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**THE SCIENTIFIC HERITAGE OF Z.G. ZALIBEKOV IN THE RESEARCH
OF GEOSYSTEMS AND SOILS**

*devoted to the
90th anniversary
of soil biologist
Zalibek Hajievich Zalibekov*

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The article is devoted to the scientific life of soil biologist Zalibek Ghadjievich Zalibekov, Doctor of Biological Sciences, chief Researcher of the Institute of Geology of the Russian Academy of Sciences, Professor of the Department of Soil Science of Dagestan State University, Honored Scientist of Dagestan and the Russian Federation, who devoted his whole life to studying issues of general biology and soils. Z.G. Zalibekov was one of the first in the development of the scientific methods to research and stop the desertification in Russia, as well as the founder and first director (1991-2006) of the Caspian Institute of Biological Resources of the DNC RAS, as part of the Dagestan Federal Research Center of the Russian Academy of Sciences. He is the founder and editor-in-chief (from 1994 to the present) of the international scientific journal "Arid Ecosystems".

Keywords: soil biologist, Z.G. Zalibekov, creative path, founder of the institute, founder of the journal, path in science, international cooperation, national program to combat desertification, anthropogenic factor, biosphere problems of soil science.

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**CLIMACTIC DETERMINATION OF INSULAR STEPPE DEVELOPMENT
IN THE SOUTHERN PART OF EASTERN SIBERIA**

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In this article we discuss perennial climatic conditions in the “near-ground air layer – soil” system in the insular steppe of the southern part of Eastern Siberia. We found out that the more severe the winters grow and the higher the climate continentality of the near-ground atmosphere from south-west to north-east is, the deeper the soils cool down in winter season, while the summer warming slightly increases in the same geographical direction. Substantial differences in the annual amplitude of underground temperature were detected for spatially separated insular steppe, with the highest value in the Southern Transbaikalia which corresponds to the strongly continental soil climate. Variations in annual mean air and soil temperatures and annual atmospheric precipitation for recent decades were determined using their perennial data series. The linear trends for air and soil temperatures are positive almost in every area, and their perennial series are highly coherent. Atmospheric precipitation in Southern Transbaikalia tends to decrease. The insignificant positive and negative trends were detected in Cisbaikalian weather stations.

Keywords: insular steppe of Eastern Siberia, air and soil temperature, atmospheric precipitations, regional climate changes, Cisbaikalia, Transbaikalia, trends.

Funding. The research was carried out within the framework of the State assignment on the topic of research AAAAA 21-121012190059-5 "Study of the structural and functional organization of geosystems of Siberian regions for planning sustainable territorial development" 2021-2025.

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**APPLICATION OF THE METHODOLOGY OF LAND DEGRADATION NEUTRALITY
FOR THE TERRITORY OF CASPIAN SEA REGION**

© 2024. G.S. Kust, D.S. Shklyueva, V.A. Lobkovskiy, O.V. Andreeva

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For more than 20 years studies of the Caspian Region have been carried out under the Framework Convention for the Protection of the Marine Environment of the Caspian Sea (Tehran Convention). Its objective is to protect the Caspian Sea and surrounding terrestrial landscapes from negative impacts. For the first time, the results of a comparative assessment of coastal land dynamics are presented for 5 countries on the basis of land degradation neutrality (LDN): the Republic of Azerbaijan, the Islamic Republic of Iran, the Republic of Kazakhstan, the Russian Federation and Turkmenistan. This approach made it possible to identify the main trends in land dynamics in the region for different observation periods, including those for individual countries and regions. The results are presented in cartographic form. The deterioration of the current situation is currently typical for most of the Caspian Region due to intensified degradation processes. The main “hot spots” of desertification are described. At the same time, the dynamics of land degradation varies in different directions for individual parts of the region and observation periods. A careful selection of different periods of comparison and baselines can help track changes in land dynamics and identify peaks in its improvement and deterioration.

Keywords: land degradation neutrality, Caspian Sea, land degradation, desertification.

Funding. The research was carried out within the framework of the state theme of the IG RAS FMWS-2022-0001 "Spatial and temporal problems of sustainable land use in the context of global climate change" (spatial data processing and formulation of the main provisions and conclusions).

