

Endemic Species of the Genus *Calligonum* L. in the Kyzylkum Desert (Uzbekistan): Population, Distribution, and Negative Impacts

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Abstract

This article provides information about the “endemic” species of the *Calligonum* L. genus found in the Southwestern Kyzylkum, specifically *Calligonum zakirovii* (Khalk.) F.O. Khass., *C. paletzkianum* Litv., *C. molle* Litv., and *C. matteianum* Drobow. The current distribution areas of these species have been identified, and modern GIS maps have been created. Negative factors influencing their populations and distribution areas have been determined. The rarity of these species has been assessed according to the Red Book of Uzbekistan and the International Red List (IUCN Red List).

Keywords

Southwestern Kyzylkum, Rare Species, Endemic, Red Book, Herbarium

1. Introduction

Currently, due to climate change, desertification, and the intensification of anthropogenic degradation of ecosystems, research on the conservation, restoration, and monitoring of populations of endemic, rare, and endangered plant species in arid regions has become particularly urgent. Endemism is one of the most important and widespread concepts in biogeography and serves as a key criterion for environmental protection. However, despite high biological diversity in many regions, knowledge about endemism remains limited [1]. This also applies to the Southwestern Kyzylkum, a region with high biological diversity, where there is insufficient information regarding the diversity and distribution of endemic species [2].

In this study area, activities related to the exploration of mineral resources (oil,

gas, gold), livestock farming, road construction, land development for agricultural use, urbanization, and climate change are factors that significantly contribute to the high risk of biodiversity loss. The extinction of a species or population under the influence of such factors negatively impacts biological diversity and leads to the loss of genetic information specific to the species. This process is most commonly observed in endemic species. Endemic plants are the most vulnerable component of flora because the extinction of even one of them leads to an irreversible loss of biodiversity [3]. The conservation of biological diversity in areas with a high concentration of endemic species and the identification of such areas is a priority task for environmental protection. The number of endemic species in the study area serves as preliminary information about the importance of preserving this region.

The Southwestern Kyzylkum is one of the most significant parts of the Central Asian deserts, rich in endemic species, and is one of the centers for the formation of local species [2]. At the same time, the region consists of various ecological landscapes, including riparian zones, sandy deserts, residual mountains, and anthropogenic environments. It can be stated that the strong manifestation of anthropogenic pressure in this area is negatively affecting the populations of endemic species.

2. Literature Review

Information about the rare and endemic plants of the Southwestern Kyzylkum has been provided in the works of I.I. Granitov [4], F.O. Khasanov *et al.* [5], H.K. Esanov [6], O.S. Abduraimov [7], K.Sh. Tojibaev *et al.* [8], and H.F. Shomurodov [9] [10].

I.I. Granitov [4] believed that subsequent research on the flora of the Kyzylkum would enrich the list of endemics. In his studies of the Kyzylkum region, he noted that there are 226 endemic species in Central Asia (25% of the total flora), of which 141 species (24%) belong to the Southwestern Kyzylkum flora. Later studies [5] indeed expanded the composition of Kyzylkum endemics, and our research results further support this finding. F.O. Khasanov *et al.* [5] reported 41 endemic species and 11 subendemics in the Kyzylkum region. H.K. Esanov [2] identified 143 species (18.01% of the region's flora) from 23 families and 70 genera of Central Asian endemics in the Southwestern Kyzylkum region. Among these, representatives of the *Calligonum* L. genus play an important role.

3. Research Methodology

The object of the research is the rare and endemic species of the *Calligonum* L. genus in the Southwestern Kyzylkum flora. Herbarium specimens collected during field studies were identified using the works Flora Uzbekistana [11] and Conspectus Florae Asiae Mediae [12]. To identify rare and endemic species, the Red Book of the Republic of Uzbekistan [13] and the International Red List (IUCN) [14] were used. To determine the distribution areas of the species, field studies

and specimens stored in the Uzbekistan National Herbarium (TASH) at the Institute of Botany, Academy of Sciences of the Republic of Uzbekistan, were used. These species were studied using a route method in the areas surrounding Dengizkul, Karakul (Poykent), and Kuljuktai in the Southwestern Kyzylkum. The populations of these species consist of 20 to 500 individuals. The study utilized data from the WCRP coupled model intercomparison project (Phase 6) and simulations from CMIP6. The obtained data were based on the WGS1984 coordinate system. For modeling, climate scenarios SSP1-RCP2.6 for the period 2021-2040 were selected. A bio-climatic model was created using the MaxEnt 3.4.4 software, and a map was generated using the ArcGIS software.

