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STUDY OF ONTOGENETIC STRUCTURE AND DENSITY OF THE COENOPOPULATION OF *Hedysarum atropatanum* Bunge ex Boiss. FLORA OF DARIDAG

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ИЗУЧЕНИЕ ОНТОГЕНЕТИЧЕСКОЙ СТРУКТУРЫ И ПЛОТНОСТИ ЦЕНОПОПУЛЯЦИИ *Hedysarum atropatanum* Bunge ex Boiss. ФЛОРЫ ДАРИДАГА

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Abstract. The article presents findings from a study of the demographic structure and density of the population of the species Hedysarum atropatanum Bunge ex Boiss., which is widely distributed in the Daridag area. A total of ten ontogenetic states (seed, seedling, juvenile, immature, virginile, young generative, middle aged generative, aged generative, subsenile and senile) of the *H. atropatanum* species were observed. The processes of ontogenesis, which can be classified as normal, fast, or slow, were identified as the primary mechanisms driving species evolution. Additionally, instances of developmental disruptions, rejuvenation, and the manifestations of aging were observed. The majority of individuals belonging to the species *H. atropatanum* exhibit a normal to rapid growth rate. It has been observed that the process of ontogenesis is slower in areas with high plant density. It was determined that the secondary quiescence period does not manifest during the initial stages of development; rather, it becomes feasible only after the individuals have reached the virginal state. It has not been observed that immature individuals bypass the virginal state and immediately transition to mature generative plants. The vitality status of the individuals was determined based on a comprehensive analysis of multiple morphological traits, including the height of the specimens, the number of shoots, the number of flower carriers, the length of the leaves, the size of the leaves, and the number of flowers in the flower group. Following the statistical processing of the data, three classes of vitality were identified. A study revealed that individuals of the second vitality level of the *H. atropatanum* species are more prevalent in the coenopopulation. The optimal habitats of the *H. atropatanum* species are characterized by sparse grasslands with a projected cover of no more than 10-35%.

Аннотация. Представлены результаты исследования демографической структуры и плотности популяции вида *Hedysarum atropatanum* Bunge ex Boiss., широко распространенного в Даридагском районе. Всего было отмечено десять онтогенетических состояний (семя, проросток, ювенильное, имматурное, виргинильное, молодое генеративное, среднее генеративное, пожилое генеративное, субсенильное и сенильное) вида *H. atropatanum*. Процессы онтогенеза, которые можно классифицировать как нормальные, быстрые или медленные, были определены как основные механизмы, определяющие эволюцию видов. Кроме того, были отмечены случаи нарушения развития, омоложения и проявления старения. Большинство особей, принадлежащих к виду *H. atropatanum*,

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демонстрируют нормальную или быструю скорость роста. Замечено, что в местах с высокой плотностью растений процесс онтогенеза замедляется. Установлено, что период вторичного покоя не проявляется на начальных этапах развития, а становится возможным только после достижения особями виргинильного состояния. Не наблюдалось, чтобы незрелые особи, минуя виргинильное состояние, сразу переходили в зрелые генеративные растения. Жизнеспособность особей определяли на основе комплексного анализа множества морфологических признаков, включая высоту экземпляров, количество побегов, количество цветоносов, длину листьев, размер листьев и количество цветков в цветочной группе. После статистической обработки данных было выделено три класса жизнеспособности. Исследование показало, что в ценопопуляции преобладают особи второго уровня жизнеспособности вида *H. atropatanum*. Оптимальные места обитания вида *H. atropatanum* характеризуются разреженными лугами с проективным покрытием не более 10–35 %.

Keywords: Daridag, populations, coenopopulations, *Hedysarum atropatanum,* ontogenesis.

Ключевые слова: Даридаг, популяции, ценопопуляции, *Hedysarum atropatanum*, онтогенез.

A number of plant species distributed in Daridagh are of great importance due to their pharmacological, nutritional, fodder, dye, and other useful properties. These species are utilized in a variety of fields, including traditional medicine, human nutrition, production of natural dyes, agriculture, technology, and industry species [5, 6, 10, 11].

