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Spatial structure of *Punica granatum* L. coenopopulations in the conditions of Northern Azerbaijan

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Abstract: The results of studying the spatial structure, ontogenetic state, morphometric and coenotic parameters of 14 coenopopulations of wild pomegranate growing in different regions of Azerbaijan are presented. Abiotic and biotic factors that could affect the variability of the phytocenotic composition, ontogenetic state, morphological parameters, and density of coenopopulations of this species were shown. Our studies showed that the studied coenopopulations belong to normal mature coenopopulations, where the individuals of the generative period constitute the maximum (51%). The content of the postgenerative fraction is small (3.9-8%). The ontogenetic spectra of CPs I, III, VII, VIII, XI and XIV are right-handed, CPs II, V, X, XII - bimodal, CPs IV, VI, IX, XIII - left-handed. Age (Δ) of the studied coenopopulations has a strong distribution amplitude from 0.22 (CP II) to 0.62 (CP XIV), efficiency indices range from 0.24 (CP II) to 0.67 (CP XIV). According to the "delta omega" criterion, three types of populations were obtained: young (CPs II, IV, V, VI, VII, IX, X, X, XII, XIII), transient (CPs I, III, VIII, XI) and aging (CP XIV). The value of the recovery index ranges from 0.14 (CP XIV) to 2 (CP VI). The most threatened state in CP XIV, because of the population is aging and unstable. The density of individuals in the studied coenopopulations ranged from 0.3 to 0.5 individuals per 100 m^2. The length of the petiole, the length and width of the leaf blade have low variation coefficients. The greatest amplitude of variation among morphological features of the species is linear dimensions of the plant height and leaf area.

Key Words: *phytocenotic characteristic, ontogenetic state, morphometric and coenotic parameters*

INTRODUCTION

Punica granatum L. from the Lythraceae family Jaume St.-Hil. is a fruit, medicinal, tannic and ornamental plant, widely distributed in the countries of the ancient Mediterranean. It is revealed that the native land of the wild pomegranate is the region covering the territories of the Caucasus, Iran and Northern India, and originates in the Middle East, Northern Iran, including Azerbaijan, in the whole of Southwest Asia [Zeynalova, Novruzov, 2017]. According to G.A. Nesterenko and A.R. Strebkova [1949], the homeland of pomegranate is Azerbaijan, Afghanistan, Balochistan, Iran. In these countries, the greatest diversity of varieties and pomegranates of wild forms is concentrated. The species is listed in the Red Book of Azerbaijan with the category vulnerable and status "VU" (in the IUCN Red List, the security status is "LC" (is under the least threat)) [Red Book of the Republic of Azerbaijan, 2013].

Recently, researchers have increased interest in studying the spatial structure of coenopopulations. The study of the spatial structure of coenopopulations makes it possible to imagine how the population size and age composition change over time, and also allows us to solve the problems of species relationships in the same cenosis and at the border of different phytocenoses [Tsenop. rast., 1977].

According to literature data, most of the research of pomegranate growing in Azerbaijan was carried out on the material of cultivated pomegranate and the data related to the biochemical composition of the plant [Garasharly, 1979; Sapozhnikova, 1940; Nesterenko, Strebkova, 1949; Aslanova, Maharramov, 2012]. The study of the biochemical composition and ways of using the fruits of wild pomegranate was done by E.V. Sapozhnikova, L.G. Gorponova [1954], A.D. Strelkova [1941], R.K. Aliyev [1949] and etc. The investigations of G.M. Levin [(Levin, 1981, 2007] is devoted to the study of Kopet-Dag wild-growing pomegranate, the studies of S.M. Gulov [1998] - to the timing of the passage of phenological phases of pomegranate in the Qussar valley, the researches of I.A. Boboev [2014] - to the study of pomegranate growing in the conditions of Tajikistan. However, in the literature there is no data on the study of the spatial structure of the cenopopulations of *Punica granatum* L., which grows in the territory of Azerbaijan. In this reason, the aim of this work is the first comprehensive work to establish the ranges of wild pomegranate distributed in Azerbaijan, the study of ontogenesis, as well as the variability of coenopopulations by morphometric and coenotic parameters.

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MATERIAL AND METHODS

Geobotanical research. The study of coenopopulations (CPs) of *P. granatum* was carried out in different districts of Azerbaijan: Khizi, Siyazan, Agsu, Agdash, Ismayilli, Yevlakh, Goychay, Sheki. The object of research was *P. granatum*, and the subject was cenopopulation of the plant. Geobotanical descriptions were carried out by generally accepted methods [Lemeza, Djus, 2008].

