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Article

Ecological assessment of the current status of the population of the species *Ikonnikovia kaufmanniana* (Regel) Lincz. in the flora of the Uzynkara Ridge

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Abstract: In this work, a comprehensive ecological and phytocenotic analysis of the rare species *Ikonnikovia kaufmanniana* (Regel) Lincz, listed in the Red Book of Kazakhstan, was carried out. It was discovered in two habitats of the Uzynkara Ridge (Tokai gorge and Kegen pass). In this regard, the aim of this study was an anatomical, morphological and ecological study of the population of the endemic species *I. Kaufmanniana* and the influence of anthropogenic impact on its natural habitat. The study showed low ecological stability of *I. kaufmanniana* in the plant community growing in the lower mountain zones of the study area. An anatomical and morphological study of *I. kaufmanniana* revealed features of the ontogenetic development of the species associated with age-related changes in morphometric characteristics. The process of formation of the life cycle (ontogenesis) of *I. kaufmanniana* from juvenile to generative showed a gradual age-related change in the length of the leaf blade and the height of the plant, which indicates an ecological optimum or favorable conditions for the development of the population. The adaptation of the studied species (*I. kaufmanniana*) to mountain conditions is characterized by anatomical features such as the development of mechanical and conductive tissues. The study revealed that the population decline of the rare and endangered species *Ikonnikovia kaufmanniana* (Regel) Lincz in the Uzynkara Range is directly influenced by human activities, including climate change, recreation, and unsystematic grazing, which in turn leads to soil degradation, affecting the recovery process of this population. The obtained results highlight the need to develop and implement effective conservation measures for *Ikonnikovia kaufmanniana* and to protect its natural habitats.

Keywords: *Ikonnikovia kaufmanniana*; population; rare plant species; Uzynkara Ridge.

1. Introduction

The conservation of biodiversity in mountain ecosystems is one of the priority tasks of contemporary botanical science and nature conservation. Mountain regions are characterized by a high degree of endemism and a wide range of ecological niches, while simultaneously remaining highly vulnerable to anthropogenic impacts and climate change. Against a backdrop of increasing recreational pressure, habitat fragmentation, and landscape transformation, research into the current status of endangered, rare, and endangered plant species has become especially important (Butt et al., 2020; Challender et al., 2023; Fremout et al., 2021; Harrison et al., 2024; Keith et al., 2022; Lughadha et al., 2020; Minin et al., 2021; Nazir et al., 2020; Orsenigo et al., 2018; Potgieter et al., 2019; Qazi et al., 2023, 2025; Varga et al., 2021).

The Uzynkara Range is one of the key floristic regions of the Northern Tien Shan, distinguished by significant species diversity and the presence of relict and endemic taxa.

2. Materials and methods

The subject of the study was natural populations of the rare species *Ikonnikovia kaufmanniana*, belonging to the family *Plumbaginaceae* and the genus *Ikonnikovia* Lincz. Research was carried out on the territory of the Uzynkara Ridge (Northern Tian Shan) using field and stationary methods. Materials for this work were collected in the species 'natural habitats. Flowering specimens of the rare and endangered plant *I. kaufmanniana* (Regel) Lincz. were located and studied in the Tokay gorge at an altitude of 1,337 m a.s.l. (Figure 1). Sample collection followed accepted botanical procedures. Fundamental keys and compilations were used for material processing and floristic identification: volumes of "Flora of Kazakhstan" (1956–1966), the "Plants of Central Asia" (1963–1989) key, and the "Illustrated Guide to the Plants of Kazakhstan" (1962–1975). Generic taxonomic classification follows the system of S.A. Abdullina (1998), and species names were verified according to the compilation of S.K. Cherepanov (1995).

