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Current status of the population of the medicinal species *Ajania fastigiata* in Trans-Ili Alatau

The genus *Ajania* Poljakov is a perennial herbaceous plant, usually with grayish shade, without shortened vegetative shoots, with erect or often ascending and branched, well-developed, densely oleate stems. Leaves are ordinary with dissected laminae covered with appressed bipinnate, sometimes with admixture of simple hairs. The purpose of this research work is to clarify the current state of the population of *Ajania fastigiata* occurring in the Trans-Ili Alatau. The objects of the study are phytocenoses with participation and dominance of the medicinal species *Ajania fastigiata* growing in Trans-Ili Alatau. As a result of the analysis of the described 3 large populations of the medicinal species *Ajania fastigiata*, the following conclusions were obtained. According to the analysis of floristic composition of communities with participation and dominance of the studied species, 104 associated species (23 families) were identified. Asteraceae — 15 species, Poaceae — 11, Fabaceae — 10, Ranunculaceae and Rosaceae — 9 each, Lamiaceae — 8, Apiaceae — 7, Boraginaceae and Caryophyllaceae — 6 each, Liliaceae — 5 species (possibly more), 18 species belong to different families. For Pop1 the tallest individuals, 120 cm in height, were recorded. Pop1 (cop2) and Pop3 (cop3) were the most abundant populations. According to the percentage of Pop1 juveniles was about 43 %, Pop2 juveniles 44 %, and Pop3 juveniles 55 %. The age composition relative to the number of individuals showed that Pop1 and Pop3 are growing populations, while Pop2 is close to a regressive population caused by anthropogenic pressure.

Keywords: Asteraceae, *Ajania fastigiata*, medicinal plant, ecology, phytocenosis, population, dominant, Trans-Ili Alatau.

Introduction

The Asian genus *Ajania* Poljakov comprises between 30 and 40 species, according to various authors [1, 2]. These species are predominantly distributed across China and Japan, while also being native to Afghanistan, Kazakhstan, Kyrgyzstan, Mongolia, Northern India, Russia, and Tajikistan. This taxon was first segregated from the genus *Artemisia* by L.P. Polyakov [3], who proposed that *Ajania* originated from ancestral taxa closely related to *Dendranthema* (DC.) Des Moul. and that its adaptation to the steppes and deserts of Central Asia led to a high degree of morphological similarity with *Artemisia* species inhabiting these ecosystems. Subsequently, to explain the phylogenetic relationships among these three genera, Bremer and Humphries [1] hypothesized that independent evolutionary lineages had descended from a common dendranthemoid ancestor. Later, A.A. Muldashev [4] segregated three species from *Ajania* into a distinct new genus, *Phaeostigma* Muldashev. Recently, a palynological analysis was conducted on two species of *Ajania* — *Ajania fastigiata* (C.Winkl.) Poljakov and *A. fruticulosa* (Ledeb.) Poljakov — as well as one species of *Phaeostigma*, *Phaeostigma salicifolium* (Mattf.) Muldashev [5, 6].

Due to its complex taxonomic history, characterized by the frequent reassignment of species between the major groups within the subtribe *Artemisiinae*, *Ajania* represents a particularly intriguing subject for research. The genus occupies a vast distribution range across Central Asia, with a predominant presence in China (from the northwestern to the northeastern and southwestern regions), as well as in Korea, Japan, and the Russian Far East [7–9].

Despite a number of cladistic studies based on morphological and molecular data, a substantial number of taxa within the subtribe *Artemisiinae* remain of uncertain systematic placement [1, 5, 10–14].

Ajania fastigiata is a perennial herbaceous plant from the Asteraceae family. The leaves of A. fastigiata have a silvery-green color and a fluffy texture, and the flowers are yellow or orange in color collected in a brush [15, 16].

This plant has medicinal properties and is used in traditional medicine to treat various diseases. For example, a decoction of the leaves of *A. fastigiata* can help with digestive problems, and also has anti-inflammatory and antiseptic properties [17–19].

In addition, *A. fastigiata* is often used in landscape design due to its decorative appearance. It can be planted both in groups and in single plantings to create a beautiful and spectacular view in the garden or in a flower bed [20].

A. fastigiata is a plant species that forms phytocenoses in various ecosystems. It belongs to the Asteraceae family and grows mainly in the mountainous regions of Eurasia.