The study of coenopopulations was carried out using the trial plot method (10 TP; 10 × 10), where the area of coenopopulation (m^2), the absolute number of individuals (pcs.), and instance saturation (density) (pcs / m^2) were studied. The density of coenopopulations in the case of large areas occupied by coenopopulations was estimated by the method of recounting individuals on trial plots (trial plot size 10 x 10). In this case, the number of plants in 10 such areas were calculated, after which the average value was estimated. For small areas, the method of direct recounting of all individuals within the population field was used [Metody izuch. tsenop. tsvetk. rast., 2015].

The names of associations (AS) were given by the number of species dominating in each tier, to which coenopopulation is confined [Shennikov, 1964]. The numbering of each association corresponded to the number of coenopopulation that was in it. The total projective cover (TPC) of the grass stand was determined by eye method.

The abundance was estimated on the Gult-Drude scale in order to identify the significance of the species in the community [Drude, 1913].

To determine the type of distribution of individuals of cenopopulations, a certain number of samples were taken and the number of individuals was calculated on equal areas and the variance (S^2) was determined [Izuc. popul. rast. naprom. otvalah, 2016]:

$$S^2 = \frac{\Sigma(x-m)^2}{n-1}$$

where m –the average number of individuals on the site; n – the number of sites.

Ontogenetic investigation. An ontogenetic spectrum was constructed for all studied coenopopulations, which reflects the percentage ratio of individuals of all ontogenetic groups and indicates a certain stage in the development of coenopopulation [Uranov, Smirnova 1969; Zaugolnova, Smirnova, 1978; Zaugolnova, 1994]. Based on the analysis of ontogenetic spectrum, the type of studied coenopopulations was determined using the classification of L.A. Zhivotovsky [2001] and L.A. Zhukova and T.A. Polyanskaya [2013].

To assess the ontogenetic spectrum of coenopopulation, the age index proposed by A.A. Uranov [1975] was used. The age index (Δ) was determined by the following equation:

$$\Delta = \frac{\Sigma\, ki \cdot mi}{\Sigma N} \quad (1)$$

where k_i – number of individuals of i of ontogenetic structure in populations; m_i –«value» of *i* ontogenetic status; N – total number of individuals in population.

The efficiency index [Zhivotovsky, 2001] was considered as the energy load on the environment by different ontogenetic groups of plants and was determined by the equation below:

$$\omega = \frac{\Sigma\, ki \cdot ei}{\Sigma N} \quad (2)$$

where k_i – the absolute number of plants of *i* age state; e_i– energy efficiency of plants of *i* ontogenetic status in population; N – total number of individuals in population.

In addition, indicators such as recovery index (I_{rec}), replacement index (I_{rep}) and aging index (I_a) were also determined.

I_{rec} is the ratio of the number of individuals of the pregenerative period (seedlings are not taken into account) to the number of individuals of the generative period [Zhukova, 1987].

$$I_{rec} = \frac{\Sigma j \rightarrow v}{\Sigma g1 \rightarrow g3} \quad (3)$$

where Σj → v is the sum of plants of all age states of the pregenerative period, Σg1 → g3 is the sum of plants of all age states of the generative period.

I_{rep} is the ratio of individuals of the pregenerative period (seedlings are not taken into account) to the sum of the numbers of individuals of the generative and postgenerative periods.

$$I_{rep} = \frac{\Sigma j \rightarrow v}{\Sigma g1 \rightarrow s} \quad (4)$$

where Σj → v is the sum of plants of all ontogenetic states of the pregenerative period, Σg1 → s is the sum of plants of all ontogenetic states of the generative and postgenerative period [Zhukova, 1987].

I_a is the ratio of the number of individuals of the postgenerative period to the number of all individuals

of the population.

$$I_a = \frac{\Sigma ss \rightarrow s}{\Sigma j \rightarrow g3} \quad (5)$$

where Σss → s is the sum of plants of all ontogenetic states of the postgenerative period, Σj → g3 sum of plants of pregenerative and generative ontogenetic states [Qlotov, 1998].

Features of all ontogenetic states are described from natural populations.

