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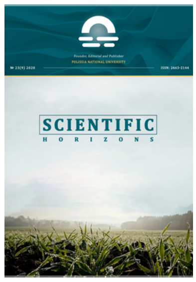

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Study of Plant Adaptation to the Arid Zone of Uzbekistan based on System Analysis

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Abstract. Studying the ecological and biological features and water regime of plants of the mountainous semidesert of Uzbekistan to determine their stability in these conditions, we concluded to use an integrated approach to solve the problem of adaptation. Functional, structural or other biological features can equally determine the resistance of a species to extreme factors, such as, for example, the rhythm of development. The purpose of the work is to identify a complex of elements of plant adaptation to arid zone to xerothermic conditions and to characterize ecological groups by the generality of adaptation systems. Based on the system analysis, the biological and structural-functional adaptive features of plants were analyzed, and the studied species were classified into ecological groups as adaptive systems and according to the generality of adaptations to the experience of the dry period. The original data obtained, which relate to the characteristics of the elements of biomorphological adaptation and adaptation of the water regime, the remaining adaptive elements were identified based on the analysis of literary data. Along with structural and behavioral signs, we focus on those features of the water regime that ensure a positive water balance among representatives of various environmental groups. Each of the selected ecological groups of plants is characterized by a certain combination of adaptive features of a physiological and biomorphological plan. With a variety of adaptive features in different plant species to drought and the absence of an integral indicator of drought resistance, it is impossible to focus on any one of them, of course, it is necessary to take into account the whole complex of signs. The complex of features will allow determining more accurately the nature of a particular combination of biomorphological and functional features peculiar to a particular ecological group

Keywords: flora, biological features, hyperxerophyte, xerothermic conditions, leaves, ecological groups

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INTRODUCTION

Hyperxerophytes have a well-balanced water regime according to all the parameters studied. High water-holding capacity determines stable hydration and low water deficiency in plants. Very high heat resistance (59.5-62.8^{0}C) characterizes Hyperxerophytes [1]. Roots of young taproot plants deepens into the soil faster than its desiccation occurs. That is of great adaptive importance for this group. Most hyperxerophytes of the arid zone of Uzbekistan (*Haloxylon aphyllum, Salsola orientalis, Halothamnus psammophilus, Anabasis eriopoda, Salsola paulsenii, Climacoptera lanata*, etc.) have reduced leaves, except for *Halimiphyllum atriplicoides, Halothamnus auriculus and Peganum harmala*, which have laminar ones. *Halimiphyllum atriplicoides* has two generations of leaves: spring leaves are large, mesophilic (falling in summer), summer leaves are small, more xerophilous, remaining green until the spring of the following year. Reducing the leaf surface is a common way to reduce the evaporation surface. In *Halothamnus auriculus* [2], as in species with reduced leaves [3; 4], a centric mesophyll type is observed, which an adaptation to arid conditions is. Some stomata are characteristic per 1 mm^2 of the leaf area. Assimilating organs have a cranial structure with signs of succulence. The retention of moisture in the leaves is facilitated by specialized water-bearing parenchyma, thin-walled, large-cell epidermis and hypoderm [5]. The walls of the epidermal cells of the leaves contain hemicellulose and pectin substances with high hygroscopicity [6].

Hyperxerophytes are characterized by a stable, relatively uniform daily and seasonal course of photosynthesis and the maximum degree of realization of its potential. The high resistance of the respiratory system to extreme temperatures has been revealed: the critical respiratory temperature is 51-57^{0}C [7].

Vegetation continues until late autumn. In August, summer generation leaves are formed. In *Kochia prostrata*, the regrowth of wintering buds is observed in spring of favorable years. However, in summer, the depression of growth processes is clearly expressed, the shedding of part of the leaves. The reduction of the evaporating surface in these species is achieved in various ways: *Kochia prostrate* is a microphilic plant; *Geratoides eversmanniana* has laminar, relatively large leaves. In both species, compared with hyperxerophytes, the signs of scleromorphosis are more pronounced and less succulent [5].

As the intensity of transpiration, the photosynthetic activity is higher in *Kochia prostrate* and *Geratoides eversmanniana* than in plants from the hyperxerophyte group [8]. Phosphorus metabolism during drought is less stable in these species, a decrease in the content of nucleic acids due to RNA was noted [4; 9]. The critical respiration temperature is almost as high (50-55^{0}C), as in hyperxerophytes.

