Current state of the cenopopulation of *Adonis vernalis* L. in the North Kazakhstan region

Moldir Zhumagul[1,2,3*], *Anar* Myrzagaliyeva [2], *Gulnara* Tleubergenova[4], *Yelena* Galaktionova[4], and *Medeu* Razhanov [3]

[1]al-Farabi Kazakh National University. Al-Farabi Ave 71, Kazakhstan, Almaty 050040
[2]Astana International University. Kabanbay Batyr 8, Kazakhstan, Astana, 010000
[3]Astana Botanical Garden, Branch of the Republican State Enterprise on the right of Economic Management, Institute of Botany and Phytointroduction, Astana, Kazakhstan 010016
[4]North Kazakhstan University named after M.Kozybaev, Petropavlovsk, 010000, Kazakhstan

Abstract. The current state of the cenopopulation of *Adonis vernalis* L. (Ranunculaceae), listed in the Red Data Book of Kazakhstan. *A. vernalis* is widespread in Europe and Asian countries, is widely used in folk medicine in Europe and China due to its cardiorespiratory properties. Studies were conducted to determine the biocenotic parameters of two cenopopopulations. The study showed that the gene pool of the studied populations is in good condition. The first cenopopulation (CP1) is dominated by *Festuca valesiaca* Gaudin, *Lathyrus pisiformis* L., projective coverage is 55-60%. The dominant species in the second cenopopulation (CP2) are *Betula pendula* Roth, *Lathyrus pisiformis* L., *Rosa acicularis* Lindl., projective coverage is 50%. The current population needs urgent conservation and restoration measures. This is due to the rapid decline of the resource. The study of the cenopopulations of this species allows to form a new idea about this species, lays the foundation for its further development.

1 Introduction

Currently, the problem of plant biodiversity conservation is very urgent, since nowadays the range of distribution of many species of wild vegetation is sharply decreasing, which is associated with the active use of natural resources. At the same time, many plant species to be destroyed are now considered as the main sources of improvement of agricultural products for the coming years [1-3].

In recent years, there has been a decline in the number of many plants, that there are activities for the conservation of rare plant species. In order to successfully address issues aimed at biodiversity conservation, knowledge of the peculiarities of reproductive biology of species and their species-specific generative traits, which together with a number of environmental factors contribute to seed production, is necessary. The genus name is derived from the name of an ancient Greek mythological character, and the genus Adonis is widely used in folk medicine in Europe and China to increase heart tone. The genus *Adonis* L.

* Corresponding author: mzhakypzhan@mail.ru

(Ranunculaceae), native to Europe and Asia, includes 32 annual or perennial herbaceous species. Rare plants that are declining in numbers include the species *Adonis vernalis* L. (Ranunculaceae). *A. vernalis* is widely used in folk and official medicine in the treatment of cardiovascular diseases [4, 5, 6, 7]. In the former Soviet Union and Germany in the early 20th century, cardiac glycosides from this plant began to be used to treat chronic heart failure [8].

According to literature data, the development and maintenance of the population of this species depends on the dynamics of natural phytocenoses. Resources, areas and dynamics of development in individual populations vary. Despite the abundance of habitats, the plant is threatened by shrub overgrowth and associated changes in light regime [9].

A. vernalis is a small herbaceous polycarpous plant, which can be found in the Northern Hemisphere, on the Kokshetau uplands and vast areas of true meadows (forest-steppe in Kazakhstan). This species is characterized by low productivity of seed reproduction [10].

The aim of the work is to study the distribution and floristic features of *A. vernalis* population in Northern Kazakhstan.

2 Materials and Methods

The work was carried out on the basis of expeditionary studies conducted in May 2023 in the steppe areas of Petropavlsk in Kazakhstan. Two populations of *A. vernalis* were surveyed and described. The study of cenopopulations was carried out by detailed-route and cameral methods, geobotanical generally accepted methods were used to describe the objects.

For the study of *A. vernalis* populations, sites with high density of flowering individuals per 1 m^2 were selected. Nine 10 × 10 m (100 m^2) study plots were established in the study populations. A total of 20 plots were counted. The type of cenopopulation was determined in accordance with the classification of A.A. Uranov and O.V. Smirnova [11, 12]. Plant systematics are given according to the POWO database [13].

