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ARTICLE

New Distribution Records of *Cardaria* Desv. Species in the Flora of the Southern Caucasus (Azerbaijan)

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ABSTRACT

The article discusses the new distribution areas of species belonging to the genus *Cardaria* Desv. in the flora of the Nakhchivan Botanical-Geographical Region of the South Caucasus (Republic of Azerbaijan). Four species of the genus *Cardaria* Desv. are recorded in the flora of the Nakhchivan Botanical-Geographical Region: *Cardaria boissieri* (N. Busch) Soó (*Lepidium boisseri* N. Busch), *Cardaria draba* (L.) Desv. (*Lepidium draba* L.), *Cardaria propinqua* (Fisch. & C.A. Mey.) N. Busch (*L. propinquum* (Fisch. & C.A. Mey.)), and *Cardaria repens* (Schrenk) Jarm. Based on the expeditionary research and collected materials from the mountainous areas surrounding several settlements in the Julfa and Ordubad districts of the Nakhchivan Autonomous Republic, the following species have been identified: *Cardaria boissieri* (N. Busch) Soó, *Cardaria draba* (L.) Desv., *Cardaria propinqua* (Fisch. & C.A. Mey.) N. Busch, and *Cardaria repens* (Schrenk) Jarm. Additionally, information about the life forms, phenophases, ecological groups, distribution coordinates, altitude ranges, and geographical elements of the species has been provided. The species composition of the phytocenosis involving the species *Cardaria draba* (L.) Desv. has been studied, and these data are presented in a tabular format. In addition, information is provided on the distribution of *Cardaria* Desv. species across the Botanical-Geographical Regions of the Azerbaijani part of the South Caucasus.

Keywords: Invasive Species; Ruderal Flora; Nakhchivan Region; Floristic Monitoring; Plant Chorology

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1. Introduction

The *Brassicaceae* Burnett. family is a widely distributed group of plants in the world flora, possessing significant ecological, economic, and agrobiological characteristics. Representatives of *Brassicaceae* are notable for their roles in global food security, medicinal applications, and industrial use, and have become key subjects of numerous scientific studies. The *Brassicaceae* (Cruciferae), or mustard family, is a monophyletic group made up of roughly 338 genera and 3709 species that are found all over the world. It has numerous economically significant ornamental and crop species[1–3]. One of the largest angiosperm families, the Brassicaceae (Cruciferae), is easily identified by its floral and fruiting characteristics[4,5]. *Cardaria* Desv. is a genus belonging to the family Brassicaceae. Renowned researchers worldwide have conducted various studies on the genus *Cardaria* Desv. Specifically, comprehensive taxonomic research has been conducted on the morphological classification of five taxa within the genus Cardaria, including studies on hybrids and invasive species in North America[6]. More studies have been conducted on the merging of this genus with other genera. Numerous studies have also focused on the taxonomic reclassification of *Cardaria*, with molecular and taxonomic analyses supporting the merging of all *Cardaria* species into the genus *Lepidium*[7]. Phylogenetic relationships among genera within the Brassicaceae family have been elucidated using molecular approaches, demonstrating that *Cardaria* is nested within *Lepidium*[8]. The genus Lepidium s.l. (including Cardaria) is monophyletic (clade F) and is characterized by a reduction in stamen number from six tofour, and sometimes two. Other phylogenetic studies show that species of Coronopus and Stroganowia are also included in Lepidium[9–11]. Molecular phylogenetic analyses have demonstrated that genera such as *Cardaria*, *Coronopus*, and *Stroganowia* are nested within *Lepidium*, and these groups have been evaluated as model systems for studying evolutionary mechanisms[12].

Representatives of *Cardaria* Desv. are primarily observed in lowland and mid-mountain zones. As is well known, factors such as climate, soil, moisture, solar radiation, and others influence the distribution of plants across different areas. These factors manifest both horizontally and vertically (altitudinally). In mountainous regions, vegetation changes gradually with increasing elevation. This is due to decreasing air temperature, changes in humidity, and other ecological conditions as altitude rises. Altitudinal belts are important factors in the formation of vegetation, especially in mountainous areas. The development of vegetation varies across geographic regions and altitudinal zones. Plants growing in high mountain and low mountain zones reflect adaptations to different environmental conditions. The differences between these two habitats shape the morphological, physiological, and ecological traits of plants. In high mountain zones, temperatures are lower, the climate is harsher, and conditions are more variable. Snow cover and strong winds during winter make plant growth more difficult, often resulting in a short growing season. In contrast, low mountain zones have milder climates, more abundant water sources, and more fertile soils. Plants in these zones typically have longer growing seasons and more favorable conditions for diverse species to thrive. Plants in high mountain areas have developed specific adaptations to cope with cold environments and low oxygen levels, such as reduced leaf area and deeply developed root systems. In low mountain zones, a wider variety of life forms exist, including trees, shrubs, and various grasses. Due to the longer growing season, plants here have more opportunity to grow and flower, often becoming larger and more floriferous. Furthermore, plants in low mountain environments play broader ecological roles by producing more biomass in fertile soils, sequestering carbon, and participating actively in biogeochemical cycles. Overall, climatic and soil factors significantly affect the altitudinal distribution of plants. In the Azerbaijani part of the South Caucasus, depending on the geographical conditions of the area, wild representatives of the local flora are distributed unevenly but predictably across different altitudinal belts and occupy various ecological habitats.

