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COENOFLORA OF *SPIRAEANTHUS SCHRENKIANUS* (Fisch. and C.A. Mey.) Maxim.

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SUMMARY

Spiraeanthus schrenkianus (Fisch. and C.A. Mey.) Maxim is a plant species that belongs to the family *Rosaceae*, endemic to Kazakhstan and possibly Kyrgyzstan, but as an endangered species. This shrub is one of the oldest plants on our planet, however, little is known about the plants that co-exist with the *S. schrenkianus*. Knowledge about the coenoflora of endemic and endangered species is fundamental for a more accurate understanding of the potential threats on the plant's existence. To fill up this gap, the 15 coenopopulations of *S. schrenkianus* found in the Boraldaytau Mountains (Central part of the Syrdarya Karatau, Kazakhstan) and seven coenopopulations from the Betpak-Dala desert of Kazakhstan were analyzed. The coenoflora of *S. schrenkianus* consists of 232 species belonging to 146 genera and 41 families. The coenoflora from Syrdarya Karatau differed significantly from the Betpak-Dala desert, where only seven species occur together i.e., *Adonis parviflora*, *Anisantha tectorum*, *Atraphaxis spinosa*, *Euphorbia falcata*, *Ixiolirion tataricum*, *Poa bulbosa*, and *Tulipa greigii*. The similarity dendrogram of coenopopulations revealed greater differences in the floral composition of the plant communities, suggesting a disjunctive range in the target areas like Syrdarya Karatau, and the Betpak-Dala desert, Kazakhstan. The stability of *S. schrenkianus* is related to the ancient relict characters of the species formed in the Paleogene's arid conditions.

Keywords: Coenopopulation, species composition, ecological-coenotic groups, *Spiraeanthus schrenkianus*, Kazakhstan

Key findings: *Spiraeanthus schrenkianus* has a disjunctive range in Syrdarya Karatau and the Betpak-Dala desert, Kazakhstan. Cereal plants showed the highest taxonomic activity in the coenopopulations of Boroldaytau (steppe character of the communities). Desert plants showed the highest taxonomic activities in coenopopulations of the Betpak-Dala, Kazakhstan.

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INTRODUCTION

Coenoflora is the set of plant species that form communities of the same type (Yurtsev, 1982), and each of which is considered as a partial flora of the lowest rank – the partial flora of the micro-ecotope ecologically (Yurtsev and Kamelin, 1987). The analysis of floral lists of different cenopopulations is particularly important for rare and endangered plant species because it allows you to determine the place of plants in each biome and the threats to their survival (Gnatyuk and Kryshen, 2005).

Spiraeanthus schrenkianus is a shrub that has plant height ranging from 60-200 cm, with a dense crown and thinly fluffy shoots covered with greyish-yellow longitudinally-cracking bark and peeling bark, and leaves shaped as narrowly linear, feathery, and with a large number of up to 80 pairs.It also has thick, small ovate lobes, inflorescences with rare oblong panicles from 4 to 20 cm long, and white and rarely pinkish flowers (Figure 1). The plant belonged to a group of ancient shrub-steppe communities that existed during the Eocene (~40 million years ago), and now occupied the territory known as Karatau in Kazakhstan (Kamelin, 1990). The said plant is one of the rarest plants in the world and is found exclusively on the territory of Kazakhstan. The *S. schrenkianus* is one of the oldest flowering plants that appeared in the early Cenozoic era (Pavlov, 1961; Wintergoller, 1984). The plant is placed on the 'Red List of Threatened Species' and is considered as one of the rarest plants in the world (IUCN, 2012). In Kazakhstan, the data recorded on endemic species were included in the Red Book of Kazakhstan (2014).

The first taxonomical classification of this plant was based on A. Schrenk's seed collections (*Inregionibus Songoro-Kirgisicus fersusfl, Tschuael Schrenk delecta*), however, the name given in the seed exchange list was not effective (Fischer and Meyer, 1879). Later on, Maksimowicz (1879) also described the said plant, apparently from collections of the Western part of the Betpak-Dala desert, from Schrenk's collections (in Sibiriae Altae caedeserto Songorico, circa puteus 4 dicrumilineribus a fluvio Tschusites, initio Octobris 1842, fr, A. Schrenk). The plant was introduced into the flora of Kazakhstan (Pavlov, 1961).

