

***Ex situ* conservation of the species *Carpinus orientalis* (Mill.) in national botanical gardens**

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Abstract. This study presents recent data resulting from the research of the endangered hornbeam species, oriental hornbeam (*Carpinus orientalis* Mill.). The protection status of the oriental hornbeam a rare endangered species is regulated at the national level by the Law on the State Protected Natural Areas Fund and by its inclusion in the Red Book of the Republic of Moldova, indicating a high risk of disappearance from the gene pool of the spontaneous flora. Currently, the monitoring and conservation of the Oriental hornbeam are carried out in two institutions in Chișinău: the "Alexandru Ciubotaru" National Botanical Garden (Institute) of USM and the Botanical Garden of the National Museum of Ethnography and Natural History. Furthermore, *ex situ* conservation in planned forest micro-exhibitions represents an efficient strategy for reducing the threat of future extinction of this valuable species for the national spontaneous flora.

Keywords: protected area, *ex situ* conservation, endangered species, *Carpinus orientalis*.

Conservarea *ex situ* a speciei *Carpinus orientalis* (Mill.) în grădinile botanice naționale

Rezumat. Acest studiu prezintă date recente rezultate în urma cercetării speciei periclitată de cărpiniță (*Carpinus orientalis* Mill.). Statutul de protecție al cărpiniței (specie rară periclitată) este reglementat la nivel național prin Legea privind Fondul Ariilor Naturale Protejate de Stat și prin includerea sa în Cartea Roșie a Republicii Moldova, indicând un risc ridicat de dispariție din genofondul florei spontane. În prezent, monitorizarea și conservarea cărpiniței se realizează în: Grădina Botanică Națională (Institut) "Alexandru Ciubotaru" a USM și Grădina Botanică a Muzeului Național de Etnografie și Istorie Naturală. De asemenea, conservarea *ex situ* în microexpoziții de pădure planificate reprezintă o strategie eficientă pentru reducerea amenințării cu dispariția viitoare a acestei specii valoroase din flora spontană.

Cuvinte-cheie: arie protejată, conservarea *ex situ*, specie periclitată, *Carpinus orientalis*.

1. INTRODUCTION

The *ex situ* conservation of the *Carpinus orientalis* Mill. is currently carried out exclusively within two botanical gardens in Chișinău: the "Alexandru Ciubotaru" National Botanical Garden (Institute) of the MSU (NBGI) and the Botanical Garden of the National Museum of Ethnography and Natural History (NMENH).

The Oriental hornbeam has been the subject of detailed studies following field expeditions, with the first relevant geobotanical research dating back to 1958. Consequently, the species was granted protected status (Category IV - Rare) under the Law on the Fund of State-Protected Natural Areas. It has been included in all editions of the Red Book of the Republic of Moldova and is currently classified as an Endangered (EN) species [13], [2].

Currently, *Carpinus orientalis* Mill. enjoys legal protection only within the "Cărbuna" Landscape Reserve and the "Molești-Răzeni" Forest Nature Reserve. Given its limited distribution range and extreme natural conditions, current protection and conservation measures are considered borderline; therefore, there is an urgent need to accelerate the development and monitoring of the species.

Previous research indicates that this taxon is at risk of extinction due to habitat fragmentation [1]. Geobotanical studies show a reduction in the number of specimens in the Cărbuna, Răzeni, and Zloți forestry districts, where the species appears sporadically and exhibits poor development compared to concentrated populations. For this reason, *ex situ* conservation within Botanical Gardens has become a strategic priority. This approach will reduce the risk of the species future disappearance from the spontaneous flora of the Republic of Moldova through the implementation of effective monitoring, reproduction, and genetic material (seed) exchange programs with similar institutions.

The *Carpinus orientalis* Mill. is a tree that reaches heights of 9–12 meters at maturity, while juvenile specimens measure between 2 and 5 meters. The trunk is distinguished by its smooth, gray bark. The leaves are oval or ovate-oblong, featuring an oblique, slightly cordate (heart-shaped) base and doubly serrated margins; they are covered with fine hairs along the veins. The plant develops dense, cylindrical male catkins, 1.4–2.5 cm in length, and short, tomentose (fuzzy) gray female catkins. The fruit is an ovoid, compressed nutlet. Flowering occurs between April and May, with the fruits ripening from August to September. It is a xerophilous species (drought-tolerant) that reproduces via seeds and shoots.