Species within the genus – *Cardaria boissieri* (N. Busch) Soó (syn. *Lepidium boissieri* N. Busch), *Cardaria draba* (L.) Desv. (*Lepidium draba* L.), *Cardaria propinqua* (Fisch. & C.A. Mey.) N. Busch (*Lepidium propinquum* Fisch. & C.A. Mey.), and *Cardaria repens* (Schrenk) Jarm.- demonstrate a high level of adaptability to diverse ecological conditions. Field expeditions and observations have shown that these species are predominantly found along roadsides, in agricultural lands, semi-arid and arid areas, around irrigation channels, and sometimes in peri-urban synanthropic

landscapes. Several factors contribute to the expansion of their distribution range: anthropogenic influence, ecological plasticity, ruderal strategies, and climate change. Land cover modification, road construction, infrastructure projects, and agricultural activities facilitate the dispersal of these plants' seeds into new areas. The dominance of these species in habitats where they frequently occur and outcompete local species is related to their ruderal characteristics.

In recent years, representatives of the genus *Cardaria* Desv. have been increasingly observed across wider areas in various phytogeographical regions of the South Caucasus, particularly within the Republic of Azerbaijan. This expansion is attributed to intensified anthropogenic impacts, climate change, and the expansion of agricultural lands. In the South Caucasus region, global warming has led to decreased precipitation in certain areas and significantly higher temperatures, favoring the spread of arid and semi-arid vegetation types. Consequently, drought-resistant species of the genus *Cardaria* Desv. are finding increasingly suitable conditions for proliferation. These species are capable of developing across various soil types and wide climatic gradients. Due to this adaptability, they may gradually shift from synanthropic components to components of the natural flora.

In the Azerbaijani region of the South Caucasus, 248 species belonging to 74 genera of the *Brassicaceae* family have been recorded[13], of which 165 species from 67 genera are represented in the Botanical-Geographical Region of Nakhchivan[14,15]. The Azerbaijani part of the South Caucasus is divided into five Botanical-Geographical Regions: the Greater Caucasus, Lesser Caucasus, Kura-Araz, Talysh, and Nakhchivan regions. Representatives of the genus *Cardaria* Desv. are found across these Botanical-Geographical Regions of Azerbaijan. Specifically, *Cardaria draba* (L.) Desv. occurs in the Greater Caucasus and Nakhchivan; *Cardaria boissieri* (N. Busch) Soó (syn. *Lepidium boissieri* N. Busch) is distributed in the Lesser Caucasus and Nakhchivan; *Cardaria propinqua* (Fisch. & C.A. Mey.) N. Busch (syn. *Lepidium propinquum* Fisch. & C.A. Mey.) is found in the Greater Caucasus, Kura-Araz, and Nakhchivan; while *Cardaria repens* (Schrenk) Jarm. is confined to the Nakhchivan Botanical-Geographical Region. These findings indicate that representatives of the genus *Cardaria* Desv. are distributed in all Botanical-Geographical Regions of the Azerbaijani part of the South Caucasus, with the exception of the Talysh region[13].

Beyond their agricultural relevance, *Cardaria* Desv. species are also of interest in floristic and biogeographical studies. Their distribution characteristics play an important role in understanding the dynamics of regional flora. Several factors justify the need for floristic-systematic research on this genus, including their expanding distribution range, ecological plasticity, and economic significance. Accordingly, it is proposed that representatives of the *Cardaria* Desv. genus be given special consideration in the new classification of the flora of Azerbaijan.

Many representatives of the family, including species of the genus *Cardaria* Desv., are characterized by high ecological plasticity and adaptive capacity. These traits enable them to be widely distributed across both natural and anthropogenically influenced habitats. However, in recent years, climate changes observed at both global and local levels, particularly the increase in drought and the rise of annual average temperatures above normal, along with the overgrazing and mismanagement of pastures and meadows, as well as the rapid expansion of agricultural lands, have negatively affected the population dynamics and phytocenotic roles of several species of the Brassicaceae family, including those belonging to the genus *Cardaria*. In this context, the study of the distribution, ecological status, and population stability of *Cardaria* Desv. species in the Nakhchivan Botanical-Geographical Region of the South Caucasus, taking into account the area's geographical and bioecological characteristics, emerges as a relevant scientific issue. The aim of this study is to assess the current status of species belonging to this genus in the region, analyze changes in their distribution areas, identify potential extinction risks, and provide relevant recommendations to the Ministry of Ecology and Natural Resources of Azerbaijan.

2. Materials and Methods of Research

The research was conducted between 2022 and 2024 in the arid and semi-arid regions of the South Caucasus within the territory of the Republic of Azerbaijan. The main objective of the study was to investigate the current distribution status and bioecological characteristics of species belonging to the genus *Cardaria* Desv. within the *Brassicaceae* Burnett.

family. For this purpose, both existing floristic data were analyzed and field studies were carried out. In the study areas, various ecological biotopes were selected, taking into account different altitude zones, soil cover types, and levels of anthropogenic impact. The field research was conducted during the active phenological period of the species (June-July). Expedition routes were planned based on vegetation conditions, phenological phases, and the phytocenotic positions of the plants, and free-route surveys were conducted accordingly. Plant samples were collected following classical floristic methods, prepared as herbarium specimens, and preserved under appropriate herbarium conditions [16]. The taxonomic identification of the samples was based on major botanical references [17–20]. In order to clarify the taxonomic status and ensure nomenclatural consistency of the species, comparisons were made using international databases such as BioLib, ITIS (Integrated Taxonomic Information System), and EOL (Encyclopedia of Life) [21–23]. The map depicting the newly identified distribution areas of Cardaria Desv. species was generated using the Google Maps application. The altitudinal ranges of the *Cardaria* Desv. species recorded in the study areas were documented. The geographical coordinates of each observation site were accurately recorded using the mobile application GPS Coordinates, which played an important role in enhancing the accuracy of the measurements. The information on the coordinates of the areas where representatives of the genus Cardaria Desv. are distributed in the Nakhchivan Botanical-Geographical Region of Azerbaijan is presented in the **Table 1**.