4. Research Results

The conducted research focused on the distribution of four species from the *Calligonum* L. genus listed in the Red Book of Uzbekistan and the International Union for Conservation of Nature (IUCN) Red List: *C. paletzkianum* Litv., *C. molle* Litv., *Calligonum zakirovii* (Khalk.) F.O. Khass., and *C. matteianum* Drobow. These species are considered rare and endemic in the region. Their distribution in Uzbekistan is most notably found around the Dengizkul area [15]-[17]. The ranges of these species are steadily shrinking due to anthropogenic impacts. This is particularly driven by livestock grazing, various geological exploration activities, land development, and other factors. Based on the research findings, current distribution areas and modern GIS maps were created (Figures 1-4). Additionally, specimens from the National Herbarium were studied, and relevant data were collected.

4.1. *Calligonum zakirovii* (Khalk.) F.O. Khass.

Shrub. Is a rare endemic species found in the foothills of the Kyzylkum desert, specifically in Uzbekistan. It is listed in the Red Book of Uzbekistan (2019). The plant is found in the foothills of Kuljuktai in the Bukhara region, with further discoveries made during research from 2020 to 2022 in the southern plains of the Bashgujumd mountains. The specific location of these discoveries is noted as: "Southwestern Kyzylkum, Bukhara region, Shofirkon district, 15 km south of Bashgujumd. №1289. 09.05.2022. N40.658212, E64.052742. H. Esanov" Two senopopulations of *Calligonum zakirovii* have been studied by H.F. Shomurodov and others in the stabilized sands of the Kuljuktai foothills. These populations cover a total area of 20 hectares, and approximately 500 individual plants were observed [8]. The main factors affecting the reduction of the species' range include livestock grazing, cutting for firewood, geological mining activities, and the creation of transport routes. *Calligonum zakirovii* is listed as an endangered species on the International Red List (IUCN Red List) with the status Endangered EN-B1ab(i, ii, iii, iv, v) + B2ab(i, ii, iii, iv, v). Thus, *Calligonum zakirovii* is a rare endemic plant in the Southwestern Kyzylkum, facing significant threats to its population due to anthropogenic pressures (Figure 1).

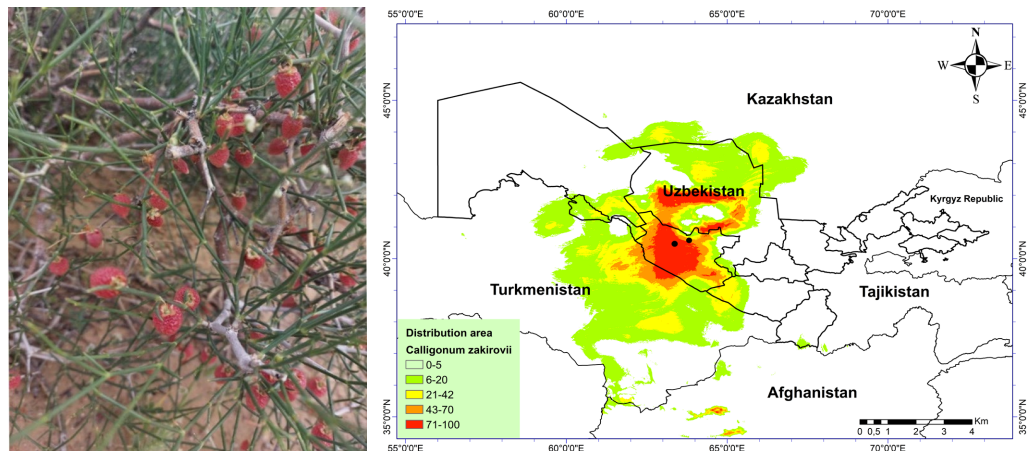


Figure 1. *Calligonum zakirovii* (Khalk.) F.O. Khass.

4.2. *Calligonum molle* Litv.

Shrub. A rare endemic plant species found in the Kyzylkum desert of Uzbekistan. Status: 2. Included in the 2nd-5th editions of the Red Book of Uzbekistan. It is found in the areas around the Poykent pumping stations in the Dengizkul and Karakul districts of the Bukhara region. This species is listed as endangered in the International Red List (IUCN Red List) with the status Endangered B2ab(iii,v) [18]. Its distribution area also includes Iran and Turkmenistan [19]. In some taxonomic references, this species is considered a synonym of *Calligonum setosum* (Litv.) Litv. However, both A.A. Maassoumi [19] and the International Red Book [18] recognize it as a distinct species. Based on this information, *Calligonum molle* was accepted as a separate species. Research conducted around Dengizkul from 2018-2020 studied the senopopulation characteristics of this species (Figure 2). The ontogenetic spectrum of the *C. molle* senopopulation was found to align with its characteristics, indicating that the species is not currently at risk of extinction [20]. The population occupies an area of no more than 2 hectares, with approximately 40 individuals. The main threats to the species are livestock grazing, technogenic impacts, and cutting for firewood [8].