Phytocenoses of *A. fastigiata* can be found in alpine meadows, steppes, forest-steppes and other types of vegetation. These plants have a high adaptive ability to various environmental conditions and can form dense thickets. In the phytocenoses of *A. fastigiata*, other plant species such as grasses, shrubs and mosses are usually found. They create unique ecosystems, providing food and shelter for various species of animals. These phytocenoses play an important role in maintaining biodiversity and ecological balance in natural communities. They can also be used in landscaping and landscaping to create beautiful and functional gardens and parks. *A. fastigiata* is a relatively little studied plant that is commonly used in landscaping due to its decorative appearance. It has stems that grow vertically and form dense bushes with silver-green leaves. Flowering occurs in late summer or autumn, when small yellow flowers appear. *A. fastigiata* grows in sunny or semi-shaded places and prefers fertile soils with a good drainage system. It can be used as a ground cover or to create hedges. In general, this plant is easy to care for and does not require special attention. However, despite its popularity in landscape design, *A. fastigiata* is still a poorly studied species, and its potential medicinal properties or other beneficial qualities may not yet be studied [21–23].

Ajania fastigiata, also known as *Ajania* shrub, is a plant that has a high ecological affinity. It is a valuable plant for gardeners and landscape designers, as it is able to adapt to various environmental conditions, including dry and poor soils [24, 25].

Ajania contributes to the conservation of biodiversity, as it provides shelter and food for various species of insects, birds and other animals. Its lush flowers also attract bees and other pollinators, which helps preserve the flora. In addition, *A. fastigiata* has the ability to phytoremediate, that is, the ability to purify the soil from harmful substances and toxins. This makes it a valuable plant for improving soil quality and protecting the environment. Thus, the ecological relevance of *A. fastigiata* makes it an important plant for maintaining biodiversity and improving the ecological state of the environment [24, 25].

The floral composition of the *A. fastigiata* population may include various plant species that grow in the natural environment of this species. Some of the possible components of the population may include: *Ajania fastigiata* and species such as Festuca ovina, Poa pratensis, *Achillea millefolium*, *Echinacea purpurea*, *Geranium sanguineum*, *Sedum spectabile*, etc. This is just a small list of possible plants that can make up the floral composition of the *A. fastigiata* population in the natural environment. The specific composition will depend on habitat conditions and environmental factors.

Ajania fastigiata is usually found in dry and sunny places in the phytocenosis, such as steppes, savannas and meadows. It can be part of the vegetation cover in plant communities with other herbaceous plants, shrubs or trees. *Ajania fastigiata* usually grows in groups or thickets, creating a dense and stable vegetation cover.

The age spectrum of *A. fastigiata* usually ranges from 3 to 5 years. At this age, the plant reaches its full height and shape, and begins to bloom. *A. fastigiata* can continue to grow and bloom for many years, provided proper care and optimal growth conditions are maintained.

Experimental

The objects of the study are phytocenoses with the participation and dominance of the medicinal species *Ajania fastigiata* growing in the Trans-Ili Alatau (within the Almaty region).

The Trans–Ili Alatau is a large mountain range of the Northern Tien Shan, which is located on the border of Kazakhstan and Kyrgyzstan. The average height of the Trans–Ili Alatau is 4000 m. The river network of the Trans-Ili Alatau belongs to the Ili River basin, which flows into Lake Balkhash. Mountain rivers have extensive catchment basins, and their sources lie at an altitude of more than 3,000 m (Fig. 1).