In order to ensure the protection of useful plant species, it is essential to ascertain the manner in which these species are utilized by the local population, both in the vicinity of the intended area of use and in areas with which they may be associated. Once the aforementioned information has been collated, it is then necessary to ascertain the availability of resources and productivity of the species in question, in order to make an informed decision regarding the viability of their population for cultivation species [7-10].

At this juncture, it is imperative to investigate the ontogenetic characteristics of the plant in question. In addition, the current status of the specified species, their position in the formation of vegetation types, their abundance, phytocenosis, associations, and microgroupings should be studied in detail. In recent years, the use of population and ontogenetic approaches has become increasingly prevalent in the assessment of useful plant species [12-14].

The study of biological diversity protection methods is inextricably linked to the study of species populations. One of the significant challenges in the study of ecological systems is to ascertain the interplay between vegetation and environmental factors. The evaluation of the coenopopulation is contingent upon whether environmental factors exert a positive or negative influence on the structure of ontogeny. Consequently, in order to achieve more effective species protection, it is necessary to determine the condition of each species and to clarify their reactions to different environmental conditions species [1-4].

Material and Methodology of the Research

The *Hedysarum atropatanum* Bunge ex Boiss. species was selected as the research object and subject among the many scientifically and practically interesting plants distributed in the flora of Darıdag. This spindle-rooted, 15-35 cm tall, silver hairy, perennial plant is found in the stony-rocky areas of the region in isolated or small groups, sometimes mixed with other species. The plant,

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which produces large flowers, flowers from May to June. It reproduces sexually via seeds. The plant is a xerophyte, heliophyte, and calcephilous species, found in stony-rocky and calcareous soils.

In order to assess species populations, the methods proposed by T. A. Rabotnov [18], O. V. Smirnova, L. A. Zhivotovski [20] and A. A. Uranov [19] were employed, and a number of relevant literature sources were consulted [15-17].

Experimental Section

The species is distinguished by relatively narrow ecological and phytocenotic growth conditions. The environmental factors that impede the growth and development of these populations include the location of the area on the brink of extinction, uncontrolled grazing in the surrounding areas, excessive recreation of the land, and wildfires, among other ecological and anthropogenic factors. In determining the age structure of the coenopopulation, the following age cases were considered according to standard criteria: seedling (p), juvenile (j), immature (im), virginal (v), young generative (g1), middle-aged generative (g2), aged generative (g3), subsenile (ss), and senile (s).

In order to characterize the ontogenetic structure of the coenopopulation, we employed a series of demographic indicators that have been widely accepted within the academic community. These included the recovery index (calculated as the ratio of the young and generative fraction) the replacement index (the ratio of the sum of the young and generative and postgenerative fractions) and the aging index (the ratio of postgenerative and old individuals in the senopopulation). A total of ten ontogenetic states (seed, seedling, juvenile, immature, virginile, young generative, middle aged generative, aged generative, subsenile and senile) of the *H. atropatanum* species were observed.

The processes of ontogenesis, which can be classified as normal, fast, or slow, were identified as the primary mechanisms driving species evolution. Additionally, instances of developmental disruptions, rejuvenation, and the manifestations of aging were observed. The majority of individuals belonging to the *H. atropatanum* species exhibit a normal to rapid growth rate. It has been observed that the process of ontogenesis is slower in areas with high plant density. It was determined that the secondary quiescence period does not occur during the initial stages of development; rather, it becomes possible only after the individuals reach the virginal state. It has not been observed that immature individuals bypass the virginal state and immediately transition to mature generative plants. (Table, Figure 1-3).