It grows on mountain slopes ranging from 12°–18°, and at an altitude of 600–850 m above sea level. It also grows on long and slightly diagonal slopes with a slope (2°–5°) covered with a continuous layer of loess (Kupriyanov *et al*., 2017). The habitat of *S. schrenkianus* includes the Syrdarya Karatau, the Chu-Illi mountains, and the Betpak-Dala

Figure 1. *Spiraeanthus schrenkianus* (Fisch. and C.A. Mey.) Maxim. in the Boroldaytau mountains.

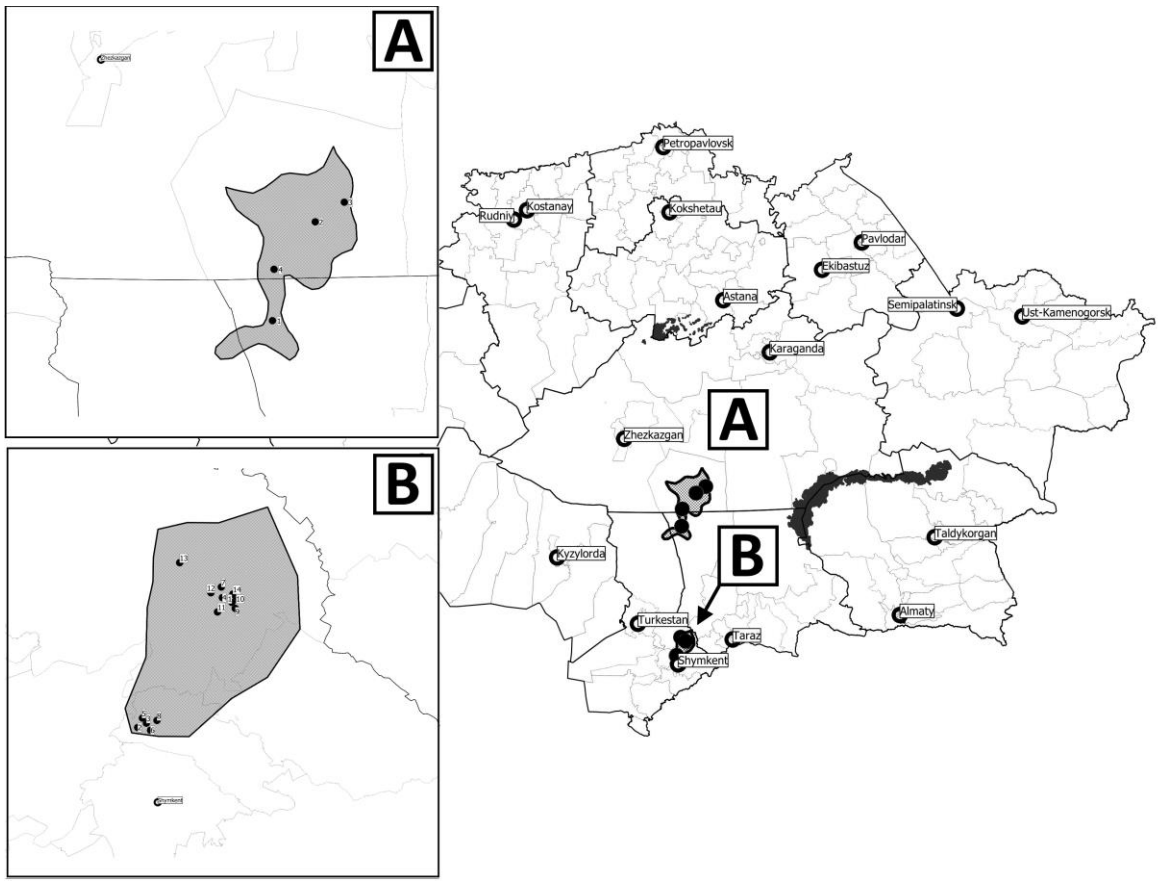

Figure 2. Location of cenopopulations *S. schrenkianus* in Boroldaytau and in Betpak-Dala: A: Betpak-Dala desert, B: Boroldaytau.

desert (Rubtsov, 1946; Tulyaganova, 1976; Wintergoller, 1984; Kamelin, 1990). The different environmental conditions of *S. schrenkianus* habitats suggest that different coenoflora might exist in the Boraldaytau (Central part of the Syrdarya Karatau mountains, Kazakhstan) and Betpak-Dala desert (Figure 2). The climate of the Syrdarya Karatau is generally sharply continental, arid but significantly softened in the depths of the mountains.

