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BOTANIC-GEOGRAPHICAL ANALYSIS OF MESOTHERMIC RELICTS OF TURGAI FLORA OF AZERBAIJAN

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БОТАНИКО-ГЕОГРАФИЧЕСКИЙ АНАЛИЗ МЕЗОТЕРМИЧЕСКИХ РЕЛИКТОВ ТУРГАЙСКОЙ ФЛОРЫ АЗЕРБАЙДЖАНА

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Abstract. From the middle of the Oligocene epoch of the Paleogene period evergreen Poltava flora had been replaced by deciduous tree species of Turgai flora. The taxonomic composition of the relict trees and shrubs belonging to the Turgai flora in Azerbaijan and their botanical and geographical characteristics are analyzed in this article. In the article also analyzed the characteristics of the relict areal and the genetic varieties that stood the changes in the geological periods, while preserving its gene pool so far. In modern times, Turgai flora remaining relicts are more common in Hirkan (Azerbaijan), in Colchis (Georgia), and partially in the forests surrounding the Southern hills of the Greater Caucasus. Mesothermic plants of Turgai flora in Azerbaijan are found combining 17 families and 28 genera in 38 species of trees and shrubs.

Аннотация. С середины олигоценовой эпохи палеогена вечнозеленая полтавская флора сменилась лиственными древесными породами тургайской флоры. В статье анализируются таксономический состав реликтовых деревьев и кустарников тургайской флоры Азербайджана и их ботанико-географическая характеристика. В статье также проанализированы характеристики реликтового ареала и генетические разновидности, выдержавшие изменения геологических периодов, сохранившие при этом свой генофонд до сих пор. В современное время сохранившиеся реликты тургайской флоры чаще встречаются в Гиркане (Азербайджан), в Колхиде (Грузия) и частично в лесах, окружающих южные холмы Большого Кавказа. Мезотермные растения Тургайской флоры Азербайджана встречаются, объединяющие 17 семейств и 28 родов у 38 видов деревьев и кустарников.

Keywords: mesothermic, relict, relict area, Poltava flora, turgai flora, Paleogene, Oligocene III period, arctic.

Ключевые слова: мезотермический период, реликт, реликтовый ареал, полтавская флора, тургайская флора, палеоген, III олигоцен, Арктика.

The examination of relict plants from many perspectives is one of today's research priorities. There are many complex causes for this. First, the study of the phylogenies of relicts allows us to obtain valuable scientific information to explain the trends in the historical evolution of these plants and the formation of their biochemical structure. Second, it allows clarifying the changes in flora from the historical point of view in different geo-ecological conditions, as well as the whole range of geological climatic changes in the region. Third, gives an opportunity to inspect the norms that

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explain the trends and mechanisms of changes in their vegetative and generic organs and the reasons why plants are exposed to the adverse effects of global climate change. Because of the most relict plants are rare and endangered species and they are playing the role of historical monuments of nature, it is necessary to study the scientific basis of protection and reproduction and the risk of their destruction.

Materials and methods

The object of research is the Turgai relicts, common in the natural flora of Azerbaijan. Species composition of Turgai relicts of Azerbaijan dendroflora is given according to A. A. Grossgeim [9], V. I. Baranov [4] and A. N. Krishtofovich [13]. In the systematization of names of species and genera in accordance with modern taxonomy used from APG-IV (https://kurl.ru/DMlZy), G. Zubkevich [19], in order to clarify how these plants are spreading in Azerbaijan used from The Red Book of the Republic of Azerbaijan [17] is used to determine the status of plants.

Discussion and Conclusions:

Relict plants are the species that were widespread in the past, but now remain in small areas in a single copy. If once the range of the species was very large and gradually decreased, the relict is considered to be in a relict area, and the species itself is a relict [1]. Factors limiting the area — climates, edaphic, other plant species, since the anthropogenic and geological mountain, valley, abyss, water basins) impact is dynamic and diverse, the boundaries of the areas where plant species are widespread have not been recorded in historical geological periods.