Based on the collected coordinates, the distribution ranges of the species were mapped using Geographic Information Systems (GIS) software. Studies on phytocenosis and plant geography were conducted based on specific methodologies [24,25]. The composition of the phytocenosis in which *Cardaria draba* (L.) Desv. was involved was studied, and a list of associated plant species was compiled. The collected phytocenotic data were organized and presented in tabular form.

Table 1. Coordinates of new distribution areas of *Cardaria* Desv. species in the Nakhchivan Botanical-Geographical Region (South Caucasus).

№	New Distribution Areas	Latitude	Longitude	Meters above Sea Level (m.a.s.l)	Ecological Environment	Date of Specimen Collection
1.	Arafsa village	39°18'25.11"	45°48'22.13"	1825 m	Dry slopes	05/04/2022
		39°19'13.99"	45°49'51.04"	1883 m	Rocky slopes	28/05/2023
		39°16'15.80"	45°48'59.16"	1788 m	Shrublands	02/07/2023
2.	Nurgut village	39°12'48.16"	45°55'43.41"	2441 m	Grasslands	12/04/2022
		39°14'25.04"	45°53'30.11"	2217 m	Arid areas	18/06/2022
		39°13'35.44"	45°52'13.62"	2202 m	Fields	20/05/2024
3.	Bekakhmed village	39°15'39.34"	45°55'56.22"	2479 m	Weedy areas	23/06/2022
		39°15'22.13"	45°53'30.86"	2457 m	Dry slopes	12/07/2022
		39°18'27.36"	45°52'15.33"	2369 m	Cultivated fields	07/04/2023
4.	Milak village	39°17'26.98"	45°45'03.80"	1781 m	Grasslands	22/04/2023
		39°16'28.65"	45°45'37.87"	1503 m	Roadside	15/06/2023
		39°16'19.08"	45°43'40.60"	1466 m	Arid areas	30/06/2024
5.	Teyvaz village	39°14'50.02"	45°47'52.02"	2038 m	Rocky slopes	17/05/2022
		39°14'06.09"	45°47'10.85"	1669 m	Grasslands	20/04/2023
		39°14'21.49"	45°44'34.11"	1562 m	Fields	05/06/2023

3. Obtained Results and Their Discussion

The expansion of *Cardaria* Desv. species in some regions of the South Caucasus (particularly in Azerbaijan) is causing noticeable changes in the local flora. For example, *Cardaria draba* (L.) Desv. and other species can exhibit invasive behavior in newly colonized areas, negatively impacting native plant populations. Being considered harmful weeds, their influence is particularly noticeable in agricultural landscapes. For instance, *Cardaria draba* (L.) Desv. is widely distributed as a weed in cotton, grape, cereal, and vegetable fields, where it significantly reduces crop yields. This poses a serious challenge for farmers, necessitating weed management strategies in cultivated lands.

The morphological characteristics of species within the *Cardaria* Desv. genus distinguish them among the Brassicaceae family. These species are mainly annual, biennial, or

perennial herbs (rarely subshrubs) based on their life forms. Their inflorescences are racemose and composed of small flowers. The four petals are typically white, and the fruit is a silicle. Some species have petioles and leaves covered with fine hairs. These features are ecologically and morphologically significant, as the presence of hairs reduces transpiration and enhances adaptation to arid conditions. Some species, however, are more commonly found in humid environments or near water bodies.

It is well known that a plant's biological traits significantly affect its dispersal intensity. These species are capable of both vegetative and generative reproduction. In particular, *Cardaria draba* (L.) Desv. reproduces via seeds as well as root structures, a trait that enhances its invasive potential. The species exhibits a high capacity for vegetative reproduction, which sets it apart from other species in terms of dispersal intensity. The seeds have a high germination rate and can remain viable in the soil for extended periods. Their ability to overwinter and germinate quickly in spring allows them to develop earlier than other plant species.

Phenological observations indicate that *Cardaria* Desv. species typically begin vegetative growth at the end of March and flower in May-June. Fruits form by July, with full ripening occurring during the summer months. During this period, the plants compete with crops for water and nutrients, leading to significant weed issues in cultivated areas.

Research has shown that several ecological factors create optimal conditions for the spread of *Cardaria* Desv. species. These include light- to medium-textured soils, adequate levels of nitrogen (N) and phosphorus (P) in the soil, low summer precipitation, and high temperatures. Such factors enhance the heat and drought resistance of *Cardaria* Desv. representatives. Currently, *Cardaria* Desv. species in the flora of Azerbaijan (South Caucasus) are regarded as both synanthropic and semi-synanthropic, indicating their parallel distribution in both natural and anthropogenic habitats.