2.1. Geobotanical methods

Comprehensive field studies were carried out in the Almaty region to assess the current status of the woody-shrub species *Ikonnikovia kaufmanniana* in its natural habitats. Route-reconnaissance surveys covered the lower montane belt of the Uzynkara Ridge, where the species is localized. To study natural regeneration, permanent plots of 100 × 100 m, 50 × 50 m, and 25 × 100 m were established to represent diverse relief forms and habitat types. Within the plots, 2 × 2 m reference subplots were recorded at 10 m intervals; quantitative parameters and the viability of juvenile individuals were assessed on these subplots. Species abundance in phytocoenoses was estimated using the Drude cover–abundance scale (Drude, 1934). Population age structure was described by diagnostic features of ontogenetic states based on a set of qualitative and quantitative characteristics reflecting morphological condition and life-cycle phase. Comparative analysis of morphometric traits among different age groups was performed using standard botanical methods. Route surveys and classical approaches to studying plant morphology, cenopopulation structure, phytocoenoses, and the species ′eco-biological traits were applied to investigate spatial distribution and geographic patterns. All fieldwork followed the methodological approaches of T. A. Uranov (1960), O. V. Smirnova (1976), and T. A. Rabotnov (1970), ensuring comparability of the obtained data with results of similar population-ecological studies.

2.2. Morphological-anatomical analysis

Anatomical and morphological analyses were conducted on in situ collected specimens preserved in ethanol:glycerin:distilled water (1:1:1). Slide preparation followed standard plant anatomy protocols (Permyakov, n.d.; Prozina, 1960; Barykina et al., 2014). Microscopic examination included roots, stems, and leaves. Stem anatomy was studied after maceration in 5 % NaOH, rinsing, and epidermis removal for surface analysis. Transverse sections were prepared using an OL-3SO

freezing microtome. Data were used to assess anatomical variability and adaptive traits of *I. kaufmanniana.*

2.3. Vegetation sampling

Ecological characteristics of the plant cover were recorded on 100 m^2 sample plots. Geobotanical descriptions include the use of a GPS device to determine the coordinates of the *I. kaufmaniana* habitat, topography, soil characteristics, and a description of the plant community. To describe the plant's life forms, the classification systems of Raunkiaer (1934) and Serebryakov (1962) were used.

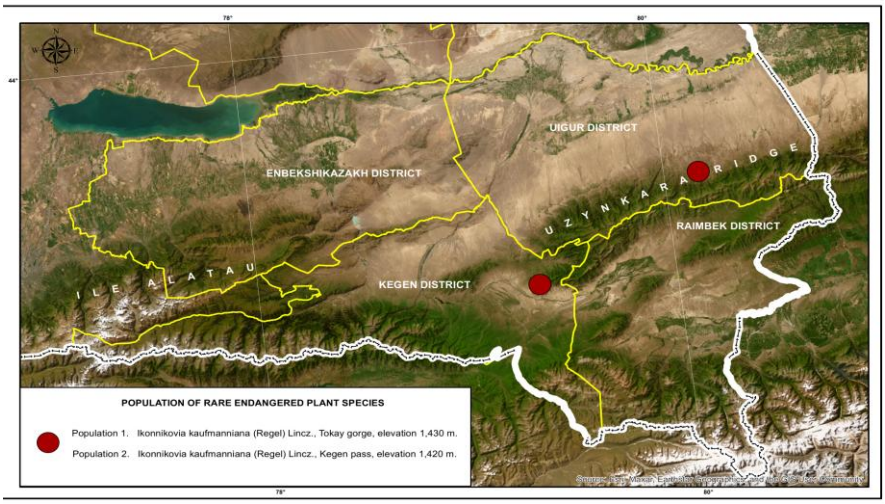


Figure 1. Map of the study area in the Uzynkara Ridge with the populations of *I. kaufmanniana* in the Tokay Gorge (1,430 m a.s.l.) and Kegen Pass (1,420 m a.s.l.) (Source: Esri, ArcGIS Online)