The survival of relict plants to our times and their further development can be explained by two complex factors. The first set of factors concerns of these very species. Thus, in historical geologic periods, relict vegetation, depending on the genetic potential of various organs, to global changes in the factors determining the range, could be idioadapted to evolutionary changes in accordance with the requirements of existing circumstances. These changes include the root system, body, leaves, bud, flowers and fruits, as well as the course and sequence of physiological processes, vegetation including duration and other features of all stages of ontogenesis. An obvious example of such changes is some of the evergreen plant species that were prevalent in tropical climates at the beginning of the third millennium. To fit into the mild and cold climate, plant life began to drop leaves. In relict species such as *Parrotia persica* (DC.) C. A. Mey., *Quercus mongolica* Fisch. ex Ledeb., *Quercus castaneifolia* C. A. Mey etc. the leaves remain in the foliage even if they turn yellow. This gives rise to the fact that these species are the elements of the Poltava flora, which is widespread when the tropical climate was dominant, have not yet differentiated in the cretaceous and in the pre-III period. As a new stage in the evolution of dendroflora, leaf litter is an important evolutionary change allowing the vegetation to endure the freezing [2, 3, 10, 16].

As an example of other changes in studied relict plants we can speak about formation of xeromorphic structures for adapting to drought resistance. For example, *Quercus* L., *Juglans* L., *Carpinus* L. and in other relict plants, the strong development of the root system at the end of the piliotic stage and during the global erosion of the IV period allowed these species to adapt to cold and drought. Hardening coating scales of buds, the thickening of the fruits of the seeds, and sometimes the embellishment (*Quercus* L., *Juglans* L., *Corylus* L, *Castanea* L., etc.), epicotil germination, changes in the biochemical composition of substances in the body are important evolutionary changes that allows adapt to environmental changes.

The second important complex factor in the survival of relicts to our time and their development is the characteristics of relict areas. III period relicts have been preserved in areas not exposed to glaciation during the ice age and have maintained their gene pools at all times. That is, a

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place was formed relict species. There are relict regions in the coastline of the Western Caucasus, in the South Caucasus, in Talysh, Colchis, Far East, Crimea and on the Pacific coast of North America [1].

As you can see, the vast majority of relief spaces are located on or near the seas and oceans. Here are two results: Firstly, the large water basins do not allow the climate in the coastal regions to change, they preserve a relatively stable situation. This can be explained by the high temperature of the water (the specific heat capacity of the water is c = 4200 C/kg×K). Secondly, in the coastal areas, there is a low probability of sharp frosts and a high probability of constant droughts and high temperatures. The high specific heat of water regulates the temperature of the region and forms the movement of water vapor in the air. Intensive evaporation, where there is a dynamic mobility of water circulation, reduces the likelihood of extreme colds, hot, drought and humidity. The duration of the day, the duration and angle of light, the geological structure and terrain are factors that affect the range of plants and determine its boundaries.

V. V. Alekhin and others divided the relicts into such groups as Mesozoic, III period, glacial period, after glacial relicts [1].

At the end of the Cretaceous Period, especially in the III period of Cenozoic, the geological map of the world, which existed at Mesozoic, has changed dramatically. Atlantic and Indian oceans formed. In the tropical continent fractures occurred on the ground and eventually the separation of Australia from the southern hemisphere. He also left Antarctica, stood next to the border of South Africa and America. The Mediterranean, Black Sea, Caspian Sea and Aral Lake were the remains of the Tethys Sea. As a result of these geo-morphological changes, the iceberg was formed in the northern part, and huge ices floated away to the seas. At the same time, because of strong mountain formation, the formation of alpine arcs began. The Himalayas, the Pamirs, the Caucasus, the Alps, and other mountain chains were concentrated here. During this period, many parts of the northern hemisphere, including some of the major flora elements of the III century, were destroyed. And in the west, on the contrary, tropical physical and geographical conditions have not changed. There was a flora of the III century here, and in the large plains trees and bushes were spread in large areas and generated rich tropical forests and savannas [1, 13].