The purpose of the study is to identify a complex of elements of plant adaptation to arid zone to xerothermic conditions and to characterize ecological groups by the generality of adaptation systems.

MATERIALS AND METHODS

The methodology of adaptation studies is based on system analysis [10]. We tried to display the ecological relationship. We have revealed that the most adapted to xerothermic conditions are representatives of hyperxerophytes: *Haloxylon aphyllum, Halothamnus psammophilus, Anabasis eriopoda, Salsola orientalis, Climacoptera lanata, S. sclerantha, Girgensohnia dintera*, etc. The given brief analysis of the biological, morphological and physiological data suggests that the considered representatives of the type of xerophytes, namely hyperxerophytes, euxerophytes, teroiremoxerophytes, hemixerophytes, are unequal in the complex of adaptive features that determine their stability in arid conditions. The growth in the same habitats and in the same type of vegetation of representatives of different drought-resistant ecological groups from the type of xerophytes indicates a wide range of plant adaptations to the conditions of the arid zone of Uzbekistan.

Our scientific research continued in the zone of the global ecological crisis of the Southern Aral Sea region of the Muynak district of the Republic of Karakalpakstan, a fibrous high-performance technical culture of kenaf is the object of the study (*Hibiscus cannabinus*). The site is located in Muynak district of Karakalpakstan 20 km from the former bank of the Aral Sea. The soil is slightly saline; groundwater is located 2.2 meters deep from the surface of the earth. Kenaf sowing was carried out on 04/12/2019. Sowing of seeds was carried out in the following way: the depth of seeding in the soil was 5 cm, between rows 60 cm, the distance between plants was 10 cm, the first shoots appeared on 04/24/2019, branching occurred in the second decade of May, budding was noted in mid-June, flowering at the end of June, fruiting was noted in July. During the growing season, watering of plants was carried out 2 times in July and August. The height of the plants at the end of the growing season reached 2-2.5 meters.

The reliability of the difference is significant between ecological groups in terms of maximum and minimum (average daily) values of transpiration, hydration and water scarcity [11]. Anatomical features play a significant role: submerged stomata of the anomocytic type, *mesophyll isopalysisus*, sclerification of the main vein of the leaf, highly developed storage tissues [12]. Along with forage plants of the arid zone, the biological and ecological features of the introduced kenaf (*Hibiscus cannabinus*) representative of the Malvaceae family were studied.

RESULTS AND DISCUSSION

The water regime of representatives of the xerophyte group is more labile than that of hyperxerophytes. The intensity of transpiration in them is much higher, and the hydration of assimilation shoots is lower. From spring to summer, the hydration of shoots decreases sharply, and osmotic pressure increases. The water retention capacity is lower than that of hyperxerophytes, and the water deficit is higher. Less economical water consumption in the mesothermic period is associated with their lower water retention capacity than that of hyperxerophytes (Table 1). There is an inverse relationship of transpiration intensity with osmotic pressure (*K*=0.5-0.9) and water-holding capacity (*K*=-0.5-0.7), as well as a positive relationship between water retention capacity and osmotic pressure (*K*=+0.4+0.8). An increase in osmotic pressure determines the stability of plants during the xerothermic period. Heat resistance is lower (59^{0}C) than in hyperxerophytes. Thus, the plants of this group are distinguished by a deep and versatile adaptation to living in conditions of lack of moisture and high temperatures.

