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ARTIFICIAL REFORESTATION OF ZANGILAN FORESTS

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Summary: *The Zangilan district, located in the southwestern part of the Republic of Azerbaijan on the southeastern slopes of the Minor Caucasus and along the left bank of the Araz River, is characterized by diverse natural landscapes and unique forest ecosystems. During nearly three decades of occupation by the Republic of Armenia, the forests and ecosystems of the district were severely degraded and subjected to ecological terrorism, resulting in the destruction of rare and valuable forest stands, including the Basitchay State Nature Reserve - home to centuries-old Oriental plane trees (Platanus orientalis L.). Comprehensive field studies conducted by the Institute of Dendrology of the Ministry of Education of the Republic of Azerbaijan revealed that the forest ecosystems of the region suffered the greatest damage among all types of natural ecosystems. The research identified that most forests in the district developed on brown mountain-forest soils and were dominated by drought-resistant and light-demanding species such as Juglans regia L., Populus alba L., Quercus araxina, Celtis australis L., Ulmus glabra Huds., Celtis caucasica Willd., Platanus orientalis L., and Populus schischkinii. The study emphasizes that the biological characteristics and ecological requirements of these tree species differ significantly. Therefore, successful forest restoration in the Zangilan district requires taking into account their ecological demands and the exposure of mountain slopes. Most dominant species are heliophilous, thermophilous, and grow predominantly on southern slopes. Considering the influence of slope exposure on the distribution, productivity, and stability of forest-forming species is essential for establishing sustainable and resilient forest ecosystems in the region. Properly planned reforestation based on these principles will ensure the recovery of healthy and ecologically stable forests in the Zangilan district.*

Keywords: *Zangilan district, forest restoration, ecological terrorism, Oriental plane tree (Platanus orientalis L.), slope exposure, ecological requirement, drought-resistant species, mountain forests*

Introduction

The Zangilan administrative district is located in the southwest of the Republic of Azerbaijan, in the southeastern part of the Minor Caucasus physical-geographical region, on the left bank of the Araz River in the area of its middle course. The territory of this district was under occupation by the Republic of Armenia for almost 30 years. It should be noted that the Zangilan district possesses attractive natural beauty due to its geographical location, specific natural conditions, and bright forests composed mainly of drought-resistant and light-loving tree species. Just like the citizens who lived in this area, the nature of the district, including its fo-

rests, was negatively affected by the Armenian occupiers. During the occupation period, the forests of the district were destroyed, and various ecosystems that had developed on its territory were devastated. In other words, the forests of the district were subjected to what can be described as ecological terrorism. As a result, a large part of the dense forests that had existed in the area was destroyed, and the sparse forests disappeared completely, being replaced by shrub vegetation of low forestry and economic value [1, 7].

A grove mainly composed of Oriental plane trees (*Platanus orientalis* L.), fascinating in its beauty and almost unique in the world, is located within the Zangilan district. To protect this relict tree species, the Basitchay State Nature Reserve was established in the district in 1974, covering an area of 107 hectares. Magnificent Oriental plane trees grow in this reserve, aged between 150–200 years, with trunk diameters at breast height of 100–150 cm (sometimes 250–300 cm) and heights ranging from 30–50 meters. This tree species is long-lived and can survive up to 1000 years. The plane grove in the Basitchay Valley is a rare natural treasure of our homeland [4,5].

During the occupation, most of these trees were cut down and transported to Armenia. Thus, the nature of the region, including its forest ecosystems-which have the most complex structure among various natural ecosystems-was subjected to ecological terrorism. Most of the forests in the district have developed on different types of brown mountain-forest soils. The most common tree species found in the forests of the district are: Persian walnut (*Juglans regia* L.), silver poplar (*Populus alba* L.), Araz oak (*Quercus araxina*), southern hackberry (*Celtis australis* L.), mountain elm (*Ulmus glabra* Huds.), Caucasian hackberry (*Celtis caucasica* Willd.), Oriental plane tree (*Platanus orientalis* L.), and Shishkin's poplar (*Populus schischkinii*) [1, 5, 6, 8].