Morphometric analysis. In population studies, it is necessary to study the morphological characteristics of plants. Qualitative and quantitative traits of individuals are useful in different ways. On the basis of qualitative characteristics the selection of the age-related states of plants and the analysis of the age spectra of populations are based. Quantitative indicators are more useful in the study of ontogenetic adaptations, in assessing the life state of individuals and in constructing the vitality spectra of populations [Zlobin, 1988]. Given the importance of morphometric studies in each TP, the height of the plant was recorded, annual shoots of *P. granatum* were taken to determine the statistical morphometric parameters of the leaves (area, length, width), as well as the leaf shape index (width / length). For this purpose, the parameters of indicator leaves were analyzed. Indicator leaves (the most sensitive to environmental factors) are the three most developed leaves on the shoot [Buzuk et al., 2006]. The area of the leaf blade was determined by the equation of I. Ju Bakkal [1990]:

$$S = a \, x \, L \, x \, W$$

where L, W - length and width of the leaf blade; a - calculated coefficient equal to 0.72.

The Latin names of the plants have been determined according to "Flora of Azerbaijan" [Flora Azerbaidjana, 1952] and The Plant List.

Statistical Analysis. Statistical analysis of the research results was carried out in accordance with generally accepted methods using the computer program "MS Excel 2010". All data were expressed as means ± SD.

RESULTS AND DISCUSSION

Plant associations. The CPs of wild-growing pomegranate, conditionally named by their location, were studied. Plant diversity within coenopopulations is the most important property of natural populations, which increases the completeness of resource use and their ability to adapt to the conditions of the plant community [Kudryavtsev, 2008]. Results on naming communities based on the dominant approach of V.V. Alekhine [1925] are shown in table 1.

The studied communities (CPs I - XIV) of *P. granatum* are characterized by a significant variety of meadow and forest meadow plants. In most of the studied cenoses, pomegranate is the dominant edificator (subviolent) with a projective cover of 60-90%. Most often, representatives of the genus *Tamarix* L., as well as species of *Rubus fruticosus* L., *Paliurus spina-christi* Mill, etc., act as codominants. The results of assessing the abundance of herbaceous species in phytocoenoses are presented in table 2.

Phytocenotic characteristic of the habitat. CPs I-II are located in Siyazan district at an altitude of 230 and 250 m a. s. l. The soils in the region are predominantly saline soils [Azərbaycan: ekoturizm potensialı, 2012]. The grass of coenopopulation I is subject to annual mowing. Along with *P. granatum*, species of the genus *Tamarix* L., as well as *Hypericum perforatum* L., *Trifolium pratense* L., *Paliurus spina-christi* Mill., *Bellis perennis* L. are abundantly represented, less abundantly - *Sorbus domestica* L., *Ranunculus repens* L., *Rhus coriaria* L., *Rosa canina* L., *Malus sylvestris* (L.) Mill. The projective cover of *P. granatum* is 70-90%.

CPs III-IV were found in Khizi district at an altitude of 200 and 250 m a. s. l. The soils of the region are represented by gray-brown salt marshes [Azərbaycan: ekoturizm potensialı, 2012]. The soils of the region are represented by gray-brown salt marshes [Azərbaycan: ekoturizm potensialı, 2012]. Small abundance in these populations is typical for *Eleagnus angustifolia* L., *Papaver rhoeas* L., *Carduus pycnocephalus* L., *Tragopogon dubius* Scop. Projective covering of pomegranate is 50-70%.

CPs V-VII are represented on the territory of Agsu district at the altitude of 420 (Aghu mountain pass), 200 (the right part of the Agsu bridge) and 190 (the left part of the Agsu bridge) m a. s. l. The main soils of the region are salt marshes [Azərbaycan: ekoturizm potensialı, 2012].The following species can be found in the herbaceous-shrubby tier: *Rubus fruticosus* L., *Malva sylvestris* L., *Hypericum perforatum* L., *Alhagi pseudoalhagi* Bieb (Fisch.), *Cirsium vulgare* (Savi) Teh. In CP VII, *Ficus carica* L tree grow in a single specimen. Projective coating of pomegranate is 30-40%.

