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ONTOGENESIS AND AGE STRUCTURE OF *ADONIS VERNALIS* L. POPULATIONS IN THE CONDITIONS OF NORTHERN KAZAKHSTAN

Abstract. The current article presents study results made on the coenoflora of *Adonis vernalis* L. in Northern Kazakhstan. The materials have been gathered in the course of field research taking into account the literary data. Ontogenesis and age structure of the coenopopulations are provided on the basis of detailed-route studies. The study of age-related stages was carried out on the territory of Northern Kazakhstan (Akmola and North Kazakhstan regions) in 2018-2019. *A. vernalis* is a short-stem grassy polycarpic plant, it is represented in Northern Kazakhstan by the populations of dry meadows (Kokshetau Upland) and real meadows (the forest-steppe of North Kazakhstan region). Ontogenesis of *A. vernalis* has three periods and 7 age stages. Plants have low seed productivity. Seeds have a long endogenous peace related to the underdevelopment of a seed germ. A characteristic feature is the presence of a long pregenerative period in plants of the "steppe" type coenopopulations and its reduction in the "meadow" type coenopopulations. There have been studied thirteen coenopopulations of *A. vernalis* located in Akmola and North Kazakhstan regions. Coenopopulations of *A. vernalis* are bound to four main habitats: forest edges, meadow steppes, meadows, artificial plantations. By age, young populations are formed on forest edges, and according to the "delta - omega" classification, there are mature coenopopulations. Mature coenopopulations are mostly formed in meadow steppes, but according to the "delta - omega" classification, all coenopopulations are aging. On meadows, there are many young coenopopulations, but according to the "delta - omega" classification, they are all mature. In artificial plantings, the majority of coenopopulations are aging, but according to the "delta - omega" classification, they are all mature. Thus, changes in habitual living conditions lead to the aging of *A. vernalis* coenopopulations. By density (pcs/100 m^2) all populations are divided into three groups: high, medium, low. All forest edge coenopopulations have a high density, in meadow steppes, the density is average, on meadows and in artificial plantings it is low. The recovery index in most coenopopulations is less than one which indicates a low recovery in *A. vernalis* populations. The range of age stages shows that in most coenopopulations they are normal, the exception is CP-5 (among artificial plantings) which indicates an old stage of the population and possibly its soon elimination.

Key words: *Adonis vernalis* L., Northern Kazakhstan, age stages, age structure, ontogenesis.

Introduction. *Adonis vernalis* L. is a fairly rare plant throughout its range [1] and in Appendix II of the CITES Convention (Convention of International Trade in Endangered Species of Wild Fauna and Flora) [3]. *A. vernalis* is protected in Ukraine [4] as well as in 36 regions of the Russian Federation [5].

Age features of *Adonis vernalis* were studied in different parts of the area [1,6-11]. The authors emphasized stenotopic characteristics of the species, poor vegetative mobility, complexity of seed reproduction, and a low level of competition with other species in plant communities.

Material and research methods. Age stages were worked out according to the guidelines [12-16]. A schematic diagram describing age-related stages is given according to Kupriyanov A.N. (2013) [17].

Ontogenetic structure and number of plants in the coenopopulation were studied on registry fields with the area of 1 m^2. A plant, a partial bush, and a partial shoot were used as counting units. The adoption of one or another counting unit was determined by the specific biomorph formed in a particular location.

Results and discussion. The study of age stages was conducted on the territory of Northern Kazakhstan (Akmola and North Kazakhstan regions) in 2018-2019.

Latent period. Seeds ripen in the first and the second decade of June. Seed productivity depends on spring conditions and age stages. The number of fruits on young generative stage is 14-29 pcs/plant and 122-212 pcs/plant on a mature generative stage. Seeds have a long endogenous dormancy because of the underdevelopment of a seed germ. The dormancy of seeds lasts 60-70 days [8]. *A. vernalis* is an autochoric plant. Its seeds do not have special devices for settlement and are concentrated mainly around the mother plant (figure 1).