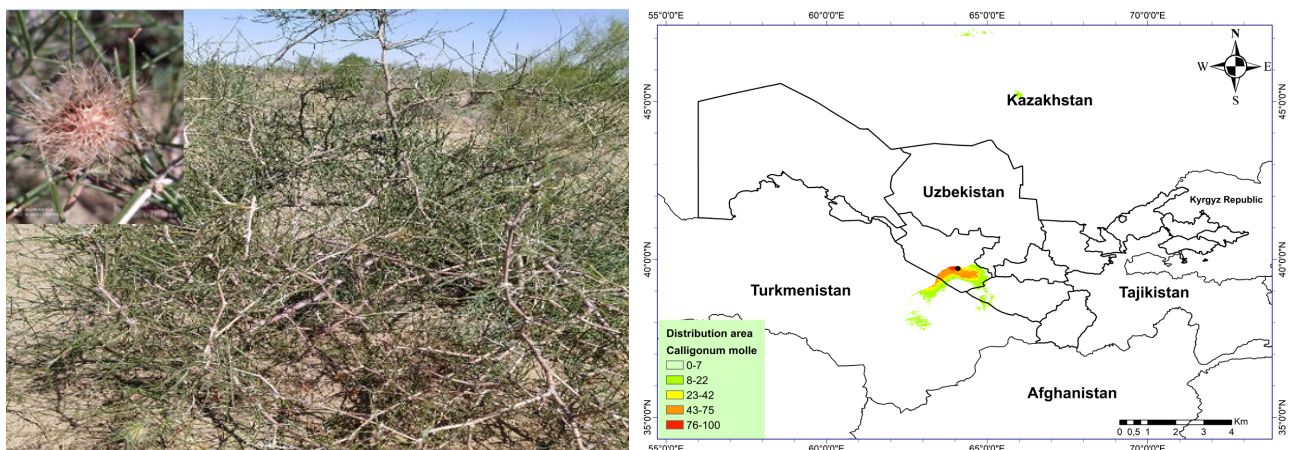


Figure 2. *Calligonum molle* Litv.

4.3. *Calligonum matteianum* Drobw

Shrub. A rare endemic species found in the sandy deserts of Central Asia. It occurs in the Kyzylkum, Sundukli, and Karakum deserts. In Uzbekistan, it is found in the areas around Dengizkul and the Poykent pumping station in the Karakul district of Bukhara region. Included in the Red Book of Uzbekistan. Status 2. During research conducted in the region, it was found in 2020 in the areas around the Poykent pumping station, Karakul district (09.07.2020. N 39.583556, E 64.026910. H. Esanov). Around Dengizkul, about 30 individuals were recorded over an area of 0.5 hectares [8]. The species is very rare in the study area and found only individually. The species is listed in the International Red List (IUCN Red List) as an endangered species, with the status Endangered B2ab(iii, v) [21]. Additionally, historical herbarium data show that it was once found near the Devkhona Lake and Shodi Well in Bukhara region. However, it was not found during recent studies around Devkhona Lake (Figure 3). The main threat to the populations around Dengizkul Lake is technogenic impacts. The population near Dengizkul occupies an area of 0.5 hectares and contains around 30 individuals. The population in the Karakul district contains about 20 individuals and occupies 0.5 hectares [8]. The populations around Dengizkul are suffering due to gas extraction activities. The populations in the Karakul district are affected mainly by local people who use the species for firewood and grazing livestock. *Calligonum matteianum* was previously found in the Kyzylkum State Reserve, but recent research shows that it is no longer present there [22].