CPs VIII-IX are noted in the territories of Agdash (50 m a. s. l.) and Yevlakh (60 m a. s. l.) districts. The soils

Table 1. Characterization of associations with the participation of *P. granatum.*

Geographical Position	№ CP (GPS data)	№ AS	Name of AS	TPC of the grass, %
Siyazan district	I ($49^0 01' 04.752''$ E - $41^0 04' 45.618''$N)	1	*Punica granatum* + *Tamarix* spp.– *Hypericum perforatum*	60-80%
	II ($49^0 00' 14.454''$ E - $41^0 04' 45.468''$N)	2	*Punica granatum –Trifolium pretense*	60-80%
Khizi district	III ($49^0 8' 42.21''$ E - $40^0 54' 15.56''$ N)	3	*Punica granatum* + *Tamarix* spp.	20-30%
	IV ($49^0 11' 18.73''$ E - $40^0 52' 43.91''$ N)	4	*Punica granatum – Crepis capillarys*	30-40%
Agsu district	V ($48^0 25' 24.33''$ E - $40^0 35' 9.40''$ N)	5	*Punica granatum* + *Rubus fruticosus – Hypericum perforatum*	60-100%
	VI ($48^0 23' 51.97''$ E - $40^0 34' 51.85''$ N)	6	*Punica granatum* +*Tamarix* spp.– *Cirsium vulgare*	60-80%
	VII ($48^0 23' 51.50''$ E – $40^0 34' 50.64''$ N)	7	*Punicagranatum*+ *Tamarix* spp.– *Alhagi pseudoalhagi*	40-50%
Agdash district	VIII ($47^0 30' 27.49''$ E - $40^0 38' 43.81''$ N)	8	*Punica granatum* + *Rubus fruticosus – Alhagi pseudoalhagi*	30-40%
Yevlakh district	IX ($47^0 12' 14.81''$ E -$40^0 44' 49.22''$ N)	9	*Punica granatum* + *Rubus fruticosus – Bellis perennis*	30-40%
Goychay district	X ($48^0 0' 48.23''$ E - $40^0 36' 54.42''$ N)	10	*Punica granatum – Trifolium pratense* + *Capsella bursa-pastoris* + *Alhagi pseudoalhagi*	60-80%
Ismailli district	XI ($48^0 14' 49.05''$ E - $40^0 37' 29.06''$ N)	11	*Punica granatum – Capsella bursa-pastoris*	80-100%
	XII ($48^0 3' 47.15''$ E - $40^0 45' 2.82''$ N)	12	*Punica granatum – Capsella bursa-pastoris +Pimpinella peregrine*	80-100%
Sheki district	XIII ($47^0 7' 31.20''$ E - $40^0 0' 22.27''$ N)	13	*Punica granatum – Trifolium pratense* + *Crepis capillaries*	80-90%
	XIV ($47^0 11' 29.33''$ E - $41^0 9' 34.33''$ N)	14	*Punica granatum – Cirsium vulgare* + *Capsella bursa-pastoris* + *Crepis capillaries*	80-90%

Table 2. Abundance of herbaceous species in associations.

Plant species	AS													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Hypericum perforatum L.	cop_3	cop_2	-	-	cop_3	sp	sp	sp	sp	-	sp	sp	sp	sp
Trifolium pratense L.	cop_2	cop_3	sp	sp	cop_1	cop_1	cop_1	sp	cop_2	cop_3	cop_2	cop_2	cop_3	cop_1
Bellis perennis L.	cop_1	cop_1	-	-	sp	-	-	-	cop_3	cop_1	sp	sp	cop_1	sp
Capparis spinosa L.	-	-	sp	cop_1	-	-	-	-	-	-	-	-	-	-
Taraxacum officinale F.H. Wigg	-	-	sp	sp	sp	cop_1	sp	cop_1	cop_1	cop_2	cop_2	cop_2	cop_1	cop_1
Cirsium vulgare (Savi) Teh.	sol	sol	sp	cop_1	sp	cop_3	sp	sol	sp	sol	sp	cop_3	sp	cop_3
Lactuca serriola L.	-	-	-	cop_2	sp	-	sp	-	-	sol	-	-	sp	-
Crepis capillary (L.) Wallr.	sp	sp	sp	cop_3	-	-	-	-	cop_2	-	-	-	cop_3	cop_3
Malva sylvestris L.	-	-	-	-	soc	cop_1	sp	-	-	-	-	-	-	-
Capsella bursa-pastoris (L.) Medik	sp	sp	sp	sp	soc	cop_1	cop_1	cop_1	cop_2	cop_3	cop_3	cop_2	cop_1	cop_3
Alhagi pseudoalhagi Bieb (Fisch.)	sol	sol	sp	sp	cop_1	cop_1	cop_3	cop_3	sp	cop_3	sp	sp	sp	sp
Pimpinella peregrine L.	-	-	-	-	-	-	-	-	-	-	sp	cop_3	-	-
Papaver rhoes L.	sp	sp	cop_1	cop_1	sp	sp	sp	-	sp	sp	sp	cop_1	cop_1	cop_1
Carduus pycnocephalus L.	-	-	sp	sp	-	sp	sp	sol	sp	sol	sol	sol	sp	-
Tragopogon dubius Scop.	sol	sp	sol	sp	sp	sp	sp	-	-	-	sp	-	-	-
Sonchus tenerrimus L.	sol	sp	-	-	-	-	-	-	-	sol	-	-	sol	-
Anacamptis morio L.	un	-	-	-	-	-	-	-	-	-	-	-	-	-
Ranunculus repens L.	sol	-	-	-	-	-	-	-	-	-	sol	sol	-	-