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**ASSESSMENT OF PRODUCTIVITY INDICATORS OF PLANT COMMUNITIES
OF THE STEPPE ZONE IN WESTERN SIBERIA OBTAINED BY
REMOTE SENSING AND DENDROCHRONOLOGY**

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The study explores different methods of combined analysis of the productivity of herbaceous and woody plants from various landscape communities, such as typical steppe, saline, woody and agricultural ones, in the arid conditions in the south of Western Siberia. The analysis was carried out remotely (by analyzing NDVI) and dendrochronologically (by analyzing width growth of the Scots pine (*Pinus sylvestris* L.) trunks in the extrazonal ribbon forests). We discovered that climatic factors that determine the dynamics of NDVI and radial growth of trees in the steppe zone are the limiting influence of summer air temperatures and the positive influence of precipitation during the previous winter and current summer seasons. Analysis of vegetation indices and radial growth showed the presence of a moderate relationship between them: NDVI of herbaceous communities (feather grass-fescue, arable lands) in May and July correlated with the width of growth rings. It was revealed that in the arid steppe the trunk width of pines' radial growth depends on the NDVI value of their crowns in May two years earlier.

Keywords: NDVI, productivity, radial growth of trees, ribbon pine forest, steppe zone, south of Western Siberia.

Funding. The research was carried out with the support of the Ministry of Science and Higher Education of the Russian Federation, the state assignment for scientific research carried out at Altai State University, project no. FZMW-2023-0007.

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**PHYTOCENOTIC POTENTIAL OF PASTURES ON THE SANDY MASSIFS
OF THE DON BASIN**

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The aim was to analyze the phytocenotic potential of pasture ecosystems in the Tsimlyansk sand massif using ecological scales of humidity, soil reactions and soil richness with mineral nitrogen according to Ellenberg N Index. The research was based on landscape-bioecological and ecological-morphological methods using special techniques to study the structure, stability and development of plant communities. The *Poaceae*, *Fabaceae* and *Asteraceae* families played the major role in the projective covering. Hemicryptophytes turned out to be the predominant life form of vegetation at all the sites (40-71%). The yield of phytocenoses averaged 156-287 g/m². The species composition and yield of pasture phytocenoses varied significantly depending on humidity, physico-chemical properties and the soil richness of N. Key species of the moist, non-drying, slightly acidic soils with an average N content were *Agrostis canina* L., *A. tenuis* Sibth., *Thlaspi arvense* L., *Typha angustifolia* L., *T. latifolia* L., *Tanacetum vulgare* L., *Phragmites australis* (Cav.) Trin. ex Steud., and *Scirpus lacustris* L. Key species of the slightly acidic soils with average humidification and an average N content were *Achillea millefolium* L., *Astragalus arenarius* L., *Elytrigia repens* (L.) Nevski, *Medicago falcata* L., and *Phleum pratense* L. Key species of the slightly acidic soils with average humidification and rich with N were *Apera spica-venti* (L.) P. Beauv., *Atriplex tatarica* L., and *Calamagrostis epigeios* (L.) Roth. Key species of the neutral soils with average humidification and average N were *Artemisia abrotanum* L., *Cirsium incanum* (S.G. Gmel.) Fisch., *Gypsophila paniculata* L., *Inula germanica* L., *Juncus gerardii* Loisel., and *Senecio erucifolius* L. Key species of the dry and slightly acidic soils with an average N were *Chamaecytisus ruthenicus* (Fisch. ex Wol) and *Festuca valesiaca* Gaudin. Key species of the dry and slightly acidic soils with poor N were *Anisantha tectorum* (L.) Nevski, *Artemisia campestris* L., *A. maritima* L., *A. marschalliana* Spreng., *A. scoparia* Waldst. & Kit., *Bromopsis inermis* (Leyss.) Holub, *Crepis tectorum* L., *Koeleria glauca* (Spreng.) DC., *Leymus racemosus* (Lam.) Tzvelev, *Potentilla incana* P. Gaertn., B. Mey. & Scherb., *Psammophiliella muralis* (L.) Ikonn., and *Stipa capillata* L. Key species of the neutral or slightly acidic soils with sufficient or variable moisture, with an average N were *Agropyron cristatum* L. and *Thlaspi arvense* L. There was a large proportion of therophytes species (22.9%) in the *Bromopsis-Calamagrostis-Artemisia* community, which indicates that the territory is under an anthropogenic pressure.