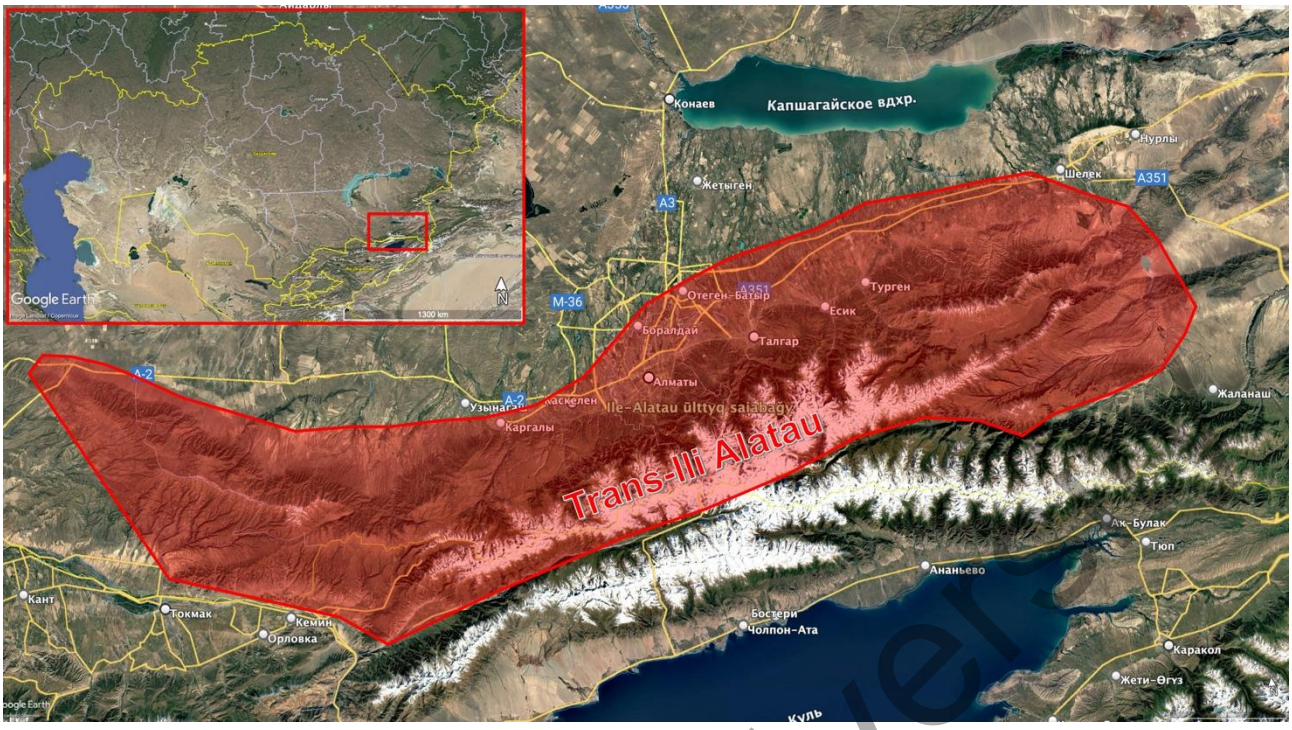

Figure 1. The study area of the Trans-Ili Alatau

The genus *Ajania* Poljakov comprises perennial herbaceous plants, typically exhibiting a characteristic grayish hue, lacking shortened vegetative shoots, and possessing erect or often ascending and branched, well-developed, densely foliated stems. The leaves are alternate, with dissected laminae covered in appressed bipartite hairs, sometimes interspersed with simple hairs.

The distribution range of the genus extends across the Eastern Palearctic [4]. In Kazakhstan, it is represented by three species, one of which is endemic—*Ajania korovinii* Kovaleusk. (Kyrgyz Alatau).

According to A.A. Muldashev, "the emergence of at least most species of the genus occurred at the end of the Neogene". However, it is also plausible that the genus began forming earlier, during the early Neogene [4, 24–26].

The aim of this study is to clarify the current population status and morphological characteristics of *Ajania fastigiata*, found in the Trans-Ili Alatau (Fig. 2).

Figure 2. *Ajania fastigiata* (C. Winkl.) Poljak in the Trans-Ili Alatau

Classical botanical (route-reconnaissance, ecological-systematic, ecological-geographical) methods were used in the research process. To identify the collected material, fundamental summaries were used: "Flora of Kazakhstan" [27], "Determinant of plants of Central Asia and Kazakhstan" [28], etc. [4, 24–26]. Latin and Russian names (in accordance with the International Plant Names Index (INPI) and Plants of the

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World Online (POWO) database, while the former names were left for some species due to the lack of sufficient phylogenetic data confirming the need for nomenclature changes) and the work of authors who study species of the Asteraceae family [5–10].

Vegetation was studied using traditional methods of field geobotanical research. The standard area of the described plots is 30x30 m [29].