Figure 1 – Fruits of *A. vernalis*: A - infructescence; B – fruits

Virginal period. Seedings (p). In natural conditions, seeds germinate at the end of April. As usual, the shoots are single or small. Since the seeds are almost on the soil surface, the germination is conventionally aboveground. The cotyledons are whole, oblong, up to 7 mm long and 3-4 mm wide with quite long stalks. In Northern Kazakhstan plants keep being in a seeding phase for a longer period, possibly, until the end of the vegetative period. The root system is represented by a stem-root of 5-7 cm with hairy roots of the second order.

The **juvenile stage** of plants (j) is seen well in the second year of life. This stage is characterized by scaly leaves. The maximum shoot growth is observed in May. At this time, there form long internodes of

Figure 2 – Age stages of *A. vernalis*: J - juvenile stage; im - immature stage; v1, v2 - virginal stage

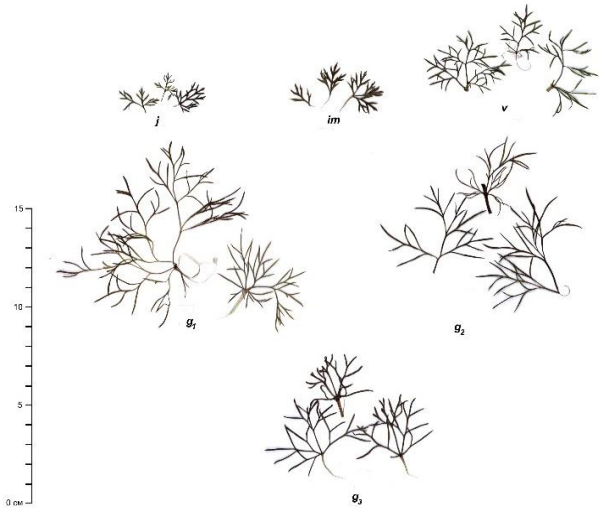

Figure 3 – Morphological features of *A. vernalis* leaves: J - juvenile stage; im - immature stage; v - virginal stage; g_1, g_2, g_3 - generative stage

3-4 cm. in June shoot growth is slowed down and leaf blades are located on shorter internodes. The plants retain monopodial growth of shoots and they reach 15 cm (figure 2, J). The leaves of juvenile plants are 1.5 cm long and 1.0-1.1 cm wide, thrice dissected, the lobes of the first order are dissected and pinnatipartite, the final ones are linear - 2-4 mm long and about 1 mm wide (figure 3, J).

Immature plants (im) get a sympodial branching: the renewal bud which forms a lateral shoot grows from the renewal buds located in the sinus of the lower true leaf. The leaves are almost rounded 1.7-2 cm long and 1.3-2 cm wide, tripartite, the first-order fractions are twice, sometimes thrice dissected. In this age leaf lobes are broadly linear, 3-7 mm long and about 2 mm wide, but not linear, which is a diagnostic sign of this age stage [11].

Plants form a short rhizome. The calendar age stage is quite difficult to determine, it depends on the tension of environmental factors: on the dry meadows of the Kokshetau Upland, it lasts for more than a year, on the meadows of the North Kazakhstan region the transition to a virginal stage occurs in the first half of summer of the second year of life.

Virginal stage (v) begins with the formation of a rhizome, with the appearance of large horizontal cord-like adventitious roots, and with the death of the primary root. Second-order shoots appear from the first leaves sinuses of the axial shoot. This stage is characterized by the formation of 2-4 axial shoots. The leaf blade is quite large, 3-4 cm long, and 2-4 cm wide, tripartite, first-order lobes are twice or thrice dissected into narrow threadlike segments of 3-7 mm long and less than 1 mm wide (figure 2, v). In Northern Kazakhstan virginal stage is normal and the calendar period depends on specific environmental conditions. It can last for several years and rhizomes with several axial shoots grow during this time.