Table

ONTOGENETIC GROUPS OF SENOPOPULATION INDIVIDUALS

The nature of the grouping	*SP*	*Ontogenetic groups of coenopopulation individuals, in percent*								
		P	*J*	*Im*	*v*	g_1	g_2	g_3	*Ss*	*S*
Petrophyte vegetation, southwest-facing slope, 5–7°, *Bothriochloa* Kuntze.-*Hedysarum* L. Group	1	7,8	6,4	5,7	10,2	16,8	17,9	25,3	2,4	7,5
	2	3,3	12,6	13,8	10,4	11,3	20,7	21,4	3,7	2,8
	3	6,0 6	6,7	3,6	12,5	28,6	28,2	7,1	5,1	2,2
	4	10,3	8,8	3,4	14,8	17,9	23,8	17	2,3	1,7
	5	6,6	10,6	11,8	13	16,4	27	9,1	3,0	2,5
Petrophytic vegetation, slope, 2–4°, *Bothriochloa* Kuntze. - varioherbosa group	1	0	0	5,3	14,7	20,7	22,6	32,7	4	0
	2	0	0,2	10,4	12,2	15,1	29,8	26,1	6,2	0
	3	0	0	6,4	15,3	22,7	33,1	15,6	6,9	0
	4	0	5,9	4,6	28,4	13,2	18,9	20,6	8,4	0
	5	0	0	4,8	7,4	15,7	33,7	33,5	4,9	0

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The nature of the grouping	*SP*	*Ontogenetic groups of coenopopulation individuals, in percent*								
		P	*J*	*Im*	*v*	g_1	g_2	g_3	*Ss*	*S*
Petrophyte vegetation, southwest-facing slope, 10–12°, *Bothriochloa* Kuntze.-*Hedysarum* L. Group	1	0	0,9	6,9	13,3	24,5	14,8	39,6	0	0
	2	2,7	5,2	7,4	22,1	30,5	20,6	10,7	0,8	0
	3	0	0	3,9	12,8	24,6	29,9	26,6	2,2	0
Average price		2,6	4,2	6,3	13,1	18,9	25,6	23,8	3,8	1,6

As illustrated in the accompanying table, the total projective cover of the *Bothriochloa* Kuntze. — *Hedysarum* L. group in the petrophyte vegetation situated on the southwest slope with an inclination of 10-12^0 is estimated to be 10-12%. The absence of first seedlings in senopopulation 3 in this cluster is likely attributable to poor seed germination. In general, the absence of juvenile individuals was not observed in the SP_1, SP_3 and SP_5 groupings of the *Bothriochloa* Kuntze. — *Varioherbosa* grouping, which exhibited a tendency of 2-4^0.

In addition, all the coenopopulations on the southwestern slope are nearly complete. The absence of mortality in the coenopopulations in other areas suggests that the senopopulations in particular Group 3 are relatively young. In the ontogenetic spectrum of the population, the proportions of individuals belonging to the vinyl and g_1, g_2, and g_3 categories, respectively, are as follows: SP1, 13.3% (v), 24.5% (g_1), 14.8% (g_2), and 39.6% (g_3); SP2, 22% (v), 1% (g_1), 30.5% (g_2), and 10.7% (g_3); and SP3, 12.8% (v), 24.6% (g_1), 29.9% (g_2), and 26.6% (g_3). The occurrence of maxima in the ontogenetic spectrum can be attributed to the humidification of the area resulting from precipitation during the spring season. Nevertheless, the practice of grazing in the early spring can result in the trampling of vegetation and the trampling and loosening of the top layer of soil. The continuous grazing of areas primarily results in the deterioration of vegetation, which significantly impairs the capacity of plants to produce seeds.