On the foothill plains of Southern Karatau (Burnoye village), the absolute minimum temperature recorded was -46 °C, but, in the Boraldaytau mountains, the frosts were less intensive. In Boraldaytau during the summer season, the absolute maximum temperature was 43 °C–46 °C, and the annual precipitation was about 400-500 mm (Kamelin, 1990). In the Betpak-Dala desert, *S. schrenkianus* exists in the flat depressions of interstitial valleys composed of saline soils of different compositions (Kubanskaya, 1956a). The Betpak-Dala soils were also characterized by high carbonate content, poor organic substances, gypsum in the underlying rocks, and low thickness.

The climate of Betpak-Dala is sharply continental, with the absolute minimum temperature of -40 °C recorded every January, while the absolute maximum was at 46 °C every July, having annual precipitation of 100–125 mm (Kubanskaya, 1956b). However, little was known about the plant populations and coenoflora associated with the *S. schrenkianus* in those habitats. The present study aims to a. evaluate the coenoflora of *S. schrenkianus*, b. identify the plant populations co-existing with the *S. schrenkianus* (coenopopulation), and c. evaluate the community structure differences between Boraldaytau and the Betpak-Dala regions of Kazakhstan.

MATERIALS AND METHODS

Study sites and coenoflora characterization

Coenoflora of *S. schrenkianus* were studied from April to July for six years (2014-2019) in the territory of the Boroldaytau section of the Syrdarya-Turkestan natural park, Kazakhstan. Soils in those regions were slightly gravelly and covered with rubble from the surface, usually having a thickness up to 65 cm. Carbonate distribution was recorded in the form of spots and streaks at 35 cm thick. The humus content does not exceed 1.8%. The reaction of the soil solution was alkaline. The soil was not saline with a medium loam granulometric composition. Fifteen coenopopulations (CP) in different ecological conditions of growth were studied (Table 1). However, seven of the sampling sites were used in the past to investigate the coenoflora of *S. schrenkianus* (Kubanskaya, 1956).

To characterize the coenoflora, the methodology of Gnatyuk and Kryshen (2005) was followed. Initially, the area was determined using GPS, and the botanical descriptions were recorded and processed using the standard geo-botanical "IBIS" system. The life forms of the plants belonging to the coenoflora were also described according to the approaches of Serebryakov (1962). Additionally, the species assessment on moisture was done using the ecological scale of Shennikov (1950). The species names were given according to Abdulina (1999), considering the current taxonomical classification.

Table 1. Characteristics of the *S. schrenkianus* coenopopulation (CP).