Figure 4 – Age stages of *A. vernalis*: g_1, g_2, g_3 - generative stage

First flowers that characterize the transition of plants into a young generative stage (g_1) appear on one of the first axial shoots. In some cases (as Poshkurlat A.P. notes correctly, 2000), this flower remains underdeveloped and dries. Plants that grow in the meadows of forest-steppe zone have one axial shoot on this stage (figure 4, g_1) [11]. In steppe conditions, plants with several well-developed axial shoots have one flower on each of several shoots. In this age, leaves reach their maximum development, are 3.5-5.0 cm long and 3.5-12.0 cm wide, thrice dissected and pinnatipartite, the lobes of the second order are thrice dissected and pinnatipartite as well, the final lobes are linear of 7 mm long and 1-1.2 mm wide (figure 3, g_1). The rhizome begins to grow and has buds of new axial shoots on it.

During an average generative stage (g_2) in the meadow steppe conditions there are up to 7-10 axial shoots, but on meadows, there are 2-3 ones. Each axial shoot has up to 4-7 lateral shoots of the second-order and 2-4 shoots of the third order with flowers on them. Leaves are rounded, 4-5 cm in diameter, thrice dissected and pinnatipartite, second-order lobes are dissected into linear-hairy lobes of the third order of 12-18 mm long and 0.5-0.8 mm wide. Branching of the rhizomes and formation of a strong system of adventitious roots continue.

Old generative plants (g_3) form a complex system of rhizomes. In this age, the life form changes from a short-brush-root to a turf one, while generative plants form a pinnatipartite root system with numerous

shoots forming a turf or a curtain. The system of underground organs is built in the way of "orthotropic-rhizome - brush-root" [21]. The structure of the leaf blade simplifies.

Subsenile plants (S) are represented by a system of dying rhizomes with single vegetative shoots. We have not found any senile plants.

It should be noted, that some changes in the ontogenetic structure of *A. vernalis* populations in Northern Kazakhstan. They are related to climatic features and as a response to the anthropogenic transformation of the flora on the studied areas.

A. vernalis is a short-stem grassy polycarpic plant, it is represented in Northern Kazakhstan by the populations of dry meadows (Kokshetau Upland) and real meadows (the forest-steppe of North Kazakhstan region). Ontogenesis of *A. vernalis* has three periods and 8 age stages. Plants have low seed productivity. Seeds have a long endogenous peace related to the underdevelopment of a seed germ. A characteristic feature is the presence of a long pregenerative period in plants of the "steppe" type coenopopulations and its reduction in the "meadow" type coenopopulations (CP).

Age structure is one of the significant signs of price population, as it provides the ability of the population system to self-sustain and determines its sustainability [15].

There have been studied 13 CP of *A. vernalis* located in Akmola and North Kazakhstan regions.

CP-1. "Burabay" SNNP. The poaceae-adonis meadow on the edge of the pine-birch forest. Total projective cover (TPC) is 90%, the TPC of *A. vernalis* is 2%, the community has 29 species. The vegetation is formed by *Artemisia latifolia* Ledeb., *Betula pendula* Roth, *Calamagrostis epigeios* (L.) Roth, *Fragaria viridis* Duch., *Pinus sylvestris* L., *Poa pratensis* L., *Ranunculus polyanthemus* L.

CP-2. "Burabay" SNNP. Sparse birch forest, the formula of the standing timber is 10B, fullness is 0.3, adonis and forb meadow. TPC is 100%, the TPC of *A. vernalis* is 0.5%, the community has 26 species. The vegetation is formed by *Betula pendula*, *Brachypodium pinnatum* (L.) Beauv., *Bromopsis inermis* (Leyss.) Holub, *Centaurea scabiosa* L., *Serratula coronata* L., *Veronica longifolia* L.

CP-3."Burabay" SNNP. The meadow steppe on the slope of a small hill, a narrow strip at the base of the hill. TPC is 70%, the TPC of *A. vernalis* is 0.5%, the community has 31 species. The vegetation is formed by *Galatella angustissima* (Tausch) Novopokr., *Medicago falcata* L., *Oxytropis pilosa* (L.) DC., *Peucedanum morisonii* Besser ex Spreng., *Phleum phleoides* (L.) H.Karst., *Stipa pennata* L.