The new distribution areas of species from the genus *Cardaria* Desv. are the Julfa and Ordubad regions of the Nakhchivan Phytogeographical District in the South Caucasus (**Figure 1**). These areas possess unique geological, climatic, and soil characteristics. The relief of the Julfa district is diverse, and it is located in the western part of the Nakhchivan Autonomous Republic. The presence of both mountainous and lowland areas significantly influences the biodiversity of the region. Heliophytic plant species are widespread in the sunny, open landscapes of the district, while xerophytic plants dominate the arid and steppe-like areas. Along rivers and in moist valleys, mesophytic plant species are typically found. The simultaneous presence of both arid and humid conditions in the Julfa district is a characteristic feature, which positively affects the diversity of the vegetation. This variety is mainly due to the district's biogeographical location and relief features. In the lower and middle mountainous zones of Julfa, mountain-brown soils are predominant. These soils typically contain relatively high levels of humus and are characteristic of steppe and mountain xerophyte zones. The district's soils mainly include mountain-meadow, mountain-forest, mountain-chestnut, brown, gray, and meadow-gray soil types. In Julfa, mountain-steppe vegetation, forest plants, and subalpine and alpine meadows are widely distributed. Ordubad district is a mountainous area located in the eastern part of the Nakhchivan Autonomous Republic. Its relief is more complex and elevated, and the climate is humid and cool. This is mainly due to the district's mountainous terrain. Therefore, plant species belonging to hydro and mesophytic ecological groups are more widespread in Ordubad. Hydrophytic species are found in marshlands, riverbanks, and moist areas, while woody mesophytic forest plants are more common in the mountainous areas. These species are typically associated with relatively fertile soils. Furthermore, the structure of the vegetation cover in the district is influenced by various elevation zones, forming a multilayered ecological structure. In the high mountain zones, drought-resistant xerophytes are present; however, mesophytic and hydrophytic species constitute the dominant biomass. This contributes significantly to the ecological diversity of the district.

The mountain-forest zone of the Nakhchivan Phytogeographical Region of the South Caucasus is a natural geographical zone located in mountainous areas, characterized by a humid climate, abundant precipitation, dense forest cover, and fertile soils. In such zones, the formation of soil is shaped by the interaction of climate, relief, and vegetation. The mountainous areas of the Nakhchivan Autonomous Republic, particularly in the Ordubad and Julfa districts, fall into this category. Mountain-meadow-tundra soils are typical for this zone. These soils are light gray or sometimes ash-colored and contain moderate to low levels of humus.

They are known for their rich biodiversity and play a key role in maintaining ecosystem stability. The vegetation includes alpine meadows, thorny and shrubby plants, and mosses. Subalpine meadows represent the most productive pasture-lands and are highly suitable for livestock farming, especially sheep breeding. These soils are rare and sensitive natural components with high ecological and economic value. They are of strategic importance for animal husbandry, climate stability, and water resource conservation. The soils of the subalpine and alpine zones are characteristic of the Ordubad district (Salvartı and Qapıcıq ranges) in the Nakhchivan Autonomous Republic [26]. Such areas with specific geomorphological, climatic, and soil characteristics are suitable for the distribution of species belonging to the genus *Cardaria* Desv.

The taxonomic classification of the genus *Cardaria* Desv., which is distributed in the Nakhchivan Phytogeographical District of the South Caucasus, is as follows:

Division: *Magnoliophyta*

Class: *Magnoliopsida*

Order: *Brassicales*

Family: *Brassicaceae* Burnett.

Genus: *Cardaria* Desv.

Species: *Cardaria draba* (L.) Desv.

Cardaria boissieri (N. Busch) Soó (*Lepidium boisseri* N. Busch)

Cardaria propinqua (Fisch. & CA Mey.) N.Busch (*L. propinquum* (Fisch. & C.A. Mey.)

Cardaria repens (Schrenk) Jarm.

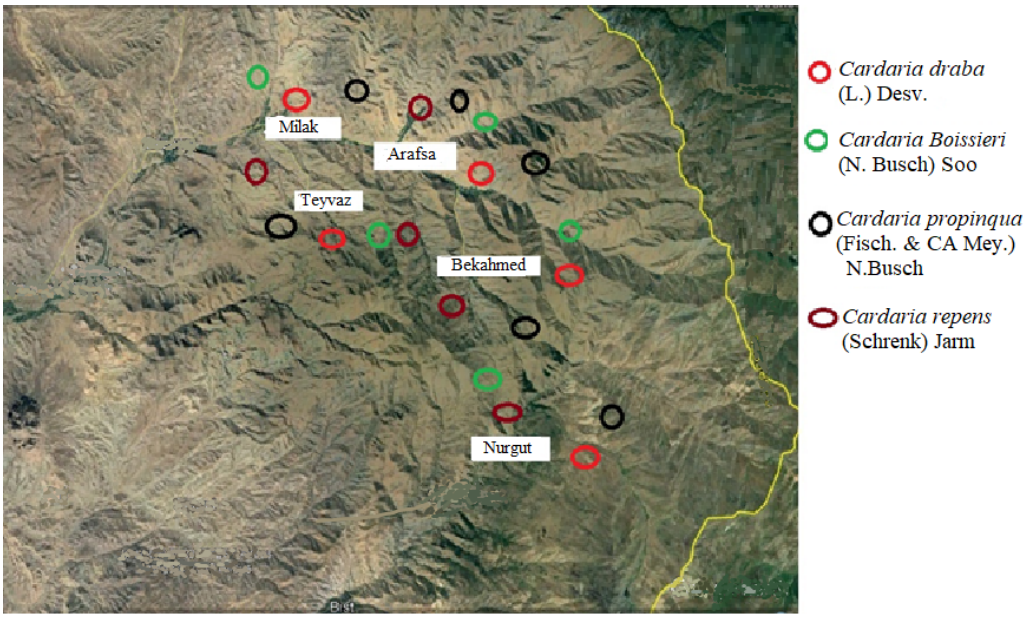

Figure 1. Habitat of species of the genus *Cardaria* Desv. (Nakhchivan Botanical-Geographical Region).