CP	Characteristics of the sampling site	Number of species in CP	Total projective cover (%)	Projective cover of *S. schrenkianus* (%)
Syrdarya Karatau, Boroldaytau				
CP-1	Boroldaу valley, dry hummocks; *Hordeum bulbosum+S. schrenkianus* loam, loess, gravelly soils	42	100	20
CP-2	The foot of the mountain Ulkentura; *Elytrigia trichophora +S. schrenkianus;* loess soil is slightly gravelly.	44	90	20
CP-3	Slopes to the Boroldaу river; *Centaurea squarrosa+S. schrenkianus;* loamy loess soils, slightly gravelly soils.	47	90	20
CP-4	Slopes to the Kashkarata river; *Artemisia karatavica+S. schrenkianus;* loam soils.	36	85	20
CP-5	Old apricot plantings; *Crupina vulgaris+Alcea nudiflora+ S. schrenkianus* loamy soils.	36	80	10
CP-6	Thickets of hawthorn; *Crataegus turkestanica+ S. schrenkianus* clay soils.	29	90	10
CP-7	The slope of the South-West; *Cerasus tianschanica+ S. schrenkianus;* clay, incomplete, stony soils.	39	90	10
CP-8	Uvaluspeak; *Poa bulbosa+ Centaurea squarrosa+ S. schrenkianus;*stony loam soil.	36	80	10
CP-9	Anthropogenic-modified meadow; *Hordeum bulbosum+Elytrigia trichophora+ S. schrenkianus*; clay soil	29	80	5
CP-10	The slopes of the Southern exposure; *Phlomis regelii+S. schrenkianus*, stony loamy soil	33	90	5
CP-11	Stony slopes; *Tulipa greigii+ Spiraea hypericifolia+ S. schrenkianus;* stony loam soil.	36	90	10
CP-12	The lower part of the South-Eastern slope; *Ferula karatavica+ S. schrenkianus;* stony loam soil.	27	80	10
CP-13	The middle part of the slope; *Inula macrophylla+ S. schrenkianus;* clay soil	37	95	10
CP-14	Slope to the Koshkarata river: *Artemisia karatavica+ S. schrenkianus;* clay soil	35	70	10
CP-15	The lower part of the Southern slope; *Elytrigia trichophora+ Poa bulbosa+ S. schrenkianus;* clay soil	27	90	10
The Betpak Dala desert				
CP-1	*Artemisia sublessingiana+S. schrenkianus,* grey-brown clay soils	21	50-60	20
CP-2	*S. schrenkianus + Artemisia sublessingiana+ Caragana grandiflora,* the soil is grey-brown.	23	65-75	15
CP-3	*Krascheninnikovia ceratoides + S. schrenkianus + Artemisia terrae-albae,* soils were grey-brown clay	22	30-90	20
CP-4	*Atriplex cana + Artemisia pauciflora+ S.schrenkianus* soils were grey-brown clay	20	50-65	20

Analysis of community structure

To evaluate the differences in community structure, the plant species were evaluated within the different families of plants found in the coenoflora of *S. schrenkianus*. Then, the PAST software was selected for cluster analysis to compare the similarities of coenoflora between the different sampling sites (Hammer *et al.*, 2001). Clusters were built using the unweighted pair group method with the arithmetic mean (UPGMA) method with Dice's similarity measure. To assess each species in the community, an integral activity indicator was used, which shows the measure of the species' life success in a given territory (Zverev, 2007).

The calculation of species activity was performed in the IBIS system using the following equation:

$$Act = \sqrt{\frac{C \times 100\%}{N} \times \frac{\sum_{i=1}^{N} A_i}{N}} = 10 \times \frac{\sqrt{C \times A_{\Sigma}}}{N}\%$$

where:
Act = estimated activity of the taxon for the monitoring area as a percentage (0-100%);
N = is the number of accounting sites (elementary meter samples);
C = taxon constancy – the absolute number of accounting sites where the taxon is registered;
Ai = projective coverage of a taxon on the i-th accounting platform, and
AΣ = the sum of the projective covers of the taxon on all accounting sites.

RESULTS

In total, the coenoflora of *S. schrenkianus* contained 232 species belonging to 146 genera and 41 families. For the Syrdarya Karatau region, the coenoflora contained 170 species belonging to 119 genera and 35 families. On the other hand, the coenoflora of the Betpak-Dala desert included 74 species belonging to 52 genera and 22 families.

In the Boroldaytau region, 10 families were accounted for 92 species, which was 54.1% of the total composition of the *S. schrenkianus* coenoflora. *Asteraceae* (24 species), *Fabaceae* (17 species), *Poaceae* (16 species), *Rosaceae* (14 species), and *Apiaceae* (11 species) were the richest families with the highest number of species. In the Betpak-Dala region, the top 10 families in the populations contained 39 species representing 54.2% of the total composition of the coenoflora. The families with the highest number of species were *Brassicaceae* (10 species), *Poaceae* (eight species), *Fabaceae* (seven species), and *Chenopodiaceae* (seven species).

According to the genera diversity in Boroldaytau populations, only 11 families were represented by three or more genera. The richest in the composition of genera were the families i.e., *Asteraceae* (16), *Poaceae* (13), *Fabaceae* (11), *Rosaceae* (10), *Lamiaceae* (8), and *Apiaceae* (8). The genera *Astragalus* (10), *Allium* (5), *Cousinia*, *Galium*, and *Medicago* lead in species diversity. In the Betpak-Dala desert, the generic families were the *Brassicaceae* (nine genera), and *Poaceae* (six genera). In terms of species diversity, the genus *Ferula* was the richest (five species).

