

BOTANY

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Ecological-Phytocoenotic Assessment and the Issues of Conservation of the Ararat Valley Relic Salt Marshes

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Introduction. In Armenia marshes occupy less than 1% of the total area of the republic, viz. about 30,000 hectares. The marsh vegetation in Armenia occurs at an altitude of 400 to 3000 m a.s.l. and is represented by 755 species of higher plants, of which 338 species are found in the desert-semidesert belt [1]. Salt marshes of Ararat valley with *Juncetea acuti* community, which are considered to be one of the refuges of the ancient Mediterranean hygro-halophytic flora, represent great scientific interest due to their originality and rich floristic composition [1 – 5]. Ararat relict salt marshes are included in the list of Natural monuments of Armenia and identified as an Important Plant Area (IPA) of global conservation concern [6]. Over the past decades, significant changes in the state of the environment and biodiversity have occurred in the salt marshes of the Ararat valley. Taking into account the intensification of anthropogenic pressure and the lack of information about the ecological-phytocoenotic state of Ararat salt marshes and about the rare and endangered plant species growing here, we have undertaken this investigation. The purpose of present study is to provide scientific data on the current state of the Ararat salt marshes for their restoration and conservation.

Materials and methods. Salt marshes have been preserved to the east of the Ararat (Ararat province of the RA). The average air temperature in the area of Ararat town in July is +25.8°C, in January –4.1°C. About 220 mm of precipitation falls annually with a maximum in May. A stable snow cover form not every year. In the vicinity of the city of Ararat, hydrocarbonate thermal mineral springs were found with a water temperature of about 20-25°C, containing biologically active components H₂SiO₃, HBO₂, elements Fe, Cu, Mn.

Near the territory of the Natural monument “Salt Marshes” there is a mineral spring “Ttu-Dzhur”. The territory of the salt marshes is located at an altitude of 792–822.5 m a.s.l., it is flat, with small micro-depressions. Monitoring of the hydrogeological state of the habitat revealed that the soils here are sulfate-alkaline with a pH of 7.6-8.0, the salt content in the soil is about 0.2%, in the water is about 0.3% [5]. A low rise of water by 10-15 cm above the soil level is noted in spring on small fragments of about 15-25 m². In the 70-80s of the last century Ararat salt marshes with *Juncetia acuti* community occupied an area about 150 hectares [4]. Current remaining area is about 87.98 hectares (Fig. 1), of which space close to the salt marshes natural condition occupier about 52.75 ha [5]. To carry out monitoring of Ararat salt marshes expeditions were made to Ararat province of Armenia in 2016-2021. Field works were done utilizing methods of unified system of environmental monitoring [7], bio-ecological [8] and phenological methods [9].



Fig. 1. Salt marshes near Ararat town. The total area of salt marshes (doted shape) is 87.98 ha (8.19 ha small and 79.79 ha large shape) [5].

Wells of different depths (30, 40, 60 cm) were drilled for the level of ground water determination. The botanical inventory of the salt marshes was carried out using the method of taxonomic analysis. Plants species abundance in the phytocoenosis was determined using the method of visual estimation according to the scale of O. Drude [10]. For mapping GPS has been used, from which received coordinates further imported to GIS inside ArcGIS 10.1 [11] program. Morphological features of plant samples will be studied using an

MBC-9 stereo microscope. Plants and habitats will be photographed with Nikon D3400 digital camera.