Note: *soc - all over the place, cop_3 - very abundant, cop_2 - abundant, cop_1 - quite abundant, sp - diffusely, sol - isolated, un - a single copy.*

of the regions are saline earth serozems [Azərbaycan: ekoturizm potensialı, 2012].CP VIII is characterized by the lowest value of the projective cover of *P. granatum* (10 - 15%) and poor species diversity, consisting of the following species: *Rubus fruticosus* L., *Capparis spinosa* L., *Alhagi pseudoalhagi* Bieb (Fisch.) and various weeds. Projective pomegranate coating in CP IX is 70-80%.

CPs X-XII have been studied in Goychay (CP X, 170 m a. s. l.) and Ismailli (CP XI, 280 m a. s. l.; CP XII, 540 m a. s. l.) districts. The cha-racteristic soils of the Goychay region are light brown soils, and those of the Ismayilli region are mountain-brown soils [Azərbaycan: ekoturizm potensialı, 2012]. Plants of *P. granatum* from CP XI are distinguished by the highest height of shoots (up to 8 m). The following species dominate in the herbaceous tier of the studied populations: *Capsella bursa-pastoris* (L.) Medik, *Alhagi pseudoalhagi* Bieb (Fisch.), *Paliurus spina-christi* Mill. Projective pomegranate coverage in these populations is 60-80%.

CPs XIII – XIV were studied in Sheki region at an altitude of 340 and 380 m a. s. l. The main soils are light chestnut and chestnut [Azərbaycan: ekoturizm potensialı, 2012]. In the grassy tier are dominated, *Paliurus spina-christi* Mill., *Trifolium pratense* L., *Crepis capillaries* (L.) Wallr. The projective coverage of pomegranate in these coenopopulations is 50-80%.

Main types of climateof regions are following: Climate of semi-deserts and dry steppes üith mild winter and dry hot summer (Siyazan, Agsu, Agdash, Yevlakh), temperatly warm climate with dry winter (Khizi, Goychay, Ismayilli), temperally warm climate with even distribution of precipitation (Sheki) [Azərbaycan Respublikası: ekoloji atlas, 2009].

The type of distribution of individuals in CPs I–IV, VIII–IX, XIII–XIV is group, CPs V-VII - random-clinial and contagious-clinial and CPs X-XII - evenly. As can be seen from theobtaineddata , the predominant type of distribution of individuals is group. According to Yu.V. Ibatulina [2007], under the condition of intensive anthropogenic impact on the vegetation cover, the group distribution of individuals of coenopopulations of one or another spesies is often preserved, which is observed in CPs I – IV, XIII – XIV. For coenopopulations of edificator species, if one of them experiences competitive pressure from the other dominant species, but is stable in the community, contagious distribution of individuals is typical [Zaugolnova, 1976]. It is believed that the random (uniform) distribution of the species over the area indicates its prosperity, the approximation of the growing conditions to its ecological norm, and its stable position in the phytocenosis [Ibatulina, 2007].

As a life form of a pomegranate, it is usually indicated that it is a tree or shrub. It should be noted that the life form of the tree in pomegranate is the result of forming and is observed only in culture. The life form of wild pomegranate is a geoxyl bush.

The density of individuals in the studied coenopopulations ranged from 0.40 to 0.88 individuals per 100 m^2. *Morphometric analysis*. In coenopopulation studies, the use of morphometric methods makes it possible to give a quantitative assessment of the morphological status, growth and production processes of plants, to assess the interrelation of individual parameters of the morphological structure of plants and, on this basis, to characterize the level of integrity of individuals, to obtain information for the subsequent identification of key, indicator morphological parameters, on the basis of which a comprehensive assessment and diagnosis of the vital state of individuals of plants is possible [Metody izuch..., 2015]. Morphometric parameters of individuals are given in table 3 which shows that the plant height and leaf area are highly variable. The length of the petiole, the length and width of the leaf blade have low variation coefficients. Plants from CPs XI, XIII have the highest height (6.33±0.9; 6±0.66 m), and from CPs III and VIII - the largest area of the leaf blade (10.07±0.27).