Plants ranging between 1–2 years old were represented by 49 species, which was 29% of the species composition coenoflora (*Aegilops cylindrica* Host, *Anisantha sterilis* (L.) Nevski, *Eremopyrum orientale* (L.) Jaub. and Spach, *Lappula kuprijanovii* Ovczinnikova, *Leptaleum filifolium* (Willd.) DC., *Medicago lupulina* L., *Milium vernale* M.Bieb., *Thlaspi perfoliatum* L., *Trigonella arcuata* C.A. Mey, and others). The flora contains a large proportion of 1–2 years old plants which is a characteristic of savannoids. The latter group was divided into long-growing annuals (38 species) and ephemera-annuals with a short vegetation period (*Adonis parviflora*, *Anisantha sterilis*, *A. tectorum*, *Bromus danthoniae*, *Cerastium inflatum*, *Galium tenuissimum*, *Milium vernale*, *Phleum paniculatum*, *Ranunculus arvensis*, and *Scabiosa micrantha*). In Betpak-Dala desert, Kazakhstan, the perennials (45 species) dominate the enduring annuals and biennials (23 species), and ephemera (six species i.e., *Adonis parviflora*, *Arabidopsis toxophylla*, *Diptychocarpus strictus*, *Eremopyrum orientale*, *Eremopyrum triticeum*, and *Veronica campylopoda*).

In terms of life forms, in Boroldaytau the coenoflora was dominated by rod-rooted grasses (73 species), characterized mainly by 1-2 years old plants and long-rooted perennial grasses (21 species). The abundance of rod-rooted annuals and a significant number of cormaceous grasses (16 species) reflect the regional conditions of severe summer drought and the environment's pressure. This situation favored large grasses and large-grass savannoids, for which a long period of summer dormancy was a characteristic feature. The tree and shrub flora were ornately represented, including six trees and 16 species of shrubs.

Rod-rooted grasses (33 species) also prevailed in the Betpak-Dala desert, which consists a large number of root-tuberous grasses (nine species), characteristic of savannoids. , However, there were very few long-rooted plants (five species), numerous shrubs (five species), and semi-shrubs (five species).

Concerning the plant's water balance, in Boroldaytau the coenoflora was formed by mesophytes (86 species) and xeromesophytes (62 species). However, the mesophytes have the largest share, as the coenoflora contained 36 ephemera and ephemeroids. Such plants take advantage of the wettest spring period for their development, since plant parts above the ground die at the heat of summer. In the populations of Betpak-Dala, ephemera mainly represent the largest number of xerophytes (29 species, 39.2%), and mesophytes (24 species, 33%).

Ecological coenotic groups were very rich in terms of species number. The largest group was made up of savannoid plants (75 species), which were distinguished by the dominance of high ephemeroid cereals i.e., *Elytrigia trichophora*, *Hordeum bulbosum*, and the participation of large grass *Alceanu diflora*, *Ferula ceratophylla*, *Inula macrophylla*, *Prangos pabularia*, and *Scabiosa songorica*. On the slopes of the low mountains, low grass savannoids formed (with the dominance of bulbous bluegrass), as well as. ephemera and ephemeroids (*Poa bulbosa*, *Eremurus lactiflorus*, and *Potentilla tianschanica*), usually containing shrubs (*Amygdalus petunnikowii*, *Cerasus tianschanica*, and *Spiraea hypericifolia*).

The second largest group presented the Mediterranean vegetation characteristics, consisting of deciduous, often drought-resistant, shrubs and low-growing trees, named Shibliaka (*Acerseme novii*, *Eremostachyskar atavica*, *Phlomoides boraldaica*, *Pistacia vera*, *Rhamnus cathartica*, and *Schrenkia golickeana*). A large group also belongs to the weed species (28 species), which include *Buglossoides arvensis*, *Carduus arabicus*, *Centaurea squarrosa*, *Cousinia microcarpa*, and *Crupina vulgaris*. The remaining groups contained 2–8 species each.