In the III century the tropical flora of the whole world began to split into three groups. The climate was changed; soon the development history of the biosphere began.

There was a Holarctic flora group on the edge of the Tropical region. In the northern hemisphere. It includes only one floristic province — Holarctic region. Near the equator there appeared a new group called Pantropical flora, which included Neotropical and Paleotropical flora areas. And in the borders of the Tropics on the southern hemisphere appeared Australian, Kap and Antarctic flora provinces which were included to the Holantarctic flora [1, 12]. V. V. Alekhin and others consider the Caucasus to belong to the Eurasian subregion of the Holarctic region, but P. M. Zhukovsky concerns it belonging to Caucasus subregion. A. Tolmachev [20] and S. A. Ovesnov [15] divided the Earth's flora to 6 flora and 34 subcontinents such as: Holarctic (9 subregions), Paleotropical (12 subregion), Neotropical (5 subregion), Cape (1 subregion), Australia (3 subregions) and Antarctica (4 subregions). The Caucasus, including Azerbaijan, belonged to the Iran-Turan boreal part of the Holarctic flora province. Endemism in this region is between 25% and 30% [14].

At the beginning of the III century Europe had a rich flora. Formation of the modern floristic plant species originates in the foreground of Cenozoic. The warm and humid climate of the Paleocene and Eocene epochs of the III period of the Cenozoic era allowed the Poltava flora, i.e. the evergreen plants to gain an advantage. According to its taxonomic composition, the Poltava flora consisting mainly of evergreen plants, which resembles the tropical flora of South Asia not having

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any grass species, dominated the Oligocene epoch. In these favorable conditions for conifers, the range of these plants has expanded from Arctic to Antarctica. Since the beginning of the Oligocene epoch of the third period, broad leaved Turgai flora began to replace the evergreen Poltava flora. This process started from Europe and expanded to the north, including the Mediterranean Sea and the Caucasus. Turgai floras *Fagus* L., *Ulmus* L., *Betula* L., *Quercus* L., *Juglans* L., *Pterocarya* Kunth., *Acer* L., *Vitis* L., *Zelkova* Spach other broad-leaved genera dominated in Azerbaijan. In the middle of the Oligocene, the Turgai flora began spreading from Asia to Japan, from Sakhalin to Kazakhstan, Ural, in Europe till to Scotland and England starting to supersede the area of the coniferous [6, 8, 11, 13, 18].

In the East Caucasus, including in Azerbaijan widespread Turgai flora started to shrink due to icing in the end of the III and beginning from IV period. In modern times, Turgai flora remaining relicts are more common in Hirkan (Azerbaijan), in Colchis (Georgia), and partially in the forests surrounding the Southern hills of the Greater Caucasus. Hirkan is generally regarded as a former mesophyll relict island of the III Period flora [3, 10, 14].

Mesothermic plants of Turgai flora in Azerbaijan are found combining 17 families and 28 genera in 38 species of trees and shrubs [5, 7, 17, 18] (Table). The Table summarizes the hazard categories, statuses and botanical-geographical areas, according to IUCN.

