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Study of the distribution of Linaria cretacea in Kazakhstan and neighboring countries: data from an electronic herbarium

Linaria cretacea Fisch. ex Spreng., commonly known as chalk toadflax, is a rare calciphilous species in the family Plantaginaceae, listed in the Red Data Books of Kazakhstan and Ukraine. Here, we present a synthesized overview of its distribution derived from digitized herbarium records (Kazakhstan, Russia, Ukraine) and recent field surveys in the Aktobe Region, alongside an ecological characterization of its chalk-derived habitats. The species' range is highly disjunct, spanning eastern Ukraine, the southern European part of Russia (Don River basin), and the far northwestern corner of Kazakhstan. Most populations occur on exposed, rubbly chalk slopes—so-called "chalk mountains." We analyzed specimen data and observations by region and year, producing summary maps and distribution tables. In Kazakhstan, only a handful of isolated populations in the Aktobe Region have been confirmed by up-to-date collections and in situ observations. Key habitat features include calcium-rich substrates, continental steppe climate, and a specialized chalk flora. We discuss the low population densities and high vulnerability of *L. cretacea* owing to its narrow ecological niche and anthropogenic threats—chalk quarrying, livestock grazing, and successional overgrowth. The current conservation status across its range is reviewed, and recommendations for population monitoring and protection are offered. We conclude by emphasizing the scientific importance of chalk ecosystems and the urgent need to safeguard these refugia for relict plant species.

Keywords: Linaria cretacea, distribution, Kazakhstan, electronic herbarium, field research, vulnerability, monitoring, plant protection.

Introduction

Significance of Studying Linaria cretacea

Linaria cretacea Fisch. ex Spreng. is a perennial herb of the Plantaginaceae (formerly Scrophulariaceae), strictly confined to chalk outcrops. Its relictual range, centered around the eastern Black Sea region, makes it of high conservation concern. The species features in the national Red Data Books of Kazakhstan and Ukraine, as well as in various regional conservation lists within the Russian Federation. Its restricted habitat—where Upper Cretaceous chalk emerges at the surface—combined with ongoing human pressures, renders *L. cretacea* particularly susceptible to local extirpations. Consequently, a detailed understanding of its distribution, population dynamics, and habitat requirements is essential to formulate effective preservation strategies.

Geographic and Taxonomic Context

The natural range of *L. cretacea* is fragmented into three main clusters: (1) the eastern Ukrainian chalk ridges of Luhansk and Donetsk oblasts; (2) disjunct pockets across the southern European Russian steppes (notably in Belgorod, Voronezh, Saratov, Volgograd, and Rostov oblasts, with outliers in Ulyanovsk Oblast); and (3) the westernmost limit in the C is Ural region (Orenburg Oblast) extending into northwestern Kazakhstan (Aktobe Region). This patchwork distribution spans a broad east‑west and north‑south gradient, reflecting both geological constraints (chalk exposed in "island" outcrops) and historic biogeographical processes. Systematically, *L. cretacea* belongs to the genus *Linaria Mill*., with earlier synonyms such as Linaria creticola Kuprian now consolidated under the accepted name *L. cretacea*.

Objectives

The present study aims to collect and analyze up-to-date information on the occurrence of *L. cretacea* in Kazakhstan and neighbouring countries with the following specific objectives:

- To collect occurrence records from electronic herbarium databases and existing literature.

- To supplement these historical data with results of targeted field studies, especially in the Aktobe region of Kazakhstan.
- To map and tabulate the geographical distribution of the species by region and collection date.
- To characterize the ecological and geomorphological conditions of its habitats on chalk outcrops.
- To assess the current status of known populations and identify the main threats.
- To propose practical recommendations for the ongoing monitoring and conservation of *L. cretacea*.

Materials and methods of research

Herbarium Data Sources

To delineate the distribution of *L. cretacea*, digitized specimen records from several major online herbariums were used: the National Herbarium of Kazakhstan (Institute of Botany and Phytointroduction, Almaty) provided collections from western Kazakhstan; the Herbarium of the Komarov Botanical Institute (LE, St. Petersburg) and the Herbarium of Moscow State University (MW) provided material covering European Russia and the Cis-Urals; and Ukrainian collections (Kholodny Institute of Botany, NASU — KW — and various university herbaria) provided finds from eastern Ukraine. For each digital record, label information was extracted, including the modern administrative location, geographic coordinates, collection date, repository, and collector's name. In total, about fifty *L. cretacea* specimens dating from the late 19th to early 21st centuries were studied across the species' range [1].

