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DISTRIBUTION AND ECOLOGY OF *Malus orientalis* Uglitzki IN HIGH-ALTITUDE ZONES OF THE NAKHCHIVAN AUTONOMOUS REPUBLIC

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РАСПРОСТРАНЕНИЕ И ЭКОЛОГИЯ *Malus orientalis* Uglitzk В ВЫСОТНЫХ ЗОНАХ НАХЧЫВАНСКОЙ АВТОНОМНОЙ РЕСПУБЛИКИ

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Abstract. Investigates the altitudinal distribution and ecological characteristics of the oriental apple (*Malus orientalis* Uglitzk.) within the territory of the Nakhchivan Autonomous Republic. Based on expeditionary observations conducted between 2003 and 2025, the study examines the species' occurrence across different elevation belts, its relationship with slope exposure, and its distribution in high mountain areas. It was determined that the upper boundary of the species' distribution reaches 2350–2400 m above sea level in certain regions, thereby expanding previously known floristic data. The research revealed that in high mountain zones the species predominantly occurs on southern and southwestern slopes. *Malus orientalis* demonstrates morphological and phenological variability across altitudinal gradients, reflecting a high degree of polymorphism and ecological plasticity. Small-fruited, resilient forms dominate in high-altitude zones, whereas large-fruited forms prevail in lower belts. These features confirm the species' importance as a valuable genetic resource for breeding. The findings open perspectives for biodiversity conservation and the development of drought- and disease-resistant cultivars.

Аннотация. Исследуются высотное распространение и экологические характеристики восточной яблони (*Malus orientalis* Uglitzk.) на территории Нахичеванской Автономной Республики. На основе экспедиционных наблюдений, проведённых в 2003–2025 гг., изучается встречаемость вида в различных высотных поясах, его связь с экспозицией склонов и распространение в высокогорных районах. Установлено, что верхняя граница

распространения вида в отдельных регионах достигает 2350–2400 м над уровнем моря, что расширяет ранее известные флористические данные. Исследования показали, что в высокогорных зонах вид преимущественно встречается на южных и юго-западных склонах. *Malus orientalis* демонстрирует морфологическую и фенологическую изменчивость по высотным градиентам, отражающую высокий уровень полиморфизма и экологической пластичности. В высокогорных поясах доминируют мелкоплодные и устойчивые формы, тогда как в нижних поясах преобладают крупноплодные формы. Эти особенности подтверждают значение вида как ценного генетического ресурса для селекции. Полученные результаты открывают перспективы для сохранения биоразнообразия и создания засухо- и болезнестойчивых сортов.

Keywords: Nakhchivan Autonomous Republic, *Malus orientalis*, altitudinal belts, polymorphism, breeding perspectives.

Ключевые слова: Нахичеванская Автономная Республика, *Malus orientalis*, высотные пояса, полиморфизм, селекционные перспективы.

The Caucasus region, particularly the Nakhchivan Autonomous Republic, is distinguished by its phytogeographic diversity and richness in endemic plant species. Among the wild fruit plants distributed in this area, the oriental apple (*Malus orientalis* Uglitzk.) holds special scientific and genetic significance. The area's soil-climatic conditions, relief structure, and anthropogenic influences have played a significant role in the formation of this species and in its distribution across different altitudinal zones [1].

The wild apple belongs to the genus *Malus* Mill. of the subfamily Pomoideae within the family Rosaceae Juss. The taxonomy and distribution range of wild apples have long been the focus of botanists. According to the literature, more than 50 wild apple species exist worldwide. A. E. Syubarov reported 33 species and over 60 varieties, while P. M. Zhukovsky noted 36 species [2].

A. C. Rajabli emphasized that due to cross-pollination, apples exhibit extensive variability, i.e., polymorphism, differing in size, phenological phases, fruit color, taste, and numerous biomorphological traits. In the Caucasus, in Azerbaijan, and particularly within the territory of the Nakhchivan Autonomous Republic, one wild apple species — the oriental apple (*Malus orientalis* Uglitzk.) — is distributed [3-6].