3. Results

3.1. Population of Ikonnikovia kaufmanniana (Regel) Lincz

3.1.1. Biological and ecological background of the species

Ikonnikovia kaufmanniana (Regel) Lincz. is a rare relict species of a monotypic genus within the family Plumbaginaceae and an endemic of the Northern Tian Shan. As a relict taxon, it represents a fragment of ancient floristic complexes that have persisted in isolated mountain refugia. Such species are typically characterized by narrow ecological amplitude, limited dispersal ability, long life cycles, and a strong dependence of population structure on stable habitat conditions. The first studied population is located in the Almaty Region, Uygur District, Uzynkara Ridge, Tokay Gorge, near Ketpen settlement (N43°27′325″, E080°22′902″) at an altitude of 1,430 m a.s.l. The second population was identified in the western part of the Uzynkara Ridge, at Kegen Pass (Kegen District), near Alasa Pass (N43°22′230″, E080°20′949″) at an altitude of 1,420 m a.s.l. Both populations occupy mountain habitats with specific microclimatic and edaphic conditions that largely determine the ontogenetic development and morphological expression of the species. Age structure and morphometric analyses were conducted in situ for both natural populations. *I. kaufmanniana* is a deciduous subshrub 15–30 cm tall with shortened, thickened branches densely covered with preserved, closely spaced remnants of leaf petioles. Leaves are arranged in dense rosettes, broad, leathery, green to glaucous-green, oblong-ovate, ending in a short, rigid mucro, with a smooth surface and distinctly serrate-wavy margins. Pedicels (1–2) are erect and robust. Flowers are large, arranged in 3–4-flowered spike-like inflorescences, forming dense, unilateral spikes on lateral branches. Petals are violet-red.

The species occurs on rocky and scree slopes of the lower mountain belt in the western part of the Uzynkara Ridge. It is listed in the Red Data Book of Kazakhstan (1981, 2004). The nearest known locality of the species is the Ile Alatau Ridge (Figure 2).

(a)

(b)

Figure 2. Natural habitats of *Ikonnikovia kaufmanniana*: (a) species; (b) habitat in the Tokay Gorge, Uzynkara Ridge (Source: Photo by the author)

3.1.2. Analysis of the age-related structural and morphological characteristics of I. kaufmanniana

We studied two populations of *Ikonnikovia kaufmanniana* growing in different habitats. Analysis of the abundance and age structure of the two *Ikonnikovia kaufmanniana* populations revealed that virgin individuals account for a significant portion of the age spectrum – 35 % and 49 % in the respective populations - while young reproductive individuals account for 68.5 % of the second population (Table 1).

Table 1. Comparative characteristics of the morphological characteristics of *I. kaufmanniana*

Name	Age groups	Juvenile (j)	Immature (i)	Virginal (v)	Generative (g)
Population 1	Total number of	27	43	72	128
	Leaf length, cm	2.45 ±0.60	3.90 ±0.95	3.25 ±1.48	11.10 ±1.12
	Leaf width, cm	1.40 ±0.55	1.70 ±0.60	1.55 ±0.05	3.05 ±0.05
	Plant height, cm	2.80 ±1.45	5.30 ±2.00	36.10 ±5.00	40.50 ±3.50
Population 2	Total number of	38	58	69	117
	Leaf length, cm	1.60 ±0.70	2.10 ±0.10	1.85 ±0.55	3.10 ±0.10
	Leaf width, cm	1.45 ±0.75	1.55 ±0.70	1.55 ±0.55	3.05 ±0.05
	Plant height, cm	3.80 ± 1.25	14.80 ± 3.90	26.00 ± 5.00	41.10 ±3.10