Keywords: phytocenoses, species diversity, sand massifs, pasture ecosystems, environmental assessment, Ellenberg scales.

Funding. This work was carried out as part of the research No.122020100450-9 “Development of a New Methodology for Optimal Management of Biological Resources in Agricultural Landscapes in the Arid Zone of the Russian Federation Using System-Dynamic Modeling of Soil-Hydrological Processes, Complex Impact Assessment of the Climatic Changes and Anthropogenic Loads on Agrobiological Potential and Forest Conditions”.

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**BOREAL PLANT SPECIES OF THE KAZAKH HUMMOCKS:
ECOLOGICAL-COENOTIC CHARACTERISTICS AND DISTRIBUTION FEATURES**

© 2024. N.B. Leonova, Ju.A. Pereverzeva

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Within the territory of the Kazakh Hummocks, far beyond the typical taiga ecosystems, boreal plants have been preserved since the Pleistocene when coniferous forests were widespread in the territory. These species are an important component of the local phytodiversity, therefore they require a comprehensive study. During our research, based on field observations data and analysis of literary sources, we obtained information on the taxonomic composition of boreal plant species, their coenotic occurrence, as well as ecological and geographical characteristics. We identified 30 species of vascular plants in the composition of the plant communities of the Kazakh Hummocks that belong to the boreal ecological-coenotic group, the ecology and coenotic affiliation of which is different from plants of zonal steppes. In a sharply continental arid climate, the studied boreal species grow in peculiar habitats, such as mountain forest-steppe landscapes and moist habitats along rivers and lake shores. Most of them grow in pine forest outliers on the slopes of rounded hills with granite outcrops. They can be also found in the areas with increased moisture level at the foot of the slopes and in depressions where azonal small-leaved forest communities usually grow. Additionally, they were discovered in intrazonal meadow and swamp coenoses, as well as on rocky slopes. According to the analysis of their distribution across the territory of the Kazakh Hummocks, the maximum diversity of boreal species is found in the Kokchetav and Karkaraly floristic regions with 23 and 29 species respectively. Three boreal species with small and vulnerable populations are listed in the Red Data Book of the Republic of Kazakhstan (2006). However, as this study has showed, a number of other boreal species requires protection as well. The main threats to the conservation of boreal populations are excessive recreation and wild fires. Thoughtful measures are required to preserve rare and vulnerable plant communities, including plant species growing at the border of their range.

Keywords: rare plant species, range boundaries, ecological and geographical characteristics, coenotic features, conservation of phytodiversity.

Funding. This work was carried out as part of the research topic No. 121051100137-4 “Spatio-Temporal Organization of Ecosystems under Conditions of Environmental Changes” and supported by Moscow University Development Program (#1220).

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HAWTHORN *CRATAEGUS RHIPIDOPHYLLA* GAND. IN THE ARID CONDITIONS OF THE REPUBLIC OF DAGESTAN

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Hawthorn *Crataegus rhipidophylla* Gand. is a typical plant in the sparse woods of the piedmont region of the Republic of Dagestan, found in the lower, middle and upper mountain zones. Identification of patterns of intraspecific and interpopulation diversity (including the quantitative traits of annual shoots and their adaptive manifestation in the conditions of species introduction) allows determining the species' optimum and adaptive potential to specific arid conditions.

In this paper we present the results of an ecogeographical experiment on the altitudinal gradation of *Crataegus rhipidophylla* using its annual shoots as an example. In our research, we used a unique scientific setup "System of Experimental Bases Located along the Altitudinal Gradient (1100 and 1700 m ASL)". We studied plants grown from seeds that were previously collected in arid ecosystems, under different conditions. We studied 10 quantitative traits and 1 qualitative trait (trichomes) of shoots and leaves to observe adaptive changes in an annual shoot under conditions of species introduction. The results were processed and evaluated by descriptive statistics, as well as by correlation, cluster and two-factor analysis of variance.

We discovered the degree and structure of variability of quantitative traits of annual shoots and leaves, and the presence of population-geographical differentiation in such traits as "shoot length", "number of leaves" and "number of prickles", depending on the conditions of germination of collected samples. We determined the quantitative and qualitative differences between specimens. With increasing altitude, the increasing number of prickles and trichomes on the shoots and leaves can be considered as one of the adaptive mechanisms of vegetative organs to abiotic factors of the arid climate in the mountainous conditions.