Results and Discussion

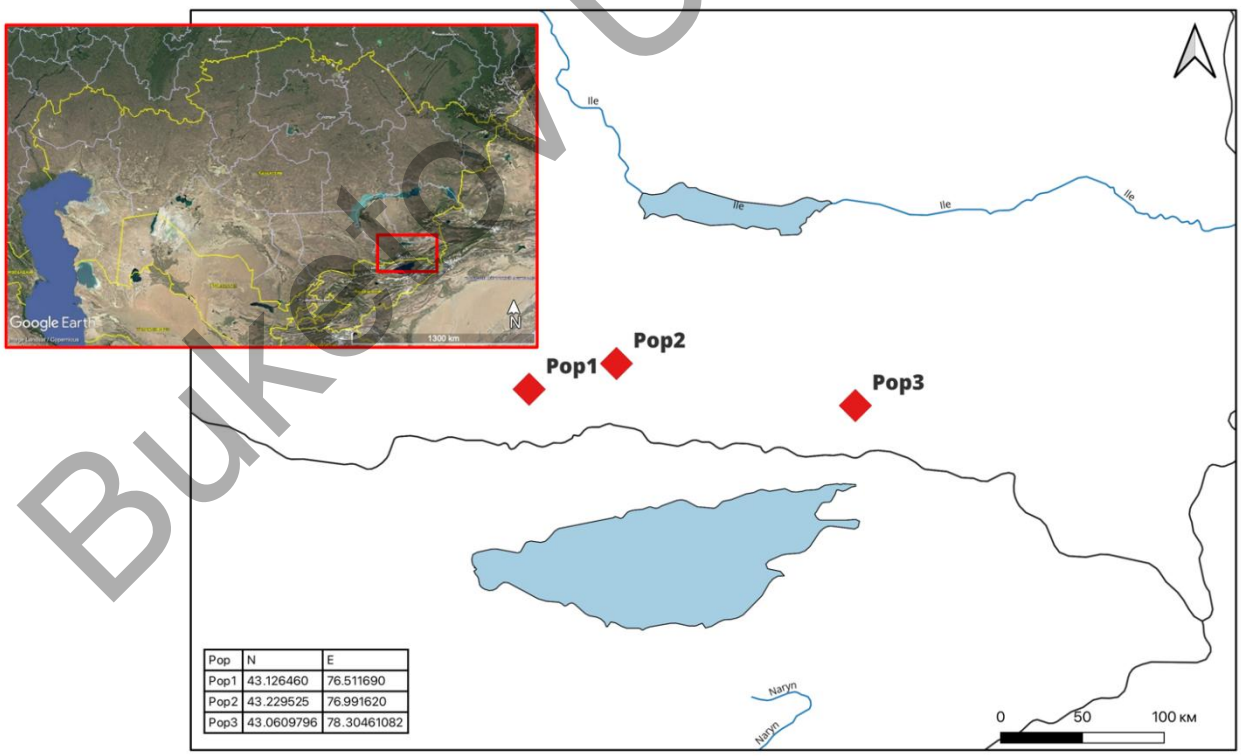
In the period from 2021–2023, several expeditionary work was carried out to identify the population of the medicinal species *Ajania fastigiata*. For comparative analysis, we have described and marked the 3 largest populations of the studied species in the Trans-Ili Alatau. Which are located at the following coordinates (Fig. 3):

Pop1 — N43.126460° E76.511690°, Karasai district, Almaty region

Pop2 — N43.229525° E76.991620°, Medeu district, Almaty

Pop3 — N43.0609796° E78.30461082°, Kegensky district, Almaty region

According to our data, shrubby thickets and grass-grass meadows are common in mountain gorges and river valleys. In the river valleys, thickets of shrubs form barberry, sea buckthorn and apricot with cereals and herbs. The lowest parts of the ridge are occupied by desolate sagebrush-feather grass steppes dominated by turf grasses with the participation of steppe grasses, confined to chestnut soils. Shrubs appear on rocky slopes in steppe communities. The belt of real steppes on typical chernozems can be divided into 2 bands: the lower — turf-slag steppes, dominated by *Stipa capillata*, *Festuca valesiaca*, with the participation of Agropyron pectinatum, Helictotrichon desertorum, as well as our studied species *Ajania fastigiata* and the upper — grass-turf-slag steppes, dominated by *Festuca valesiaca*, *Stipa lessingiana*, *S. capillata*, *Koeleria cristata* and steppe grasses, sometimes with the participation of Bothriochloa ischaemum. *Stipa kirghisorum*, *Festuca valesiaca* and *Helictotrichon schellianum* of the steppe are also found. But since *Ajania fastigiata* is a more xerophilic plant, it dominates drier slopes. The ecological amplitude of the studied species is quite wide, therefore it allows it to occur in various types of vegetation, mainly in grassy dry meadows and on southern slopes among shrub communities.



Pop	N	E
Pop1	43.126460	76.511690
Pop2	43.229525	76.991620
Pop3	43.0609796	78.30461082

Figure 3. A map of the locations of the described populations

According to our analysis of the floral composition of communities with the participation and dominance of the studied species, 104 associated species were identified, which are divided into 68 genera

and 23 families. Of these, Asteraceae Dumort. 15 species prevail the most, 7 of which belong to the genus *Artemisia* L., *Ajania fastigiata* belongs to the same family. The genera *Ajania* and *Artemisia* are considered to be closely related. Then we have other families by the number of species: Poaceae Barnhart. — 11 species, Fabaceae Lindl. — 10 species, Ranunculaceae Juss. and Rosaceae Juss. — 9 types each. Lamiaceae Lindl. — 8 species, Apiaceae Lindl. — 7 species, Boraginaceae Juss. and Caryophyllaceae Juss. — 6 species each, Liliaceae Juss. — 5 species (possibly more) and 18 species from other families (Fig. 4).