The age spectrum of the two populations studied contains all the main developmental stages, including juveniles (j), immatures (i), virgins (v), and reproductive (g) individuals, indicating a full ontogenetic spectrum. This population structure indicates the capacity for natural renewal and long-term sustainability of the population. However, the demographic composition of the populations is characterized by an uneven distribution of age groups. In the first population, generative plants constitute the largest proportion of individuals (47.4 %; 128 specimens), while juvenile and immature plants are represented in small numbers - 10.0 % (27 specimens) and 15.9 % (43 specimens),

respectively. Vegetative plants are represented by 72 specimens, accounting for 26.7 % of the total population. A similar distribution pattern is observed in the second population: here, generative plants also predominate, accounting for 54.9 % (117 specimens) of the total number of plants, while juvenile and immature plants constitute 17.8 % (38 specimens) and 27.2 % (58 specimens), respectively. A predominance of mature, generative individuals with a relatively small number of young plants is characteristic of many perennial relict species. Similar population structures are often observed in endemic taxa growing in unstable or restricted ecological conditions. In such species, population persistence is primarily ensured by the long lifespan of adult plants, while the emergence of young individuals is irregular and highly dependent on favorable environmental conditions, particularly adequate moisture, where the spatial structure of habitats is dictated by microrelief. According to the ontogenetic classification, the studied populations can be classified as stable populations with a weak regressive tendency.

3.1.3. Ontogenetic differentiation of morphological traits

The morphometric characteristics of the two studied populations changed significantly with increasing ontogenetic age. Analysis of morphometric parameters (Table 1) revealed a gradual increase in leaf length and plant height from the juvenile to the generative stage as individuals developed, indicating normal vegetative organ development. In the first population of *I. kaufmanniana*, leaf length in generative plants reached 11.10 ± 1.12 cm, while in juveniles it was 2.45 ± 0.60 cm. Leaf width also showed a steady increase, from 1.40 ± 0.55 cm to 3.05 ± 0.05 cm. The most significant differences were observed in plant height: it increased from 2.80 ± 1.45 cm in juveniles to 40.50 ± 3.50 cm in the generative period. The most intense growth rate was observed in virginal plants, indicating active formation of aboveground biomass before entering the reproductive phase. A similar trend was observed in the second population. However, leaf parameters at early stages of development were generally smaller compared to the first population. Leaf length varied from 1.60 ± 0.70 cm in young plants to 3.10 ± 0.10 cm in generative individuals. Depending on the age of *Ikonnikovia kaufmanniana*, the plant height increases from 3.80 ± 1.25 cm to 41.10 ± 3.10 cm. The stage preceding flowering and the phase of seed formation in virginal individuals is characterized by increased vegetative growth of the plant and intensive elongation of the stem, the size of which reached up to 26.00 ± 5.00 cm. Compared to the first population, the second population of *Ikonnikovia kaufmanniana* had smaller leaf sizes in juvenile plants. Leaf length in virginal plants reached 1.60 ± 0.70 cm, while in generative specimens it was 3.10 ± 0.10 cm. Moreover, the coefficient of variability decreased from 43.8 % to 3.2 %, demonstrating an increase in the stability of morphological traits depending on the plant's life stage, which can also be seen in plant height. For example, in young specimens, plant height varied from 3.80 ± 1.25 cm to 41.10 ± 3.10 cm, compared to mature plants. These changes and differences between the two *Ikonnikovia kaufmanniana* populations studied are related to the heterogeneity of the habitat. Differences in soil composition, moisture regime, microrelief, and the degree of anthropogenic disturbance can influence the development of vegetative organs and the overall size of plants. In relict species with a relatively narrow ecological range, such local environmental factors can have a significant impact on morphological traits, although the overall ontogenetic pattern remains unchanged.