The smallest length is characteristic for specimens of CP IX (3.40±0.5 cm), and the smallest width of the leaf blade is characteristic for plants of CP XIV (1.25±0.14 cm). The length of the leaf petiole in plants from CP X is much higher than in other samples (2.00±0.21 cm). Morphological measurements of fruits were represented in a previous research [Zeynalova et al., 2019].

Ontogenetic analysis. The obtained biometric values of pomegranate allow us to introduce another quantitative characteristic of the degree of development of the individual. Studies of the age state of pomegranate specimens revealed the following states: juvenile (j), immature (im), virgin (v), generative (g1, g2, g3), and post-generative (ss, s).

The ontogenetic structure of coenopopulations of *P. granatum*, growing on the territory of the Great Caucasus (within Azerbaijan), has not been studied yet. According to the classification of L.A. Zhivotovsky [2001] studied coenopopulations belong to normal mature coenopopulations, where the maximum falls on individuals of the generative period (5-51%). The content of the postgenerative fraction is small - 3.9-8% (Fig.).

Table 3. Statistical morphometric parameters of the studied pomegranate bushes.

№ CPs / Parameters	CPs													
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII	XIV
H	4.9± 0.66	3.9± 0.54	3.7± 0.2	4.37± 0.51	4.16± 0.58	4.23± 0.51	3.33± 0.48	4.66± 0.55	4.57± 0.63	4.23± 0.51	6.33± 0.9	3.77± 0.18	6± 0.66	4.1± 0.6
L_{fol}	5.09± 0.31	4.87± 0.72	5.05± 0.74	4.90± 0.68	4.87± 0.35	5.32± 0.74	5.41± 0.43	6.39± 0.9	3.40± 0.5	4.70± 0.7	5.11± 0.66	4.80± 0.70	5.37± 0.72	5.41± 0.31
Wh_{fol}	1.74± 0.2	2.10± 0.31	2.77± 0.4	1.97± 0.29	1.38± 0.11	1.76± 0.25	1.67± 0.09	1.93± 0.05	1.42± 0.21	1.42± 0.03	2.17± 0.27	1.89± 0.23	1.36± 0.16	1.25± 0.14
S_{fol}	6.38± 0.31	7.36± 0.44	10.07± 0.27	6.95± 0.59	4.84± 0.07	6.74± 0.15	6.5± 0.13	8.88± 0.09	3.48± 0.05	4.81± 0.23	7.98± 0.67	6.53± 0.74	5.26± 0.14	4.87± 0.22
L_{fol} / Wh_{fol}	2.93± 0.16	2.32± 0.09	1.82± 0.23	2.49± 0.33	3.53± 0.41	3.02± 0.06	3.23± 0.29	3.31± 0.37	2.39± 0.24	3.30± 0.08	2.35± 0.03	2.54± 0	3.94± 0.37	4.33± 0.05
L_{pet}	0.48± 0.05	0.51± 0.06	0.33± 0.3	0.25± 0	0.32± 0.02	0.41± 0.04	0.45± 0.01	0.47± 0.06	0.41± 0.02	2.00± 0.21	0.49± 0.06	0.42± 0.04	0.33± 0.01	0.32± 0.01

Note: *H – plant height, L_{fol} – leaf blade length, Wh_{fol} – leaf blade width, S_{fol} – leaf blade area, L_{pet} – petiole length.*

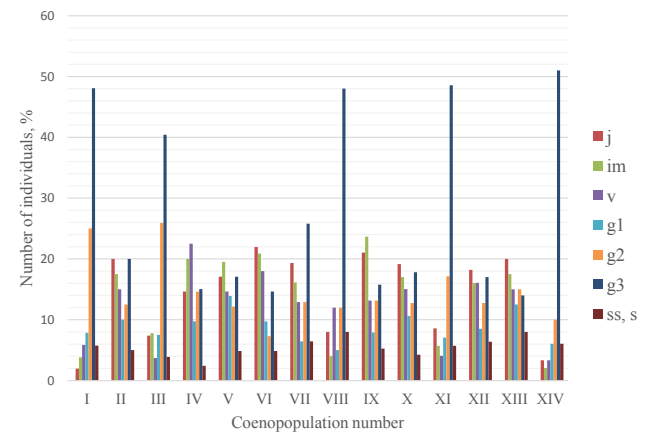

Figure. Ontogenetic spectrums of *P. granatum* populations.