Species *Cardaria boissieri* (N.Busch) Soó and *C. draba* (L.) Desv. have been found in the territory of the Shahbuz district, and have medicinal and ornamental properties [27–29]. A number of authors have proposed the inclusion of *Cardaria draba* (L.) Desv. in the "Black Book" of the flora of the Samara region [30]. In their work, several authors noted the distribution of plants from the *Brassicaceae* Burnett. family in various ecological-geographical conditions across different countries [31]. *Cardaria boissieri* (N. Busch) Soó is a perennial herb with a stem height of 40–60 cm. Its phenophase occurs in June, and it is widespread in the lower and middle mountain belts of the local flora, in dry slopes, weedy areas, cultivated fields, and gardens. It belongs to the xerophytic ecological group and the Eastern Asia geographical type. It has been observed around the villages of Nurgut, Arafsa, Teyvaz, Bekahmed, and Milakh.

The natural range of *Cardaria draba* is confined to the Old World, including southern Europe, northern Africa, western and parts of central Asia, and the southern part of western Siberia. At present, *C. draba* is widely distributed in non-tropical regions of Eurasia, North and South America, Australia, and Africa [32]. Due to its ecological characteris-

tics, *Cardaria draba* (L.) Desv. is resistant to anthropogenic factors in a wide range of environmental conditions [33]. The authors [34] mention *Cardaria draba* (L.) Desv. as a synonym of *Lepidium draba* L. *Cardaria draba* (L.) Desv. widely distributed in crops, along field edges, and by roadsides [35].

Cardaria draba (L.) Desv. is an annual medicinal herb with a stem height of 20–50 cm [36,37]. *C. draba* flowers serve as a pollen and nectar source for several insects. Its foliage becomes coarse and bitter as it matures, and is therefore considered unpalatable to the livestock, but sheep graze the plants at the early growth stage and cattle ingest the seed heads [38]. Its phenophase occurs in April-May, May-June (July), and it is widespread in the local flora of dry slopes, weedy areas, and fields in the plains, foothills, and sometimes the middle mountain belt. It belongs to the xeromesophytic ecological group and the Mediterranean geographical type. It is especially common on moist sandy-clay soils around the village of Bekahmed, along roadsides. It is relatively rare around the villages of Nurgut, Teyvaza, Milakh, and Arafsa.

Cardaria propinqua (Fisch. & C.A. Mey.) N.Busch is a perennial herb with a stem height of 20-50 cm. Its phenophase occurs in May-July (August), June–September, and it is widespread in the local flora in the dry slopes, shrublands, mountain meadows, and fields from the plains to the middle mountain zone. It belongs to the xerophytic ecological group and the North Iran geographical type. It has been noted that it is rarely found in relatively dry areas around the villages of Bekahmed, Nurgut, Teyvaza, Milakh, and Arafsa. However, it is widely distributed in areas near protected territories near the village of Bekahmed. The species composition of other plants that make up the phytocenosis is richer here.

Cardaria repens (Schrenk) Jarm. is a perennial herb with a stem height of 20-51 cm. Its phenophase occurs in April–July, and it is widespread in the local flora of the middle mountain zone, rocky slopes, dry, salty areas, meadows, and fields. It belongs to the xerophytic ecological group and the Eastern Asia geographical type. Collected from the vicinity of the villages: Nurgut, Teyvaza, Milakh, Arafsa, and Bekahmed, especially on the northern side of mountain slopes and in flat areas.

Representatives of the genus *Cardaria* Desv. are also distributed in various regions of the world, including Israel, Palestine, Syria, Switzerland, Georgia, Argentina, Morocco, the United States of America, Serbia, China, Japan, France, Spain, Denmark, and other countries (**Figure 2**) [39].