A. A. Grossheim, in his work *Flora of the Caucasus*, highlighted the importance of the oriental apple in the Caucasian flora [7].

V. V. Ponomarenko provided valuable data on the distribution boundaries of this species in his studies on the vegetation of the Caucasus [8].

Research by E. M. Ibrahimov on the variability of oriental apple forms in the Nakhchivan Autonomous Republic further clarified the degree of polymorphism of this species. In the region, oriental apple occurs in foothill and mountain belts, forming communities together with hawthorn, dog rose, oak, juniper, *Celtis*, and other trees in forests and sparse woodlands. At elevations of 1900–2350 m above sea level, wild apple trees reaching heights of 7–9 m, and occasionally up to 14–16 m, can be found [8-12].

Analysis of the literature shows that although information exists on the distribution and biomorphological features of oriental apple, the altitudinal distribution patterns within the Nakhchivan Autonomous Republic have not yet been fully clarified. The aim of the study is to determine the altitudinal distribution patterns of the oriental apple (*Malus orientalis* Uglitzk.) within the territory of the Nakhchivan Autonomous Republic, to analyze its biomorphological

characteristics, and to identify promising forms from the perspective of breeding. Research conducted in this direction provides an important contribution both to floristic studies of the region and to the conservation of genetic resources.

Materials and Methods

The study was conducted between 2003 and 2025 through expeditionary observations across various districts of the Nakhchivan Autonomous Republic. Research routes covered the foothill and mountainous areas of Shahbuz, Ordubad, Julfa, Babek, Sharur, and Kangarli districts. To clarify the distribution boundaries of *Malus orientalis* Uglitzk., altitudinal measurements were taken, and the elevation of each site above sea level was recorded. The selected sites included river valleys, gorges, and slopes located in foothill, mountainous, and forested zones, thereby allowing the investigation of the species under diverse ecological conditions [13-15].

Morphological observations included tree height, trunk diameter, fruit size and color, and phenological phases (flowering, fruiting). Within the framework of exposure analysis, slope orientation (north, south, east, and west) was determined to assess its influence on species distribution. A comparative approach was applied to evaluate the obtained results against previous literature data, enabling the identification of differences in distribution boundaries. During the analysis of the collected material, minimum and maximum altitudinal limits, slope exposures, and distribution features across districts were comparatively assessed.

The methodological framework allowed for the identification of both the degree of ecological plasticity of the species and the impact of anthropogenic factors on its distribution. As a result, the altitudinal distribution zones of the oriental apple were clarified, and promising forms for breeding purposes were identified.

Discussion

The distribution of the oriental apple (*Malus orientalis* Uglitzk.) across different altitudinal zones in the Nakhchivan Autonomous Republic confirms its high polymorphic potential. Morphological variability observed during expeditions — including differences in tree height, fruit color and size, and phenological phases — demonstrates the genetic richness of the species. This diversity has been shaped by both natural selection and anthropogenic influences.

The research shows that the distribution boundaries of the oriental apple (*Malus orientalis* Uglitzk.) within the territory of the Nakhchivan Autonomous Republic are broader than previously reported in the literature. According to earlier sources, the species was noted only at elevations of 1800 m [3, 9].

However, expeditions carried out in the territory of the Nakhchivan Autonomous Republic between 2003 and 2025 established that the distribution boundaries of the species are wider and, in some cases, extend up to 2350–2400 m (Table). This fact proves its degree of ecological plasticity and adaptive potential.

The studies show that the distribution range of the oriental apple (*Malus orientalis* Uglitzk.) in the territory of the Nakhchivan Autonomous Republic is wider than previously reported in the literature. Previously, it was noted that the species is found only at an altitude of 1800 m [9, 10].