3.1.4. Ecological and population implications

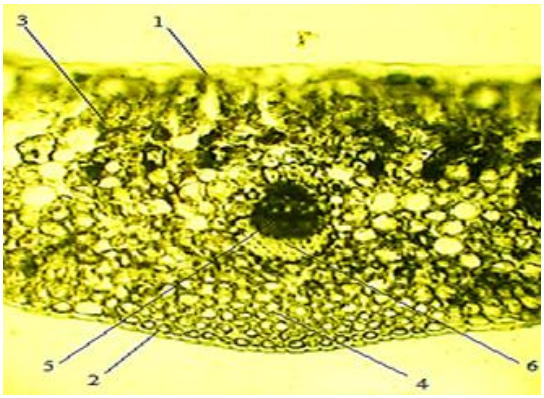
High values of the variation coefficient in juvenile and immature individuals indicate increased sensitivity to environmental conditions and high morphological variability in early developmental stages of plants. In contrast, generative plants are characterized by relatively low variability in morphometric traits, reflecting a high degree of structural stability in local habitat conditions. Furthermore, the predominance of mature generative individuals against a low proportion of young plants may indicate limited recruitment (renewal) and potential difficulties in natural population renewal. Overall, the ontogenetic structure of the studied *I. kaufmanniana* populations corresponds to a normal population with preserved reproductive capacity. As shown by our studies, the uneven

growth of the population of *Ikonnikovia kaufmanniana* on the Uzynkara Ridge indicates the need for constant monitoring to identify the dynamic state of the population by carrying out environmental protection measures to preserve the endangered red book species in the studied territory. In the second population, leaf parameters were generally smaller, although mature plants reached the same height as in the first population. This may reflect differences in resource allocation strategies for growth under different environmental conditions.

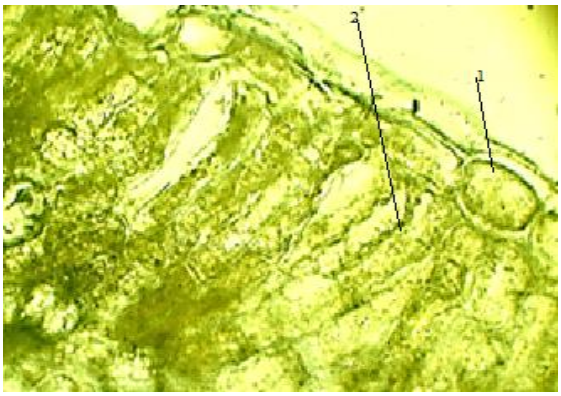
In both populations, plant height steadily increased during ontogenetic development, demonstrating a general growth pattern for the species. The most pronounced morphological changes were observed during the transition from the immature to the virginal period - the stage of most intense vegetative growth and structural differentiation.

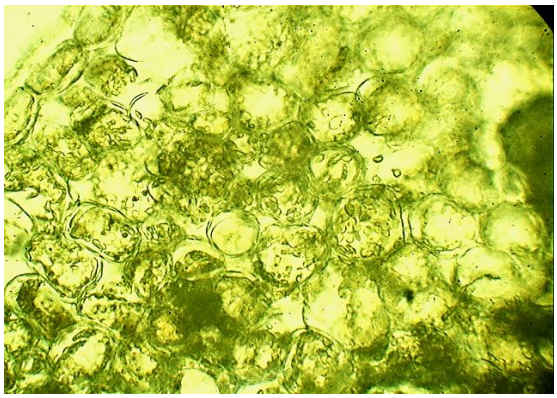
3.2. Anatomical structure of the leaf of Ikonnikovia kaufmanniana (Regel) Lincz.

A cross-section of the leaf of *I. kaufmanniana* is of the dorsiventral type. Epidermal cells of the leaf blade are densely arranged and covered with a thick cuticle. Stomata are of the anomocytic type.



(a)





(b) (c)

Figure 3. Leaf anatomical structure of *Ikonnikovia kaufmanniana*: (a) 1 - upper epidermis, 2 - lower epidermis, 3 - palisade mesophyll, 4 - parenchyma, 5 - vascular bundle, 6 - sclerenchyma; (b) upper epidermis and palisade mesophyll; (c) palisade mesophyll (Source: compiled by the authors)