Results and discussion. Ararat salt marshes are a rich habitat with a great plant diversity often with a close herbaceous cover. The main edificator and the dominant species of Ararat salt marshes with a high frequency of occurrence and abundance is *Juncus acutus* L. The species forms a kind of habitat's micro-relief, consisting of tussocks 80-120 cm in diameter, up to 30 cm high, located at a distance of 100-200 cm from each other, and inter-tussocks spaces with small depressions. Tussocks consist of accumulations of old, dry parts of rhizomes, roots and stems of *Juncus*, as well as the remains of some other plants, which eventually become covered with soil. The tussocks of *J. acutus* are considered as "minimal phytogenic fields" or "edapho-spheres" [4, 12], on which many other plant species settle. According to our observations, on the tussocks of *J. acutus* grow annual, biennial and perennial plants, belonging to the main components of the community: *Microcnemum coralloides* (Loscos et Pardo) Font Quer ssp. *anatolicum* Wagenitz, *Lysimachia maritima* (L.) Galasso, Banfi & Soldano, *Falcaria falcarioides* (Bornm. et H. Wolff) H. Wolff., *Linum barsegianii* Gabr. et Dittr., *Thesium compressum* Boiss. & Heldr., *Suaeda altissima* Pall., *S. salsa* (L.) Pall., *Cynodon dactylon* (L.) Pers., *Thymelaea passerina* (L.) Coss. & Germ., *Geranium collinum* Steph. ex Willd. and some others.

Besides *J. acutus* the most widespread, background plants on the salt marshes are such species as *Gypsophila perfoliata* L., *Thymelaea passerina* (L.) Coss. et. Germ., *Elytrigia obtusiflora* (DC.) Tzvelev, *Elytrigia repens* (L.) Nevski, *Cynanchum acutum* L., *Cynodon dactylon* (L.) Pers., *Aeluropus litoralis* (Gouan) Parl., *A. pungens* (M. Bieb.) K. Koch, *Alhagi pseudalhagi* (M. Bieb.) Desf. ex B. Keller & Shap. The predominance of listed plant species indicates the ongoing processes of dehumidification of the habitat.

One of the most common species on studied territory is *Cynodon dactylon*. This perennial plant with elongated rhizomes forms an almost closed coverage (80-100%) in many places and occupies large areas of habitat. *C. dactylon* is a natural component of the community, but its expansion leads to clogging of the phytocenosis and can be considered as a biological threat factor. Camel thorn *Alhagi pseudalhagi*, which does not belong to the natural elements of the *Juncetea acuti* community, also actively grows due to drainage and changes in the level of groundwater in salt marshes. For comparison, in the period from 1973 to 1980, its occurrence on salt marshes was 10% [4]. Currently, camel thorn occupies entire areas, being a factor of expansion and threat to this ecosystem. *A. pseudalhagi* is distinguished by its adaptability to changing environmental conditions, high population density, which excludes the penetration of native plant species into fragments of its habitat.

The relatively common components of the phytocenosis are such species as *Althaea officinalis* L., *Calamagrostis epigejos* (L.) Roth, *C. pseudophragmites* (Haller f.) Koeler, *Carex pachystylis* J. Gay, *Centaureum pulchellum* (Sw.) Druce, *Bassia hyssopifolia* (Pall.) Kuntze, *Cirsium alatum* (S. G. Gmel.)

Bobrov, *Frankenia hirsuta* L., *Geranium collinum* Stephan ex Willd., *Inula aucheriana* DC., *Iris musulmanica* Fomin, *Linum barsegianii* Gabr. et Dittr., *Lotus tenuis* Waldst. & Kit., *Falcaria falcarioides* (Bornm. et H. Wolff) H. Wolff, *Lysimachia maritima* (L.) Galasso, Banfi & Soldano (= *Glaux maritima* L.), *Merendera sobolifera* C.A. Mey., *Microcnemum coralloides* (Loscos et Pardo) Font Quer ssp. *anatolicum* Wagenitz, *Petrosimonia brachiata* (Pall.) Bunge, *Plantago lanceolata* L., *P. major* L., *P. tenuiflora* Waldst. & Kit., *Puccinella gigantea* (Grossh.) Grossh., *P. distans*, *Pulicaria vulgaris* Gaertn., *Scorzonera parviflora* Jacq., *Suaeda altissima* Pall., *S. heterophylla* Bunge ex Boiss., *S. salsa* (L.) Pall., *Sphaerophysa salsula* (Pall.) DC., *Teucrium scordioides* Schreb and some others.