Field Surveys and Observations

Particular attention was paid to current locations in Kazakhstan. In 2023, a study of natural cenopopulations of *L. cretacea* was conducted in the natural population of the species in the Ishkargantau chalk massif (Fig. 1).

Figure 1. Ishkargantau chalk massif (photo by the author)

GIS Analysis.

A geodatabase of *L. cretacea* occurrence points was compiled.

Habitat and ecology data processing

Habitat characterization was based on field notes and published ecological reports. For each site, substrate type (hard chalk, shingle chalk, or marl), slope aspect and gradient, evidence of recent erosion or vegetation cover, and degree of disturbance were recorded.

Conservation status assessment

Based on national and regional Red Data Books and recent botanical literature, the rarity categories assigned to *L. cretacea* across its range were reviewed, and the populations occurring within protected areas were identified. The situation in Kazakhstan has been studied in detail: despite its inclusion in the national

Red Book, no formal protection measures currently protect the known habitats of this species in the Aktobe region, which highlights the urgent need for special conservation measures.

Description of the data set

L. cretacea occurrence table in Darwin Core format (occurrence.csv) with the following fields: occurrenceID, scientificName, eventDate, country, stateProvince, locality, decimalLatitude, decimalLongitude, basisOfRecord, etc.

Link: https://github.com/olessya-max/linaria-cretacea.git

Results and discussions

Regional distribution of Linaria cretacea

The known localities of *L. cretacea* form a highly fragmented range concentrated in three main areas:

Eastern Ukraine — mainly in the Luhansk and Donetsk regions, corresponding to the chalk-rich Seversky Donets River catchment and adjacent chalk ridges;

Southeastern European Russia — primarily the Don River basin and the lower Volga-Don interfluve (Belgorod, Voronezh, Rostov, Volgograd, Saratov regions), with distant records extending north to the Ulyanovsk region;

The Cis-Urals and Northwestern Kazakhstan — chalk outcrops of the Orenburg region (Russia) and the adjacent Aktobe region (Kazakhstan).

In each of these zones, *L. cretacea* is associated with steppe landscapes wherever chalk outcrops pierce the surface. The composite map (Fig. 2) displays all verified localities taken from literature, herbarium specimens, and fieldwork.

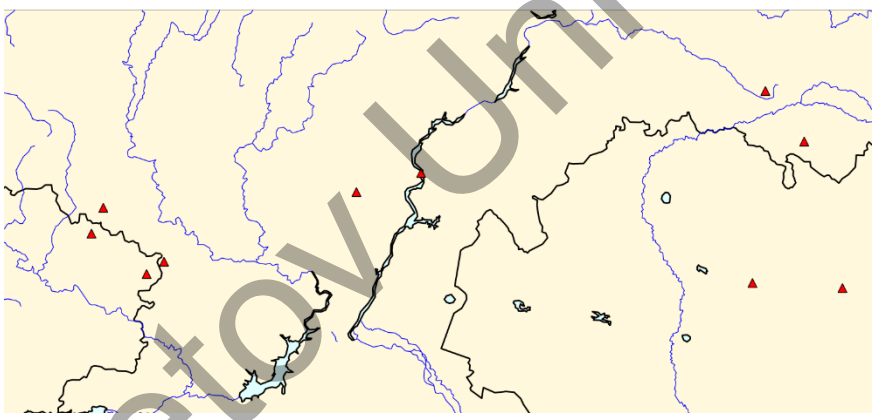

Figure 2. *Linaria cretacea* distribution: triangles marking the species locations in Eastern Europe and Northwestern Kazakhstan

In Ukraine, *L. cretacea* is found exclusively in the Far East of the country. Classic localities include the environs of Slavyansk and Svyatogorsk (Donetsk Oblast) and the chalk outcrops near Streltsovka (Meloevsky district, Luhansk Oblast), in particular the “Streltsovka steppe”. These localities provided the original specimens on which Fischer and Sprengel based their 1825 description. Recent field visits (e.g. 2017) have confirmed its persistence on the chalk cliffs around Streltsovka. Although some populations have been degraded by industrial development and regional conflicts, *L. cretacea* remains listed in the 2009 Red Data Book of Ukraine as a vulnerable species, known only from these two areas.