As shown in Figure 3, the anatomical structure of the *Ikonnikovia kaufmanniana* leaf exhibits a distinct dorsiventral organization characteristic of dicotyledons. The upper and lower leaf surfaces differ in cell size and structural organization. The cells of the adaxial epidermis are larger than those of the abaxial epidermis. The average thickness of the upper epidermis is 6.07 ± 0.54 μm, while the lower epidermis is somewhat thinner at 5.07 ± 1.10 μm. Both epidermal layers consist of densely packed cells covered by a continuous cuticle, which plays an important role in reducing water loss

and protecting tissues from excessive solar radiation. Stomatae are predominantly located on the lower epidermis and are of the anomocytic type - they lack clearly differentiated subsidiary cells. This stomatal distribution is typical of dorsiventral leaves and is an adaptation that maintains gas exchange while limiting transpiration in dry conditions. The mesophyll is clearly differentiated into palisade and spongy tissues. Palisade mesophyll cells are elongated, closely adjacent to one another, and arranged perpendicular to the upper epidermis. Their thickened walls and numerous chloroplasts indicate high photosynthetic activity. Spongy mesophyll consists of loosely arranged, polyhedral, oval, or irregularly shaped elongated cells with intercellular spaces facilitating internal gas circulation. The vascular system consists of relatively small fibrovascular bundles distributed along the main vein of the leaf. Each bundle is surrounded by 2–3 layers of sclerenchyma cells, 6.14 ± 0.37 µm thick, providing additional mechanical support. The bundles are collateral in structure: the xylem faces the adaxial side, and the phloem faces the abaxial side of the leaf.

Overall, the anatomical features of the leaf reflect the species' adaptation to dry, mountainous habitats with high isolation and periodic moisture deficits. The spongy mesophyll, located toward the abaxial side, consists of loosely arranged cells of variable shape (polygonal, oval, or elongated) with well-developed intercellular spaces that facilitate gas exchange. Cells of both mesophyll layers contain abundant chloroplasts, indicating active photosynthetic function. The vascular system is represented by small bundles arranged along the leaf veins. To withstand the abiotic environmental factors typical of mountain habitats (winds, sharp temperature fluctuations, periodic drought, and climate change associated with warming), *Ikonnikovia kaufmanniana's* vascular-fibrous bundles, surrounded by several layers (up to three) of sclerenchyma, reach 6.14 ± 0.37 µm.

Thus, analysis of the anatomical and morphological structure of the *I. kaufmanniana* leaf revealed the importance of a high level of tissue differentiation and function (protective, asymptomatic, conductive, and mechanical) and the high adaptability of the studied species to the extreme conditions of mountainous areas.

These anatomical features ensure an optimal balance between photosynthetic performance, water regulation, and structural stability, contributing to the long-term persistence of the species in its natural habitats.

4. Discussion

The study of the age structure and morphological variability of *Ikonnikovia kaufmanniana*, a rare relict endemic species of the study area, contributes to the development of a deep understanding of the population organization and adaptive characteristics of this taxon to modern environmental conditions. As the only representative of a monotypic genus in the family *Plumbaginaceae*, this species is of particular scientific interest because relict plants often retain conservative biological and structural traits formed under early climatic conditions.

The studied populations include all major ontogenetic stages - juvenile, immature, virginal, and generative - representing a complete ontogenetic spectrum. The presence of all developmental stages in population biology is generally considered evidence of the capacity of populations for long-term self-sustainment. However, the quantitative distribution of individuals across age groups is uneven. Mature generative plants clearly predominate, while juvenile and immature individuals are represented by relatively few. A similar demographic structure is often observed in perennial relict and endemic species characterized by a long-life cycle and irregular renewal. In such taxa, population stability is primarily ensured by the long lifespan of adult plants, and successful seedling development occurs only under favorable environmental conditions. Thus, the observed ontogenetic structure of *I. kaufmanniana* may indicate the long-term stability of favorable habitats and the limited potential for continuous renewal under current environmental conditions.

Morphometric analysis revealed age-related changes in vegetative traits in both populations. Leaf length and width, as well as plant height, gradually increased from the juvenile to the generative period, indicating a normal course of ontogenetic development and progressive differentiation of vegetative organs. The most intense changes were observed during the transition from the immature to virginal period - the stage of active biomass accumulation and structural development of the plant.