The vascular plants in the *Juncetea acuti* community are represented by three life forms: annuals, perennials and shrubs. Leading role in the vegetation cover belongs to perennial herbs, while other life forms are much less. Shrubs are represented by single specimens of *Tamarix ramosissima* Ledeb. When analyzing the taxonomic composition of the habitat's flora, the predominance of Poaceae family representatives is revealed: 37 species from 20 genera of the Poaceae family were found [13]. Other common plant families (Apiaceae, Asteraceae, Caryophyllaceae, Chenopodiaceae, Fabaceae, Frankeniaceae, Geraniaceae, Iridaceae, Juncaceae, Lamiaceae, Linaceae, Malvaceae, Onograceae, Orchidaceae) include from 1 to 9 species. The species composition of the Cyperaceae family is now significantly depleted. Occasionally such species as *Bolboschoenus maritimus* (L.) Palla, *Scirpoides holoschoenus* (L.) Soják, *Holoschoenus vulgaris* Link, *Schoenus nigricans* L., *Acorellus pannonicus* (Jacq.) Palla, *Carex diluta* M. Bieb., *Carex pachystylis* J. Gay are met. The Chenopodiaceae species *Salicornia perennas* Willd. and *Salsola soda* L., and such marsh flora species as *Triglochin maritima* L., *T. palustris* L. (Juncaginaceae), *Alisma lanceolata* With. (Alismataceae), *Butomus umbellatus* L. (Butomaceae) are not found.

Edificators and the main components of the community are distributed over 4 layers – from the upper to the lower layer. In some areas, the vegetation is represented only by the lower layer to 5-15(20) cm in height, with the participation of some soil cover plants species such as *Aeluropus littoralis*, *A. pungens*, *Cynodon dactylon*, and by *Microcnemum coralloides* ssp. *anatolicum*, *Petrosimonia brachiata*, *Frankenia hirsuta*, *Crypsis acuteata*, *Linum barsegianii*. Sometimes creeping form of *Phragmites australis* is noted. In wet areas in the lower layer of vegetation, *Lysimachia maritima*, *Merendera sobolifera* and *Carex pachystylis* J. Gay are distributed. *Acorellus pannonicus* (Jacq.) Palla is met on some strongly moistened small fragments. The second layer (50-80 cm) is represented by *Cirsium alatum*, *Inula aucheriana*, *Thymelaea passerina*, *Falcaria falcarioides*, *Gypsophila perfoliata*, *Lythrum salicaria*, *Suaeda altissima*, *S. heterophylla*, *S. salsa*, *Bassia hyssopipholia*, *Teucrium scordioides* and others. In the third layer (1-1.2 m in height) there are such species as *Jucus acutus*, *Iris musulmanica*, while the previously observed large numbers of marsh plants *Carex diluta* M. Bieb., *Scirpoides holoschoenus*

(L.) Soják, *Schoenus nigricans* L., *Juncus maritimus* Lam. are very rare at present. The upper fourth layer (1.5-2 m height) is represented by *Puccinellia gigantea*, *Althaea officinalis*, *Elytrigia obtusiflora*, *Phragmites australis*, *Typha domingensis*, *Tamarix ramosissima*.

Depending on the micro-relief, the depth of groundwater, humidification and salinity, the composition of the vegetation of the habitat varies. The grassy vegetation in salt marshes is dense, with coverage about 80%-100%. By the end of summer and in autumn, the cover is reduced compared to the spring vegetation, due to dehumidification of the habitat. On relatively lowered fragments with high humidity vegetation groups with *Juncus acutus*, *Althaea officinalis*, *Ononis arvensis* L., *Iris musulmanica*, *Lysimachia maritima*, *Cirsium alatum*, *Lotus tenuis*, *Lythrum salicaria* L., *Plantago maritima*, *P. tenuiflora*, *Trifolium fragiferum* L., *Geranium collinum* Steph. ex Willd., sometimes *Scirpoides holoschoenus*, *Schoenus nigricans* L., *Carex diluta* M. Bieb., *Orchys palustris*, *Samolus valerandii* L. and some other species are observed.