Various shrubs, including juniper (*Juniperus polycarpos*), wild rose (*Rosa* L.), Christ's thorn (*Paliurus* Mill.), buckthorn (*Rhamnus* L.), saltwort (*Salsola nodulosa*), pistachio (*Pistacia vera* L.), and hawthorn (*Crataegus* spp.), are also common in the district. The restoration of forests, almost completely destroyed during the occupation, is a challenging task that requires careful planning, considering the ecological requirements of tree species and the influence of slope exposure on their distribution, productivity, and resilience. Previous studies by S.R. Tagiyev [8], G.A. Rzayeva [6, 7], G.N. Aliyeva [1], and others have shown that mountainous relief, particularly slope orientation, strongly affects forest composition, growth, and stability by influencing factors such as light, heat, moisture, soil, wind, and snow distribution. This study aims to assess forest degradation in the Zangilan district and provide recommendations for sustainable restoration, focusing on key forest-forming species, their ecological needs, and strategies to conserve rare trees like the Oriental plane tree (*Platanus orientalis* L.) while restoring the region's unique.

Materials and Methods

The research was conducted in the Zangilan district, located in the southwestern part of the Republic of Azerbaijan, within the southeastern sector of the Minor Caucasus physical-geographical region, on the left bank of the middle course of the Araz River. The total area of the district is about 707 km², with altitudes ranging from 400 to 1600 meters above sea level. The relief is mainly mountainous, characterized by a combination of steep slopes, foothills, and river valleys. The soils are predominantly brown mountain-forest soils of varying mechanical composition and fertility [1, 7].

The climate of the district is moderately warm and dry, with short, mild winters and long, hot summers. The average annual temperature is +12…+13°C, with average January temperatures of 0–2°C and July temperatures reaching +25, +27°C. The annual precipitation varies from 400 to 600 mm, with most rainfall occurring in spring and autumn. The hydrographic network is represented mainly by the Basitchay River and its tributaries. The combination of warm, dry climate and brown mountain-forest soils provides favorable conditions for the growth of drought-resistant, light-demanding, and thermophilous tree species [6,8].

The research material consisted of tree and shrub species naturally distributed in the Zangilan district prior to the occupation. The study mainly focused on forest-forming tree species such as *Jug-*

lans regia L., *Populus alba* L., *Quercus araxina*, *Celtis australis* L., *Ulmus glabra* Huds., *Celtis caucasica* Willd., *Platanus orientalis* L., and *Populus schischkinii*. Additionally, typical shrub species (e.g., *Juniperus polycarpos K. Koch*, *Rosa L.*, *Paliurus Mill.*, *Rhamnus L.*, *Crataegus Tourn. ex L.*) were recorded for assessing the general structure of the forest vegetation.

Field research was carried out during 2023–2024 by specialists from the Institute of Dendrology of the Ministry of Education of the Republic of Azerbaijan. The studies included field expeditions to the liberated territories of the Zangilan district to identify the current state of forest ecosystems and to develop ecological principles for artificial reforestation [2].

1. Vegetation survey and data collection:Visual and geobotanical observations were conducted on sample plots located at different slope exposures (north, south, east, west) and elevations (500–1100 m). For each plot, the dominant and accompanying species, their density, age group, and vitality were recorded.

2. Soil and ecological characterization:Soil samples were collected from 0–30 cm depth to determine the main edaphic properties — texture, pH, humus content, and moisture-holding capacity. Based on soil and slope characteristics, each site was classified into ecological groups (dry, moderately moist, and moist habitats).

3. Climatic data and slope exposure analysis:Meteorological data (temperature, precipitation, relative humidity) were obtained from the nearest weather stations. The influence of slope exposure on microclimatic conditions, soil moisture, and illumination was evaluated to determine the optimal slope orientation for each tree species.

4. Species selection for artificial reforestation: The distribution of tree species according to slope exposure, soil type, and altitude was analyzed. Based on these parameters, species with the highest adaptive capacity and ecological compatibility were selected for reforestation planning [4, 9].

In selecting species for artificial reforestation, the following ecological factors were taken into account [2, 3, 9]:

- **Light requirement:** Most species (e.g., *Juglans regia L.*, *Platanus orientalis L.*, *Quercus araxina*) are heliophilous and thrive on southern slopes.
- **Temperature tolerance:** Warm and moderately dry conditions favor *Celtis australis L.* and *Populus schischkinii*.
- **Soil moisture:** Moist and deep soils along river valleys are suitable for *Platanus orientalis L.* and *Populus alba L.*, while dry, rocky slopes are appropriate for *Celtis caucasica Willd.* and *Quercus araxina*.
- **Altitude and slope exposure:** The optimum elevation range for most species is 500–1100 m, southern and southeastern slopes are most favorable for heat-loving species, while northern slopes support relatively moisture-loving species such as *Ulmus glabra Huds.*

The collected field data were analyzed statistically to determine the relationship between slope exposure, soil moisture, and species distribution. Comparative ecological assessment was used to identify the best combinations of species for creating productive and ecologically stable forest stands resistant to external stress factors such as drought and wind.