Keywords: acclimatization, population, variability, ecological-geographical experiment, altitudinal gradient, factor influence, hawthorn, Republic of Dagestan.

Funding. This work was carried out as part of the state task No. 0206-2019-0007 "Geoclimatic Peculiarities of Distribution and Description of Communities with Populations of Rare and Resource Tree Species of the North Caucasus".

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**HETEROGENEITY OF THE PASTURE FODDER AND ITS FRAGMENTATION
WITHIN THE COMPLEX OF HERBIVOROUS MAMMALS DURING JOINT GRAZING**

© 2024. B.D. Abaturov

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In this article we discuss that the digestibility of pasture vegetation depends negatively on the amount of grasses (graminoids) in the fodder, which in turn is caused by the limiting effect and the increased amount of silicon compounds in grasses. On the example of 4 herbivorous species (Przewalski's horse, American bison, Bactrian camel and saiga antelope) with very different digestion habits, we explored their feeding selectivity in relation to 2 differently digested groups of plants, such as grasses and forbs. Saiga antelopes, as well as other picky animals that feed on highly digestible fodder, prefer forbs with a reduced silicon content and increased digestibility. If the poorly digestible grasses are dominant in the pastures, therefore, forcing antelopes to consume them, the antelopes' population cannot be viable. Przewalski's horses and American bison, as well as other equines and large ruminants, are specialized in consuming poorly digestible grasses due to their peculiar digestive systems. Meanwhile, they do not eat forbs because of their increased toxicity. Bactrian camels are not picky about different grasses and forbs, preferring fallow lands (former arable lands) dominated with weed plants and ignored by other herbivores. Diverse preferences of forage plants during joint grazing of different animal species allow them to use pasture resources separately and independently, excluding competition and preserving the species diversity of plant species.

Keywords: herbivorous mammals, pasture plants, grasses and forbs, digestibility of feed, selectivity of nutrition, joint grazing.

Funding. This work was carried out as part of the grant No. 03-04-48024 of the Russian Foundation for Basic Research "Connection between Animal Populations and Habitual Conditions: The Role of Foraging Parameters of Rangeland Vegetation in the Dynamics and Sustainability of Herbivorous Mammal Populations" and the grant No. 15-04-03542 "Forage Quality of Vegetation in Natural Rangeland Ecosystems as a Factor of food Availability and Viability of Herbivorous Mammal Populations".

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FEATURES OF THE DEMOISELLE CRANES' USING THE EUROPEAN PART OF THEIR RANGE IN SPRING-SUMMER AND THE PRE-MIGRATORY PERIOD

© 2024. E.I. Ilyashenko*, K.D. Kondrakova*, E.A. Mudrik**, M. Wikelski***, Cao Lei****, V.Yu. Ilyashenko*

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Remote tracking revealed that the Yeruslan and Maly Uzen Interfluvium and the Manych Basin, located 600-800 km from each other, serve as the most important spring-summer staying and key trophic areas for the Caspian, Volga-Ural and Cis-Ural subpopulations of the demoiselle cranes (*Anthropoides virgo*, Linnaeus 1758) which breed from the Central Ciscaucasia to Cis-Urals. During both spring-summer and trophic stage of their migration, cranes of the Caspian subpopulation stay only in the Manych Basin. Crane families from the Trans-Volga Region of the Volga-Ural subpopulation use both key territories during the trophic stage, while families from Western Kazakhstan spend most of it in the interfluvium of Yeruslan and Maly Uzen rivers, moving out to the Manych Basin before the start of the transit stage of their autumn migration. The total area of the territory used by demoiselle cranes in the Yeruslan and Maly Uzen Interfluvium and the Manych Basin is 6948.6 km² and 29457.2 km², respectively.

In the Manych Basin, cranes of the Volga-Ural subpopulation use a larger territory unlike the Caspian subpopulation which mostly adheres to the Manych coastal zone. Cranes nesting in the Manych Basin are the first to begin the transit stage of migration, their departure being the most extended one, while cranes of the Volga-Ural subpopulation leave much later, but faster.

Keywords: Demoiselle Crane, trophic stage of migration, key trophic areas, remote tracking.