3 Results and Discussion

Spring is the flowering time of *A. vernalis*, with blooms beginning in late April to early May. Under natural conditions, reproduces generatively. *A. vernalis* develops very slowly and requires a special soil composition and suitable weather conditions.

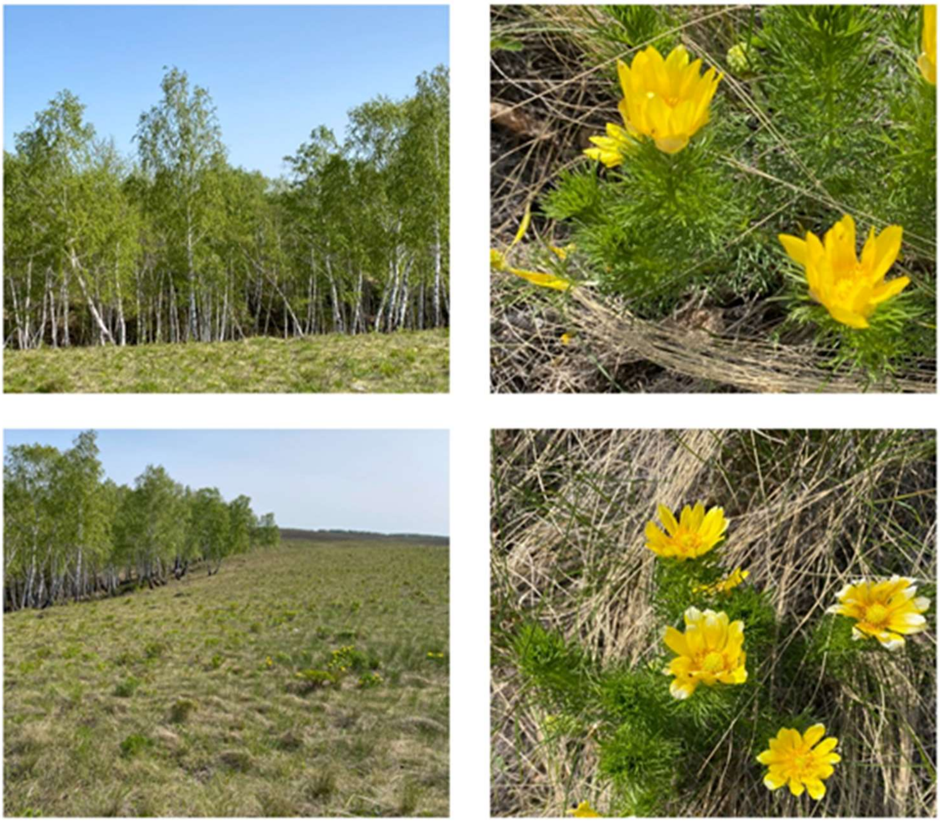

Fig. 1. Flowering of *A.vernalis* Kyzylzhar district, North Kazakhstan region, near Berezovka village

Characterization of cenopopulations (CP) of *A.vernalis* is given below:

1 CP was surveyed in Kyzylzhar district, North-Kazakhstan region, near Berezovka village. Site coordinates - 55002'35.1" N, 69013'40.6" E, altitude 120 m above sea level (Fig. 1). *A. vernalis* is a member of herbaceous -typchak communities. The dominant species in the phytocenosis are *Festuca valesiaca* Gaudin, *Lathyrus pisiformis* L. Steppe species are often found in the community: *Peucedanum morisonii* Besser ex Schult, *Spiraea hypericifolia* L. Total projective cover is 55-60%. (Table 1).

