PHYTOSENENOLOGICAL STUDY OF ZOSIMA ABSINTHIFOLIA (VENT.) LINK. IN AZERBAIJAN

Elman Yusifov
Institute of Dendrology of Azerbaijan Academy of Sciences, Baku, Azerbaijan
E-mail: yusifov_e@yahoo.com

Abstract. Describes the study of the habitats, populations and phytocenology of the Zosima absinthifolia (Vent.) Link. Zosima absinthifolia belongs to the Apiaceae family and the only species of the genus distributed in the Nakhchivan Autonomous Republic and Absheron Peninsula in the steppe landscapes. The results showed that in 6.7,10th senopopulations the coefficient of efficiency was higher (ω = 0.59-0.67). This is due to the fact that, in these populations, the dynamics of the number of plants belonging to the juvenile and immature phases before the generative developmental phases is high, and individuals with aging (s, ss) phases were few. In favorable conditions seed reproduction increases the number of seedling senopopulation (35.48%). In such cases, the post-generation fraction level decreases (25.87%). As the environment deteriorates, the role of vegetative reproduction increases. As a result, sprouts in the age spectrum are minimized (3.97%). The maximum share of j+im+v (47.4%) in the III senopopulation decreased accordingly (7.77-35.38%). Number of individuals in populations VI, VII and X is increasing. In other populations, a decrease in the number of individuals was observed.

1. Introduction
Study of population age structure of Zosima absinthifolia (Vent.) Link. very important for determining its status and category, its sustainability. Study of the cenopopulation of Z. absinthifolia also has practical significance. This plant is used in folk medicine for a variety of purposes. Its roots and seeds have antibacterial and antifungal activity. Therefore, there are risks of a decrease in stocks of this species. In previous years Z.absinthifolia was represented by 6 populations on the Absheron Peninsula. Currently? The structure of populations has changed significantly. Now the representatives of the studied species are represented either as separate individuals or occupy small fragmentary areas. The results will allow estimating the permissible limit of this plant for medicinal purposes. Therefore, our goal was to carry out phytocoenological assessments in the areas of distribution of this species.

Zosima absinthifolia (Vent.) Link. is a small, gray, perennial herb, a typical plant for steppe landscapes of Azerbaijan. Plant stem is straight and reaches up to 50 cm in height. 3-pinnately basal leaves divided into 2 or 3 times are elongated and lanceolate shaped. Umbels are multi-radiant and has many unequal rays. Flowers is small and petals are yellowish. The fruits are elliptical and flattened, up to 7 - 11 mm long. The flowering peak occurs in IV-V and the fruiting peak occurs in VI-VII months [1]. It grows in Eastern-Mediterranean and Iranian-Turanian zones [2]. Zosima is a genus of 6 species and are found in Middle East (Iran, Turkey, Iraq, Cypris) and Central Asia (Afganistan, Kazakhistan). Only one of them is found in Azerbaijan.

In the studied areas occurs up to middle mountain zones. It is especially widespread in the Nakhchivan Autonomous Republic on the dry rocky and gravel slopes, from -20–2000 m of Daridagh,
Arajidag and Demirlidagh, and in the territory of Absheron (Girmaku Mountain) and Gobustan (Kichikdash Mountain), in the steppes of Shirvan National Park [3].

The seeds of the plant have medicinal properties, the fruits are used as food flavoring and as a food spice. It is used also in folk medicine for lymphatic and oncological diseases. In some regions, seeds are used in religious beliefs and rituals.

Taking into account the medicinal properties of plant seeds, we aimed to study the phytocenology of the species in the main places of its distribution.

2. Material and Methods

Field research and expeditions conducted in 2018-2020 covered all regions of Azerbaijan. During the research, we selected 10 natural populations with *Z. absinthifolia* in 3 out of 12 plant types in the area.

Formations and associations have been identified, project cover of areas has been calculated [4], abundance has been determined (Drude, 5-point scale) and the data obtained are shown in the table.

Age condition and seed yield were studied on the basis of generally accepted methods [5, 6]. Adaptations of the organism at the population level were studied to determine the life strategy [7]. Seed productivity of the plant was studied according to the generally accepted methods [8, 9]. The area of senopopulations selected for the study of seed productivity of *Z. absinthifolia* was not less than 5 hectares. To determine the stock of plant materials in certain territories, special sites were marked and model samples were selected [10, 11].