2. MATERIALS AND METHODS

The monitoring and assessment study of the endangered status of the *Carpinus orientalis* Mill. was conducted during the period 2024–2025, being initiated alongside the project "Assessment of the status of plant, fungal, and animal species, development of the list of species with rarity status, and the algorithm for their presentation in the 4th edition of the Red Data Book of the Republic of Moldova". The *ex situ* conservation activity of the *Carpinus orientalis* Mill. aligns with the research concept of the project. This analysis allowed for the determination of chorological characteristics, *ex situ* growth

particularities, as well as population size and structure. The taxonomic identification of the plant species was carried out by consulting specialized botanical keys [3], [5], [11].

3. RESULTS AND DISCUSSIONS

The study of *Carpinus orientalis* Mill. populations within the “Alexandru Ciubotaru” National Botanical Garden (Institute) of the MSU has been ongoing for over 45 years in the “Vegetation of Moldova” Exhibition. This exhibition was established to ensure the *ex situ* conservation of plant diversity, particularly rare species from the territory of the Republic of Moldova, and is managed by the “Alexandru Ciubotaru” National Botanical Garden (Institute) [8].

The *Carpinus orientalis* Mill. was planted in the “Sessile Oak Forest with Oriental Hornbeam” micro-exhibition in 1980, according to the accounts of dr. hab. prof. Postolache Gh. He is the author of the design principles for the forestry exhibition and the methods for the *ex situ* conservation of the native gene pool [7]. The “Vegetation of Moldova” exhibition comprises 12 forestry micro-exhibitions that replicate the natural habitat. For the purpose of protecting and conserving the endangered *Carpinus orientalis* Mill. *ex situ*, the “Sessile Oak Forest with Oriental Hornbeam” micro-exhibition was created, including subplots 8A (0.25 ha) and 8B (0.16 ha), “Alexandru Ciubotaru” National Botanical Garden (Institute) [7].

In subplot 8A, the stand composition of the sessile oak and *Carpinus orientalis* Mill. habitat consists of 135 specimens. The dominant species, sessile oak (*Quercus petraea*), accounts for 97 trees, while the associate and mixed species, *Carpinus orientalis* Mill., accounts for only 4 trees. Alongside these species, the following are also present: Norway maple (*Acer platanoides*) - 14 trees; small-leaved lime (*Tilia cordata*) - 2 trees; silver lime (*Tilia tomentosa*) - 7 trees; and wild cherry (*Cerasus avium*) - 5 trees. In subplot 8B, the stand composition of the sessile oak and *Carpinus orientalis* Mill. habitat comprises 129 specimens. Of these, the dominant species, sessile oak (*Quercus petraea*), makes up 62 trees, while the *Carpinus orientalis* Mill. serves as the associate species with 5 trees. The following species are also recorded in the stand composition: pubescent oak (*Quercus pubescens*) - 30 trees; silver lime (*Tilia tomentosa*) - 10 trees; Norway maple (*Acer platanoides*) - 8 trees; European ash (*Fraxinus excelsior*) - 6 trees; tatar maple (*Acer tataricum*) - 4 trees; and wild service tree (*Sorbus torminalis*) - 1 tree.

In 2020, 15 specimens of *Carpinus orientalis* Mill. (1 m in height) were brought from the Cărbuna Forestry District to the “Sessile Oak Forest with Oriental Hornbeam” micro-exhibition by dr. Ghendov V. and research scientist Belous Ș. These were planted in

subplot 8 B. "Alexandru Ciubotaru" National Botanical Garden (Institute), 11 specimens have dried out, while 4 remain in an active state of vegetation.

In 2024, the “Sessile Oak Forest with Oriental Hornbeam” exhibition was supplemented with 9 *Carpinus orientalis* Mill. saplings, donated by the National Museum of Ethnography and Natural History. These saplings were planted through volunteer efforts in subplots 8A and 8B by the team from the Geobotany and Forestry Laboratory, in collaboration with the KEC International company in Moldova. Out of these 9 saplings, 4 have dried out, while the remaining 5 specimens are viable and developing well. Also in 2024, to support natural regeneration and the conservation of endangered species, I personally contributed to the “Sessile Oak Forest with Oriental Hornbeam” exhibition. I brought 2 specimens of *Carpinus orientalis* Mill., measuring 80 cm in height, from the Silvo-Cinegetic Sil-Răzeni Enterprise. These were planted in subplots 8A and 8B. Both specimens have recorded a good establishment and growth rate (Figure 1).