CP-4."Burabay" SNNP. A shrub thicket on the edge of the birch forest. TPC is 100%, the TPC of *A. vernalis* is 1.5%, the community has 37 species. The vegetation is formed by *Caragana arborescens* Lam., *Phleum phleoides* (L.) H.Karst., *Poa angustifolia* L., *Rosa acicularis* Lindl., *Spiraea hypericifolia* L., *Stipa pennata* L.

CP-5. "Burabay" SNNP. Artificial pine plantations of 35-40 years old (maybe on the site of a dry meadow), the formula of the standing timber is 9C1B. TPC is 60%, the TPC of *A. vernalis* is 0.5%, the community has 19 species. The vegetation is formed by *Betula pendula* Roth, *Caragana arborescens* Lam., *Gypsophila altissima* L., *Otites wolgensis* (Hornem.) Grossh., *Pinus sylvestris* L., *Vicia cracca* L.

CP-6. "Burabay" SNNP. A meadow steppe on the edge of a sparse birch-pine forest, fullness is 0.2-0.3. TPC is 80%, the TPC of *A. vernalis* is 1.0%, the community has 32 species. The vegetation is formed by *Clausia aprica* (Stephan) Korn-Tr., *Dianthus versicolor* Fisch. ex Link, *Filipendula vulgaris* Moench, *Otites wolgensis* (Hornem.) Grossh., *Oxytropis pilosa* (L.) DC., *Polygala comosa* Schkuhr.

CP-7. "Burabay" SNNP. A meadow among the sparse birch forest, the formula of the standing timber is 9B1C, fullness is 0.3. TPC is 100%, the TPC of *A. vernalis* is 2.0%, the community has 32 species. The vegetation is formed by *Achillea asiatica* Serg., *Betula pendula* Roth, *Calamagrostis epigeios* (L.) Roth, *Conioselinum tataricum* Hoffm., *Hieracium umbellatum* L., *Koeleria cristata* (L.) Pers., *Pinus sylvestris* L.

CP-8. "Burabay" SNNP. A forb and calamagrostis meadow on the edge of a birch forest. TPC is 100%, the TPC of *A. vernalis* is 0.2%, the community has 28 species. The vegetation is formed by *Asparagus officinalis* L., *Bromopsis inermis* (Leyss.) Holub, *Calamagrostis epigeios* (L.) Roth, *Cirsium setosum* (Willd.) Bess., *Galium boreale* L., *Phlomoides tuberosa* (L.) Moench.

CP-9. "Burabay" SNNP. The steppe communities on the edge of a birch forest. TPC is 70%, the TPC of *A. vernalis* is 2.0%, the community has 35 species. The vegetation is formed by *Aster alpinus* L., *Festuca valesiaca* Gaudin, *Fragaria viridis* (Duchesne) Weston, *Helictotrichon desertorum* (Less.) Nevski, *Pilosella echioides* (Lumn.) F.Schultz & Sch.Bip., *Scorzonera purpurea* L., *Stellaria graminea* L.

CP-10. "Burabay" SNNP. A dry meadow with very rare pines (artificial plantings), the fullness is 0.2. TPC is 70%, the TPC of *A. vernalis* is 2.0%, the community has 25 species. The vegetation is formed by *Allium strictum* Schrad., *Carex supina* Willd. ex Wahlenb., *Festuca valesiaca* Gaudin, *Koeleria cristata* (L.) Pers., *Phleum phleoides* (L.) H.Karst., *Phlomoides tuberosa* (L.) Moench., *Verbascum phoeniceum* L.

CP-11. North Kazakhstan region. A wet meadow on the edge of a birch forest. TPC is 100%, the TPC of *A. vernalis* is 0.5%, the community has 21 species. The vegetation is formed by *Equisetum hyemale* L., *Filipendula ulmaria* (L.) Maxim., *Sedum telephium* L., *Thalictrum minus* L., *Urtica dioica* L.