In the area of Ararat salt marshes 12 rare and endangered, as well as endemic and relict plant species, included in Red Book of Plants of RA [14] were currently recorded: *Cirsium alatum* (S. G. Gmel.) Bobrov, *Inula aucheriana* DC., *Merendera sobolifera* C. A. Mey., *Juncus acutus* L., *Puccinellia grossheimiana* V. I. Krecz., *Sphaerophysa salsula* (Pall.) DC., *Iris musulmanica* Fomin, *Falcaria falcarioides* (Bornm., H. Wolff) H. Wolff, *Microcnemum coralloides* (Loscos et Pardo) Font Quer ssp. *anatolicum* Wagenitz, *Linum barsegianii* Gabr. et Dittr., *Thesium compressum* Boiss., *Trigonella capitata* Boiss. Such species as *Cirsium alatum*, *Falcaria falcarioides*, *Linum barsegianii*, *Thesium compressum* are known in the flora of Armenia only from this habitat. It should be noted that *Microcnemum coralloides* ssp. *anatolicum*, which is a relic of the Early Miocene, is of particular interest in Ararat salt marshes. The species is included in Annex 6 of the Berne Convention. *Microcnemum* has a disjunctive range, except for Armenia, it is found in Spain, Iran, Anatolia, Syria, where it is also protected as an endangered species.

During the expeditions in June 2019 in the vicinity of Ararat town, another new fragment of salt marsh vegetation with an area of about 1.5 hectare was discovered, located around the mineral spring. The vegetation in this area is represented by all the main species that make up the *Juncetea acuti* community and is distinguished by a higher density. Rare and endangered species *Cirsium alatum*, *Inula aucheriana*, *Juncus acutus*, *Sphaerophysa salsula*, *Iris musulmanica*, *Falcaria falcarioides* were here registered. *Microcnemum coralloides* ssp. *anatolicum* was not found.

The conducted ecological-phytocoenotic studies confirm the scientific importance of the relic salt marshes in the vicinity of Ararat town because of its originality and rich floral composition. As a result of monitoring during the period 2016-2021, new data on phytocoenotic diversity and the current ecological situation of the habitat were obtained. At present, the extant habitat of Ararat salt marshes with *Juncetea acuti* community occupies more about two times smaller area than in the 1990s before. In the context of the aggravation of

environmental problems, which is the result of the disturbance and degradation of natural ecosystems, salt marshes near Ararat are a territory that requires special environmental attention. Measures aimed at protecting and maintaining the natural state of the territory, as well as preserving the biological diversity of Ararat salt marshes should be assessed from these positions.

Rare and endangered, as well as endemic and relic species of plants growing on Ararat salt marshes are among natural objects of special protection. As a result of the monitoring, it was found that the abundance, vitality and frequency of occurrence of such rare and endangered species as *Inula aucheriana*, *Cirsium alatum*, *Merendera sobolifera*, *Juncus acutus*, *Falcaria falcariaoides*, *Microcnemum coralloides* ssp. *anatolicum*, *Linum barsegianii* in the investigated territory is satisfactory. Due to intensive grazing, ignition of vegetation, drainage of marshes, there is a reduction in the number of populations of some rare and endangered species of Armenian flora such as *Thesium compressum*, *Iris musulmanica*, *Frankenia pulverulenta*, *Dianthus cyri*, *Orchis palustris*, *Puccinellia grossheimiana*, *Saussurea salsa*. Aridization, drainage, lowering of the groundwater level negatively affects the wetland flora and vegetation of this ecosystem, leading to a reduction in phytocoenosis the species of the families *Cyperaceae*, *Juncaceae*, *Juncaginaceae*, some *Chenopodiaceae* halophyte species *Salicornia perennas* Willd. and *Salsola soda* L., such marsh flora species as *Triglochin maritima* L., *T. palustris* L. (*Juncaginaceae*), *Alisma lanceolata* With. (*Alismataceae*), *Butomus umbellatus* L. (*Butomaceae*) and some others.