This developmental dynamic is characteristic of perennial mountain species, especially those that are exposed to strong abiotic stressors in their early stages. As the analysis showed, the high degree of variability in immature and virginal individuals of *Ikonnikovia kaufmanniana* at the initial stage of development indicates high phenotypic plasticity, where in mature generative plants one can see the stability of structural traits associated with the adaptability of a given species to local habitat conditions. Moreover, the studied populations not only exhibited similar developmental trends but also differed in morphological traits of vegetative organs, such as leaf size. For example, generative individuals of the first population were characterized by large leaf sizes, indicating optimal habitat conditions, such as adequate moisture, favorable soil conditions, and moderate anthropogenic load. In the second population, a reduction in leaf blade size was observed, which is associated with local environmental conditions of the microrelief and low moisture availability. The evolutionary and historical growth of *I. kaufmanniana* populations in the desert-steppe lower mountain zone has led to the development of heterogeneous morphological traits within the population, with the leaf structure of this species exhibiting a distinctly differentiated dorsoventral structure. The leaf structure contains both layers of epidermis, the upper epidermis being thicker than the lower layer and covered by a protective film - the cuticle - that prevents moisture loss under the high solar radiation conditions of the study area. Morphological analysis of *Ikonnikovia kaufmanniana* showed clear differentiation of the mesophyll, where its palisade tissue is elongated and rich in chloroplasts, indicating high photosynthetic activity. Anomocytic stomata located on the lower epidermis are characteristic of many plant species adapted to arid habitats.

Thus, the morphological and anatomical structure of the rare and endangered species *Ikonnikovia kaufmanniana* demonstrates high ecological adaptation to intense solar insolation and insufficient soil moisture typical of mountainous regions.

5. Conclusion

The results of a study of the *Ikonnikovia kaufmanniana* population revealed quantitative heterogeneity in the ontogenetic structure, with a predominance of generative individuals and a small number of virginal plants. This demographic structure is characteristic of rare, endemic plant species with long life cycles, demonstrating a stable-regressive ontogenetic strategy in which population survival is ensured by the adapted lifespan stability of adult generative organisms. The intense changes in morphological traits occurring during the virginal stage of development reflect its significant role in the formation of plant life forms.

The studied traits reflect the species' long-term adaptation to mountain habitats and promote efficient photosynthesis, water balance, and mechanical stability. In general, the studied populations of *Ikonnikovia kaufmanniana* retain reproductive potential and structural integrity; however, the imbalance between young and mature age groups indicates possible constraints on sustainable regeneration. Continuous population monitoring, habitat protection, and the preservation of favorable microhabitat conditions are essential for the long-term conservation of this rare relict endemic of the Northern Tien Shan. Further research is necessary to study the population dynamics, reproductive biology, and the effects of climatic and anthropogenic factors on the current state of *Ikonnikovia kaufmanniana.*

6. Supplementary material: No Supplementary Materials.

7. Author contributions

Conceptualization - G.S.; methodology - G.S., O.K.; software - B.N., E. Zh., M.D.; validation - E. Zh., O.K., M.A.; formal analysis - G.S.; investigation: G.S., B.N., O.K.; resources: G.S., O.K., Z.R.; data curation: S.G.; writing-original draft - O.K., A. Sh.; writing- review & editing - G.S.; visualization - B.N.; supervision - G.S.; project administration - G.S. All authors have read and agreed to the published version of the manuscript.