CP-12. North Kazakhstan region. Young birch forest, the formula of the standing timber is 10B tree, fullness is 0.4-0.5. TPC is 50%, the TPC of *A. vernalis* is 0.1%, the community has 16 species. The vegetation is formed by *Betula pendula* Roth, *Chenopodium album* L., *Populus tremula* L., *Potentilla humifusa* Willd. ex Schltdl., *Rubus saxatilis* L., *Sanguisorba officinalis* L., *Urtica dioica* L.

CP-13. North Kazakhstan region. Kochkarny meadow on the edge of a birch forest TPC is 100%, the TPC of *A. vernalis* is 0.5%, the community has 33 species. The vegetation is formed by *Calamagrostis epigeios* (L.) Roth, *Filipendula ulmaria* (L.) Maxim., *Galium boreale* L., *Kadenia dubia* (Schkuhr) Lavrova et V.N.Tikhom., *Ranunculus polyanthemos* L., *Sanguisorba officinalis* L., *Seseli libanotis* (L.) W.D.J.Koch, *Urtica dioica* L.

The CP of *A. vernalis* are bound to four main habitats: forest edges (CP-1, CP-4, CP-8), meadow steppes (CP-3, CP-6, CP-9), meadows (CP-2, CP-7, CP-11, CP-13), artificial plantations (CP-5, CP-10, CP-12). By the age, young populations grow on forest edges, and according to the "delta - omega" classification, there are mature CP with $\Delta < 0.35$, a $\omega > 0{,}6$. Mature CP mostly grow in meadow steppes (except CP-6, which is young), and according to the "delta - omega" classification all CP are aging with $\Delta < 0.55$, a $\omega > 0{,}6$. Young CP mostly grow in meadows (except CP-2, which is old), and according to the "delta - omega" classification all CP are mature with $\Delta < 0.35$-0.54, a $\omega > 0{,}7$. Old CP mostly grow in artificial plantings (except CP-2, which is aging), and according to the "delta - omega" classification, all CP are mature (Table). Thus, changes in habitual living conditions lead to the aging of *A. vernalis* CP.

By density (pcs/100 m^2) all populations are divided into three groups: high – > 90 pcs/100 m^2, medium – 89-40 pcs/100 m^2, low – > 40. All forest edge CP have a high density, in meadow steppes, the density is average, on meadows and in artificial plantings, it is low (table).

Characteristics of *A. vernalis* coenopopulations

№	TPC, %	TPC of *A.vernalis*,%	Area of CP, m^2	Density of plants, pcs/100 m^2	Quantity of plants in CP, pcs	Δ	ω	I
CP-1	90	2	3000	142	4260	0.29	0.65	0.50
CP-2	100	0.5	1500	52	780	0.48	0.80	0.30
CP-3	70	0.5	6000	63	3780	0.45	0.82	0.31
CP-4	100	1.5	6000	90	5400	0.40	0.9	0.25
CP-5	60	0.5	1500	28	420	0.78	0.34	2.5
CP-6	80	1.0	1500	66	990	0.36	0.85	0.46
CP-7	100	0.2	2000	10	300	0.62	1.0	0
CP-8	100	2.0	5000	96	4800	0.39	0.81	0.14
CP-9	70	2.0	3000	60	1800	0.48	0.87	0.15
CP-10	70	0.5	1000	28	280	0.63	0.88	0
CP-11	100	0.5	2000	16	320	0.28	0.65	1.0
CP-12	50	0.1	2000	8	160	0.50	1.0	0
CP-13	100	0.5	3000	40	1200	0.32	0.73	0.67

The recovery index in most CP is less than one (except CP-11=1.0), which indicates a low recovery in *A. vernalis* populations.

The range of age stages shows that in most CP they are normal, the exception is CP-5 which indicates an old stage of the population and possibly its soon elimination.