Conclusion

Monitoring carried out by the Institute of Dendrology of the Ministry of Education of the Republic of Azerbaijan in the liberated territories of Zangilan revealed that among various ecosystems that once existed in the district, the forest ecosystems were the most severely damaged. Most of the Oriental plane trees — the rare jewels of Zangilan's forests — were cut down. Fires were intentionally set to erase traces of the trees, resulting in the complete destruction of the plane grove in the Basitchay Nature Reserve, along with other forest ecosystems.

For the restoration of forests that existed in the Zangilan district before the occupation, a classification table was developed based on the ecological requirements and biological characteristics of the most widespread forest-forming tree species (Table 1).

Table 1

The most common tree species in the forests of Zangilan District

№	Tree species	Soils	Slopes where it grows best	Biological characteristics	Ecological requirements	Altitude of growth
1	**Persian walnut** (*Juglans regia L.*)	Brown mountain-forest soils	Southern slopes	Light-loving, thermophilic, and moisture-loving. However, due to its strong root system, it is drought- and wind-resistant	Requires fertile and moist soil, intolerant to shade	600–1000 m
2	**Silver poplar** (*Populus alba L.*)	Brown mountain-forest soils	Southern slopes	Not very demanding to climatic conditions. Light-loving, thermophilic, and drought-resistant	Requires fertile and moist soil, poorly tolerates saline soils	Up to 1000 m
3	**Araz oak** (*Quercus araxina*)	Brown mountain-forest soils	Southern slopes	Light-loving, thermophilic, and drought-resistant	Undemanding to soil, intolerant to saline soils and shade	500–1100 m
4	**Southern hackberry** (*Celtis australis L.*)	Brown mountain-forest soils	Southern slopes	Light-loving, thermophilic, drought-resistant, and cold-tolerant	Undemanding to soil, poorly tolerates saline soils, intolerant to shade	600–700 m
5	**Mountain elm** (*Ulmus glabra Huds.*)	Brown mountain-forest soils	Northern slopes	Moisture-demanding, drought-resistant, light- and heat-loving.	Requires fertile soil, shade-tolerant and cold-resistant	800–1000 m
6	**Caucasian hackberry** (*Celtis caucasica Willd.*)	Brown mountain-forest soils	Southern slopes	Light-loving, thermophilic, drought-resistant, and moderately cold-tolerant	Undemanding to soil, can grow on dry and rocky slopes, intolerant to shade	600–1000 m
7	**Oriental plane tree** (*Platanus orientalis L.*)	Brown mountain-forest soils	Common along riverbanks and flowing waters, does not tolerate stagnant water	Light-loving, thermophilic, drought- and cold-tolerant.	Requires fertile soil, both light-demanding and relatively shade-tolerant	600–1000 m
8	**Shishkin's poplar** (*Populus schischkinii*)	Brown mountain-forest and alluvial meadow-forest soils	Southern slopes	Light-loving, thermophilic, and cold-tolerant	Not very demanding to soil, moisture-loving	Up to 1000 m

Analysis of this data shows that almost all the dominant tree species in Zangilan's forests are light-lovi ng, thermophilic, and prefer southern slopes. Their biological and ecological characteristics vary significantly. Therefore, these species should be distributed in accordance with their ecological needs and biological traits -on the slopes where they can grow well and form productive and environmentally resilient forests.

By following this principle, it will be possible to successfully restore the destroyed forests of the district and to cultivate healthy, sustainable, and environmentally resistant forest ecosystems.

Studying the influence of slope exposure on the distribution of individual tree species in mountainous areas, as well as their productivity and resistance to adverse environmental factors, is therefore of great practical importance. The obtained results can serve as a scientific and methodological basis for forestry specialists engaged in the artificial reforestation of mountain ecosystems in the Zangilan district.