Frequently encountered species in populations and cenopopulations with dominance and participation of the studied species: *Achillea millefolium* L., *Aconitum leucostomum* Worosch., *Aegopodium alpestre* Ledeb., *Allium oreophilum* C.A. Mey., *Allium tianschanicum* Rupr., *Althaea officinalis* L., *Anemone petiolulosa* Juz., *Anthriscus sylvestris* (L.) Hoffm., *Aquilegia atrovinosa* M. Pop., *Atragene sibirica* L., *Calamagrostis epigeios* (L.) Roth, *Calamagrostis pseudophragmites* (Haller f.) Koeler., *Campanula glomerata* L., *Centaurea ruthenica* Lam., *Dracocephalum integrifolium* Bunge, *Elymus caninus* (L.) L., *Epilobium hirsutum* L., *Eragrostis minor* Host., *Euphorbia alatavica* Boiss., *Festuca pratensis* Huds., *Geranium transversal* Vved., *Geum rivale* L., *Hierochloe odorata* (L.) Wahl., *Koeleria cristata* (L.) Pers., *Lathyrus gmelini* Fritsch., *Lonicera altmannii* Regel & Schmalh., *Medicago romanica* Prod., *Mentha asiatica* Borris., *Oxytropis brachycarpa* Vass., *Oxytropis chinobia* Bunge, *Oxytropis globiflora* Bunge, *Poa bulbosa* L., *Potentilla reptans* L., *Potentilla sericea* L., *Prangos didyma* (Regel) M. Pimen. & V. Tichomirov, *Pulsatilla campanella* Fisch.ex Regel et Til., *Ranunculus repens* L., *Rosa alberti* Regel, *Rosa fedtschenkoana* Regel, *Scutellaria galericulata* L., *Seseli schrenkianum* (C.A. Mey.ex Schischk.) M. Pimen. & Sdobnina, *Sonchus arvensis* L., *Stachyopsis lamiiflora* (Rupr.) M. Pop.et Vved., *Stipa lessingiana* Trin.et Rupr., *Thalictrum collinum* Wallr., *Thalictrum foetidum* L., *Thermopsis alpina* (Pall.) Ledeb., *Thymus marschalianus* Willd., *Trigonella geminiflora* Bunge, *Tulipa ostrowskiana* Regel, *Vicia tenuifolia* Roth, *Ziziphora clinopodioides* Lam.

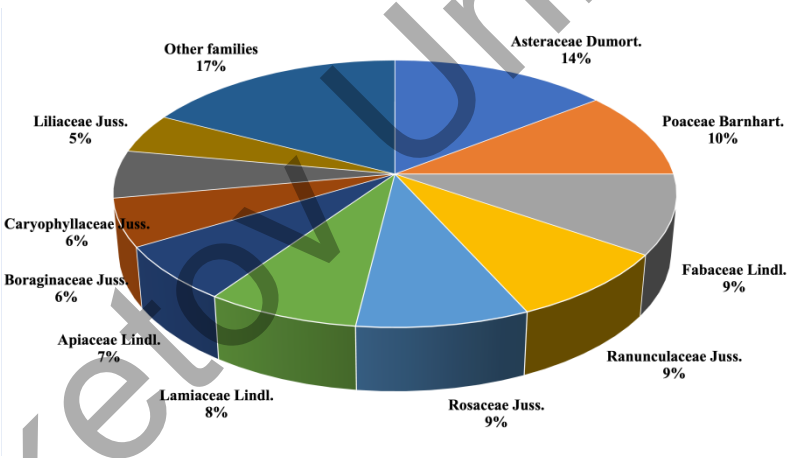
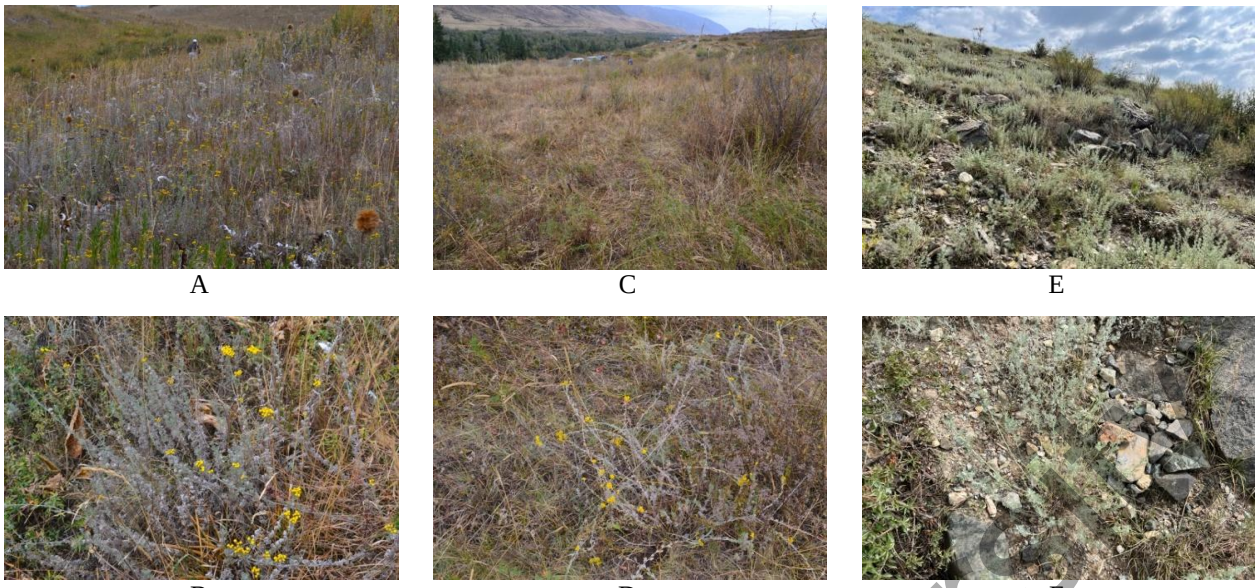