Conclusion. The research results revealed a tendency to decrease the naturalness of plant diversity on the territory of the Ararat salt marshes. The observed progressing desertification processes, drainage, lowering of the groundwater level and other anthropogenic factors impact, lead to a disturbance of the ecological balance of habitat and have a negative influence on the marsh flora and vegetation. This conducts to the dominance of more drought tolerant plant species in the composition of *Juncetea acuti* community, and the appearance of new species previously uncommon for this habitat.

At present, the issues of the conservation of endangered plant communities and habitats have become very urgent in the world. Relic salt marshes of the Ararat valley are a vanishing habitat. Despite the changes taking place, due to the uniqueness and rich floristic composition, preserved salt marshes habitat is of considerable scientific and aesthetic interest. In the context of the aggravation of environmental problems, which is the result of the disturbance and degradation of natural ecosystems, salt marshes near Ararat town are a territory that requires special environmental attention. Measures aimed at protecting and maintaining the natural state of the territory, as well as preserving the plant diversity of Ararat salt marshes should be assessed from this position.

In order to Ararat salt marshes with *Juncetea acuti* community and numerous endangered species of Armenian flora preservation, the following recommendations should be taken into account: reviewing the issue of raising the conservation status of relic salt marshes near Ararat town and improving

protection regime; conducting periodic monitoring and inventory of the state of vegetation and endangered species; ensuring the necessary control over the environmental changes in the habitat; search for new fragments of this community preserved in the Ararat valley; providing ecological education and the local population involvement in the “Ararat salt marshes” Natural Monument protection activities; listing it in the number of objects for the ecotourism organization. The results of present study can be used in organizing measures for the salt marshes of the Ararat valley conservation.

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Ecological-Phytocenotic Assessment and the Issues of Conservation of the Ararat Valley Relic Salt Marshes

The Ararat valley relict salt marshes with *Juncetea acuti* community represent a considerable scientific interest due to their originality and rich floristic composition. Salt marshes of Ararat are considered to be one of the refuges of the ancient Mediterranean hygro-halophytic flora and are included in the list of natural monuments of Armenia. Data on natural conditions, flora composition, ecological and phytocenotic characteristics of the habitat are given in the article. The states of rare and endangered plants species are estimated. The need of the habitat conservation regime regulation is discussed.

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Արարատյան հարթավայրի ռելիկտային աղակալած ճահիճների պահպանման խնդիրները և էկոլոգաֆիտոցենոտիկ գնահատականը

Արարատյան հարթավայրի ռելիկտային աղակալած ճահճուտները նշանակալի գիտական հետաքրքրություն են ներկայացնում իրենց յուրօրինակությամբ և հարուստ ֆլորիստիկ կազմով: Դրանք դիտվում են որպես հինմիջերկրածովային հիգրոհալոֆիտ ֆլորայի ապաստաններից մեկը և ընդգրկված են Հայաստանի բնության հուշարձանների ցանկում: Էդեկություններ են բերվում բնական պայմանների, ֆլորայի կազմի, բնակմիջավայրի էկոլոգիական և ցենոտիկ բնութագրերի վերաբերյալ: Տրվում է տարածքում աճող հազվագյուտ և վտանգված բուսատեսակների ներկա վիճակի գնահատականը: Քննարկվում է տվյալ տարածքի պահպանման ռեժիմի կարգավորման անհրաժեշտությունը:

Ж. А. Акопян, А. Г. Гукасян, Ж. О. Овакимян

Эколого-фитоценотическая оценка и задачи сохранения реликтовых засоленных болот Араратской равнины

Реликтовые ситниково-касатиковые засоленные болота Араратской равнины по своей оригинальности и богатому флористическому составу представляют значительный научный интерес. Они рассматриваются как один из рефугиумов древ-

несредиземноморской гигрогалофитной флоры и включены в список природных памятников Армении. Приводятся сведения о природных условиях, составе флоры, экологическая и ценогическая характеристика местообитания. Дана оценка состояния произрастающих здесь редких и исчезающих видов растений. Обсуждается необходимость урегулирования режима сохранения данного местообитания.

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