Funding. This work was funded by the project No. 17-04-01287 of the Russian Foundation for Basic Research "Population-Genetic Structure of the Demoiselle Cranes and White-Naped Cranes: Geographic Distribution of Their Variability and Differentiation Levels by Nuclear and Mitochondrial Markers" as part of the Joint CAS-MPG Research Project, grant No. HZXM20225001MI, as well as the "Remote Monitoring of South Russian Populations of the Demoiselle Cranes, a Flag Species for the Conservation of Biodiversity of the Russian Steppes" project of the Russian Geographical Society, and as part of the topic (state registry No. AAAA-A18-118042490055-7) of the Severtsov Institute of Ecology and Evolution of the Russian Academy of Sciences "Fundamental Problems of Wildlife Protection and Rational Use of Bioresources".

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**CHANGES IN SOIL PROPERTIES UNDER DRAINAGE AND SECONDARY WATERING
OF THE STEPPE ZONE, SOUTHERN URAL REGION**

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An abrupt change of hydrological regime, caused by drainage during amelioration in the steppes of the South Ural Region (Russia, Republic of Bashkortostan), transforms many soil properties, which can result in soil degradation. Drainage of the Berkazan-Kamysh Natural Boundary resulted in a list of negative processes, the main of which are mineralization of peat organic matter and soil salinization so severe that it has formed a few meadow solonchaks completely devoid of any vegetation. However, a secondary watering after drainage in the Serek-Kul Natural Boundary did not cause soil degradation, and therefore can be considered one of the most effective methods of restoration for boggy ecosystems.

Keywords: chernozem-meadow soils, peat-bog soils, drainage, secondary watering, soil salinization, agrochemical properties.

Funding. The study was carried out within the framework of the state assignment of the Ministry of Science and Higher Education of the Russian Federation "Program for the creation and operation of a carbon landfill in the Republic of Bashkortostan "Eurasian carbon landfill" for 2022-2023 (Publication number: FEUR-2022-0001) and No. 075-00326-19-00 on the topic No. AAAAA-A18-118022190102-3. Some of the results were obtained using the equipment of the Agidel Central Research Center.

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**STUDY OF THE IMPACT OF DUNE FIXATION ON LAND USE
IN THE SEMI-ARID STAGE: DJELFA, ALGERIA**

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The various dune fixation works carried out at the level of the dune belt are extremely useful, on the one hand to fight against desertification via the creation of a microclimate which ensures the ecological sustainability of fragile ecosystems, and on the other hand, to improving the way of life of rural populations. In this context, carry out a diachronic study, with the aim of quantifying the floristic diversity after 31 years of planting. Also, the application of Factorial Correspondence Analysis (FCA) and CAH to 118 statements and 74 species revealed 4 plant groups. The main factors that determine them are: slope (axis 1), soil humidity (axe 2). The analysis of the results of the diachronic study shows that the overall percentage of vegetation increases in line with the altitudinal gradient, it occupies the lowest topographies of the dune where soil humidity is high and the action of the wind is minimal; windward topographies are generally difficult to colonize; they are drier and more exposed to the prevailing wind (SW), on the other hand the leeward topographies which are in shelter are cooler and therefore easily colonizable. Each fixing species occupies the dune differently as well: *Retama retam* Webb, grows across the entire dune at different topographies and exposures. *Tamarix gallica* L colonizes all the topographies of the dune except the summits at high altitudes exposed to the wind. *Tamarix aphylla* (L.) Karst and *Eleagnus angustifolia* L colonize the lower slopes and inter-dune spaces. *Lycium arabica* Boiss, recorded a success rate of less than 10%, especially in topographic position facing the wind.

Keywords: desertification, dune fixation, floristic richness, dune belt, *Retama retam* Webb, Biological ascent.

Conflict of interest. The authors declare no conflict of interest.

Funding. This research received no external funding.

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**EXPERIENCE AND PROSPECTS OF GROUNDWATER DEVELOPMENT
IN OASIS IRRIGATION OF SANDS IN THE WESTERN CASPIAN REGION**