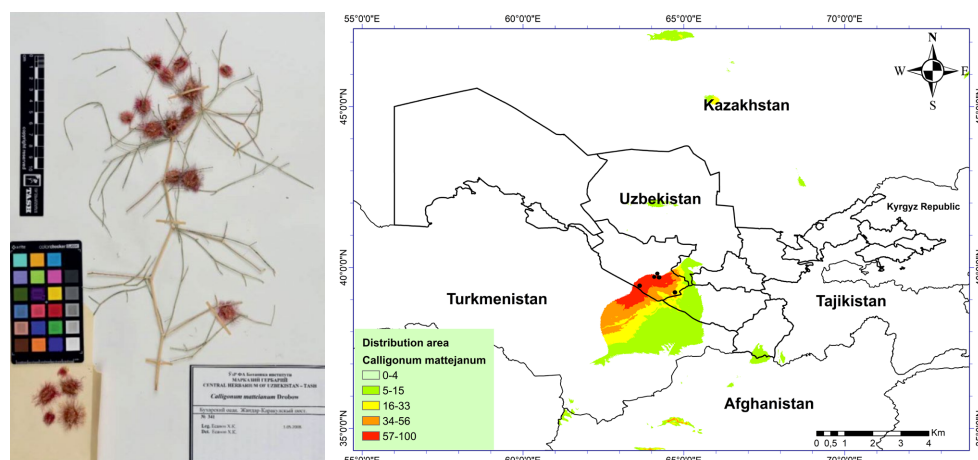


Figure 3. *Calligonum matteianum* Drobw

4.4. *Calligonum paletzkianum* Litv.

Shrub. A rare, endemic plant in Uzbekistan. Its distribution range is also observed in Turkmenistan, Tajikistan, and Iran [19] [23]. It has been listed as a rare species (status 2) in the 2006 and 2009 editions of the Red Book of Uzbekistan, and as a declining species (status 3) in the 2019 edition. The International Red Book (IUCN Red List) categorizes it as a Vulnerable species B2ab(iii, v) [24]. In the

study area, it is found in sandy deserts, stabilized, and disturbed sands. In Bukhara region, it is found around the Dengizkul and Karakul oasis (**Figure 4**). In 2019-2020, small populations were found in a 1-hectare area near Dengizkul, where 60 individuals were recorded [8]. For the first time in Uzbekistan, it was collected by I.F. Momotov and A. Li in 1955 from semi-stabilized sands near the Shodi well in the Olot district of Bukhara region (TASH). Currently, geological mining activities and grazing are affecting the reduction of its range in this area. Despite the protected status of the Dengizkul area, the influence of anthropogenic factors is still noticeable.

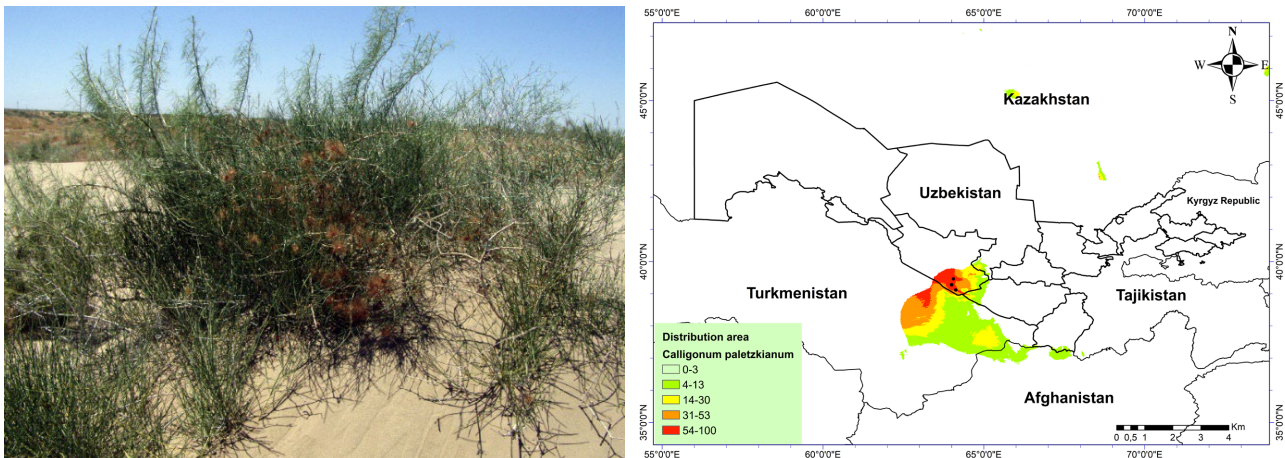


Figure 4. *Calligonum paletzkianum* Litv.

5. Discussion and Conclusion

In conclusion, the Kyzylkum Desert is one of the main centers of development for the species of the *Calligonum* genus. In Kyzylkum, *Calligonum* is considered a leading genus rich in endemic species. The increasing anthropogenic impacts in the region are negatively affecting the populations and distribution areas of these species. In particular, the growing use of species for firewood, climate change, a decrease in precipitation, and the increasing number of livestock (around 10,000) and their uncontrolled grazing are contributing to these negative effects. To prevent further damage, it is necessary to establish protected areas in regions where these rare and endemic species are distributed.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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