In the Betpak-Dala desert, 34 species (46%) were plants of the Northern deserts (*Anabasissalsa*, *Artemisia terrae-albae*, *Artemisia turanica*, *Ferula canescens*, *F. dubjanskyi*, *F. varia*, *Leontice incerta*, *Megacarpaea megalocarpa*, and *Salsolalarici folia*). Steppe plants were represented by 23 species (31%), including many kinds of cereal (*A. caragana*, *P. bulbosa*, *S. capillata*, *S. caucasica*, and *S. sareptana*). Weeds were also represented by 11 species (15%).

The dendrogram of the similarity of flora showed complete differences of floral composition between the cenopopulations of the Boroldaytau (Syrdarya Karatau) and the Betpak-Dala desert (Figure 3). The floral composition of the coenopopulation of *S. schrenkianus* has only seven species that occur together i.e., *A. parviflora*, *Anisantha tectorum*, *Atraphaxis spinosa*, *Euphorbia falcata*, *Ixiolirion tataricum*, *P. bulbosa*, and *Tulipa greigii*.

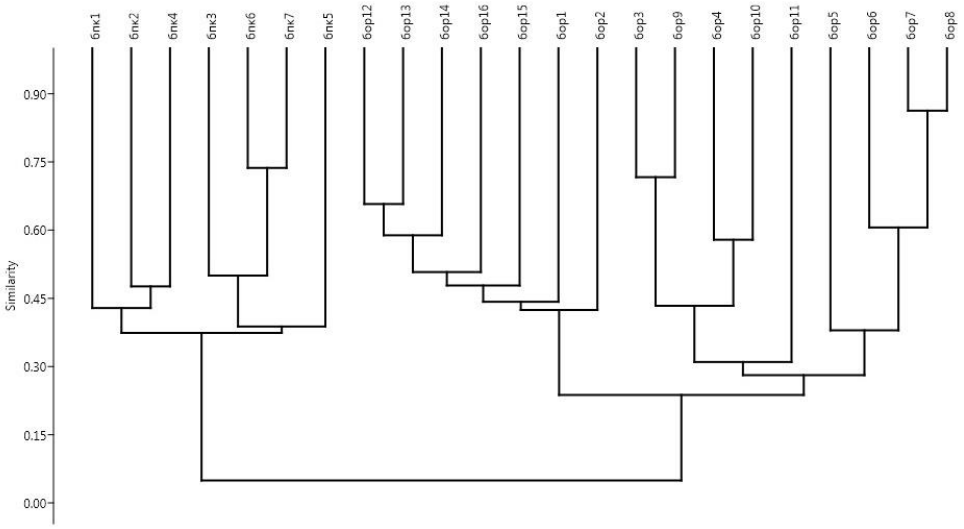

Figure 3. Dendrogram of similarity of the floral composition of cenopopulations of *S. schrenkianus.*

For coenopopulations of the Boroldaytau, cereals (*E. trichophora, H. bulbosum,* and *P. bulbosa*) have the highest taxonomic activity, which indicates the steppe character of the communities (Table 2). For coenopopulations of the Betpak-Dala desert, desert plants *Artemisia sublessingiana, A. terrae-albae,* and *Kraschenninnikovia ceratoides* showed the highest taxonomic activity (Table 3).

Table 2. Leading families of coenoflora of *Spiraeanthus schrenkianus* for two sampling sites.