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10. Conflicts of interest: The authors declare no conflicts of interest

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Ұзынқара жотасы флорасындағы *Ikonnikovia kaufmanniana* (Regel) Lincz. түрі популяциясының қазіргі жағдайына экологиялық баға беру

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Аңдатпа. Бұл зерттеу Қазақстанның Қызыл кітабына енгізілген және Ұзынқара жотасының екі мекендеу ортасында (Тоқай шатқалы мен Кеген асуы) кездесетін сирек кездесетін *Ikonnikovia kaufmanniana* (Regel) Lincz түрінің кешенді экологиялық және фитоценотикалық талдауын ұсынады. Сондықтан, бұл зерттеудің мақсаты эндемикалық *I. kaufmanniana* түрінің популяциясын және оның табиғи мекендеу ортасына антропогендік факторлардың әсерін анатомиялық, морфологиялық және экологиялық зерттеу жүргізу болды. Зерттеу аймағының төменгі тау белдеулерінде өсетін өсімдіктер қауымдастығында *I. kaufmanniana-ның* экологиялық тұрақтылығының төмен екенін көрсетті. *I. kaufmanniana-ның* анатомиялық және морфологиялық зерттеуі түрдің онтогенетикалық дамуының морфометриялық белгілердің жасқа байланысты өзгерістерімен байланысты ерекшеліктерін анықтады. *I. kaufmanniana* тіршілік циклінің (онтогенезінің) балауса кезеңнен генеративтік кезеңге дейін дамуы жапырақ тақтасының ұзындығы мен өсімдік биіктігінің біртіндеп жасқа байланысты өзгерістерін анықтады, бұл популяцияның дамуы үшін экологиялық оңтайлы немесе қолайлы жағдайларды көрсетеді. Зерттелген түрдің (*I. kaufmanniana*) тау жағдайларына бейімделуі механикалық және өткізгіш тіндердің дамуы сияқты анатомиялық ерекшеліктермен сипатталады. Зерттеу Ұзынқара жотасындағы сирек кездесетін және жойылып бара жатқан *Ikonnikovia kaufmanniana* (Regel) Lincz түрінің популяциясының азаюына климаттың өзгеруі, рекреация және жүйесіз жайылым сияқты адам қызметінің тікелей әсер ететінін көрсетті, бұл өз кезегінде топырақтың деградациясына әкеледі және бұл популяцияның қалпына келуіне әсер етеді.

Түйін сөздер: *Ikonnikovia kaufmanniana*; популяция; сирек өсімдік түрлері; Ұзынқара жотасы.

Экологическая оценка современного состояния популяции вида *Ikonnikovia kaufmanniana* (Regel) Lincz. флоры хребта Узынкара

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Аннотация. В данной работе проведен комплексный экологический и фитоценотический анализ редкого вида *Ikonnikovia kaufmanniana* (Regel) Lincz, занесенного в Красную книгу Казахстана, обнаруженного в двух местообитаниях хребта Узынкара (ущелье Токай и перевал Кегень). В связи с этим целью данного исследования явилось анатомо-морфологическое и экологическое изучение популяции эндемичного вида *I. kaufmanniana* и анализ влияния антропогенного воздействия на ее природное местопроизрастание. Исследование показало

низкую экологическую устойчивость *I. kaufmanniana* в растительном сообществе, произрастающем в нижних горных поясах исследуемой территории. Анатомо-морфологическое исследование *I. kaufmanniana* показало особенности онтогенетического развития вида, связанные с возрастными изменения морфометрических признаков. Процесс формирования жизненного цикла (онтогенеза) *I. kaufmanniana* от ювенильных до генеративных показал постепенное возрастное изменение длины листовой пластинки и высоты растения, что указывает на экологический оптимум или благоприятные условия для развития популяции. Адаптация исследуемого вида (*I. kaufmanniana*) к горным условиям характеризуются анатомическими признаками, такими как развитие механических и проводящих тканей. В результате исследования было выявлено, что на сокращение популяции редкого и исчезающего вида *Ikonnikovia kaufmanniana* (Regel) Lincz. хребта Узынкара прямое влияние оказывает деятельность человека (включая рекреацию, бессистемный выпас скота) и изменение климата, которые обусловливают деградацию почвенного покрова и нарушают процесс восстановления данной популяции.

Ключевые слова: *Ikonnikovia kaufmanniana*; популяция; редкие виды растений; хребет Узынкара.