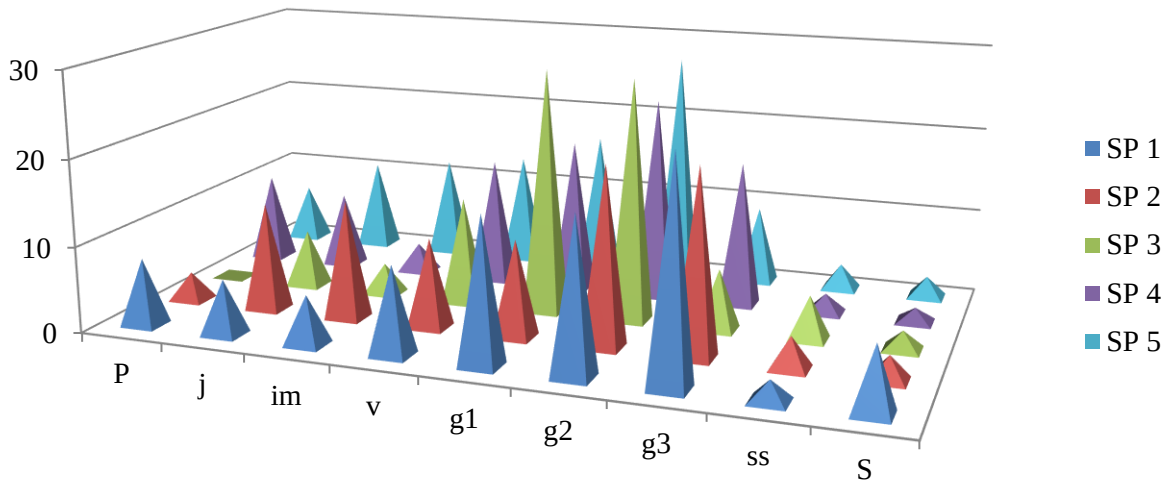

Figure 1. Petrophyte vegetation, southwest-facing slope, 5–7°, *Bothriochloa* Kuntze. — *Hedysarum* L. group

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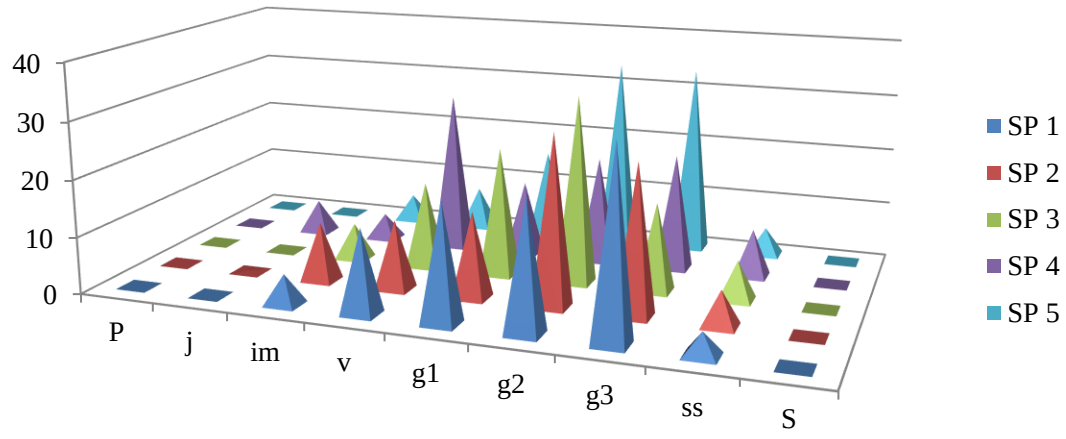

Figure 2. Petrophytic vegetation, slope, 2–4°, *Bothriochloa* Kuntze. — *varioherbosa* grouping

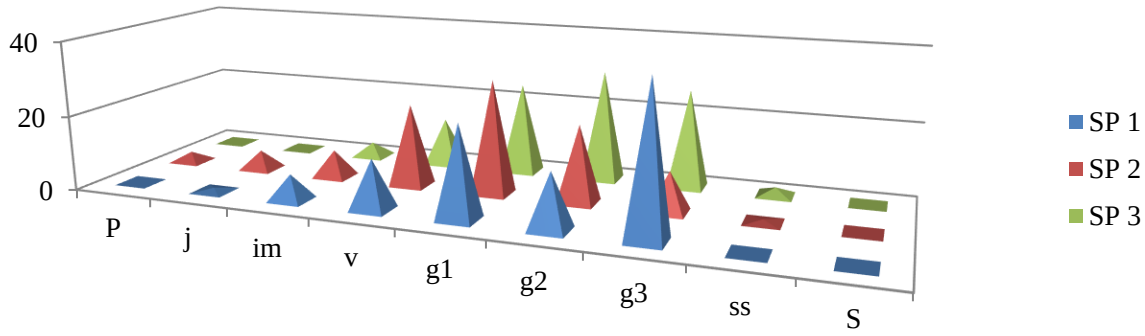

Figure 3. Petrophyte vegetation, southwest facing slope, 10–12°, *Bothriochloa* Kuntze. — *Hedysarum* L. group