However, during the expeditions to the territory of the Nakhchivan Autonomous Republic in 2003–2025, it was determined that the distribution range of the species is wider and in some cases reaches heights of 2350–2400 m (Table). This fact proves its degree of ecological plasticity and adaptive potential. As shown in the table, the oriental apple is distributed at altitudes of 1400–2200 m in Babek, 1650–2350 m in Shahbuz, 1400–2200 m in Julfa, 2000–2100 m in Sharur, 1650 m in Kangarli, and 1100–2200 m in Ordubad. In lower mountain belts, the species tends to dominate on northern, northeastern, and northwestern slopes, while at higher elevations it is more frequently found on southern slopes.

Table

ALTITUDINAL DISTRIBUTION OF *Malus orientalis* Uglitzk.
 IN THE NAKHCHIVAN AUTONOMOUS REPUBLIC

<i>Areas of distribution</i>	<i>Village territory</i>	<i>Altitude, m</i>	<i>Slope exposure</i>
Shahbuz district			
Along the river valley	Badamli	1650	Northeast
Left bank of Kuku River	Gunev Qishlaq	2150-2280	South, Southwest
Derebogaz valley	Kuku	2250	South
Left bank of Nakhchivan River	Yukhari Qishlaq	2000	Southeast
Nakhchivan River	Ashagi Qishlaq	1470-1520	Northeast
Nakhchivan River basin	Batabat plateau	2200-2300	South, Southwest
Nakhchivan River basin	Bichenek forest	1800-2350	Throughout forest
Zarnatun River	Southwest of Bichenek	1600-1800	Northeast
Julfa district			
Khazine valley	Arafsa	1950-2200	Northeast, Southeast
Zogala River basin	Goyruk	1420-1560	Northeast, Northwest
Yarpaqly and Qaralar	Northeast of the village of Khanegah	1740	Northeast
Babek district			
Saridagh	Near Sirab village	1430-1520	Northeast, Southeast
Lizbirt valley and foothills of Qaragush Mountain	Near Buzgov village	1800-2200	South, Southwest
Sharur district			
Havush River	Havush	2000-2130	North, Northwest
Surroundings of Shahbulag village	Shahbulag	1500-1800	Southeast
Ordubad district			
Nasirvaz River	Nasirvaz	2000-2350	South, Southeast, Northeast
Gilanchay basin	Nurgut	2200-2300	South, Southeast, Southwest
Slopes and valleys near Pezmeri village	Pezmeri	1600-1760	Northeast
Kotam River	Kotam	1100-1800	Northeast
Kangarli district			
Slopes and valleys near Chalkhangala village	Chalkhangala	1650	Southeast

The greatest variability in altitudinal distribution was recorded in the mountainous and foothill zones of the Shahbuz and Ordubad districts, where the oriental apple occurs between 1800–2350 m. On southern and southwestern slopes, the species is distributed at elevations of 2100–2350 m, whereas on northern, northeastern, and northwestern slopes it grows at 1100–1800 m. Wild apple has been mainly preserved on high mountain slopes, in inaccessible areas, and around settlements. People, without touching the apple trees near their dwellings, cut down the forests and used their fruits. Therefore, even today, it is possible to encounter rather old wild apple trees along the edges of pastures. During expeditions in the territory of the Nakhchivan Autonomous Republic, it was observed that, as altitude increases, the polymorphism of traits characteristic of the oriental apple (*Malus orientalis* Uglitzk.) occurs within certain limits [9].

The natural variability of this species is determined by its growth under diverse conditions, the degeneration of cultivated varieties, and the intensity of hybridization processes occurring between