Table 1. Geobotanical description of cenopopulation (CP 1) *A. vernalis*

List of species	Phytocenotic role	Plant height, cm	Drude scale abundance	Projective coverage	Phenophase	Vitality
Festuca valesiaca Gaudin	Dominant	20-25	Cop^1	40	Start of flowering	3
Peucedanum morisonii Besser ex Schult.	Sodominant	30-40	Sp	20	Vegetation	3
Adonis vernalis L.	Component	17-25	Sol	5	Flowering-beginning of fruiting	3

Continuation of Table 1

Cotoneaster melanocarpus (Bunge) Fisch. ex Loudon	Component	50	Un-Sol	3	Flowering	3
Spiraea hypericifolia L.	Component	40-50	Sp	10	Flowering	3
Lathyrus pisiformis L.	Dominant	20-25	Sol	5-7	Vegetation-Flowering	3
Filipendula ulmaria (L.) Maxim.	Component	10-20	Un-Sol	3-5	Vegetation	3
Phlomis tuberosa L.	Component	15	Un	2-3	Vegetation	3
Betula pendula Roth	Component	1000-1250	Sp	10	Flowering	3
Rosa majalis Herrm .	Component	15-30	Sol	5	Flowering	3
Pulsatilla patens (L.) Mill.	Component	20-25	Un	2-3	Beginning of flowering	3

2 CP was surveyed in Kyzylzhar District, 5 km south of Dolmatovo village, (along the edge of the forest) Sogrovsky Reserve. Site coordinates are 55.29501o N, 69.52630o E, elevation 130 m above sea level (Fig. 1). *A. vernalis* is a member of sagebrush-typchak communities. The dominant species in the phytocenosis are *Betula pendula* Roth, *Lathyrus pisiformis* L. It is a frequent steppe species in the community: *Rosa acicularis* Lindl. The total projective cover is 50 %. (Table 2).

Table 2. Geobotanical description of cenopopulation (CP 2) *A. vernalis*

List of species	Phytocenotic role	Plant height, cm	Drude scale abundance	Projective coverage	Phenophase	Vitality
Betula pendula Roth	Dominant	2500	Cop^1	30	Flowering	3
Rosa acicularis Lindl.	Sodominant	200	Sp	20	Vegetation	3
Equisetum sylvaticum L.	Component	10	Sol-Sp	15	Vegetation	3
Pteridium pinetorum C.N. Page & R.R. Mill	Component	10	Sol	5-10	Vegetation	3
Stellaria sp.	Component	2-7	Sol	5	Flowering	3

Continuation of Table 2

Glechoma hederacea L.	Component	5-7	Un	3-5	Vegetation	3
Fragaria vesca L.	Component	3-5	Sp	12	Vegetation	3
Geranium sylvaticum L.	Component	10-15	Un	3	Vegetation	3
Pyrola rotundifolia L.	Component	5-7	Un	3	Vegetation	3
Viburnum opulus L.	Component	70-210	Un-Sol	4	Vegetation	3
Viola mirabilis L.	Component	5-7	Un-Sol	3-5	Vegetation	3
Pulmonaria mollis Wulfen ex Hornem.	Component	10-12	Un	1-2	Boutonization	3
Orthilia secunda (L.) House	Component	5-7	Un	1	Vegetation	3
Lathyrus pisiformis L.	Dominant	10-15	Sol	5-7	Vegetation	3
Lathyrus sylvestris L.	Component	7-10	Sol	5	Vegetation	3
Arctium tomentosum Mill.	Component	12	Un-Sol	3-5	Vegetation	3
Cypripedium calceolus L.	Component	15	Un	1-2	Beginning of vegetation	3
Phlomis tuberosa L.	Component	10	Un	2-3	Vegetation	3
Rubus saxatilis L.	Component	10-15	Sol	5-10	Vegetation	3
Maianthemum bifolium (L.) F.W. Schmidt	Component	5-6	Sol	5	Vegetation	3