The ontogenetic spectrum of the coenopopulation, which is the most extensive in the mature reproductive state, serves as the foundation for the species under study. The duration of this state is contingent upon the aggregation of generative individuals into groups that typically constitute the "core" of the population. The second most prevalent category is that of the senescent generative individuals of the coenopopulation, which account for 23.8% of the total population. The third most prevalent category is that of the young productive species, which account for 18.9% of the total population. The regeneration of natural populations of the *H. atropatanum* species is primarily facilitated by 1-2-year-old seed-bearing species.

Although the actual seeding capacity is relatively low, the mean index of recovery (Ib=0.38), individual change (Id), and aging index (Iy=0.05) indicate that *H. atropatanum* is the subdominant species in some phytocenosis (SP No. 1–5), occupying the dominant position.

The vitality status of the individuals was determined based on a comprehensive analysis of multiple morphological traits, including the height of the specimens, the number of shoots, the number of flower carriers, the length of the leaves, the size of the leaves, and the number of flowers in the flower group. Following the statistical processing of the data, three classes of vitality were identified. A study revealed that individuals of the second vitality level of the *H. atropatanum* species are more prevalent in the coenopopulation.

The spatial structure of the xenopopulation is defined by the concentration of unfertilized plant individuals in proximity to fertile plants. The presence of six to seven adult *H. atropatanum* individuals per square meter is a positive indicator. In small populations, the size of aggregations is

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relatively modest in comparison to the distance between them. Individuals were observed in the interstitial spaces between aggregations. In other instances, the aggregations were found to be distributed in isolation, with no intervening individuals.

The optimal habitats of the *H. atropatanum* species are characterized by sparse grasslands with a projected cover of no more than 10-35%. In this instance, the species is able to maintain a stable territory by exhibiting high competitiveness and aggressive characteristics. The ontogenetic fractions indicate that virginal and mature generative plants grow in relatively high density, while immature, young, and old generative samples grow in medium density, low density is characteristic of the settlement of subsenile individuals and seedlings. Consequently, the principal ontogenetic categories are present in equal proportions. This suggests that the regional grouping is stable in a number of locations.

Aggregation is a defining feature of the spatial structure of *H. atropatanum* individuals. Aggregations represent approximately 60-70% of the total number of individuals in a population. The mean diameter of clusters of specimens is 30-60 cm, although the largest clusters reach 2 m in length and 1.5 m in width.

Consequently, the principal ontogenetic groups are equally represented. This indicates that the populations in the region are stable at numerous points in time. Nevertheless, some structural differences are also characteristic of these populations, which indicate the variability of ontogenetic spectra and spatial organization.

As individuals mature and grow in coenopopulations, their numbers typically decline. Consequently, in mature generative plant populations (including phytogenic areas), there is an average of 1.5 to 2 individuals per unit area, with some populations exhibiting up to 6 individuals per unit area at any age. When evaluating the gaps between aggregations, it should be noted that mature fertile and virginal individuals are distributed relatively evenly between populations.

Conclusion

1. It has been observed that ontogenesis is relatively slow in areas with high plant density. It was determined that the secondary quiescence period does not manifest during the initial stages of development; rather, it becomes feasible only after the individuals have reached the virginal state. It has not been observed that immature individuals bypass the virginal state and immediately transition to mature generative plants.

2. The results of the population evaluation of the *Hedysarum atropatanum* species indicated that the vitality status of individuals was determined based on the analysis of several morphological characteristics, including the height of the samples, the number of shoots, the number of flower carriers, the length of the leaves, the size of the leaves, and the number of flowers in the flower group. Following the statistical processing of the obtained data, three classes of vitality were identified. It was observed that individuals belonging to the second vitality level were more prevalent in the SP of the *H. atropatanum* species.

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