The ontogenetic spectrums of CPs I, III, VII, VIII, XI and XIV are right-handed (with an absolute maximum on old generative individuals), CPs II, V, X, XII - bimodal (with a maximum in the virgin and generative parts, respectively), CPs IV, VI, IX, XIII - left-handed (with an absolute maximum for young individuals). A high percentage of middle-aged generative plants in the examined coenopopulations, and on the other hand, is determined by the elimination of young fractions as a result of various factors, and on the other, with a gradual increase in the life expectancy of individuals in the generative period.

The minimum proportion of individuals on the right side of the spectrum in most cases is associated with frequent death of individuals in the postgenerative period. All studied populations are full-term and are in a definitive state.

Table 4. Some demographic indicators of *P. granatum* coenopopulations.

№ CP / Parameter	Ceonopopulations													
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII	XIV
I_{rec}	0.35	1.23	0.24	1.35	1.16	2	1.07	0.35	1.57	1.25	0.29	1.44	1.24	0.14
I_{rep}	0.32	1.10	0.26	1.35	1.05	1.73	0.93	0.31	1.38	1.13	0.27	1.44	1.16	0.17
I_a	0.1	0.08	0.07	0.03	0.07	0.01	0.08	0.06	0.02	0.07	0.12	0.04	0.05	0.15
Δ	0.43	0.22	0.37	0.30	0.30	0.26	0.25	0.36	0.32	0.31	0.36	0.30	0.27	0.62
ω	0.46	0.24	0.41	0.33	0.32	0.30	0.28	0.43	0.35	0.34	0.42	0.33	0.31	0.67
Type of CP by criterion of "delta-omega"	T	Y	T	Y	Y	Y	Y	T	Y	Y	T	Y	Y	A
Type of CP by I_{rep}	U	P	U	P	P	P	U	U	P	P	U	P	P	U

Note: *T – transition, Y – young, A – aging, P – perspective, U – unstable.*

Thus, the CPs of wild pomegranate, represented by the majority of ontogenetic states, prevails, which indicates the stability and ability of the CPs to maintain themselves.

In order to assign *P. granatum* populations to a certain class, we calculated Δ, ω, I_{rep}, I_a, and I_{rec} (Table 4).

Age (Δ) of the studied coenopopulations has a strong distribution amplitude from 0.22 (CP II) to 0.62 (CP XIV), efficiency indices range from 0.24 (CP II) to 0.67 (CP XIV). Three types of populations were obtained by the using the "delta omega" [Zhivotovskij, 2001] criterion: young (CPs II, IV, V, VI, VII, IX, X, X, XII, XIII), transient (CPs I, III, VIII, XI), aging (CP XIV). The recovery index determined by the content of the young ontogenetic part of the population ranges from 0.14 (CP XIV) to 2 (CP VI). The table shows that the most threatened state in CP XIV in which the population is aging and unstable. The minimum share of the pregenerative fraction in this assessment population can be conditioned by the following factors: the death of immature individuals occurs as a result of grazing and trampling of vegetation by cattle, which cause a decrease in productivity and the effectiveness of seed and vegetative propagation; soil and climatic conditions and interpopulation relations hinder the increase of the number of young individuals in this CP of pomegranate.

CONCLUSION

The ceonopopulations of *P. granatum*, which are spread in various districts of Azerbaijan, are characterized by a significant variety of meadow and forest-meadow plants. In all studied cenoses, pomegranate is most often the dominant. The greatest amplitude of variation among the morphological characters of the species is the linear size of the shoot height and the area of the leaf blade. The age structure of the *Punica granatum* coenopopulations in different localities of Azerbaijan is heterogeneous, due to the dependence on a specific ecological and phytocenotic situation. An analysis of morphometric parameters, phytocenotic composition, ontogenetic state, and density of coenopopulations of the studied species suggests that abiotic and biotic factors could influence the variability of these parameters. Among the abiotic factors, the main ones were: the influence of soil and climatic factors and the height of growth. Among biotic factors – the duration of passage of age-related conditions; lower mortality of individuals of high vitality; accelerating the pace of development and reducing the time spent in the corresponding age states, grazing and trampling of young individuas by cattle, which cause a decrease in productivity, the effectiveness of seed and vegetative propagation.