Figure 1. *Carpinus orientalis* Mill. specimens in the “Sessile Oak Forest with Oriental Hornbeam” exhibition within the GBNI

In the “Sessile Oak Forest with Oriental Hornbeam” exhibition, the current population consists of 5 *Carpinus orientalis* Mill. trees reaching heights of 5–9 meters and diameters of 8–14 cm, alongside 8 saplings measuring 0.50–1 m in height, all of which are in good vegetative condition under the Botanical Gardens environment. Research has highlighted that the *Carpinus orientalis* Mill. specimens in the exhibition exhibit weak fruiting and do not undergo natural regeneration. A possible cause could be the juvenile developmental stage of the specimens or a soil substrate deficient in nutrients.

The Botanical Garden of the NMENH, designed by the renowned Italian architect Alessandro Bernardazzi, was established with the primary goal of the *ex-situ* conservation of rare plant species from various types of vegetation across Bessarabia. This 0.75-hectare park, remarkable for the beauty of its native plants, has established itself as an essential practical-scientific laboratory for disseminating knowledge to the general public (Figure 2).



Figure 2. Oriental hornbeam specimens in the “Oriental Hornbeam Forest” exhibit from MNEIN

Currently, the MNEIN Botanical Garden is structured into micro-exhibits interconnected by paved paths, which largely replicate the main types of vegetation found in the Republic of Moldova. Based on the research conducted, it has been established that a gene pool consisting of approximately 160 species of higher plants has been mobilized within the MNEIN Botanical Garden territory. This includes 28 tree species, 25 shrub species, and about 110 herbaceous plant species. Among these are approximately 30 rare species with varying degrees of rarity and endangerment, 13 of which are included in the Red Data Book of Moldova, editions I-III [4].

The largest part of the Sector of Flora and Spontaneous Vegetation of the Botanical Garden is occupied by spontaneous forest vegetation, which forms structures corresponding to it layers of trees, shrubs, and herbs, specific to native forest communities. These are found in 6 zones or micro-exhibits of spontaneous flora within the MNEIN Botanical Garden [4].

The *ex situ* conservation of the *Carpinus orientalis* Mill. is carried out in the “Oriental Hornbeam Forest” micro-exhibit within the forest vegetation section, according to the general layout of the MNEIN Botanical Garden. The “Oriental Hornbeam Forest” micro-exhibit consists of 6 mature trees and several saplings growing under the canopy of the mature specimens. The micro-exhibit is composed exclusively of *Carpinus orientalis* Mill. and occupies a small area within the forest micro-exhibits. The specimens are viable and grow here together with the saplings in a favorable environment. The mature trees are vigorous, reaching heights of 10–12 meters and diameters of 16–22 cm; compared to their natural habitat in the Republic of Moldova, they can be considered a remarkable group of trees. Under the conditions of the MNEIN Botanical Garden, natural regeneration and normal fruiting of the mature trees occur, indicating that they have adapted well and are undergoing all phenological stages.

4. CONCLUSIONS

1. The *ex situ* conservation of the *Carpinus orientalis* Mill. within Botanical Gardens is a strategic priority to reduce the threat of extinction of this important species from the spontaneous flora.

2. The protection and *ex situ* conservation of the endangered *Carpinus orientalis* Mill. species are carried out in the “Vegetation of Moldova” exhibit, specifically within the “Sessile Oak Forest with Oriental Hornbeam” micro-exhibit, which contains 5 tree specimens and 8 saplings.

3. At the Botanical Garden of the National Museum of Ethnography and Natural History, the *ex situ* conservation of the *Carpinus orientalis* Mill. is achieved in the “Oriental Hornbeam Forest” micro-exhibit, consisting of 6 mature trees and several saplings growing under the canopy of the mature specimens.

4. The *Carpinus orientalis* Mill. is a species protected by the Law on the Fund of State Protected Natural Areas and the Red Data Book of the Republic of Moldova; it is classified as an endangered species (EN). Within the National Botanical Gardens, its monitoring and conservation will be ensured through exhibits that replicate its natural habitat.

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