Throughout southern and central European Russia, *L. cretacea* occurs in scattered colonies. The northernmost stands are in Belgorod and Voronezh Oblasts, marking the upper boundary of the Cretaceous steppe flora. In Belgorod (e.g. Rovensky District, Nagolnoye village), field confirmations date back to no later than 2019. In Voronezh, there are several historical sites (Liski, Rossoshansky, Kantemirovsky Districts) with herbarium material covering the 1930s–1980s. To the south, along the Don River, the species occupies chalk hills in Rostov Oblast and on river banks in Volgograd Oblast (Olkhovsky, Kalachevsky Districts). In Saratov Oblast, it has been known from the Khoper and Medveditsa valleys since the 1990s, and the only record from the early 20th century exists on the right bank of the Bityug River in Ulyanovsk Oblast. Each of these regions includes *L. cretacea* in its own Red Book (categories from II — decreasing numbers, to III — rare).

Although population sizes are generally small and declining, some clusters (for example, along the Don in the south of Voronezh and north of Rostov regions) still form locally abundant stands.

Orenburg region is the easternmost outposts of the Eurasian distribution of the species. Here, two key chalk massifs — Sol-Iletsky (Upper Chebendinsky Mountains) and Perevolotsky (Chesnokovsky Hills) — yielded records from the mid-2000s: herbarium collections in 2008 and 2015 on the slopes of the Chesnokovsky Ridge and field observations in 2016 on the Upper Chebendinsky Ridges. These steppe semi-desert outcrops are floristically distinct from European sites, but demonstrate the species' tolerance of more continental climates. *L. cretacea* is classified as rare (category III) in the regional Orenburg Red Book, with explicit calls for population monitoring [2].

In Kazakhstan, *L. cretacea* reaches its eastern limit, today bounded by the northwest Aktobe Region. The following chalk localities have been studied:

Akyrap. The Ishkargantau chalk ridge is located southwest of the village of Akyrap, Kobdinsky District, Aktobe Region (about 15–17 km) and 70–80 km northwest of the village of Kursay. The chalk ridge consists of high cliffs and deep ravines rising separately from the surrounding plains.

Two chalk massifs in the Khobdinsky District, Aktobe Region, should be designated as natural monuments. One of them, Mount Shangrou, is located 15 km west of the village of Akrab, on the left bank of the Bolshaya Khobda. The other, Mount Itas, or Zhantyztau, is located 13 km southwest of the village of Novonayezhdinkiy in the upper reaches of the Kil River.

The Aktolagay Ridge is located in the Baiganinsky District. The length of the mountain range is 90 km, the width is 5–10 km, and its highest point is Mount Kiyakty (217 m). The difference in altitude on the plateau ledge reaches more than 130 m. It connects with the Caspian Lowland along the bank of the Zhem River. The ridge is composed of chalk rocks.

Bestau is a chalk mountain that occupies the east and northeast of the village, 40–45 km from the village of Kobda. It is located approximately 4-5 km south of the nearest rural district of Bestau (former Pyatigorka). Consequently, in Kazakhstan, *L. cretacea* is highly localized, and its total national range covers only a few tens of square kilometers. First listed in the Red Book of the Kazakh SSR in 1981 and assigned to Category II (rare) in the Red List of Kazakhstan in 2006, none of these remnant populations currently fall within any of the protected areas [3–5].

Table 1

Analysis of the electronic herbarium of the distribution of *Linaria cretacea*

Region	Number of samples	Main locations	Collection date	Data source	Notes
Kazakhstan	15	Aktobe region, Uralsk, Kostanay, Pavlodar	1950-2020	Institute of Botany and Phytointroduction	The most complete data on the distribution of the species.
Russia	36	Southern Urals, Siberia, Altai	1955-1990	Electronic Herbarium of the Kyrgyz National Academy of Sciences	Limited number of specimens, requires clarification.
Ukraine	18	Kharkiv region, Lugansk region,	1904-1970	Russian Academy of Sciences, Moscow State University	
General information	69	-	-	-	Need for further research.