© 2024. G.A. Surkhaev, G.M. Surkhaeva

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In this article we assess the hydrogeological potential of the Terek-Kuma sands in the Western Caspian Region, which contain significant underground water reserves (artesian and groundwater) of the Caspian Depression centered near the feeding glaciers of the Greater Caucasus. According to their chemical composition, these waters are suitable for irrigation of tree and herbaceous ameliorant crops. This is supported by long-term scientific and experimental works of Achikulak Research Forest Experimental Station of the All-Union Research Institute of Agroforestry (these days known as the North Caucasian Branch of the Federal Scientific Center of Agroecology, Complex Meliorations and Protective Forestry of the Russian Academy of Sciences), carried out in the sands of the Bazhigan Massif. The latter determines a wide potential for the use of self-pressure (artesian) and non-pressure (groundwater) underground water in oasis irrigation of sandy territories. Using groundwater to irrigate arable phytocenoses directly from the wells with the help of pulsed sprinkling and renewable energy sources (sun, wind) seems to be a more cost-effective method with a faster payback than the capital-intensive method of storing flowing artesian water in tanks. According to our estimates, the groundwater potential of this region is high enough for hydromelioration successfully carried out in more than 100 thousand ha of sandy lands in the arid region.

Keywords: moving sands, underground water, artesian water, groundwater, oasis irrigation, sand irrigation, pasture irrigation, water well, ameliorants.

Funding. This work was carried out as part of the state task No. 0713-2019-0002 “To Develop Scientific Bases, New Methods, Models and Technologies of Sufficient Development of Afforestation Amelioration and Multipurpose Use of Low-Productive and Degraded Lands of the Arid Zone of the Russian Federation”.

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**BIODIVERSITY OF MALACOFAUNA IN THE CASPIAN-MANYCH-PONT SYSTEM
DURING THE LAST INTERGLACIAL EPOCH**

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The conditions of the biodiversity formation and their comparative analysis at individual stages of development of the Ponto-Caspian basins in the MIS 5 epoch have been identified. The work was carried out based on the results of studying materials from many years of field research in the Caspian, Azov-Black Sea regions and the Manych Depression. The biodiversity of malacofauna in the Caspian-Manych-Pont system under the climatic conditions of the MIS 5 epoch was closely linked with the basin's history. Two transgressive basins, Late Khazarian and Hyrcanian, have been reconstructed in the Caspian Sea. The Late Khazarian malacofauna of the northern part of the paleo-Caspian Sea is represented by 26 species. The majority of the Late Khazarian species belongs to the Cardiidae family and are Caspian endemics. The main species is *Didacna surachanica* Andrusov, 1910. The Hyrcanian malacofauna includes 22 species, the majority of which are also Caspian endemics. The main species are *Didacna subcatillus* Andrusov, 1910 and *Didacna cristata* Bogachev, 1932. The malacofauna composition is influenced by factors such as inheritance from the previous basin, aquatic environment's salinity and temperature, and the introduction of freshwater fauna with river runoff. The significant impact of unexpected catastrophic events, such as the sudden break of a periglacial lake and the subsequent flow of its waters into the Caspian Sea, has led to a sharp change in the biodiversity of the Hyrcanian basin in comparison to the Late Khazarian basin. The Pont's Karangatian transgression occurred in three stages. In the northeastern part of the Pont, the malacofaunal composition consists of 37 species, mostly Mediterranean species, both euryhaline and stenohaline. Each stage is characterized by its malacofaunal complex, which includes varying degrees of euryhaline or stenohaline elements. The second complex, corresponding to the maximum stage of transgression, was characterized by the greatest diversity and the presence of the most halophilic elements. An important feature of the third complex is the presence of Caspian species characteristic of the Hyrcanian transgression of the Caspian Sea. The events that occurred in the Manych Depression, which are closely associated with the evolution of the Caspian and the Pont, have been reconstructed: the ingressión gulf of the Karangatian transgression of the Pont in the second stage of its development; reduction in the length of the bay, with the simultaneous advance of waters of the Hyrcanian transgression and their discharge into the bay; complete release of the Manych Depression from the Karangatian waters and the discharge of the waters of the Hyrcanian transgression into the Karangatian basin in the third stage of its development. The Pont's species diversity was determined by the malacofauna composition that migrated from the Mediterranean Sea. At the final stages of the development of the Karangatian transgression its faunal composition was influenced by Caspian invasive species that penetrated the Pont with the waters of the Hyrcanian transgression through the Manych Strait. The composition of malacofauna in the Caspian Sea was primarily the result of evolutionary processes. Migration was the main factor in the formation of the Black Sea malacofauna, without any evolutionary influence.

Keywords: Late Pleistocene, climate change, Late Khazarian transgression, Hyrcanian transgression, Karangatian transgression, species evolution, malacofauna migration.

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