

Original Research Article

Bioecological and phytocenological assessment of *Equisetum arvense* L. populations in the Great Caucasus of Azerbaijan

Sayyara J. Ibadullayeva^{1*}, Narmin R. Salmanova², Nuri V. Movsumova¹,
Gulnara S. Shiraliyeva¹, Sevda Z. Ahmadova³

Department of Biology, ¹Institute of Botany of ANAS, Baku, ²State Agrarian University, Azerbaijan
³Department of Ecology, Ganja State University, Genge, Azerbaijan

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*Correspondence:

Dr. Sayyara J. Ibadullayeva,
E-mail: ibadullayeva.sayyara@mail.ru

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ABSTRACT

Background: The use and reproduction of natural resources that are interested in improving the living standards of the population is based studying of scientifically complex. Studying the biodiversity of medicinal plants based on cenological assesments are depending on their ecological diversity is always relevant. This study was aimed to estimate population of *Equisetum arvense* L. phytocenologically and ecologically and registrations during in different years.

Methods: Ontogenetical descriptions of *Equisetum arvense* species have been shown according to form of ontogenetically periods. It has been used discrete descriptive conception of ontogenesis and development stages of the individuals have been charactered. Results have been analysed by χ^2 comparison of criteria.

Results Three natural cenopopulations and cenological state of *E. arvense* were assessed during 2017-2019 years. It is defined that, 1st and 3rd cenopopulations were transitions and 2nd was mature in 2017, in 2018 1st was young, 2nd and 3rd were mature, in 2019 1st and 2nd were young and 3rd was mature. Restoration of 1st and 2nd cenopopulations were higher in 2019 than in 2017-2018.

Conclusions: Properties of soil-climate condition in *E. arvense* formation has been a cause for a determining development rhythm feature in the Equiseta vegetation. Important changes in ecology temperature, dampness and other factors influence on strongly seasonal dynamism of grasses in the Zagatala territory, but semi-shrubs tier that *E. arvense* dominates is constant. Seasonal distribution of the atmosphere rainfalls influences on development dynamism of populations. For this reason restoration parameters of some populations were high in compared to previous years.

Keywords: *Equisetum arvense* L., Bioecological properties, Phytocenose, Cenopopulation, Medicinal plants

INTRODUCTION

In the conditions of the present phase of development of the human society when scientific and technical revolution brings basic changes into the environment, the arrangement of scientifically based complex use and reproduction of natural resources get an actual significance interested with increase of a standard of life of the population.¹

This problem is also actual and urgent because of the stresses of anthropogenic factors that cause threat during recent decades and global ecological changes have more increased, biodiversity sharply began to decrease by ecosystems degradation, many valuable species (mainly medicinal plants) have been lost or they are under threat of to be lost.²

Equisetum arvense is used by local communities in urinary system disorder, pulmonic disorder, dysentery, antirheumatic, tuberculosis, stomatitis, diarrhea.³

The originality of physical and geographical environmental conditions of Azerbaijan, a variety of climate, soils, a relief of the locality, abundance of water sources, solar radiation, etc., favored to abundance and a variety of current flora which throughout many centuries was a source for many purposes including medicinal therapy. Species content of useful plants was ascertained by the long-term expedition surveys that have covered all natural and geographical areas of Azerbaijan: the Great Caucasus, the Small Caucasus, the East-Western Lowland, the Steppe Plateau, Gobustan, Talysh as well Nakhichevan. Studying the biodiversity of medicinal plants in this area is always relevant.

METHODS

Research had been carried out in Great Caucasus territory (forests and meadows of Zaqatala, Ilisu, Gakh and Sheki districts of Regions) of the Azerbaijan Republic in 2017-2019 years. *E. arvense* L. belongs to the family *Equisetaceae* Richx. ex DC.⁴

In order to evaluate *E. arvense* populations phytocenologically and ecologically and registrations carried out by general methods accepted in the geobotany and characteristic local populations were selected for *E. arvense* so that its biotope answers a few ecological factors.

