring. Newly-collected seeds were sown in autumn on specially prepared substrate in the conditions of orangery, whereas the stratified seeds – in spring. For the 90-day stratification of seeds we have selected 1 portion of moss and 2 portions of wood sawdust damped every fortnight. Table 2 gives the indices of wingnut seeds autumn and spring sprouts (%).

Table 2. Degree of wingnut - *Pterocarya pterocarpa (Michaux) Kunth. ex Iljins.* Seed sprouting (%)

Species	Year	Start of sprouts (Day)	Autumn sowing Newly collected	Spring sowing	
				Stored without stratification (+15°C)	With stratification (+ 5°C, 90 days)
Wingnut	2012	18	70	50	75
Pterocarya pterocarpa	2013	16	80	50	85
	2014	20	85	55	80

The table shows that the sprouting period covers 18-20 days from the planting of seeds. Sprouting of newly collected seeds comprised 70-85%. Relatively low indices were obtained from the seeds sowed without stratification (+15°C) – 50-55%. The

Table 3 shows the results of the experiments for vegetative reproduction of ლაფანი, degree of rooting (%) using control and bio-stimulators.

Pict. 1 Sprouts of *Pterocarya pterocarpa* newly-collected

Pic. 2 *Pterocarya pterocarpa* 5-months plantings seeds in autumn (25 days)

Table 3. ***Pterocarya pterocarpa*** **(Michaux) Kunth. ex Iljins. Degree of rooting using control and bio-stimulators (%)**

Species	H_2O Control	Versions of processing with bio-stimulators (concentration %)				
		indoleacetic acid 0,02 %	indolebutyric acid 0,01%	lignohumic 0,05%	potassium permanganate 0,1%	sucrose 5 %
Wingnut *Pterocarya pterocarpa*	80	95	85	90	75	80

The table shows that the rooting indices of the grafts processed with indoleacetic acid 0,02 % solution bio-stimulator comprised 95%, comprising 2 months. The grafts processed with lignohumus 0,05% developed double number of second-row roots and one time more length compared to the rest of the samples. The results enabled to estimate the rooting degree of wingnut using bio-stimulators as high indices (75-95%). The experiments confirmed that biometric indices of vegetative six-month specimens were 70 cm in height, size of crown circumference r=40 cm X 30 cm, with well-developed 1-6 row of lateral branches that considerably exceed the specimens obtained with seeds.

Pic.3. ***Pterocarya pterocarpa*** **vegetative reproduction**

Pic.4. ***Pterocarya pterocarpa*** **sample obtained with grafting**

In future the study of species in the collection of the Batumi Botanical Garden protected by global and national "Red Lists" will continue in scientific-methodological aspect for the purpose of conservation as well as creation of *ex-situ/in-situ* conservation base that will have the significance and value of global and national biodiversity preservation.

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