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Table 2

Additional data on herbarium specimens from the electronic herbarium of the Institute of Botany and Phytointroduction»

Family	Genderindex	View	Region	Collection (label)	Date	Collectorsanddeterminants
Scrophu-lariaceae	7480Linaria	Linaria cretaceaFisch.ex Spreng.	Spurs of the Common Syrt	Ural region Okr.g. Uralsk.	01.06.1925	Poyarkova T. F.
Scrophu-lariaceae	7480Linaria	Linaria cretaceaFisch.ex Spreng.	Embinsky	Adaevsky u. Between the river Amboy and Ust-Urtom. Chalk outcrops between Kopty-Kuduk and Khan-dyurt-kul.	14.06.1926	Rozhevits R. Yu., Ilyin M. M., Avramchik M. N.
Scrophu-lariaceae	7480Linaria	Linaria cretaceaFisch.ex Spreng.	Embinsky	Adaevsky u. Between the river Amboy and Ust-Urtom. G. Burlyu-pak on the river. Embe. Chalkoutcrops.	29.06.1926	Krasheninnikov I. M.
Scrophu-lariaceae	7480Linaria	Linaria cretaceaFisch.ex Spreng.	Embinsky	Adaevsky u. Between the river Amboy and Ust-Urtom. ChalkmountainAk-tau.	10.06.1926	Rozhevits R. Yu., Ilyin M. M., Avramchik M. N.

Digital herbarium analysis shows that *L. cretacea* (Fig. 3) is quite widespread in Kazakhstan, especially in the Aktobe region, where most of the specimens are concentrated. This is supported by data collected from various sources, including herbarium collections, which indicate the presence of stable populations in this region. For example, in the Aktobe region, 15 specimens were recorded, collected between 1950 and 2020, which highlights the importance of this region for the conservation of this species [6, 7]. Also, the studies of Aubakirova, Baytenov and others demonstrate the use of data from herbariums for a more detailed study of the flora and fauna of Kazakhstan [8, 9].

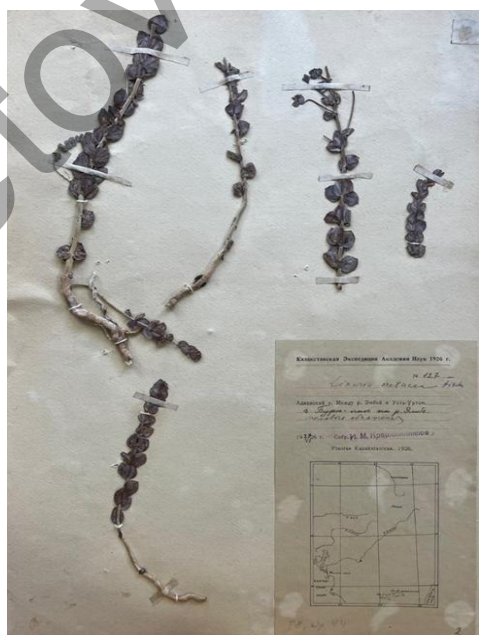

Figure 3. Herbarium of Linaria cretacea

Ecological characteristics of habitats

Landforms and soils. *L. cretacea* is an obligate calciphile, associated with outcrops of Upper Cretaceous chalk and marl. It thrives on steep, often south-facing, chalk escarpments where the substrate is either bare

rock or a thin layer of humus over chalk rubble, an extreme edaphic environment with very high calcium carbonate content. The species is absent from areas where continuous turf has formed on the chalk; it prefers fresh erosional landforms such as scree slopes, gully walls, and isolated outcrop hills. In the Cis-Urals and northwest Kazakhstan, these chalk ridges — locally known as "chalk mountains" — rise 150–200 m above the surrounding semi-desert steppe plain. A typical habitat with scattered individuals on an open chalk slope is shown in Figure 4.

Figure 4. Chalk toadflax (*Linaria cretacea*) on an open chalk slope, ID:44-228-5009 [10]

Climate. All known populations of *L. cretacea* inhabit the conditions of moderate continental steppe climate. Winters are cool (average January temperature fluctuates from –5 °C in the southern sectors to –15 °C in the north), and summers are hot (average July temperature from +22 to +25 °C). Annual precipitation decreases from west to east — from 450–500 mm in Ukraine and western Russia to 300–350 mm in the foothills of the Urals and Aktobe region — often falling in the form of irregular heavy showers. Due to their height and white substrate, chalk ridges are intensely heated by direct sunlight and are subject to rain erosion. *L. cretacea* demonstrates xerophytic adaptations: a glaucous leaf surface and a short growing season (flowering in June–July followed by partial death of the above-ground parts). In dry springs the number of flowering shoots may be sharply reduced; the plant survives by means of rhizomes and recovers when moisture conditions improve. Thus climatic limitations act in combination with substrate sparseness to limit the distribution of the species.