Figure 4. The spectrum of families by the number of species

The populations for comparative analysis were not chosen by chance, geographical location, features of floral composition and environmental characteristics were taken into account. Geographically, Pop1 and Pop2 populations are located close to each other, but nevertheless have sufficient distance and geographical factors that allow them to be considered different populations. From an ecological point of view, Pop1 is located on the northern slope, and Pop2 on the zapodny, Pop3 at all on the southern slope of the Trans-Ili Alatau ridge. If in Pop1 and Pop2 populations, the main dominants were woody plants, then in Pop3 we also had shrubby species. Of course, in grass stands, due to competition for sunlight, plant growth varies quite a lot. So, in Pop1, the tallest individuals were noted, reaching 120 cm in height. Pop2 individuals took the second place, and Pop3 individuals took the third place, with an average height of 35–40 cm. Pop1 (sor2) and Pop3 (cop3) populations have become more abundant. The depressed state of the Pop2 (sp-cop1) population can be attributed to the fact that it is located too close to the city of Almaty, and is subject to strong anthropogenic influence (Fig. 5).



A-B — population 1 (Pop1); C-D — population 2 (Pop2); E-F — population 3 (Pop3)

Figure 5. Illustrations of the described populations

The age composition of the *Ajania fastigiata* population was considered more carefully, this is the distribution of individuals by age and developmental phases, the indicator of which is the main one in assessing the current state of the population.

We have identified the following age stages: p — seedlings; j — juvenile plants; im — immature; v — virgin_nile; g1 — young generative; g2 — middle-aged generative; g3 — old generative; ss — subsenile; s — senile [29].

At the seedling stage, plants exhibit a mixed nutrition strategy, utilizing both the seed's stored reserves and their own assimilation processes. At this phase, small plants develop with embryonic structures, including cotyledons, an actively growing radicle, and, typically, a uniaxial shoot with small leaves that often have a simpler morphology compared to those of mature plants.

Juvenile plants transition to complete autotrophic nutrition. Cotyledons are absent, but the overall structural organization remains relatively simple. Morphological uniformity is often preserved, and the leaves are distinct in shape and smaller in size compared to adult individuals.

Immature (pre-reproductive) plants exhibit transitional characteristics between the juvenile and fully mature vegetative stages. At this stage, shoot branching commonly begins, leading to an expansion of the photosynthetic apparatus.

Adult vegetative plants display the typical structural features of their life form, including well-developed underground and aerial organs. The vegetative body fundamentally corresponds to the generative state, yet reproductive organs have not yet formed.

Young generative plants enter the reproductive phase, initiating flowering and fruit production, while their structural development reaches full maturity. In some years, interruptions in flowering may occur.

Middle-aged generative plants achieve peak biological capacity, demonstrating the highest annual growth rates and maximum seed production. In clonal species, this stage is often accompanied by the onset of individual fragmentation and clone formation. Periodic interruptions in flowering may also occur.

Old generative plants are characterized by a marked decline in reproductive function, a weakening of shoot and root formation, and a gradual dominance of senescence processes over new growth. Structural disintegration becomes increasingly pronounced.

Old vegetative (subsenile) plants experience the cessation of fruiting, a significant reduction in vigor, and the intensification of degenerative processes. The connection between shoot and root systems weakens, and in some cases, the life form simplifies, with leaves reverting to an earlier developmental type.