Family	Coenopopulations of Boroldaytau (Syrdarya Karatau)			Coenopopulations of the Betpak-Dala desert		
	Species number	Species (% of total)	Plant genera (% of total)	Species number	Species (% of total)	Plant genera (% of total)
Asteraceae	I	24 (14.1)	16 (13.4)	V–VI	6 (8.3)	3 (5.8)
Fabaceae	II	17 (10.0)	10 (8.4)	III-IV	7 (9.8)	4 (7.7)
Poaceae	III	16 (9.4)	13 (10.9)	II	8 (11.2)	6 (11.6)
Rosaceae	IV	14 (8.2)	10 (8.4)	X	2 (2.9)	2 (3.8)
Apiaceae	V	11 (6.5)	8 (6.7)	V– VI	6 (8.3)	2 (3.8)
Lamiaceae	VI	10 (5.9)	8 (6.7)	XI–XXII	1 (1.4)	1 (1.9)
Scrophulariaceae	VII	7 (4.1)	4 (3.4)	XI–XXII	1 (1.4)	1 (1.9)
Brassicaceae	VIII-IX	6 (3.5)	6 (5.0)	I	10 (14.0)	9 (17.4)
Boraginaceae	VIII-IX	6 (3.5)	5 (4.2)	XI–XXII	1 (1.4)	1 (1.9)
Caryophyllaceae	X	5 (2.9)	5 (4.2)	VIII-IX	3 (4.2)	2 (3.8)
Chenopodiaceae	XV-ILV	1(0.005)	-	VII	7(5.9)	-
Number of species in top 10 families	-	92(54.1)	69 (58.8)	-	39 (54.2)	28 (53.8)
Total	-	170(100)	119 (100)	-	74 (100)	52 (100)

Table 3. Species with the highest taxonomic activity in the coenopopulation of *S. schrenkianus* (Zverev, 2007).

Coenopopulations of Boroldaytau (Syrdarya Karatau)		Coenopopulations of the desert Betpak-Dala	
Type	Taxonomic Activity (%)	Type	Taxonomic Activity (%)
Hordeum bulbosum L.	46	*Artemisia sublessingiana* Krasch. & Poljakov	48
Spiraeanthus schrenkianus (Fisch. & C.A. Mey.) Maxim.	36	*Spiraeanthus schrenkianus* (Fisch. & C.A. Mey.) Maxim.	47
Elytrigia trichophora (Link) Nevski	26	*Artemisia terrae-albae* Krasch.	17
Poa bulbosa L.	22	*Kraschenninnikovia ceratoides* (L.) Gueldenst.	17
Centaurea squarrosa Willd.	15	*Caragana balchaschensis* Kom.	17
Crataegus turkestanica Pojark.	13	*Achnatherum caragana* (Trin.) Nevski	16
Artemisia karatavica (Krasch. & Abolin)	10	*Hulthemia berberifolia* Pall.	11
Phlomis regelii Popov	9	*Stipa sareptana* A. Becker	10
Onobrychis grandis Lipsky	8	*Caragana grandiflora* (M.Bieb.) DC.	9
Crupina vulgaris Cass.	7	*Ferula soongarica* Pall. ex Spreng.	8
Tulipa greigii Regel	6	*Haplophyllum versicolor* Fisch. & C.A.Mey.	7
Alcea nudiflora L.	6	*Spergularia diandra* Guss.	7
Cerasus tianschanica Pojark.	6	*Tauscheria lasiocarpa* Fisch. ex DC.	7
Inula macrophylla Kar. & Kir.	6	*Salsola laricifolia* Turcz. & Litv.	7
Schrenkia golickeana Regel & Schmalh.	6	*Kochia prostrata* (L.) Schrad.	6
Hypericum scabrum L.	6	*Trigonella arcuata* C.A.Mey.	6
Buglossoides arvensis L. f.	5	*Alyssum turkestanicum* var. *desertorum* (Stapf) Botsch.	5
Ferula karatavica Regel & Schmalh.	5	*Eremopyrum triticeum* (Gaertn.) Nevski	5
Spiraea hypericifolia L.	5	*Ferula canescens* (Ledeb.) Ledeb.	5
Haplophyllum latifolium Kar. & Kir.	5	*Diptychocarpus strictus* (Fisch.) Trautv.	4
Lepidolopha karatavica Pavlov	5	*Eremopyrum orientale* (L.) Jaub. & Spach	4
Galium aparine L.	4	*Neotorularia brevipes* (Kar. & Kir.) Hedge & J.Leonard	4
Rheum cordatum Losinsk.	4	*Cuscuta monogyna* Vahl	4

DISCUSSION

In *Spiraeanthus schrenkianus*, a wide variety of floristic compositions of coenoflora and an extremely wide range of ecological and cenobitic groups were observed. Usually, rare and endemic species have a similar set of species of coenoflora that belongs to certain ecological groups (Baranov, 1959; Lashchinsky *et al.*, 2019). Probably, this plant appeared in the Paleogene, marine transgression covered almost all the Central Asia, and the Paratethys marine basin was formed on this territory (Kupriyanov *et al.*, 2019).