Table

MESOTHERMIC RELICTS OF TURGAI FLORA IN AZERBAIJAN

Species	*Categories and statuses according to IUCN*	*Botanical-geographical areas of species distribution* *
Acer velutinum Boiss.		1, 4, 5
A. laetum C. A. Mey.		1, 2, 4
A. hyrcanum Fisch. & C. A. Mey.	Azerbaijan rare species. NT	1, 2, 4, 5
A. pseudoplatanus L.	Azerbaijan rare species. NT	1
Alnus subcordata C. A. Mey.	Azerbaijan rare, relict species. VUA2cd+3cd.	4
A. barbata C. A. Mey.	It is a rare plant species in Azerbaijan. VU D2.	1, 3, 4
Betula raddeana Trautv.	It is Azerbaijan rare species. VU C2a (II).	1, 2
Carpinus orientalis Mill.		1, 2, 4
C. betulus L.		1, 5
Castanea sativa Mill.	It is Azerbaijan rare, relict species.VU A2c+3cd.	1, 2, 4
Corylus avellana L.		1, 2, 4
C. colurna L.	It is Azerbaijan rare, relict pecies. VU D2.	1, 2, 4
Cornus mas L.		1, 2, 3
Cerasus incana (Pall.) Spach		1, 3, 5
Fagus orientalis Lipsky		1, 2, 4
Frangula grandifolia (Fisch. & C. A. Mey.) Grubov	It is Azerbaijan rare, relict pecies.VU A2c.	1, 4
Fraxinus coriariifolia Scheele	Azerbaijan rare, relict species. LC	1, 4
F. excelsior L.		1, 2, 4, 5
Juglans regia L.	It is Azerbaijan rare species. NT	1, 2, 4, 5
Mespilus germanica L.		1, 5
Prunus spinosa L.		1, 4
Pyrus boissieriana Boiss. & Buhse	Azerbaijan rare, relict species. CR A2abc.	4
Pinus kochiana Klotzsch ex K. Koch.	Azerbaijan rare, relict species. NT.	1, 5

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Species	*Categories and statuses according to IUCN*	*Botanical-geographical areas of species distribution* *
Pterocarya pterocarpa (Michx.) Kunth, 1824	Azerbaijan rare, relict species. VU D2.	1, 4
Philadelphus caucasicus Koehne		1
Quercus castaneifolia C. A. Mey.	Azerbaijan rare, relict species. NT.	1, 4
Q. iberica Steven	Azerbaijan rare species. DD	1, 2, 4
Sorbus boissieri C. K. Schneid.		2, 4, 5
S. torminalis (L.) Crantz		1, 2, 4
Rhamnus ×spathulifolia Fisch. et C. A. Mey.		1, 2, 4, 5
Salix alba L.		1, 5
Staphylea colchica Stev.	Azerbaijan rare species. CR B2b (I, II, III)	1
Tilia caucasica Rupr.	Azerbaijan rare species. NT	1, 2, 4
Ulmus scabra Mill.		1, 2, 4, 5
Ulmus glabra Huds.		1, 2, 4, 5
Vaccinium arctostaphylos L.		1, 2
Vitis sylvestris C. C. Gmel.	Azerbaijan rare, relict species. VUD2	1, 5
Zelkova carpinifolia (Pall.) K. Koch	Is Azerbaijan rare, relict species. EN B1ab (I, II, III, IV, V) c (III)+2b(I)c (II, III).	2, 4

* 1 — Greater Caucasus (GC), 2 — Lesser Caucasus (LC), 3 — Kura-Araz (KA), 4 — Talysh (T), 5 — Nakhchivan (N)

Thus, according to our observations and studies by some scientists on relict plants:

In the III century, the whole world has largely been subdivided into three groups of Tropical flora — Holarctic, Pantropic, Holantarctic differentiations;

From the early Oligocene epoch, the broad leaved Turgai flora start to substitute evergreen plants of Poltava flora which dominated in the Paleocene and Eocene epochs of the III period of Cenozoic era. The reason for this is climate mitigation.

The vast majority of relict areas are located on the sea, ocean shores, or near it. The large water basins do not allow the climate in the coastal regions to change, they preserve a relatively stable situation. The length of the day, the decline and the fall of the light, the geological structure and relief of the area are also factors that determine the boundaries of the relict terrain.

The composition of Turgai relict species is even richer in the geographical regions of Talysh and the Greater Caucasus.

There are 38 species of trees and shrubs belonging to the Turgai flora of the III period spread in Azerbaijan's dendroflora. 20 of these are rare and endemic plants. The Turgai relicts were even more common in Hirkan and in the forests surrounding the Southern slopes of the Greater Caucasus.

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