Senile plants are characterized by extreme decrepitude, a decrease in size, few buds are realized upon renewal, some juvenile features appear a second time (leaf shape, character of shoots, etc.).

According to the percentage ratio in Pop1, the undergrowth of the population was about 43 %, and generative individuals were about 47 %, at this time 10 % of individuals belong to sub-senile and senile. In Pop2, the undergrowth of the population is also 44 %, generative individuals are 31 %, and withering individuals are 35 %. Pop3 undergrowth is 55 %, generative 41 %, withering only 4 % (Fig. 6).

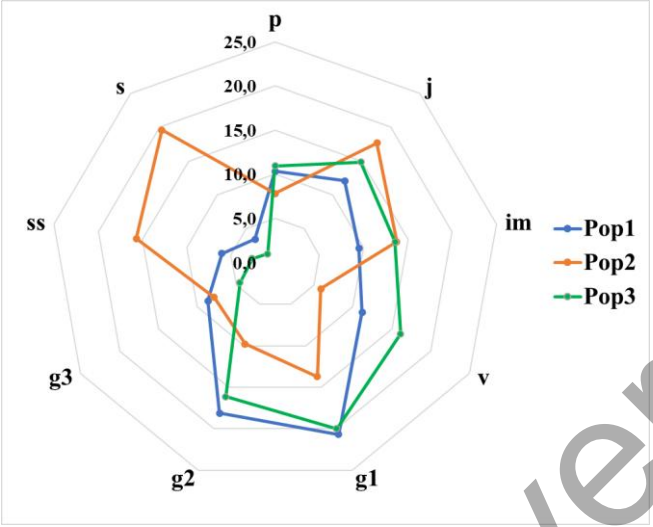


Figure 6. Percentage ratio of the age composition of the population

As we can see, the percentage of the age composition of the population does not always provide accurate objective data, as in our case, the state of Pop2 visually seems to be averaged. But if we consider the same conditions for all populations not by percentage, but by the quantitative ratio of individuals in populations, then we will get a different picture (Fig. 7). Regarding the data obtained, we will consider them according to the following points: the ratio of age groups of plants [29].

The invasive one consists mainly of young individuals, is not capable of self-maintenance and depends on the introduction of rudiments from the outside.

In a normal population, there are all age groups (if this is typical of the life cycle of the species). Such populations are further subdivided into young, middle-aged and old.

The regressive one mainly consists of old individuals. The age structure of populations is adaptive. It is formed on the basis of the biological properties of the species, but it always reflects the strength of environmental factors.

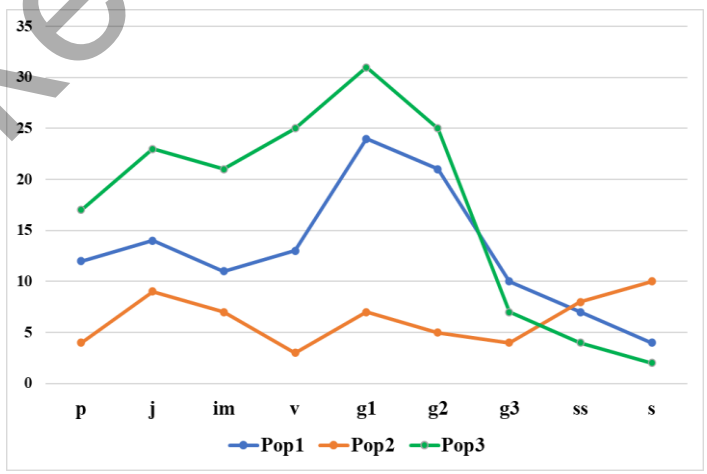


Figure 7. Population age structure

p — seedlings; j — juvenile plants; im — immature; v — virginal; g1 — young generative; g2 — middle-aged generative; g3 — old generative; ss — subsenile; s — senile

As we can see from the data obtained, more than one population does not belong to the invasive group. Pop1 and Pop3 belong to normal (growing) populations, and Pop2 belongs to the beginning regressive population.

Conclusion

As a result of the analysis of the described 3 large populations of the medicinal species *Ajania fastigiata*, the following conclusions were obtained. According to the analysis of the floral composition of communities with the participation and dominance of the studied species, 104 associated species (23 families) were identified. Asteraceae by the number of species — 15, Poaceae — 11, Fabaceae — 10, Ranunculaceae and Rosaceae — 9 each, Lamiaceae — 8, Apiaceae — 7, Boraginaceae and Caryophyllaceae — 6, Liliaceae — 5 species (possibly more), 18 species belong to different families. For Pop1, the tallest individuals were noted, 120 cm in height. Pop1 (cop2) and Pop3 (cop3) populations prevailed in abundance. According to the percentage ratio in Pop1, the undergrowth was about 43 %, Pop2 undergrowth of the population was 44 %, and Pop3 undergrowth was 55 %. The age composition relative to the number of individuals showed that Pop1 and Pop3 are growing populations, and Pop2 is close to a regressive population caused by anthropogenic pressure.