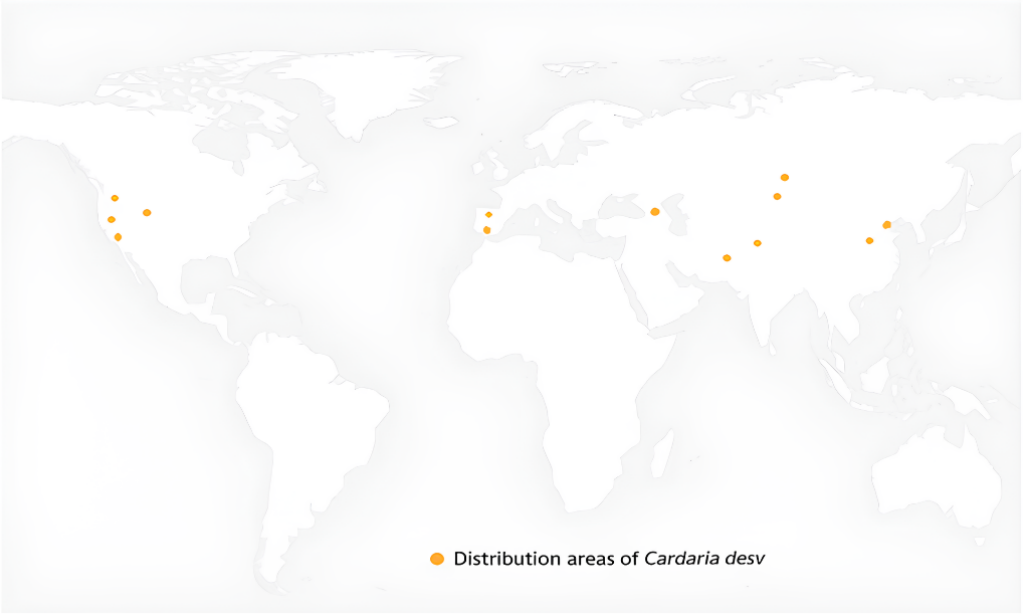

Figure 2. Geographical Distribution of *Cardaria* Species Worldwide.

In the village of Bekahmed in the Julfa district, the phytocenosis with the species *Cardaria draba* (L.) Desv. includes representatives of various genera (**Figures 3** and **4**): *Ranunculus arvensis* L., *Astragalus strictifolius* Boiss.,

Crataegus pentagyna Waldst. & Kit., *Crataegus meyeri* Pojark., *Crataegus orientalis* Pall.ex Bieb, *Pyrus salicifolia* Pall., *Hordeum bulbosum* L., *Papaver orientale* L., *Papaver fugax* Poir. *Capsella bursa-pastoris* L. (Medic), *Grammosciadium platycarpum* Boiss. & Hausskn., *Hypericum formosissimum* Takht., *Equisetum arvense* L., *Allium atroviolaceum* Boiss., *Artemisia vulgaris* L., *Trifolium alpestre* L., *Helichrysum callichrysum* DC., *Falcaria vulgaris* Bernh. [*F.siosides* (Wib.) Aschers.], *Eryngium campestre* L., *Phlomis orientalis* Mill., *Prangos ferulacea* (L.) Lindl. (*P.Biebersteinii* Karjag.), *Chaerophyllum aureum* L. (*Ch. maculatum* Willd. ex DC.), *Euphorbia orientalis* L., *Stachys lavandulifolia* Vahl., *Stachys inflata* Benth., *Iris imbricata* Lindl. (*I.ulfurea* C.Koch) and *Centaurea behen* L. [*Microlophus behen* (L.) Takht.], forming plants as shown in **Table 2**.

Figure 3. Phytocoenosis of Bekahmed village.

Figure 4. *Cardaria draba* (L.) Desv. community around the village of Bekahmed.

Table 2. The species composition of the plant community involving the species *Cardaria draba* (L.) Desv. near Bekahmed village.

№	Familia	Genus	Species	Life Forms	Ecological Groups
1.	*Equisetaceae* Michx. ex DC.	*Equisetum* L.	*Equisetum arvense* L.	Perennial	Mesophyte
2.	*Poaceae Barnhart.*	*Hordeum* L.	*Hordeum bulbosum* L.	Perennial	Xeromesophyte
3.	*Rosaceae* Juss.	*Crataegus* L.	*Crataegus pentagyna* Waldst. & Kit.	Shrub	Mesoxerophyte
4.	*Rosaceae* Juss.	*Crataegus* L.	*Crataegus Meyeri* Pojark.	Shrub	Mesoxerophyte
5.	*Rosaceae* Juss.	*Crataegus* L.	*Crataegus orientalis* Pall.ex Bieb	Shrub	Mesoxerophyte
6.	*Rosaceae* Juss.	*Pyrus* L.	*Pyrus salicifolia* Pall.	Tree	Xerophyte
7.	*Brassicaceae* Burnett	*Capsella* Medik	*Capsella bursa-pastoris* L. (Medik)	Annual	Mesophyte
8.	*Fabaceae* Lindl.	*Astragalus* L.	*Astragalus strictifolius* Boiss.	Shrub	Xerophyte
9.	*Fabaceae* Lindl.	*Trifolium* L.	*Trifolium alpestre* L.	Perennial	Mesophyte
10.	*Papaveraceae* Juss.	*Papaver* L.	*Papaver orientale* L.	Perennial	Xeromesophyte
11.	*Papaveraceae* Juss.	*Papaver* L.	*Papaver fugax* Poir.	Biennial	Xerophyte
12.	*Hypericaceae* Juss.	*Hypericum* L.	*Hypericum formosissimum* Takht.	Perennial	Xerophyte
13.	*Amaryllidaceae* J.St.-Hil.	*Allium* L.	*Allium atroviolaceum* Boiss.	Perennial	Xerophyte
14.	*Asteraceae* Bercht. & J.Presl	*Artemisia* L.	*Artemisia vulgaris* L.	Perennial	Mesokerophyte
15.	*Asteraceae* Bercht. & J.Presl	*Helichrysum* Mill.	*Helichrysum callichrysum* DC.	Perennial	Xerophyte
16.	*Asteraceae* Bercht. & J.Presl	*Centaurea* L.	*Centaurea Behen* L.	Perennial	Mesophyte