wild and cultivated forms. It was also established that the soil and climatic conditions of the Autonomous Republic have contributed not only to the formation of wild apple forms but also to their distribution under different environmental settings. The conducted research shows that the altitudinal distribution trends of the oriental apple are accompanied by morphological variability. In the lower mountain zones (1100–1600 m), large-fruited forms predominate; in the middle mountain zones (1600–2000 m), diverse morphological forms are observed; while in the high mountain zones (2000–2400 m), small-fruited and resilient forms are widely distributed. The forms encountered in the high mountain zones (2000–2400 m) are more adapted to harsh climatic conditions, producing small yet resilient fruits. Conversely, the forms observed in the lower zones (1100–1600 m) are distinguished by their large fruits and a longer vegetation period. These results confirm the species' adaptive capacity to ecological conditions and demonstrate that its morphological variability is closely linked to the altitude factor. Anthropogenic impacts within the territory of the Nakhchivan Autonomous Republic have had a significant influence on the distribution of the oriental apple (*Malus orientalis* Uglitzk.). As a result of deforestation and the expansion of pasturelands, the species has been mainly preserved on inaccessible mountain slopes. At the same time, agricultural activities have led to natural hybridization with cultivated varieties, thereby increasing genetic diversity. Thus, while anthropogenic factors have restricted the distribution range of the species on the one hand, they have, on the other hand, enhanced its level of polymorphism, forming an important resource from the perspective of breeding [16].

Observations conducted in different districts show that slope exposure also influences the distribution of the species. On northeast-facing slopes, denser forms predominate, whereas on south- and southwest-facing slopes, more resilient forms are dominant. This is associated with the species' adaptation to microclimatic conditions. The results obtained reveal new scientific facts compared to previous studies. The expansion of the altitudinal distribution boundaries of the oriental apple (*Malus orientalis* Uglitzk.) increases its significance as a genetic resource. This species possesses considerable potential for breeding drought- and disease-resistant cultivars.

Selection Perspectives

The wide distribution and high level of polymorphism of the oriental apple (*Malus orientalis* Uglitzk.) within the territory of the Nakhchivan Autonomous Republic indicate its importance as a valuable genetic resource for breeding. One of the main causes of polymorphism is natural hybridization between cultivated and wild forms. Agricultural activities in the region have facilitated genetic exchange between cultivated apple varieties and wild populations, leading to the emergence of new forms and an increase in genetic diversity. From a breeding perspective, the oriental apple represents a significant genetic reservoir. Its high-altitude forms, adapted to harsh mountain conditions, exhibit remarkable drought tolerance, which can be utilized in developing productive cultivars resilient to climate change. The long-term survival of wild forms under natural conditions has enhanced their resistance to diseases, making them suitable for breeding disease-resistant varieties. In lower altitudinal zones (1100–1600 m), large-fruited forms are found, which are valuable for improving fruit quality and overall productivity.

The preservation of wild forms in their natural habitats plays a crucial role in maintaining genetic diversity and serves as a genetic bank for future breeding programs. Thus, the genetic richness of *Malus orientalis* formed under diverse ecological conditions can be effectively used in breeding programs to develop both high-yielding and resilient cultivated varieties, ensuring sustainable fruit production and biodiversity conservation.

Conclusion

The conducted research demonstrated that the oriental apple (*Malus orientalis* Uglitzk.) in the Nakhchivan Autonomous Republic is distributed across various altitudinal zones characterized by

distinct ecological conditions. The obtained data confirm the species' high adaptive capacity and show that genetic polymorphism ensures its ecological stability. With increasing altitude, morphological and phenological variations become evident: in mountainous zones, tree height decreases and fruits become smaller but more resilient, whereas in lower zones, large-fruited forms predominate. These patterns reflect the species' ecological plasticity and the intensity of natural selection processes. It was established that the upper boundary of wild apple distribution in mountainous areas mainly occurs in Shahbuz and Ordubad districts at elevations of 1800–2350 m, occasionally reaching up to 2400 m above sea level. This finding confirms the species' ecological flexibility and adaptive potential. The preservation of wild forms and their inclusion in breeding programs will enable the development of apple cultivars resistant to drought, diseases, and climate change. This is of strategic importance for both agricultural sustainability and biodiversity conservation in the region. Thus, the study of the altitudinal distribution patterns of *Malus orientalis* in the Nakhchivan Autonomous Republic provides not only floristic insights but also valuable genetic and breeding implications.

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