To calculate the plant's raw material reserves, 15-20 plants of *Z. absinthifolia* were removed from each population and weighed. During geobotanical researches to study the current state of *Z. absinthifolia* and to assess its senopopulations a number of methods were used [12, 2]. To study the developmental stages in plant individuals, the concept of discrete description of ontogeny has been used [5, 13].

The description of ontogenesis of *Z. absinthifolia* is given on the basis of forms of ontogenetic condition. The plant was registered in immature (im), virginil (v), young generative (g1), middle age (g2), old generative (g3), subsenil (ss) and senil (s) periods. The obtained results were analyzed by the comparative criterion \( \chi^2 \) [14]. During the study 9 populations were assessed. Materials collected from different phases of ontogeny were based on the generally accepted method of studying populations [14]. The size of the experimental areas was 50x50, the number was from 10 to 150. The species under study were excluded from the field and a spectrum of ontogenetic status was compiled.

In order to determine the integrated characteristics of the demographic structure of the plant following population indicators were used:

1. Age index [12].

\[
\Delta = \frac{\sum k_i n_i}{N}
\]

i-ontgenetic state; \( k_i \) – “cost”, \( n_i \) - number of plant individuals, i- population status, N- the total number of individuals in the population.

2. Efficiency index [16]:

\[
\omega = \frac{\sum n_i e_i}{\sum N_i}
\]

\( n_i \)- number of plants, i- plant condition, \( e_i \)- the effectiveness of the plant, \( \sum N_i \) - total number of plants.

3. Results and Discussion

Arealis, populations and phytocenology of the only species of *Zosima* distributed in the Nakhchivan Autonomous Republic and Absheron Peninsula - *Zosima absinthifolia* (Vent.) Link - have been studied. To determine the demographic structure and environmental compatibility of the plant 10 populations were selected. Four of them were registered in Nakhchivan AR: I cenopopulation (CP) of Bichanak village of Shahbuz district (39.500127, 45.755412), II CP in Kendshahbuz (39.381683, 45.589571), III CP in Daridagh area (39.500127, 45.755412) of Julfa district, and IV CP from Dirnis village of Ordubad district (38.989577, 45.967462). The last 6 populations were registered at the
Z. absinthifolia was observed on the second sub-layer in vegetation types - steppe, semi-desert and mountain-xerophytic phytocenoses. The dynamics of plant samples corresponding to different phases of ontogeny in selected populations is shown in figure 1.

**Figure 1. Zosima absinthifolia** (Vent.) Link.

The figure 2 shows the number of individuals in each population for all phases. As seen from the picture, there are more individuals in the generative development phase. This indicates that the plant is in constant growth. This indicates that the plant is developing.
Figure 2. Dynamics of ontogeny of Z. absinthifolia.

We evaluated 10 populations in different phytocenoses. The structure of ontogeny was calculated on the basis of materials collected from different phases of ontogeny. The results of the calculations show that the highest rate in Z. absinthifolia is in the stages of generative development (225-243 units). An integral characteristic of the demographic structure of the plant cenopopulation was determined. In some populations, the number of individuals was either very small, or there were no individuals belonging to certain age states. The result of calculating the indexes of age, recovery and aging are shown in the table 1.

Table 1. Demographic structure of Z. absinthifolia senopopulation.

| CP   | 2018 | 2019 | 2020 | 2018 | 2019 | 2020 | 2018 | 2019 | 2020 |
|------|------|------|------|------|------|------|------|------|------|
| I_{recovery} | 0.34 | 0.29 | 0.53 | 0.59 | 0.2  | 1.7  | 0.62 | 0.87 | 0.62 |
| I_{substitution} | 0.3  | 0.2  | 0.36 | 0.44 | 0.14 | 1.7  | 0.56 | 0.81 | 0.48 |
| Δ    | 0.46 | 0.54 | 0.45 | 0.49 | 0.56 | 0.22 | 0.34 | 0.32 | 0.46 |
| ω    | 0.67 | 0.64 | 0.56 | 0.57 | 0.63 | 0.47 | 0.67 | 0.57 | 0.59 |

The efficiency factor is higher in the 6th, 7th and 10th cenopopulations (ω = 0.59-0.67). It is because of that, in these populations the number of plants belonging to the juvenile and immature phases before the generative developmental phases was high and the number of individuals belonging to the aging (s, ss) phases was low. Since in the given 3 populations there are many plant individuals, the calculations in the tables were carried out only in these CPs.