Table 2. *Cont.*

№	Familia	Genus	Species	Life Forms	Ecological Groups
17.	*Apiaceae* Lindl.	*Grammosciadium* DC.	*Grammosciadium platycarpum* Boiss. & Hausskn.	Perennial	Mesoxerophyte
18.	*Apiaceae* Lindl.	*Falcaria* Fabr.	*Falcaria vulgaris* Bernh.	Biennial (sometimes perennial)	Mesophyte
19.	*Apiaceae* Lindl.	*Eryngium* L.	*Eryngium campestre* L.	Perennial	Xerophyte
20.	*Apiaceae* Lindl.	*Prangos* Lindl.	*Prangos ferulacea* (L.) Lindl.	Perennial	Xeromesophyte
21.	*Apiaceae* Lindl.	*Chaerophyllum* L.	*Chaerophyllum aureum* L.	Perennial	Mesophyte
22.	*Lamiaceae* Martinov	*Phlomis* L.	*Phlomis orientalis* Mill.	Perennial	Xerophyte
23.	*Lamiaceae* Martinov	*Stachys* L.	*Stachys inflata* Benth.	Subshrub	Xerophyte
24.	*Lamiaceae* Martinov	*Stachys* L.	*Stachys lavandulifolia* Vahl.	Annual	Xerophyte
25.	*Euphorbiaceae* Juss.	*Euphorbia* L.	*Euphorbia orientalis* L.	Perennial	Xeromesophyte
26.	*Iridaceae* Juss.	*Iris* L.	*İris imbricata* Lindl	Perennial	Xerophyte
27.	*Ranunculaceae* Juss.	*Ranunculus* L.	*Ranunculus arvensis* L.	Annual	Mesophyte

In the phytocenosis involving *Cardaria draba* (L.) Desv. in the Bekahmad area of the Julfa district, 27 plant species are present. According to the ecological group, 11 species are xerophytes (40.74%), 7 are mesophytes (25.92%), 5 are mesoxerophytes (18.51%), and 4 are xeromesophytes (14.81%). According to life form, 16 species (59.25%) are perennials, 3 species (11.11%) are annuals, 2 species (7.40%) are biennials, and 6 species (22.22%) are woody plants (4 shrubs, 1 subshrub, 1 tree). The dominant species of the phytocenosis is *Grammosciadium platycarpum* Boiss. & Hausskn. Perennial herbaceous plants dominate the formation.

Phytocenosis: 1. *Heracleum sp.* 2. *Galium album* Mill. 3. *Astragalus karjaginii* Boiss. 4. *Astragalus regelii* Trautv. 5. *Campanula armena* Steven 6. *Campanula glomerata* L. 7. *Lallemantia peltata* (L.) Fisch. & C.A. Mey. 8. *Tussilago farfara* L. 9. *Melilotus officinalis* (L.) Lam. 10. *Hordeum bulbosum* L. 11. *Acer ibericum* M. Bieb. ex Willd. 12. *Galium verum* L. 13. *Pyrus salicifolia* Pall. 14. *Coronilla varia* L. 15. *Salix caprea* L. 16. *Stachys pubescens* Ten. 17. *Stachys lavandulifolia* Vahl. 18. *Trifolium pratense* L. 19. *Teucrium capitatum* L. 20. *Atraphaxis spinosa* L. 21. *Onosma caucasica* Levin. 22. *Papaver orientale* L. (**Table 3**).

Table 3. The species composition of the plant community involving the species *Cardaria draba* (L.) Desv. near Arafsa village.

№	Familia	Genus	Species	Life Forms	Ecological Groups
1.	*Apiaceae* Lindl.	*Heracleum* L.	*Heracleum sp.*	Perennial	Xeromesophyte
2.	*Rubiaceae* Juss.	*Galium* L.	*Galium album* Mill.	Perennial	Mesophyte
3.	*Rubiaceae* Juss.	*Galium* L.	*Galium verum* L.	Perennial	Mesophyte
4.	*Fabaceae* Lindl.	*Astragalus* L.	*Astragalus Karjaginii* Boiss.	Subshrub	Mesophyte
5.	*Fabaceae* Lindl.	*Astragalus* L.	*Astragalus Regelii* Trautv.	Subhrub	Mesophyte
6.	*Fabaceae* Lindl.	*Melilotus* Mill.	*Melilotus officinalis* (L.) Lam.	Biennial	Mesophyte
7.	*Fabaceae* Lindl.	*Coronilla* L.	*Coronilla varia* L.	Perennial	Mesophyte
8.	*Fabaceae* Lindl.	*Trifolium* L.	*Trifolium pratense* L.	Perennial	Mesophyte
9.	*Campanulacea*e Juss.	*Campanula*L.	*Campanula armena* Steven	Perennial	Mesophyte
10.	*Campanulacea*e Juss.	*Campanula*L.	*Campanula glomerata* L.	Perennial	Mesophyte
11.	*Asteraceae* Bercht. & J.Presl	*Tussilago* L.	*Tussilago farfara* L.	Perennial	Mesophyte
12.	*Poaceae Barnhart.*	*Hordeum* L.	*Hordeum bulbosum* L.	Perennial	Xeromesophyte
13.	*Sapindaceae* Juss.	*Acer* L.	*Acer ibericum* M. Bieb. ex Willd.	Tree	Mesophyte
14.	*Rosaceae* Juss.	*Pyrus* L.	*Pyrus salicifolia* Pall.	Tree	Xerophyte
15.	*Salicaceae* Mirb.	*Salix* L.	*Salix caprea* L.	Tree	Mesophyte
16.	*Lamiaceae* Martinov	*Stachys* L.	*Stachys pubescens* Ten.	Perennial	Xeromesophyte
17.	*Lamiaceae* Martinov	*Stachys* L.	*Stachys lavandulifolia* Vahl.	Annual	Xerophyte
18.	*Lamiaceae* Martinov	*Teucrium* L.	*Teucrium capitatum* L.	Perennial	Xerophyte
19.	*Lamiaceae* Martinov	*Lallemantia* Fisch. & C.A.Mey.	*Lallemantia peltata* (L.) Fisch. & C.A. Mey.	Annual	Xerophyte
20.	*Polygonaceae* Juss.	*Atraphaxis* L.	*Atraphaxis spinosa* L.	Shrub	Xerophyte
21.	*Boraginaceae* Juss.	*Onosma* L.	*Onosma caucasica* Levin.	Perennial	Xerophyte
22.	*Papaveraceae* Juss.	*Papaver* L.	*Papaver orientale* L.	Perennial	Xeromesophyte