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ZƏNGİLAN MEŞƏLƏRİNİN SÜNİ BƏRPASI

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Xülasə: *Azərbaycan Respublikasının cənub-qərb hissəsində, Kiçik Qafqazın cənub-şərq yamaclarında və Araz çayının sol sahilində yerləşən Zəngilan rayonu təbii landşaft müxtəlifliyi və unikal meşə ekosistemləri ilə seçilir. Ermənistan Respublikasının təxminən 30 illik işğalı dövründə rayonun meşələri və ekosistemləri ciddi şəkildə deqradasiyaya uğramış, ekoloji terrorizmə məruz qalmış, nadir və qiymətli meşə massivləri, o cümlədən qədim Şərq çinarlarının (Platanus orientalis L.) bitdiyi Bəsitçay Dövlət Təbiət Qoruğu tamamilə məhv edilmişdir. Azərbaycan Respublikasının Təhsil Nazirliyinin Dendrologiya İnstitutunun apardığı ekspedisiya tədqiqatları nəticəsində müəyyən edilmişdir ki, işğal dövründə Zəngilan rayonunda ən çox zərər çəkmiş təbii ekosistemlər məhz meşələr olmuşdur. Tədqiqatlar göstərmişdir ki, rayonun əksər meşələri qəhvəyi dağ-meşə torpaqları üzərində formalaşmışdır və əsasən Juglans regia L., Populus alba L., Quercus araxina, Celtis australis L., Ulmus glabra Huds., Celtis caucasica Willd., Platanus orientalis L. və Populus schischkinii kimi işıqlı və quraqlığa davamlı ağac növlərindən ibarətdir.*

Tədqiqatın nəticələrinə görə, bu növlərin bioloji və ekoloji xüsusiyyətləri bir-birindən fərqlənir. Buna görə də Zəngilan rayonunda meşələrin uğurlu bərpası üçün ağac növlərinin ekoloji tələbləri və yamacların ekspozisiyası nəzərə alınmalıdır. Əksər dominant növlər işıqsevən və istiliksevəndir, əsasən cənub yamaclarında yayılmışdır. Yamac ekspozisiyasının meşəəmələgətirici növlərin yayılmasına, məhsuldarlığına və ekoloji davamlılığına təsirinin öyrənilməsi regionda sağlam və davamlı meşə ekosistemlərinin bərpası üçün mühüm əhəmiyyət kəsb edir.

Açar sözlər: *Zəngilan rayonu, meşələrin bərpası, ekoloji terrorizm, şərq çinarı (Platanus orientalis L.), yamac ekspozisiyası, ekoloji tələblər, quraqlığa davamlı növlər, dağ meşələri*

ОБ ИСКУССТВЕННОМ ВОССТАНОВЛЕНИИ ЛЕСОВ ЗАНГЕЛАНА

Сейфаддин Тагиев, Гюллю Алиева, Минара Гасанова, Фейза Джандан, Седагат Алиева, Гюльхар Рзаева

Аннотация: *Зангеланский район, расположенный на юго-западе Азербайджанской Республики, на юго-восточных склонах Малого Кавказа и на левом берегу реки Араз, отличается разнообразными природными ландшафтами и уникальными лесными экосистемами. В течение почти 30-летней оккупации со стороны Республики Армения леса и экосистемы района подверглись серьёзной деградации и экологическому терроризму, что привело к уничтожению редких и ценных лесных массивов, включая Басутчайский государственный природный заповедник, где произрастали многовековые платаны восточные (Platanus orientalis L.). По результатам экспедиционных исследований, проведённых Институтом дендрологии Министерства образования Азербайджанской Республики, установлено, что среди всех природных экосистем именно лесные экосистемы района понесли наибольший ущерб. Исследования показали, что большинство лесов района сформировалось на бурых горно-лесных почвах и представлено засухоустойчивыми и светолюбивыми породами: Juglans regia L., Populus alba L., Quercus araxina, Celtis australis L., Ulmus glabra Huds., Celtis caucasica Willd., Platanus orientalis L., Populus schischkinii и др.*

Установлено, что биологические особенности и экологические требования этих пород значительно различаются. Поэтому успешное восстановление лесов Зангеланского района требует учёта их экологических потребностей и экспозиции склонов. Большинство доминирующих видов являются светолюбивыми, теплолюбивыми и произрастают в основном на южных склонах. Изучение влияния экспозиции склонов на распространение, продуктивность и устойчивость лесообразующих пород имеет важное значение для восстановления здоровых и экологически устойчивых лесов региона.

Ключевые слова: *Зангеланский район, восстановление лесов, экологический терроризм, платан восточный (Platanus orientalis L.), экспозиция склонов, экологические требования, засухоустойчивые виды, горные леса*