Due to the importance of Z. absinthifolia seeds, its regional reserves have been assessed by us (table 2). First, the dominant individuals in the area were selected. Their abundance in phytocenoses varied between 3-4 points. There are 4-6 plants in every 4-5 m². The number of trunks varies between 2-3. Age weight is 230-450 grams. In the populations where the plant is spread in the territory of Absheron, it is possible to collect 1000 and more plants per hectare.

Six natural senopopulations of Z. absinthifolia were studied in ecological-senotic conditions in Absheron area. Biomorphological parameters of 15 vegetative and generative organs were taken into account on 30 plant samples within the senopopulation. The recovery index of senopopulation (IVC) was determined by the dependence of seed multiplication on the rapid development.
The results of measuring the spectrum of life of individuals show that in the Absheron region (100 m a.s.l.) in well-lit semi-desert landscapes of the southeastern slopes and in areas exposed to low loads, high (IVC 1.85), constant strong winds in the southern part of the slopes at 30 m SP is low in areas exposed to solar radiation. Such termination conditions also exist in SP II (1500 m a.s.l.). Here, IVC is 1.067. The size of the efficiency index is 1.496 in this SP.

*Z. absinthifolia* is propagated by seeds. It rejuvenates strongly in the generative and post-generative periods. In this case, the SP reaches the juvenile state, the ontogeny is close to full development. In the Absheron region, the increase in PSY of *Z. absinthifolia* (from 200 to 300) is reflected in the reproductive strategy of the components, while the growth rate reaches 1.5 under favorable conditions (Table 2).

**Table 2. Seed productivity of *Z. absinthifolia* in Absheron Peninsula.**

| CP     | CP VI          | CP VII         | CP X         |
|--------|----------------|----------------|--------------|
| N fl.a. | 21.25+6.03     | 19.05+6.28     | 27.5+9.81    |
| N fr.a. | 20.35+6.39     | 18.75+6.16     | 25.82+8.99   |
| Fruit formation % | 95.76         | 98.42         | 93.89        |
| SQR    | 122.1+38.36    | 111.9+36.54    | 154.9+53.97  |
| RSP    | 83.05+28.83    | 92.5+31.1      | 98.1+45.99   |
| PSY amount | 2484.73     | 2098.12       | 3999.52      |
| RTM. amount | 1690.06     | 1734.37       | 2533.97      |
| Amount of seeds % | 68.02       | 82.66         | 63.36        |
| Amount of seeds neuter % |           |               | 71.35        |
| Product quantity m² | 3.8387.39 | 12168.43      | 57774.52     |
| The growth of individuals m² | 36.67   | 1.3           | 7.93         |
| Realization of SP % | 0.095      | 0.011         | 0.014        |
| Sprouting % | 43          | 90            | 20           |
| Germination capacity % | 528.76    | 33.08         | 63.32        |

Note: N fl.a. vs N fr.a. - the average number of flowers and fruits in the stalk; PSY – potential seed yield; RSP – real seed productivity; SQN – seed quantity ratio; IVC – index of variability in the number and density of individuals in the population (I SP and II SP according to 70, 14 according to $m^2$ and 2.262 672.2 according to 67 according to $m^2$). The generative plant index increases due to low (0.69 to 0.49) vegetative reproduction. Under favorable conditions, self-healing increases through seed multiplication (SP I and SP III).

The alternation of stress components increases the tolerance of the seedlings of the species under favorable conditions. The lowest indicator of seed productivity is the ISP (area 12168.43 m²). Under favorable conditions, the pessimism of SP increases. In this case, the ratio of relationships between species (0.5: 1: 0.2) depends on the percentage of seed yield, the yield is high (93.89-93.42%). In unfavorable conditions, the pessimism decreases slightly. Proper seed propagation under favorable conditions leads to an increase in the number of SP seedlings (35.48%). In this case, the post-generative fraction is low (25.87%). As conditions worsen, the role of vegetative reproduction increases. As a result, seedlings in the age spectrum reach a minimum (3.97%), $j + im + v$ has a maximum share (47.4%). SP III decreases respectively (7.77 and 35.38%).