In the phytocenosis involving species of the genus *Cardaria* Desv. in the Arafsa area of the Julfa district, 22 plant species are present (**Figures 5–7**). In the formation of this phytocoenosis, plant species belonging to the family *Fabaceae* Lindl. predominate in terms of abundance dynamics. Based on life form classification, the composition in-

cludes 13 perennial herbs (59.09%), 2 annual herbs (9.09%), 1 biennial species (4.54%), 3 tree species (13.63%), 1 shrub species (4.54%), and 2 subshrubs (9.09%). According to the ecological group classification, 12 species (54.54%) are mesophytes, 6 species (27.27%) are xerophytes, and 4 species (18.18%) belong to the xeromesophyte group. Thus, perennial herbaceous plants dominate in terms of life form, while mesophytes are predominant from an ecological perspective.

Figure 5. The phytocoenosis of the Kola forest 21/06/23.

(**a**) The phytocoenosis of Arafsa village. (**b**) *Cardaria draba* (L.) Desv.

Figure 6. Cardarian-grass and herbaceous plant communities of the Kola forest, located around the village of Arafsa in the Julfa district (21/06/2023).

Figure 7. Phytocoenosis of the surroundings of the village of Arafsa.

As a result of the investigations conducted in the newly identified distribution areas of Cardaria representatives, it was observed that these species can thrive under a variety of ecological conditions. The study sites exhibit relatively similar characteristics in terms of soil composition, relief features, and levels of anthropogenic impact. Among the key factors influencing the distribution of the species are the prevailing soil types and the intensity of human activities, particularly agricultural practices and livestock grazing. In order to systematize the data obtained during the fieldwork, the dominant soil types and the degree of anthropogenic pressure were assessed for each study area. **Table 4** below presents the prevailing soil types and estimated levels of anthropogenic impact in the newly recorded distribution areas of Cardaria species in the Azerbaijani part of the South Caucasus.

Table 4. Soil types and levels of anthropogenic impact in the newly recorded distribution areas of Cardaria Desv. Species.

№	New Distribution Areas	Dominant Soil Types	Level of Anthropogenic Impact
1.	Arafsa village	Light clay, sandy	Low
2.	Nurgut village	Light clay, sandy	Moderate
3.	Bekahmed village	Grey soils	Low
4.	Milak village	Chestnut soils	Moderate
5.	Teyvaz village	Grey soils	Moderate

The data presented in the table not only serve as an important basis for future floristic and ecogeographical studies but also contribute to the assessment of the species' adaptive capacities and potential distribution trends.

4. Conclusions

The altitude zones and coordinates of the study area for the distribution of the species *Cardaria draba* (L.) Desv., *Cardaria boissieri* (N. Busch) Soó (*Lepidium Boisseri* N. Busch), *Cardaria propinqua* (Fisch. & CA Mey.) N. Busch (*L. propinquum* (Fisch. & C.A. Mey.)), and *Cardaria repens* (Schrenk) Jarm. have been determined. The range and ecological environment of the species have been clarified. The species composition of the phytocenosis involving *Cardaria draba* (L.) Desv. has been clarified. During the research, the distribution of species belonging to the genus *Cardaria* Desv. was also investigated across the Botanical-Geographical Regions of the Azerbaijani part of the South Caucasus. It was found that representatives of this genus are distributed in all regions except for the Talysh Botanical-Geographical Region of Azerbaijan. The newly identified distribution areas of the genus *Cardaria* Desv. are primarily found within the lower and middle mountain belts. The species of the genus are distributed in ecological environments such as stony and rocky areas, grasslands, and cultivated fields. In the newly recorded habitats of the genus within the Azerbaijani part of the South Caucasus, there are no significant differences in terms of soil types or indicators of anthropogenic impact. For instance, the Arafsa and Bekahmed regions are located near the territory of the Zangezur National Park and are therefore considered protected areas, where the influence of anthropogenic factors is minimal. Similarly, in the Nurgut, Milakh, and Teyvaz regions, the number of grazing livestock is relatively low, resulting in limited anthropogenic pressure. Moreover, since these areas are located close to each other, there are no sharp differences in annual precipitation levels or average annual temperatures — these climatic parameters are generally similar across the regions. The results of this research are also significant in terms of biodiversity conservation, floristic monitoring, and sustainable ecosystem management in the region.

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Data Availability Statement

The data supporting the findings of this study are cited in the References section.

Conflicts of Interest

The author declares no conflict of interest.

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