To describe *E. arvense* phytocenose using measure of Grosshaim, up to 50 geobotanical description has been carried out in areas where spread associations.⁵ In order to determine the floristic composition, more than 90 herbariums materials were gathered from investigation zone. Taxonomy was given on the basis of modern.⁶

According to scientists, vegetation of *E. arvense* starts to germinate at positive 7-10⁰ C and finishes positive 4-6⁰ C temperature. Vegetation period continues 140-150 days.⁷

Discrete descriptive conception of ontogenesis by Rabotnov and Uranovis used and development stages of the individuals have been charactered.^{8,9} Ontogenetical descriptions of *E. arvense* species have been shown according to form of ontogenetically. Registration of immature (im), virginal (v) young generative (g₁), middle aged period (g₂), old generative (g₃), subsenil (ss) and senil (s) periods have been carried out. Results have been analysed by χ^2 comparison of criteria.^{10,11} The following indicators as integral description of the demographic structure have been used:

Age index (Δ)⁹;

$$\Delta = -\frac{\sum k_i x n_i}{N}$$

Where k_i is the "mark", of the ontogenetical situation, n_i is the number of the individuals, i is the state of the population, N is the general number of the individuals in the population.

Restoration index changed by Glotov (IB), pre-generative individuals is expressed in the form relationship of total of pregenerativ and generative.^{12,13}

$$I_b = \frac{\sum_{i=3} N_i}{\sum_{i=3} N_i}$$

Aging index:¹³

$$I_q = \frac{\sum_{i=9} N_i}{\sum_{i=3} N_i}$$

Effectiveness index:¹⁴

$$\omega = \frac{n e_i}{\sum N_i}$$

n_i is the number of plants, i is the condition, e_i is the effectiveness of plants.

Effective of biological density of population (M_e) accoring to Jivatovski was defined as:

$$M_e = \sum n_i \cdot \omega_i$$

n_i is the number of plants, i is the condition, ω_i is the energetic effectiveness of plants.

RESULTS

Equisetum arvense are spreading everywhere in Azerbaijan territory, river banks, sunken meadows, weak salty land of lowland and highland regions. Great Caucasus territory in Azerbaijan is one of the territories where *E. arvense* group is spread widely (Figure 1). Forests and meadows plant covers distributed on the territory of mountainous areas to botanical-geographically side.



Figure 1: *E. arvense* of winter pastures of the Great Caucasus territory (Zagatala).

Gathering materials were carried out in systematical and scattered Transects. Transect must pass the areas, and must characterize rather high or low abundances of the any selected species. So, investigated species has taken out from areas and ontogenetic situation specified, created spectrum.

During phytosenology and ecological investigations, individuals involve all phases of ontogenese were assessed in populations of *E. arvense* species, age,

efficiency, ageing and restoration coefficients calculated. Three natural cenopopulations (CP) out of groups where *E. arvense* spread have been selected in the investigation years. General area of selected CP was not less than 40 hectares. There is given information about ontogenetical structure of *E. arvense* in the Table 1 in different years (for each 4 hectares). Type of CP has been determined by using Uranov's absolute maximum criterion.⁹ The calculations had been carried out during the investigation.

Table 1: Assessment of *E. arvense* CP.

No. of CP	CP type	Development phase of ontogenesis (%)		
		Pre-generative (j, im,v)	Generative (g ₁ -g ₃)	Post-generative (s-ss)
2017	1 Transition	26,6	62.5	11
	2 Mature	12	72.1	16.2
	3 Transition	26.43	43.4	13
2018	1 Young	55.5	35.6	9
	2 Mature	14.28	61	25
	3 Mature	0	72.41	28
2019	1 Young	59	42	0
	2 Young	60	35.3	6
	3 Mature	16.72	52.1	31.25

J: Juvenile; im: immature; v: virginal; g₁: young generative; g₃: old generative; s: senil; ss: subsenil, CP: cenopopulations.

Comparison of the population parameters of any plants selected from populations in different years implemented by student's T-criteria with Shidac's comparison correction. In the result, varieties occur in the ontogenesis of the plants of CP were calculated (Figure 2).

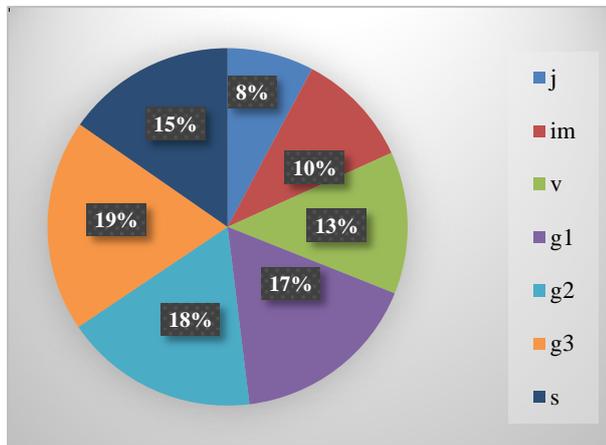


Figure 2: Ontogenetic spectrum of *E. arvense* CP species (2017-2019).