The ecological-senotic strategy (S) of the species is equal. Signs of explerents (R) rise in the form of *Z.absinthifolia*.

The formation of a mechanism of protection against stress (ecotypic symptoms) occurs at the level of the organism and the population. The distribution of reserve nutrients from the roots provides long-term ontogeny and the pre-generative period, as well as active vegetative reproduction and slow growth. The ability of a seed to regulate reproduction depends on its propagation conditions.
4. Conclusion
The following data have been obtained from population-level studies: The age spectrum of SP is normal and complete. The presence of a wide range of bases of the species, the close concentration of individuals, the formation of a spatial structure in general, the emergence of a defense mechanism during stress (increased some indicators of seed multiplication), self-defense is realized in different ways. The strength of the species depends on abiotic stress. Due to unfavorable conditions, the resistance drops by 2.5 times. The diversity of reproduction (size, morphology, dynamics, rhythm) depends on the state of the phytocenosis. Thus, the patient-experimental type (stress-tolerant) is characteristic for the species. Under unfavorable conditions, the ecological-senotic strategy of SPs corresponds to its protective components. Under favorable conditions, the symptoms of individuals appear. Thus, the existence of a mixed type strategy allows the species to develop in long-term, permanent ecological-senotic and anthropogenic conditions.

Acknowledgments
I would like to give special thanks to prof. S.D.Ibadullaeva for her helping in discussion of the results.

References
[1] Ibadullayeva S 2004 Apiaceae of the Azerbaijan flora (Baku: Elm) p 374
[2] Kamelin R 1973 Florogenetic analysis of the natural flora of Central Asian mountains (Leningrad: Nauka) p 356
[3] Yusifov E and Isayeva N 2007 Biodiversity: Natural Monumentys of Absheron Peninsula (Baku: Nurlar) p 82
[4] Kapten Yu L 1983 To the method of determination of projective cover in the florogenetic analysis Vestnik Leningrad University 3 vol 6 pp 115-116
[5] Rabotnov T A 1950 The life cycle of perennial herbaceous plants in meadow phytocenoses Trudy Bot. Inst. Akad. Nauk SSSR Ser 3 Geobot vol 6 pp 7-204
[6] Khodachek E A 1970 Seed Productivity and Seed Yield in the Tundra of Western Taimyr Bot.Zh. vol 55 7 pp 995-1010
[7] Ishbirdin A R and Ishmuratova M M 2004 Adaptive morphogenesis and ecological-cenotic strategies for the survival of herbaceous plants Collection of materials of the VII All-Russian population workshop (Syktyvkar, February 16–21, 2004) (Syktyvkar) Part 2 pp 113-120
[8] Zayko L N, Pimenova M E and Maslikov V U 2007 Review of the method and results on study of herbs of Russia (VILAR) Transactions of the Int. Scientific and Practical Conference. Present-day problems of phytodesign (Belgorod) pp 148-157
[9] Krylova I V and Shreter A I 1971 Guidelines on the study of resources of medicinal use of wild plants (Moscow: VILAR) p 21
[10] Bukhasheva T G, Sandanov D V, Aseeva T A, Chirikova N K and Shishmarev V M 2007 Cenopopulations age structure and raw material phytomass of Scutelleria baikalensis (Lamiaceae) in Eastern Zabaikalye Rastitelnye resursy vol 43 4 pp 23-31
[11] Vedernikova O P 2003 Population-developmental approach to the assessment of the biological resources of medicinal plants in the Republic of Mari El Botanical studies in Asian Russia.Barnaul vol 3 pp 9-10
[12] Yurtsev B A 1975 Some trends in the development of the specific flora method Bot. Zh vol 60 1 pp 69-83
[13] Uranov A A 1975 Age spectrum of phytocenopopulations as a function of time and energy wave processes Biol. Nauki 2 pp 7-33
[14] Smirnova O V, Zagulnova LB and Yermakova I M 1976 Cenopopulations of plants (basic concepts and structure (Moscow: Nauka) p 217
[15] Zaugolnova L B, Zjukova L A, Smirnova O V and Komarov A S 1988 Cenopopulations of plants (Essays on population biology) (Moscow: Nauka) p 184
[16] Zhivotovsky L A 2001 Ontogenetic states, effective density, and classi cation of plant populations. Russian Journal of Ecology 21 pp 3-7