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Іле Алатауындағы *Ajania fastigiata* дәрілік түрдің популяцияларының қазіргі жағдайы

Ajania Poljakov туысы — көпжылдық шөптесін өсімдіктер, әдетте сұрғылт реңктері бар, қысқартылған вегетативті өсінділері жоқ, тік немесе жиі өсетін және тармақталған, жақсы дамыған, жапырақ сабақтары тығыз. Жапырақтары екі жақты түктермен, кейде қарапайым түктермен араласып жабылған, тілімді тақшайшалары кезектесіп отырады. Зерттеу жұмысының мақсаты Іле Алатауында кездесетін *Ajania fastigiata* популяциясының қазіргі жағдайын нақтылау. Зерттеу нысаны Іле Алатауында өсетін *Ajania fastigiata* дәрілік түрінің қатысуымен және үстемдігімен болатын фитоценоздар. *Ajania fastigiata* дәрілік түрінің сипатталған 3 ірі популяциясын талдау нәтижесінде келесі тұжырымдар алынды. Зерттелетін түрдің қатысуымен және үстемдігімен қауымдастықтардың флористикалық құрамын талдау бойынша 104 түр (23 тұқымдас) анықталды. Asteraceae түрлерінің саны бойынша — 15, Poaceae — 11, Fabaceae — 10, Ranunculaceae және Rosaceae — әрқайсысы 9, Lamiaceae — 8, Apiaceae — 7, Boraginaceae және Caryophyllaceae — әрқайсысы 6, Liliaceae-5 түрі (мүмкін одан да көп), 18 түрі әртүрлі тұқымдастарға жатады. Pop1 үшін биіктігі 120 см болатын ең биік даралар белгіленді. Pop1 (cop2) және Pop3 (cop3) популяцияларының көптігі басым болды. Pop1-дегі пайыздық көрсеткіш шамамен 43 % құрады, Pop2 — популяция 44 %, ал Pop3 — 55 %. Жеке даралар санына қатысты жас құрамы, Pop1 және Pop3 өсіп келе жатқан популяциялар, ал Pop2 антропогендік қысым тудыратын регрессивті популяцияға жақын екенін көрсетті.

Кілт сөздер: Asteraceae, *Ajania fastigiata*, дәрілік өсімдік, экология, фитоценоз, популяция, доминант, Іле Алатауы.

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Современное состояние популяции лекарственного вида *Ajania fastigiata* в Заилийском Алатау

Род *Ajania* Poljakov — это многолетние травянистые растения, обычно с сероватым оттенком, без укороченных вегетативных побегов, с прямостоячими или часто восходящими и разветвленными, хорошо развитыми, густолиственными стеблями. Листья очередные с рассеченными пластинками, покрытыми прижатыми двураздельными, иногда с примесью простых, волосками. Целью данной исследовательской работы является уточнение современного состояния популяции *Ajania fastigiata*, встречающегося в Зайлийском Алатау. Объектами исследования являются фитоценозы с участием и доминированием лекарственного вида *Ajania fastigiata*. В результате анализа описанных 3 крупных популяций лекарственного вида *Ajania fastigiata*, были получены следущие выводы. По анализу флористического состава сообществ с участием и доминированием изучаемого вида, выявлено 104 сопутствующих видов (23 семейства). Asteraceae по количеству видов — 15, Poaceae — 11, Fabaceae — 10, Ranunculaceae и Rosaceae — по 9, Lamiaceae — 8, Apiaceae — 7, Boraginaceae и Caryophyllaceae — по 6, Liliaceae — 5 видов (возможно больше), 18 видов относятся к различным семействам. Для Pop1 были отмечены самые высокие особи – 120 см в высоту. По обилию приобладали популяции Pop1 (cop2) и Pop3 (cop3). Согласно процентному соотношению в Pop1 подрост составило около 43 %, в Pop2 – 44 %, а подрост в Pop3 – 55 %. Возрастной состав по количеству особей показал, что Pop1 и Pop3 являются растущими популяциями, тогда как Pop2 приближается к регрессивной популяции, причиной которой является антропогенное давление.

Ключевые слова: Asteraceae, *Ajania fastigiata,* лекарственное растение, экология, фитоценоз, популяция, доминант, Заилийский Алатау.

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