The most optimal conditions for the formation of CP are edge areas occupied by dry meadows. These CP have the highest density of *A. vernalis* from 90 to 142 pcs/100m^2. They are young, but according to the "delta - omega" classification, are maturing. In more xerophytic conditions the density of *A. vernalis* decreases to an average of 89-40 pcs/100 m^2. They form mature CP. According to the "delta-omega" classification, they are aging. *A. vernalis* is a meadow-steppe plant. The typical habitats are meadow steppes, dry meadows, steppe communities [1,9,10,11]. Meadow CP of *A. vernalis* on the Kokshetau Upland and in Northern Kazakhstan are not characteristic habitats, so the density is lower there (less than 40 pcs/100 m^2). The CP are aging, according to the "delta - omega" classification "delta - omega" they are all mature.

Conclusion. *A. vernalis* is a short-stem grassy polycarpic plant, it is represented in Northern Kazakhstan by the populations of dry meadows (Kokshetau Upland) and real meadows (the forest-steppe of North Kazakhstan region). Ontogenesis of *A. vernalis* has three periods and 8 age stages. Plants have low seed productivity. Seeds have a long endogenous peace related to the underdevelopment of a seed germ. A characteristic feature is the presence of a long pregenerative period in plants of the "steppe" type coenopopulations and its reduction in the "meadow" type coenopopulations.

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СОЛТҮСТІК ҚАЗАҚСТАН ЖАҒДАЙЫНДА ADONIS VERNALIS L. ПОПУЛЯЦИЯ ОНТОГЕНЕЗІ ЖӘНЕ ЖАС ҚҰРЫЛЫМЫ

Аннотация. Мақалада Солтүстік Қазақстанда *Adonis vernalis* L. ценофлорасын зерттеу нәтижелері берілген. Материалдар далалық зерттеу нәтижесінде алынды, әдеби мәліметтер ескерілді. Егжей-тегжейлі бағыттық зерттеулер негізінде онтогенез және ценопопуляция жас құрылымы келтіріледі.

Adonis vernalis ареал бойынша сирек кездесетін өсімдік Қазақстанның Қызыл кітабына (2014) [1] және Convention of International Trade in Endangered Species of Wild Fauna and Flora (CITES) Конвенцияның II қосымшасына енгізілген [2, 3]. *A. vernalis* Украинада, сондай-ақ РФ 36 субъектісінде қорғалады [5].

Жас жағдайын зерттеу Солтүстік Қазақстан аймағында (Ақмола және Солтүстік Қазақстан облысы (СҚО) 2018-2019 жж. жүргізілді.

A.vernalis – Солтүстік Қазақстандағы қысқа-өзекті шөпті поликарпті құрғақ шалғын (Көкшетау қыртысы) мен нағыз шабындықтар (Солтүстік Қазақстан облысының орманды даласы) құрамындағы популяция негізінде ұсынылған.

A. vernalis онтогенезінде үш кезең және 7 жас жағдайына бөлінген. Өсімдіктердің аз мөлшерде тұқымдық өнімі бар. Дамымаған ұрық тұқымына байланысты тұқым ұзақ эндогенді күйсіз сипатқа ие. «Дала» типіндегі ценопопуляция өсімдігінде ұзақ уақыт дегенеративтік кезеңнің болуы және оның «шалғындық» типіндегі ценопопуляцияда азаюы ерекшелігі болып саналады.

Жас құрылымы ценопопуляцияның маңызды белгілерінің бірі болып саналады, өйткені популяциялық жүйенің өзін-өзі ұстау қабілетін қамтамасыз етеді және оның тұрақтылығын анықтайды [15]. Өсімдіктерді зерттеудегі популяциялық тәсілді Т.А. Работнов (1960) ұсынды [20]. Негізгі термин «ценопопуляция» ұғымы – белгілі бір фитоценоз шекарасындағы жеке түрлердің жиынтығы.

A.vernalis: Ақмола және Солтүстік Қазақстан облыстарында орналасқан 13 ценопопуляция зерттелді. *A. vernalis* ценопопуляциясы негізгі төрт орынға негізделген: орман, шабындық дала, шабындық, жасанды екпелер. «Бурабай» МҰТП аумағында табиғи Қарағайлы екпелердің өте көп саны XIX мен XX ғасырдың басында кесілген, табиғи екпелердің бір бөлігі өрт салдарынан жойылды, сондықтан орманды қалпына келтірілді және мұндай жұмыстар кеңірек жүргізіледі.