Plant community context. In each locality *L. cretacea* occurs in chalk steppe communities — petrophyll grasslands dominated by calciphilous forbs and dwarf shrubs. Common associate species include Euphorbia cretophila (chalk spurge), Polygala cretacea (chalk spurge), Matthiola fragrans (fragrant rootstock), Gypsophila paniculata (paniculate gypsophila) and low shrubs such as Artemisia salsoloides and cushion plants such as Nanophytonerinaceum. On more stable grassy chalk plateaus (with tussocks of Stipa capillata and Astragalus spp.) *L. cretacea* is displaced and absent. Its optimum occurs on unstable screes and fresh eroding slopes, where it is one of the few perennials able to establish near small shrubs and annuals. The complete absence of soil (vertical chalk surfaces) is also unsuitable; the species prefers small terraces or benches that capture enough substrate for rooting. The texture — fine chalk rubble — is crucial for seedling establishment and vegetative regeneration. These consistent edaphic requirements throughout its range emphasize the narrow specialization of the species to chalk ecotopes [11].

Population Size and Trends

Across its entire range, *L. cretacea* exists in small, discrete populations, each typically comprising only a few to a few dozen individuals on sites of a few hundred square meters to a hectare. For example, most colonies in Belgorod and Voronezh oblasts consist of 10–30 flowering shoots—and rarely up to 100—while Orenburg Oblast populations number 20–50 plants. In Kazakhstan, each known site contains no more than around 50 specimens. Detailed morphometric studies of four populations in Aktobe Region reveal similar demographic structures: a dominance of mature, reproductive individuals, limited recruitment of seedlings,

and an overall density of only 2-3 plants per 10 m². These data suggest stable but low reproductive output, with population sizes remaining at a consistently low plateau.

Historical comparisons indicate either stable low numbers or outright declines since the mid‑20th century, likely driven by habitat destruction and successional change. In Rostov Oblast, several 1980s sites have not been relocated in 2000s surveys—probably lost to slope exploitation or shrub encroachment. In Voronezh Oblast, once-common stands along the Toluchëevka and Bityug rivers now survive as mere isolated clumps. In Luhansk and Donetsk oblasts, industrial land use and regional conflicts have further contracted the species' footprint. Nonetheless, some strongholds—such as the Don valley border between Voronezh and Rostov oblasts, and the Streltsivska Steppe reserve in Luhansk—still harbor hundreds of individuals, serving as refugia for chalk flora.

Long-term monitoring in protected sites is rare but encouraging: in the Belogorye Nature Reserve (Belgorod Oblast), a chalk slope population of approximately 50 plants has shown no decline over two decades of observation. Such cases remain exceptional. The prevailing pattern is one of acute vulnerability and potential extirpation of local populations absent ongoing management and monitoring.

Limiting Factors and Threats

Substrate Specialization. The primary natural constraint on *L. cretacea* is its strict dependence on pure chalk substrates. The species cannot establish on any soil type other than freshly exposed Cretaceous chalk, which confines its distribution to isolated "islands" of chalk outcrops. Even within these sites, it occupies only very specific microhabitats—rocky scree slopes with minimal plant competition. This extreme habitat specialization fragments its range into discrete patches, effectively isolating populations and limiting gene flow. Such isolation fosters genetic differentiation among colonies and may reduce their resilience to environmental stress.

Livestock Grazing and Trampling. Although chalk slopes are generally unsuitable for agriculture, they are often used informally as summer grazing grounds. Cattle and sheep are herded along narrow trails across chalk outcrops, causing direct mechanical damage to plants and accelerating soil erosion. A single herd can wipe out an entire small colony, since *L. cretacea* grows in tight patches. Hoof compaction also degrades the fragile chalk substrate, impeding seedling establishment and further diminishing recruitment. Grazing pressure thus contributes significantly to population declines, especially where no formal protection exists.