***Table 1**. Water regime main indicators of plants from various ecological groups*

Environmental group and type	Average daily evapotranspiration rate, m/g/h	Average daily moisture content, %	Water-retaining capacity, %	Maximum water deficiency, % of full saturation	Average daily osmotic pressure, atm.	Frequency of transpiration rate below 400 mg/g/h, %
Hyperxerophytes						
Haloxylon aphyllum (Minkv.) Jljin	123/630*	60.8/80.6	82.1	7/6	6/42	70.6
Halimiphyllum atriplicoides (Fesch et Mey.) Boriss.	276/518	64.8/85.5	81.8	19.7	6/22	09.9
Halothamnus psammophilus Botsch sp. nov.	240/349	72.6/83.8	94.2	11.4	7/17	97.5
H. auriculus (Moq.) Botsch	170/580	74.4/81.1	94.0	11.5	8/15	69.3
Anabasis eriopoda (Schrenk) Benth	127/344	68.3/74.4	–	7.6	8/23	01.0
Peganum harmala L.	225/412	71.2/79.5	–	21	24/34	64.6
Salsola orientalis S.G.Gmel.	169/660	52.2/86.2	83.8	12.2	5/43	82.7
S. paulsenii Lity.	161/625	69.7/78.5	88.4	25	10/32	66.3
S. sclerantha C.A.Mey	68/296	58.2/73.7	87.3	27.9	9/19	95.8
Girgensohnia dintera Bge.	133/401	54.4/63.7	89.1	26	9/44	66.2
G.oppsitiflora (Pall.) Pens.	95/644	51.0/73.3	87.8	27.8	9/28	–
Climacoptera lanata (Pall.)	65/186	75.0/86.2	95.2	17.0	6/19	–
Euxerophytes						
Kochia prostrata (L.) Schrad. subsp. grisea Prat.	114/762	34.9/76.4	–	45.9	6/22	65
K. prostrata (L.) Schrad. subsp. virescens.	180/900	36.1/79.9	71.7	24.0	6/65	65
Geratoides eversmanniana (Stschrq. ex Losinsk.) Botch. et Jkon.	175/170	37.2/78.5	72.6	49.0	7/67	56.0
Ceratocarpus utriculosus B.uk.	204/1017	34.1/75.2	62.4	34.0	9/50	40.2
Theroiremoxerophytes						
Artemisia ferganensis H. Krasch.	226/1704	42.3/77.5	56.0	58.0	5/56	63.8
A.Sogdiana Bge.	230/1676	46.0/80.6	56.0	63.3	4/56	52.8
A. turonica H.Krasch	226/1670	42.5/79.1	50.5	59.0	6/65	52.2
F. tenuisecta Nevski.	224/1645	35.4/76.1	52.7	57.2	6/65	55.2
Hemixerophytes						
Alhagi pseudaalhagi (Bieb.) Desv.	414/1267	61.3/78.7	70.5	14	5/23	19.0
Capparis spinosa L.	519/900	63.1/72.0	–	19.0	5/37	19.0

As can be seen from the above data, the adaptation of euxerophytes was in the direction of increasing the ability to reduce the evaporating surface in summer, increase osmotic parameters, and change the generation of leaves from spring mesophilic to summer xerophilous. A smaller variety of adaptive features determined their lesser adaptability to xerothermic conditions [13].

Artemisia-wormwood species from the Seriphidium section *are* very widespread in the deserts and semi-deserts of Uzbekistan, which we refer to the group of theroiremoxerophytes, i.e. summer-resting xerophytes. Structurally and functionally, they are less adapted to xerothermic conditions than species from the hyper- and euxerophyte groups. The high viability of wormwood in arid conditions is mainly determined by the peculiarities of seasonal rhythmic and the specifics of the morphological structure of vegetative organs, to a lesser extent adaptation affected the more conservative anatomical and functional features.

The leaves of wormwood are small, dissected, pubescent, but anatomically less xeromorphic than those of the representatives of the above groups; the mesophyll is thin-walled, with an insignificant number of water-bearing cells located only around the veins [14].

The water regime of wormwood is even more labile than that of euxerophytes. The intensity of transpiration is very high in spring, and it decreases by six times in summer. The water content of assimilation shoots is halved in summer. Water retention capacity is significantly lower than that of representatives of hyper – and euxerophytes, water deficiency reaches high values. This causes a violation of the water balance and a forced period of semi-rest, when assimilation processes are minimized. The preservation of the water reserve in the summer is possible due to a sharp reduction in transpiration and an increase in osmotic parameters, as well as a decrease in the evaporating surface by dropping leaves (70-100% of leaves fall off). The development of shoots begins in autumn, and then continues in spring. In summer, there is a pronounced depression of growth processes. The maximum heat resistance is lower (52-56^{0}C), than in hyper- and euxerophytes [1].

Photosynthetic activity in wormwood is active during the mesothermic period of the year, however, in summer, like water exchange, it slows down. The adaptability of photosynthesis to high temperatures and illumination is limited: light saturation is observed in the range of 40-50 thousand lux, and the temperature zone of the optimum of photosynthesis is in the range of 12-37^{0}C. Critical breathing temperature – 47-50^{0}C, which is somewhat lower than in all the plants described above [8]. So, the representatives of this group are characterized by a decrease in functional and biological activity during the xerothermic period, which is a kind of "escape" from unfavorable conditions.