The families found in the coenoflora of *S. schrenkianus* were typical for the Mediterranean region's flora dominated by *Asteraceae*, *Fabaceae*, *Poaceae*, and the high places in the 10 leading families i.e., *Apiaceae*, *Lamiaceae*, *Scrophulariaceae*, and *Brassicae*. These were mainly the high-grass savannas typical of the Western Tien Shan (Sultangazina *et al.*, 2019). It should be noted here that the species belonging to a certain ecological coenotic group reflects its predominant occurrence in a particular type of vegetation and its local ecological preferences. Therefore, even though there were no meadows and steppes in the areas where *S. schrenkianus* grows, there were species with a preference for meadow and steppe phytocenoses (Kupriyanov *et al.*, 2019). In the Central part, there was the formation of basement denudation plains and the formation of peneplain, which forms relict savannoid elements and ancestral types of relict proshibljak and shrub-steppe genera, including *S. schrenkianus* (Kamelin, 1990).

In the early Eocene, the territory of the Syrdarya Karatau and Betpak-Dala was represented by a single elevated plain with a fairly arid climate (Kamelin, 1990). The division of the *S. schrenkianus* range occurred in the middle Pleistocene when the Northern Karatau was separated from Betpak-Dala by a system of lake basins of the lower PRA-Chu and Sarysu rivers. Since that time, harsh arid conditions have dominated the territory of Betpak-Dala, and in the Karatau mountains, it was softened under the influence of the Western Tian Shan. The resilience of *S. schrenkianus* was supported by the fact that in the Betpak-Dala desert, it was the only species of Paleogene biota preserved in the Northern desert zone. Few studies paid attention to the extremely small number of early age groups in *S. schrenkianus* (Yurtsev, 1982; Wintergoller, 1984; Zverev, 2007). According to present observations, "bursts" of seed reproduction occur quite rarely, once every 5-10 years. This was enough to maintain the state of populations at the level of maturing.

The present findings showed that *S. schrenkianus* has a disjunctive range in the mountains of the Syrdarya Karatau and the Betpak-Dala desert. The disjunction of the area likely occurred in the middle Pleistocene, when the Northern Karatau was separated from Betpak-Dala by a system of lake basins of the lower PRA-Chu and Sarysu rivers. Coenoflora *S. schrenkianus* has a pronounced steppe character, hence, coenoflora populations located in the Betpak-Dala thrive in desert environment. The stability of *S. schrenkianus* was associated with the ancient relict character of the species, which was formed in the Paleogene's arid conditions. In the Boroldaytau mountains, *S. schrenkianus* lives on foothill plumes and mid-mountains covered with almost unsalted loess in the Betpak-Dala desert on the highly saline tertiary clays. Thus, the study confirms the high resilience of the species to various environmental conditions.

CONCLUSIONS

Spiraeanthus schrenkianus coenoflora consists of 232 species belonging to 146 genera and 41 families. In the Boroldaytau region, 10 families accounted for 92 species, representing 54.1% of the total plants found in the *S. schrenkianus* coenoflora. Similarly, for the Betpak-Dala region, the top 10 families represented 54.2% of the total composition of the coenoflora, however, only 39 species characterized these families. The importance of these families differed substantially between sampling regions. The coenoflora of *S. schrenkianus* in the Boroldaytau region was formed mainly by *Asteraceae* (24 species), *Fabaceae* (17 species), *Poaceae* (16 species), *Rosaceae* (14 species), and *Apiaceae* (11 species). In contrast, in the Betpak-Dala region, the richest families were *Brassicaceae* (10 species), *Poaceae* (eight species), *Fabaceae* (seven species), and *Chenopodiaceae* (seven species). Additionally, the coenoflora of *S. schrenkianus* in these regions also differed in plants' life forms and ecological coenotic groups, where Boroldaytau exhibited more taxonomic activity of cereals while the Betpak-Dala showed more classification activity of the desert plants. In summary, the present study provided evidence that *S. schrenkianus* has a disjunctive range of habitats and coenoflora.

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