From the Table 1, individuals in the three-year assessment of CP (35.3-72.41) dominated in the stage of generative. During the studies, the index of age (Δ), efficiency (ω), regeneration (\bar{I}_r) and aging (\bar{I}_a) were determine by Jivatovski's delta-omega normal CP classification (Figure 3).

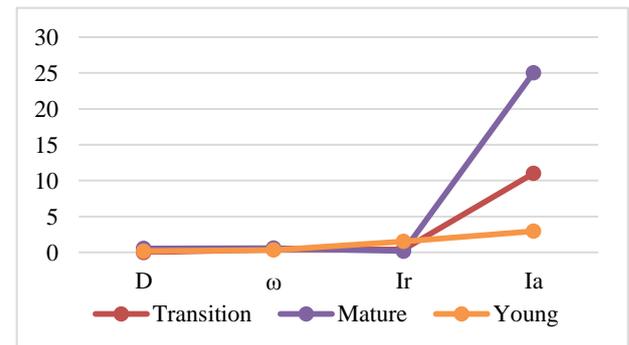


Figure 3: Indexes of plant development.

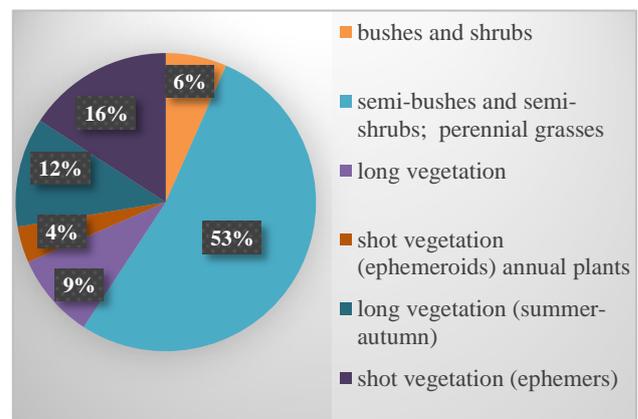


Figure 4: Life forms of phytocenose created in abundance of *E. arvense* in the Zagatala territory.

So, in calculation in order to defining CP type are; 1. (2018), 1-2 (2019) CP young ($\Delta=0.23-0.26$; $\omega=0.27-0.42$), 1 (2017) and 3 (2017) CP transition ($\Delta=0.42-0.46$; $\omega=0.42-0.45$), 2 (2017), 2 (2018), 3 (2018) and 3 (2019) CP mature ($\Delta=0.52-0.62$; $\omega=0.53-0.72$) populations.

Life forms of the botanical groups in *E. arvense* populations have been specified in the investigation. There are the following life forms in structure of *E. arvense* (Figure 4), grains, perennial and annual grasses are included into xeromezophytes group and ephemers and ephemeroïdes are to mezophytes group.

As shown in the diagram, ephemers dominates being 55% in the *Equiseta* formation and they create fullness with semibushes.

DISCUSSION

Materials have been gathered according to general accepted methods during investigation of populations in different Phytocenose.^{10,11} Floristic composition of the *Equiseta* formation of the *E. arvensum* class formation populations is quite rich.¹⁵ It is determinate from our investigations that *E. arvense* forest flora of the Great Caucasus territory has formed more than 50-60 species of plant. Representatives of the Goosefoot, Grain, Aster, Nightshade, and the vast majority of trees. Meadows vegetation of *E. arvensum* has been organized by holoractic and forest areal types. In floral composition of some species *Equiseta* are meet as well as common species in the flora structure of boreal.

In the result of succession, *E. arvense* and different herbs follow each other systematically in these areas and they grow in the same areas. *Equisetum arvense*, *Thalictrum minus* and *Fumaria officinalis* follow clean to *Juniperus oblonga* Bieb. There is a similarity between *Equisetum arvense* with *E. ramosissimum* Desf. in the structure of flora. *Equiseta* (grains, legumes, geoffites, and different herbs) and Efemer's majority are spreading in structure of both phytocenoses.

All plants in structure of the associations of *E. arvense* were separated from 4 groups that each of them forms special sinusation. These sinuations are located on stages: perennial sinusation (shrubs, bush, semi-bush and semi-shrubs); sinusation of the spring-autumn; ephemers and ephemeroïdes sinusation (fugutitives); sinusation of the primitive plants.