Peculiar xerophytes are plants that have an extremely deep root system, up to 20-30 m, penetrating into horizons with constant moisture, i.e., according to the method of water nutrition, they belong to phreatophytes. The most common representatives of phreatophytes in the arid zone are *Alhagi pseudalhagi*, *Capparis spinosa* and *Glycyrrhiza* species. We attributed them to hemixerophytes, as they are adapted to the transfer of air, but not soil drought. These species are characterized by high transpiration; its lower limit is on average 414 mg/g h per day. During the flight period, the intensity of transpiration increases, which is unusual for representatives of other ecological groups such as xerophytes. The water content of assimilation shoots decreases little during the growing season, osmotic pressure and water deficit increase slightly by summer. As can be seen, the plants of this group have a relatively stable water regime. Unlike hyperxerophytes, high transpiration, stable hydration and osmotic pressure are provided by the activity of a deep root system reaching the groundwater level. They vegetate from spring to late autumn, maintaining high vital activity throughout the summer period.

The aboveground organs are xerophilic in structure. According to L. Shamsuvalieva and M.N. Davletshina [12], *Alhagi pseudalhagi* is characterized by mesophyll isopalysisus, sclerification of the main vein of the leaf, axial organs and thorns, strong development of water-retaining tissue with a large amount of starch.

The intensity of photosynthesis in representatives of hemixerophytes is higher than in the above-mentioned groups. According to S.F. Fazylova [15; 16], near Tashkent, *Alhagi sparsifolia* photosynthesis intensity was 57 mg CO_2 dm^2/h, and *Alhagi pseudalhagi* was 40 mg CO_2 dm/h^2. The maximum heat resistance was 60^{0}C.

The functional adaptation of hyperxerophytes to the conditions of existence in the arid zone is manifested in the stability of the water balance and photosynthesis. Their water management is characterized by significant hydration of assimilating organs, economical water consumption, its insignificant deficit, high water retention capacity. The high heat tolerance of the assimilation apparatus determines the ability of plants of this group to tolerate overheating well.

Unlike hyperxerophytes, the lability of many biomorphological and functional features is of adaptive importance for euxerophytes. This is clearly manifested when comparing plants in sharply different meteorological conditions in years: in dry years, the rhythm of generative phases shifts, the assimilating surface decreases sharply in summer. During the growing season, in accordance with environmental conditions, the levels of the main indicators of the water balance (transpiration intensity, hydration, osmotic indicators, etc.) change dramatically.

In theroiremoxerophytes, the most important adaptation to experiencing an unfavorable xerothermic period is the ability to almost completely shed leaves in summer, which reduces water consumption for transpiration, and this does not interfere with the normal development of reproductive organs. This feature (reduction of the evaporating surface) is very labile; its severity is determined by the degree of soil drought. Functional adaptation manifests itself in a sharp change in the activity of photosynthesis and the level of indicators of the water regime during the growing season: the most physiologically active period falls at the end of spring – beginning of summer, before the onset of soil drought [17].

In hemixerophytes, signs of functional adaptation are poorly expressed; high transpiration, low osmotic pressure, adaptability to living in xerothermic conditions are provided, first, by a deeply penetrating root system (up to 20-30 m), reaching constantly moistened soil horizons. In the conditions of the Southern Aral Sea region in Muynak, highly efficient, comprehensively used for various purposes (fiber, paper, cardboard, tarpaulin, etc.). The biological and ecological features of kenaf have not been fully studied by scientists [18; 19]. Kenaf has a biological feature, about 30-40 days after germination it grows very slowly (3-5 mm per day), and from budding to flowering its rapid growth begins (50-60 mm per day). The yield of green kenaf depends on the height of the plant and its development, which in turn is due to the density of standing. The yield of the aboveground mass of kenaf is 27.5 c/ha.

CONCLUSIONS

From the above material, it can be seen that according to the degree of adaptation to extreme xerothermic conditions, the studied species of the arid zone of Uzbekistan can be divided into a number of ecological groups. Representatives of each of them have similar adaptive traits, although their combination and severity in species belonging to the same group may be ambiguous, and this determines their different (within the group) degree of fitness. The analysis made it possible to deduce a complex of adaptive features inherent in environmental factors, the physiological essence of the ways of adaptation. The ability to tolerate the xerothermic period normally is characteristic of a wide type of xerophytes. In hyperxerophytes and euxerophytes, this is achieved not only by structural adaptations of assimilation organs, but also as a result of the development of a powerful root system that provides water from the soil, economical consumption, increased water retention capacity, in teroiremoxerophytes – as a result of a reduction in the evaporating surface during the xerothermic period, increased osmotic pressure, in hemixerophytes due to the strong development of the root system reaching groundwater.