4 Conclusion

In the conducted scientific work phytocenotic characterization of the studied territory of Northern Kazakhstan is given. The results of geobotanical description of the studied cenopopulations of the studied species with ontogenetic full-member composition were obtained. Dominant species in plant communities were determined. The projective coverage of *A. vernalis* L. in cenopopulations was determined. The geobotanical spectrum is dominated by herbaceous-typchak vegetation. Based on the results obtained, it can be concluded that the condition of the studied *A. vernalis* cenopopulations is in a satisfactory state and is provided by vegetative and seed reproduction methods. In the first cenopopulation there were species of *Festuca valesiaca* Gaudin, *Peucedanum morisonii* Besser ex Schult., *Adonis vernalis* L., *Cotoneaster melanocarpus* (Bunge) Fisch. ex Loudon., *Spiraea hypericifolia* L., *Lathyrus pisiformis* L., *Filipendula ulmaria* (L.) Maxim., *Phlomis tuberosa* L., *Betula pendula* Roth., *Rosa majalis* Herrm., *Pulsatilla patens* (L.) Mill. The following species were often found in the second cenopopulations: *Betula pendula* Roth, *Rosa acicularis* Lindl., *Lathyrus pisiformis* L. Anthropogenic impact on cenopopulations, unaffected or slightly affected by anthropogenic impact, occurs in the form of ontogenetic spectrum, in which the absolute maximum falls on the age periods of the pre-generative period. According to the level of development and degree of viability, they can be referred to the average level. Grazing in cenopopulations results in a decrease in plant viability and seed reproduction.

Acknowledgments

Research work was carried out on the basis of the project No AP15473108 of the Committee of the Ministry of Education and Science of the Republic of Kazakhstan.

References

1. Jandt, U., Bruelheide, H., Jansen, F., Bonn, A., Grescho, V., Klenke, R. A., & Wulf, M. More losses than gains during one century of plant biodiversity change in Germany. Nature, **611**(7936), 512-518 (2022). https://doi.org/10.1038/s41586-022-05320-w
2. Kardol, P., Fanin, N., & Wardle, D. A.. Long-term effects of species loss on community properties across contrasting ecosystems. Nature, **557**(7707), 710-713 (2018). https://doi.org/10.1038/s41586-018-0138-7
3. Isbell, F., Calcagno, V., Hector, A., Connolly, J., Harpole, W. S., Reich, P. B., & Loreau, M.. High plant diversity is needed to maintain ecosystem services. Nature, **477**(7363), 199-202 (2011). https://doi.org/10.1038/nature10282
4. Shang, X., Yang, F., & Zhang, J. The genus Adonis as an important cardiac folk medicine: a review of the ethnobotany, phytochemistry and pharmacology. Frontiers in Pharmacology, **10**, 407153 (2019). https://doi.org/10.3389/fphar.2019.00025
5. Gostin, I. N. Anatomical and micromorphological peculiarities of *Adonis vernalis* L.(Ranunculaceae). Pakistan Journal of Botany, **43**(2), 811-820 (2011)
6. Ghorbani N. M., Azizian D., Sheidai M., Khatamsaz M. Pollen morphology of some Adonis L. species (Ranunculaceae) from Iran. Iran. J. Bot., **14**, 165–170 (2008).
7. Shikov A. N., Pozharitskaya O. N., Makarov V. G., Wagner H., Verpoorte R., Heinrich M. Medicinal plants of the Russian pharmacopoeia; their history and applications. J. Ethnopharmacol., **154**, 481–536 (2014). https://doi.org/10.1016/j.jep.2014.04.007.
8. Deng S. X., Li C. D., He G. P. The cardiotonic effect of the total glycosides of Adonis brevistyla Franch. Acta Pharm. Sin. **10**, 677- 680 (1963)
9. Luszczynski, J., & Luszczynska, B. Current resources of the population of Adonis vernalis L. in the Niecka Nidzianska basin. Herba Polonica, **3**(55), 20-29 (2009).
10. Sultangazina, G. J., Kuprijanov, A. N., Kuprijanov, O. A., & Beyshov, R. S. Ontogenesis And Age Structure Of Adonis Vernalis L. Populations In The Conditions Of

Northern Kazakhstan. Scientific journal "Bulletin of the National Academy of Sciences of the Republic of Kazakhstan, (5), 56-64 (2020)
11. Smirnova O.V. The volume of the counting unit in the study of coenopopulations of plants of various biomorphs. Plant pricing: Basic concepts and structure. M, 1976, 72–80
12. Uranov A.A. Age spectrum of phytocenopulation as a function of time and energy processes. Biol. Sciences.1975, vol. 2, 7-34.
13. POWO Plants of the World Online [Electronic resource]: Facilitated by the Royal Botanic Gardens, Kew. 2023. Available online // URL: http://www.plantsoftheworldonline.org/ (Date accessed: 9 October, 2023).