Chalk Quarrying. Chalk is a valuable raw material for construction and industry, and many chalk hills have been exploited by quarry operations. In quarries, vegetation cover is completely removed, eradicating all local populations. For instance, in Donetsk Oblast, several historic *L. cretacea* sites were destroyed by mid‑20th‑century mining. While active extraction has not yet impacted the known populations in Kazakhstan and Orenburg Oblast, future development plans for these resources pose a potential risk to the remaining colonies.

Successional Overgrowth. Where grazing or quarrying cease, open chalk slopes often undergo natural succession. Pioneer shrubs (e.g., Caragana frutex, Rosa spinosissima) and turf‑forming grasses gradually colonize eroded scree, shading out *L. cretacea*. As these microhabitats stabilize and lose their bare-rock character, suitable niches vanish. Paradoxically, limited natural disturbance—minor rock falls or ephemeral erosion—is essential to maintain the sparse, open conditions that *L. cretacea* requires. Both cessation and intensification of disturbance (through uncontrolled grazing) can upset this balance and lead to habitat loss.

Conservation Status and Current Measures. *L. cretacea* is legally protected at national and regional levels across its range. It is classified as Rare or Vulnerable in the Red Data Books of Ukraine and Kazakhstan and appears in the regional Red Data Books of at least eight Russian oblasts. Some populations occur within existing protected areas—such as Belogorye Nature Reserve (Belgorod Oblast), the Toluchëevka River steppes (Voronezh Oblast), and several nature monuments in Luhansk Oblast. However, most colonies lie outside any formal conservation unit. In Kazakhstan, none of the chalk ridges harboring the species have protected status, a gap highlighted by recent studies as a serious threat even to currently stable populations. Immediate action is needed to initiate monitoring and protective measures.

Recommendations for Monitoring and Conservation

Long‑term Population Monitoring. Establish fixed monitoring plots at each known *L. cretacea* site. Conduct systematic counts of individuals, record demographic structure, and assess habitat condition annually or every 2-3 years. In Kazakhstan, these plots should be set on the Ishkargantau and Akshatau ridges; in

Orenburg Oblast on the Upper Chebendinsky and Chesnokovsky hills; and in Ukraine and Russia at key chalk reserves and steppes. Local botanical institutions and universities should be enlisted for ongoing data collection and analysis.

Designation of New Protected Areas. Expand the network of conservation reserves to include the most important chalk ecosystems supporting *L. cretacea*. In Aktobe Region, Kazakhstan, confer "nature monument" status on one or more chalk ridges (e.g., Ishkargantau, Akshatau) to secure legal protection against mining and unmanaged grazing. Similarly, in Orenburg Oblast, establish a dedicated zakaznik (protected landscape) on the Chesnokovsky chalk hills, where multiple rare chalk-specialist species co‑occur. Existing reserves in Russia and Ukraine should have their management plans reviewed and amended to prohibit any slope-disturbing activities.

Regulation of Grazing and Quarrying. For populations outside protected zones, engage local herders and land users in management plans. Restrict livestock access to critical slopes during the species' growing season (spring–summer) by creating alternative herding routes. Legally ban any new chalk mining within known *L. cretacea* habitats and direct extraction to less biodiverse areas. Public information campaigns—including informational signage at trailheads—should raise awareness of the species' protected status and the importance of preserving chalk ridges.

Ex Situ Conservation and Reintroduction Research. Seed collection and cultivation experiments should be initiated in regional botanical gardens (e.g., Voronezh State University, Almaty Botanical Garden, Astana Scientific Center). Maintaining living ex situ populations will safeguard the genetic diversity of *L. cretacea* and allow for propagation trials. Parallel development of reintroduction protocols—using restored chalk spoil slopes or artificially created scree terraces—can pave the way for population reinforcement or reestablishment at sites where the species has been extirpated. Although technically challenging, these measures offer a promising route to bolster in situ conservation outcomes.