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Şimali Azərvaycan şəraitində *Punica granatum* L. senopopulyasiyalarının məkan quruluşu

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Məqalədə Azərbaycanın müxtəlif rayonlarında bitən adi nar növünün 14 senopopulyasiyasının məkan quruluşu, ontogenetik vəziyyəti, morfometrik ve senotik göstəricilərinin öyrənilməsinin nəticələri verilir. Senopopulyasiyanın sıxlığının dəyişməsinə, dayanıqlığı prosesinə, fitosenoloji tərkibinə, ontogenetik vəziyyətinə, və morfometrik ölçülərinətəsir edə biləcək abiotik və biotik amillər göstərilmişdir. Tədqiqat göstərir ki, öyrənilən populyasiyalar normal yetkin senopopulyasiyalara aiddir. Beləki, fərdlərin maksimum miqdarı (51%) generativ, az hissəsi (3.9-8%) postgenerativ dövrdədir. I, IV, V, VI, VII, IX, X, XII, XIII senopopulyasiyaların baza spektrı sağ yönümlü, SP II, V, X, XII – bimodal və SP IV, VI, IX, XIII – sol yönümlüdir. Öyrənilən senopopulyasiyaların yaş vahidi (Δ) geniş paylanma amplitudasına 0.22 (SP II) - 0.62 (SP XIV) arasında dəyişir. "Delta-omega" qiymətləndirməsindən istifadə etdikdə 3 tip senopopu-

lyasiya: cavan (II, IV, V, VI, VII, IX, X, XII, XIII), keçid (SP I, III, VIII, XI) və yaşlı (SP XIV) aşkar edilmişdir. Senopopulyasiyaların bərpa olunma indeksi 0.14 (SP XIV)-2.0 (SP VI) arasında dəyişir. Müəyyən edilmişdir ki, SP XIV yaşlı və qeyri-sabit fərdlərdən təşkil olunub, təhlükə həddindədir. Tədqiq olunan senopopulyasiyalardaki fərdlərin sıxlığı 100 m^2 sahədə 0.3-0.5 arasında dəyişilir. Saplağın uzunluğu, yarpaq ayasının uzunluğu və eni aşağı variasiya əmsalı göstəricisinə malikdirlər. Növün morfoloji əlamətləri arasında kolun hündürlüyü və yarpaq ayasının ölçüləri daha çox amplituda dəyişkənliyilə fərglənir.

Açar sözlər: *fitosenotik xüsusiyyət, ontogenetik vəziyyət, morfometrik və senotik göstəricilər*

Пространственная структура ценопопуляций *Punica granatum* L. в условиях Северного Азербайджана

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Представлены результаты изучения пространственной структуры, онтогенетического состояния, морфометрических и ценотических параметров 14 ценопопуляций дикого граната, произрастающих в различных районах Азербайджане. Были показаны абиотические и биотические факторы, которые могли влиять на изменчивость фитоценотического состава, онтогенетического состояния, морфологических параметров и плотности ценопопуляций этого вида. Наши исследования показали, что изученные ценопопуляции относятся к нормальным зрелым ценопопуляциям, где преобладают особи генеративного периода (51%). Содержание постгенеративной фракции невелико (3.9-8%). Онтогенетические спектры ЦП I, III, VII, VIII, XI и XIV - правосторонние, ЦП II, V, X, XII - бимодальные, ЦП IV, VI, IX, XIII - левосторонние. Возраст (Δ), исследованных ценопопуляций имеет сильную амплитуду распределения от 0.22 (ЦП II) до 0.62 (ЦП XIV), показатели эффективности колеблются от 0.24 (ЦП II) до 0.67 (ЦП XIV). По критерию «дельта-омега» было получено три типа популяций: молодые (ЦП II, IV, V, VI, VII, IX, X, X, XII, XIII), переходные (ЦП I, III, VIII, XI) и старые (ЦП XIV). Значение индекса восстановления варьируется от 0.14 (ЦП XIV) до 2 (ЦП VI). Наиболее угрожаемоесостояниеу ЦП XIV, популяция является стареющей и неустойчивой. Плотность особей в исследованных ценопопуляциях составляла от 0.3 до 0.5 особей на 100 $м^2$. Длина черешка, длина и ширина листовой пластинки имеют низкие коэффициенты вариации. Наибольшей амплитудой вариации среди морфологических признаков характеризуются линейные размеры высоты побега и площади листьев.

Ключевые слова: *фитоценотическая характеристика, онтогенетическое состояние, морфометрические и ценотические параметры*