Жас шамасы бойынша түкшемен қапталған жерлерде жас популяциялар қалыптасады, ал «дельта – омеганың» жіктелуіне сәйкес жетілген ЦП қалыптасқан, онда $\Delta < 0.35$, ал $\omega > 0{,}6$. Шалғынды далада негізінен жетілген ЦП қалыптасқан, ал «дельта – омега» жіктелуі бойынша барлық ЦП ескірген $\Delta > 0.55$, ал

ω > 0.6 жатады. Шалғынды далаларда ЦП-ның көпшілігі жас болып келеді, ал «дельта – омега» жіктелуі бойынша барлық ЦП кемелденген Δ 0.35–0.54, мұнда ω >0.7. Жасанды екпелерде ЦП-ның көпшілігі ескірген, ал «дельта-омега» жіктелуі бойынша барлығы жетілген ЦП-ға жатады. Осылайша әдеттегі өмір сүру жағдайының өзгеруі A.vernalis ЦП тоздырады.

Көптеген ЦП қалпына келтіру индексі бірліктен аз, бұл *A. vernalis* популяцияларында қалпына келтірудің төмендігі байқалады.

Жас жағдайының спектрі көптеген ЦП-да олардың қалыпты екенін көрсетеді, ерекшелік ЦП-5 (жасанды екпе арасында) құрайды, бұл популяцияның бұрынғы жай-күйін және жедел элиминацияны куәландырады.

ЦП қалыптастыру үшін ең оңтайлы жағдай-құрғақ шалғынымен айналысатын түкше кеңістігі болып саналады, бұл ЦП тығыздығы *A. vernalis* 90-дан 142 дана/100м^2-ге дейін, олар жас «дельта-омега» жіктеуі бойынша пайда болады. Көп ксерофитті жағдайларда a.vernalis тығыздығы орташа 89-40 данаға/100 м^2 дейін азаяды, онда ескіргендерге жататын «дельта – омега» жіктемесі бойынша жетілген ЦП қалыптасады. *A. vernalis* шалғынды-дала өсімдігі, шалғынды дала, құрғақ шалғын, дала қоғамдастықтары [1,9-11], шалғынды ЦП. Көкшетау төбесінде және Солтүстік Қазақстан облысы vernalis мекені болатын жер емес және соның салдарынан «дельта – омега» жіктемесі бойынша жататын ЦП-да (40 дана/100 м^2-ден кем) ескірген даралық тығыздығының төмендігі жетілген ЦП-ға жатады.

Түйін сөздер: *Adonis vernalis* L., Солтүстік Қазақстан, жас ерекшелік жағдайы, жас құрылымы, онтогенез.

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ОНТОГЕНЕЗ И ВОЗРАСТНАЯ СТРУКТУРА ПОПУЛЯЦИЙ ADONIS VERNALIS L. В УСЛОВИЯХ СЕВЕРНОГО КАЗАХСТАНА

Аннотация. Изучены возрастные особенности онтогенеза и структура 13 ценопопуляций *Adonis vernalis* L. на территории Северного Казахстана. Материалы получены в результате полевых исследований, учтены литературные данные. На основании детально-маршрутных исследований приводится онтогенез и возрастная структура ценопопуляций.

Adonis vernalis L. – довольно редкое растение на протяжении всего ареала [1], внесен в Красную книгу Казахстана (2014) и в Приложение II Конвенции Convention of International Trade in Endangered Species of Wild Fauna and Flora (CITES) [2,3]. *A. vernalis* охраняется в Украине [4], а также в 36 субъектах РФ [5].

Изучение возрастных состояний проводилось на территории Северного Казахстана (Акмолинская и Северо-Казахстанская области (СКО) в 2018-2019 гг.