Our research has revealed that kenaf adaptation to the conditions of the Southern Aral Sea region has the following ecological properties: kenaf is a therophyte (annual plant) in its life form in relation to photoheliophyte (photophilous) to mega temperatures (thermophilous). It is a hemixerophyte by the water factor and halomesophyte by the soil salinity. The root system is rapidly growing (more than 2 meters), it reaches the moistened horizon of the soil trichohydrophite. Based on our scientific research, it should be noted that kenaf is a promising highly profitable crop, ecologically adapted to the conditions of the Southern Aral Sea region. In addition, its role is great to optimize the environment as a sand protection.

The developed ecological classification of forage plants is the scientific basis of their zoning during phytomelioration. Representatives of ecological groups are unequal in the degree of adaptation to xerothermic factors. Plants with stable (hyperxerophytes) and medium-stable (euxerophytes) water regime, content with limited water supply, can be widely zoned in the arid zone. Culture phytocenoses are profitable only from teroiremoxerophytes in areas where the annual precipitation exceeds 200 mm/year.

REFERENCES

[1] Zaprometova, N.S. (1977). Heat resistance of plants introduced into the culture. In *Ecological and biological basis for the creation of artificial pastures and hayfields on adyrs of the Ferghana Valley* (pp. 98-110). Tashkent: Ukituvchi.

[2] Paizieva, S.A., & Rakhimova, T. (1972). Biology *Aellenia auricula* (Mey.) Ulbr. and *Aellenia subaphylla* (CAM) Aellen. In *Morphobiological and structural features of forage plants in Uzbekistan* (pp. 52-58). Tashkent: Izdatelstvo Akademii Nauk.

[3] Butnik, A.A. (1983). Anatomy *Haloxylon aphyllum* (Minkw.) Jljin. In D.K. Saidov (Ed.), *Adaptation of forage plants to the conditions of the arid zone of Uzbekistan* (pp. 151-154). Tashkent: Izdatelstvo Akademii Nauk.

[4] Nigmanova, R. (1983). Anatomy *Salsola orientalis* S.G. Gmel. In D.K. Saidov (Ed.), *Adaptation of forage plants to the conditions of the arid zone of Uzbekistan* (pp. 98-102). Tashkent: Izdatelstvo Akademii Nauk.

[5] Butnik, A.A. (1977). About adaptive traits of leaves of Chenopodioideae. In *Biological and structural features of useful plants in Uzbekistan* (pp. 4-15). Tashkent: Izdatelstvo Akademii Nauk.

[6] Lyshede, O.B. (1982). Structure of the outer epidermal wall in xarophytes. In D.F. Cutler, K.L. Alvin, & C.E. Price (Eds.), *The plant cuticle* (pp. 87-98). London: Academic Press.

[7] Alekseeva, L.N. (1983). *Ceratoides eversmanniana, Kochia prostrata, Salsola orientalis, Halothamnus subaphyllus, Haloxylon aphyllum, Artemisia turanica, Artemisia ferganensis* – respiration. In D.K. Saidov (Ed.), *Adaptation of forage plants to the conditions of the arid zone of Uzbekistan*. Tashkent: Izdatelstvo Akademii Nauk.

[8] Zakharyants, I.V., Naaber, L.Kh., Fazylova, S.F., Alekseeva, L.N., & Oshanina, N.P. (1971). *Gas exchange and metabolism of plants of the Kyzylkum Desert.* Tashkent: Izdatelstvo Akademii Nauk.