Conclusion

Linaria cretacea is an example of a relict species of the Cretaceous flora of southeastern Europe and adjacent Asian regions. Our consolidated analysis shows that, despite its fragmented distribution and declining numbers, the species persists in isolated "islands" of the Cretaceous steppe from the Luhansk region of Ukraine, parts of Eastern Russia and its Orenburg region, and the Aktobe region of Kazakhstan. With appropriate conservation measures, Cretaceous toadflax can maintain viable populations. From a scientific point of view, *L. cretacea* is invaluable as an indicator of specialized calciphile communities and as a model for studying the evolution of narrow endemics, their morphological plasticity and genetic diversification. Moreover, it significantly enriches the biodiversity of steppe ecosystems, which are particularly vulnerable. Its chalk habitats serve as refuges for numerous rare taxa and provide insight into the evolutionary history of the Eurasian flora. Conservation of *L. cretacea* is of both national and international importance, as its range crosses many borders. Continued collaboration between botanists and ecologists from Ukraine, Russia and Kazakhstan is essential for coordinated monitoring and protection efforts. Implementation of the recommended measures—from the establishment of new protected areas to public awareness campaigns—will ensure the long-term survival of *L. cretacea* and preserve these unique "white mountains" of the steppe for future generations.

Author Contributions

The author is solely responsible for the conception, conduct of the study, data analysis, writing of the article and all aspects of publication.

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Linaria cretacea-ның Қазақстанда және оған жақын елдерде таралуын зерттеу: электронды гербарий деректері

Мақалада электронды гербарий деректеріне баса назар аудара отырып, сирек кездесетін *Linaria cretacea* өсімдік түрлерінің Қазақстанда және көршілес елдерде таралуы қарастырылған. Зерттеудің мақсаты — бұл түрдің Ақтөбе облысындағы таралу аймағын нақтылау, әсіресе борлы беткейлер оның мекендеу ортасына қолайлы жағдай туғызады. Гербарий деректерін талдау *Linaria cretacea*-ның шектеулі, бірақ айтарлықтай таралуын көрсетті, оның негізгі табылған жерлері Қазақстанда, сондай-ақ Ресей мен Украинада. Жұмыста осы түрдің өсуі үшін бор экожүйелерінің маңыздылығы атап көрсетіліп, оның таралуын жеңілдететін қоршаған орта жағдайлары сипатталған. Далалық зерттеулерде мекендеу орындары анықталды, бұл тұрақты мониторинг және популяцияның жай-күйі туралы мәліметтерді жаңарту қажеттілігін көрсетеді. Сондай-ақ мақалада *Linaria cretacea*-ның антропогендік әсерлерге және климаттың өзгеруіне әсері қарастырылып, сирек кездесетін өсімдіктер түрлерін қорғау шараларын әзірлеу қажеттілігіне баса назар аударылады. Зерттеу нәтижелері болашақ зерттеулер үшін жаңа мүмкіндіктер ашады, соның ішінде *Linaria cretacea*-ның генетикалық әртүрлілігін және басқа түрлермен өзара әрекеттесуін зерттеу, бұл сирек кездесетін түрді сақтау және қалпына келтіру стратегияларын тиімдірек дамытуға мүмкіндік береді.

Кілт сөздер: *Linaria cretacea*, таралуы, Қазақстан, электронды гербарий, далалық зерттеу, осалдық, мониторинг, өсімдіктерді қорғау.

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Изучение распространения *Linaria cretacea* в Казахстане и сопредельных странах: данные электронного гербария

В данной статье рассматривается распространение редкого вида растений *Linariac retacea* в Казахстане и сопредельных странах с акцентом на данные электронного гербария. Целью исследования является уточнение ареала этого вида, особенно в Актюбинской области, где меловые склоны создают благоприятные условия для его обитания. Анализ данных гербария показал, что *Linaria cretacea* имеет ограниченное, но значительное распространение — основные находки приходятся на территорию Казахстана, а также России и Украины. В работе подчеркивается важность меловых экосистем для произрастания данного вида и описываются экологические условия, способствующие его распространению. В результате полевых исследований были выявлены местообитания, что свидетельствует о необходимости регулярного мониторинга и обновления данных о состоянии популяций. В работе также уделяется внимание уязвимости *Linaria cretacea* к антропогенным воздействиям и изменению климата, подчеркивается необходимость разработки мер по охране редких видов растений. Результаты ис-

следования открывают новые направления для будущих работ, в том числе по изучению генетического разнообразия и взаимодействий *Linaria cretacea* с другими видами, что позволит более эффективно разрабатывать стратегии сохранения и восстановления этого редкого вида.

Ключевые слова: *Linaria cretacea*, распространение, Казахстан, электронный гербарий, полевые исследования, уязвимость, мониторинг, охрана растений.

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