E. arvense creates sinusation as background and dominant plant by bushes, shrubs, semishrubs and semibush. There are also *Saponaria officinalis*, *Rumex alpestris*, *Datisca cannabina*, sometimes, *Malva sylvestris*, *Rubus caesius* etc. in this sinusation as well as saltwort. *Equisetum arvense* changes between 65-80% in the phytocenoses.

In phytocenoses of *E. arvense* all semishrubs form upper layer (exception wormwood). Their height reaches 50-115 cms. Sinusation with spring-autumn plants are organised in the result of long vegetation one-year plants. It is: *Glycyrrhiza glabra* L., *Chaerophyllum bulbosum* L., *Sambucus nigra* L., *Valeriana tiliifolia* Troitzk., *Tragopogon reticulatus* Boiss. et Huet, *Lamium album* L., *Fritillaria caucasica* Adams, *Asparagus persicus* Baker. etc. Composition as subedificators in the *E. arvense* structure and especially they cover wide areas in strong watery lands. Spring-autumn annual plants form the secondary layer in autumn. Ephemers and ephemeroïdes create sinusation with fungus. One of characteristic features of *E. arvense* phytocenose is participation grain ephemeras in the cenoses.

Assessment of CP where spreading *E. arvense* was carried out in different years, and there was diminishing in the number of individuals of the CP in 2018-2019 in the relation to 2017. However, this diminishing was restored by increasing the number of generative individuals in 2019.

Changeability of CP is related with ecological condition, reconstructions and restoration, by influence of the associated anthropogenic factors.

In CP of *E. arvense* species determined that CP 1 and 3 were transition, 2 was mature in 2017, CP 1 young, 2 and 3 mature in 2018, in 2019 1 and 2 young, 3 CP mature. Analysis of the population parameters shows that, at present all investigated CP are restored well. In CP 1 and 2-restoration index was higher in 2019 than in 2017 - 2018.

According to investigator of the *Equiseta* lawn, such relation in life forms of *Equiseta* is characteristic damp and moderate climate in Azerbaijan. Plant representatives of the groups of different life forms of flora composition are the followings such as bushes: *Juniperus oblonga*, *Ephedra procera* Fisch. ex C.A. Mey., *Chelidonium majus* L., *Clematis orientalis* L., *Rubus caesius* L., perennial grasses: *Convolvulus arvensis* L., *Cynoglossum officinale* L., *Leonurus cardiaca* L., *Origanum vulgare* L., Ephemeroïdes: *Poa bulbosa*, *Gladiolus italicus* Mill., *Allium rubellum*, Summer-autumn annual: *Cichorium intybus* L., *Scorzenera cana* (C.A. Mey.) O. Hoffm., *Lappula patula* (Lehm.) Menyharth, *Solanum nigrum* L., *Salvia viridis* L., *Hordeum leporinum*, *Centaurea cyanus* L. etc.

During investigations of phytocenose's development it has been known that development cycle of the *E. arvense* species is analogous almost everywhere in the Great Caucasus plain. *E. arvense* begins the vegetation in the March-April months, forms flower buds in June in these areas. The blossoming is in August, fruit in September, perishing in the beginning of December.

Two existing dominant lives (semi-bushes and ephemers) have been a cause for formation of two sharp sinuziations having different development rhythm in the plant cover. Development Cycle of semi-shrubs continues from September-October months to April-May. Their Water source is capillary border of the ground waters. *E. arvense* continues growth of intensive height, shoot and development of the leaves until hot summer, development in hot period of the summer weakens. Semi-shrubs vegetation continues in the autumn. Their green shoots and leaves perish when temperature comes down. Development cycle of spring-autumn annual semi-shrubs continues from the end of the spring to the end of the autumn. They yield harvest and perish in this time.

CONCLUSION

Properties of soil-climate condition in *E. arvense* formation have been a cause for a determining development rhythm feature (high summer temperature, much dampness, high mineralized of ground waters) in the Equiseta vegetation. Important changes in ecology temperature, dampness and other factors influence on strongly seasonal dynamism of grasses in the Zagatala territory.

Water source of the majority of the plants in *E. arvense* phytocenose is ground water as well as precipitation waters. Semi-shrubs tier that *E. arvense* dominates is constant. Seasonal distribution of the atmosphere rainfalls influences on development dynamism of populations. For this reason restoration parameters of some populations were high in compared to previous years.

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