[9] Nigmatov, M.M. (1983). Phosphorus exchange *Ceratoides eversmanniana, Kochia prostrata, Salsola orientalis, Haloxylon aphyllum, Artemisia turanica*. In D.K. Saidov (Ed.), *Adaptation of forage plants to the conditions of the arid zone of Uzbekistan*. Tashkent: Izdatelstvo Akademii Nauk.
[10] Baranovskaya, N.V. (2013). *Modern problems of ecology and nature management*. Tomsk: Tomsk Polytechnic University.
[11] Rakhimova, T. (1988). *Biological characteristics of prospective forage plants introduced in the adyr zone of Uzbekistan*. Tashkent: Institute of Botany.
[12] Shamsuvalieva, L., & Davletshina, M. (1983). Anatomy *Alhagi pseudalhagi* (Bieb.) Desv. In D.K. Saidov (Ed.), *Adaptation of forage plants to the conditions of the arid zone of Uzbekistan* (pp. 226-229). Tashkent: Izdatelstvo Akademii Nauk.
[13] Khasanov, O.Kh., Vernik, R.S., & Rakhimova, T. (1982). Ecological characteristics of plants promising for introduction into culture in the Fergana adyrs. *Ecology*, 3, 16-21.
[14] Alimukhamedova, S. (1974). The influence of growing conditions on the formation of the internal structure of the turanian and spreading wormwood leaf. In *Morphological and biological characteristics of wild plants in Uzbekistan* (pp. 3-6). Tashkent: Izdatelstvo Akademii Nauk.
[15] Fazylova, S.F. (1960). On the photosynthetic ability of some plants of the Southern Kyzylkum, depending on the phase of their development. *Uzbek Biological Journal*, 4, 34-39.
[16] Fazylova, S.F. (1983). Photosynthesis *Ceratoides eversmanniana, Kochia prostrata, Salsola orientalis, Halothamnus subaphyllus, Haloxylon aphyllum, Artemisia turanica, Artemisia ferganensis, Alhagi pseudalhagi*. In *Adaptation of forage plants to the conditions of the arid zone of Uzbekistan*. Tashkent: Izdatelstvo Akademii Nauk.
[17] Komilova, N.K., Rakhimova, T., Allaberdiev, R.K., Mirzaeva, G.S., & Egamberdiyeva, U.T. (2021). Ecological situation: The role of education and spirituality in improving the health of the population. *International Journal of Health Sciences*, 5(3), 302-313. doi: 10.53730/ijhs.v5n3. 1512.
[18] Abdurazakova, N.A. (1982). Influence of pre-sowing soil cultivation on the growth, development and productivity of zelenz kenaf. Questions of biology, growth, development of kenaf and elements of its agricultural technology. In *Proceedings of the Uzbek experimental station of bast cultures*. Tashkent: Uzbek Experimental Station of Bast Cultures.
[19] Ayadi, R., Hanana, M., Mzid, R., Hamrouni, L., Khouja, M.I., & Salhi Hanachi, A. (2017). *Hibiscus cannabinus* L. Kenaf: A review paper. *Journal of Natural Fibers*, 14(4), 466-484.

Вивчення адаптації рослин до посушливої зони Узбекистану на основі системного аналізу

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Анотація. Вивчаючи еколого-біологічні особливості та водний режим рослин гірської напівпустелі Узбекистану для визначення їхньої стійкості в даних умовах, автори статті дійшли висновку про необхідність комплексного підходу до вирішення проблеми адаптації. Стійкість виду до екстремальних факторів може однаковою мірою визначатися функціональними, структурними або іншими біологічними особливостями, як, наприклад, ритміка розвитку. Мета роботи – виявлення комплексу елементів адаптації рослин до аридної зони до ксеротермічних умов і характеристика екологічних груп щодо спільності адаптаційних систем. На основі системного аналізу проаналізовано біологічні та структурно-функціональні пристосувальні особливості рослин, як адаптаційні системи та за спільністю пристосувань, до переживання посушливого періоду вивчені види класифіковані на екологічні групи. Отримані оригінальні дані, що належать до характеристики елементів біоморфологічної адаптації та адаптації водного режиму, інші адаптаційні елементи виявлено на підставі аналізу літературних даних. Поряд із структурними та поведінковими ознаками основну увагу приділено тим особливостям водного режиму, які забезпечують позитивний водний баланс у представників різних екологічних груп. Для кожної з виділених екологічних груп рослин характерне певне поєднання пристосувальних ознак фізіологічного та біоморфологічного плану. При різноманітності адаптаційних ознак у різних видів рослин до посухи та відсутності інтегрального показника посухостійкості не можна орієнтуватися на будь-який з них, безумовно, необхідно враховувати весь комплекс ознак. Комплекс ознак дозволить більш точно встановити характер того чи іншого поєднання біоморфологічних і функціональних особливостей, властивих тій чи іншій екологічній групі

Ключові слова: флора, біологічні особливості, гіперксерофіт, ксеротермічні умови, листя, екологічні групи