A. vernalis – коротко-стержневой травянистый поликарпик в Северном Казахстане представлен популяциями в составе суходольных лугов (Кокшетауская возвышенность) и настоящих лугов (лесостепь Северо-Казахстанской области). В онтогенезе *A. vernalis* выделено три периода и 7 возрастных состояний. Растения обладают низкой семенной продуктивностью. Семена обладают длительным эндогенным покоем, связанным с недоразвитием зародыша семени. Характерной особенностью является наличие длительного предгенеративного периода у растений в ценопопуляциях «степного» типа и сокращение его в ценопопуляциях «лугового» типа.

Возрастная структура представляет собой один из существенных признаков ценопопуляции, так как обеспечивает способность популяционной системы к самоподдержанию и определяет ее устойчивость [15]. Популяционный подход к изучению растений был предложен Т.А. Работновым (1960) [20]. Ключевым термином является понятие «ценопопуляция» – совокупность особей вида, существующих в границах определенного фитоценоза.

Изучено 13 ценопопуляций *A. vernalis*: расположенных в Акмолинской и Северо-Казахстанской областях. Ценопопуляции *A. vernalis* приурочены к четырем основным местообитаниям: опушки леса, луговые степи, луга, искусственные насаждения. Необходимо отметить, что на территории ГНПП «Бурабай» очень большое количество естественных сосновых насаждений было вырублено в течение XIX, начала XX веков, часть естественных насаждений погибла в результате пожаров, поэтому лесовосстановление проводилось и проводится в широких масштабах. По возрастности в опушечных местообитаниях формируются молодые популяции, а согласно классификации «дельта – омега» сформированы зреющие ЦП, в которых Δ < 0.35, а ω > 0,6. В луговых степях в основном сформированы зрелые ЦП, а по классификации «дельта – омега» все ЦП

относятся к стареющим, в которых Δ >0.55, а ω > 0.6. На лугах большинство ЦП относятся к молодым, а по классификации «дельта – омега» все ЦП относятся к зрелым, в которых Δ 0.35–0.54, а ω >0.7. В искусственных насаждениях большинство ЦП относятся к стареющим, а по классификации «дельта – омега» все ЦП относятся к зрелым. Таким образом, изменения привычных условий обитания приводит к старению ЦП *A. vernalis*.

По плотности (шт/100 м^2) все популяции разделены на три группы: высокая – > 90 шт/100 м^2, средняя – 89-40 шт/100 м^2, низкая > 40. Все опушечные ЦП имеют высокую плотность, в луговых степях плотность средняя, на лугах и в искусственных насаждениях – низкая.

Индекс восстановления в большинстве ЦП менее единицы, что свидетельствует о низкой восстанавливаемости в популяциях *A. vernalis.*

Спектр возрастных состояний показывает, что в большинстве ЦП они нормальные, исключение составляет ЦП-5 (среди искусственных насаждений), что свидетельствует о старческом состоянии популяции и, возможно, скорой элиминации.

Наиболее оптимальными условиями для формирования ЦП являются опушечные пространства, занятые суходольными лугами, эти ЦП имеют наибольшую плотность *A. vernalis* от 90 до 142 шт/100м^2, они являются молодыми, а по классификации «дельта – омега» – зреющими. В более ксерофитных условиях плотность *A. vernalis* уменьшается до средней 89-40 шт/100 м^2, в них формируются зрелые ЦП по классификации «дельта – омега» относящиеся к стареющими. *A. vernalis* лугово-степное растение, характерными местообитаниями являются луговые степи, суходольные луга, степные сообщества [1,9,10,11], луговые ЦП *A. vernalis* на Кокшетауской возвышенности и в Северо-Казахстанской области являются не- характерными местообитаниями и, как следствие, низкая плотность особей в ЦП (менее 40 шт/100 м^2) стареющие ЦП, относимые по классификации «дельта – омега» все ЦП, относящиеся к зрелым ЦП.

Ключевые слова: *Adonis vernalis* L., Северный Казахстан, возрастные состояния, возрастная структура, онтогенез.

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