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A SYNOPSIS OF THE GENUS ASPARAGUS L. IN THE TERRITORY OF THE SOUTHERN ARAL SEA

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This article presents a new checklist of *Asparagus* in the Southern Aral Sea region. The synopsis includes 6 species for the Southern Aral Sea region as a result of field collecting missions, studies, and examination of Tashkent (TASH), Moscow (MW), Madrid (MA), and Karakalpak SRI of natural sciences herbarium collections. *Asparagus breslerianus A. inderiensis* and *A. turkestanicus* are found in new localities in the Aral Sea region, of them *A. turkestanicus* is endemic to Central Asia. The distribution of species and species richness in the Southern Aral Sea region were calculated for phytogeographical areas. Geographic coordinates were determined based on Google Earth, ArcGIS 10.6.1 program. The World Geodetic System 1984 projection was used to create the maps. The geographical distribution of *Asparagus* for the Southern Aral Sea region in Uzbekistan (Karakalpakstan) was mapped.

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Keywords: *Asparagus*; Aral Sea; Central Asia; endemic; distribution

بررسی اجمالی گونه های جنس مارچوبه (Asparagus) در قلمرو منطقه دریای آرال جنوبی

دیلارون مناجاتدینوا تاجدینوا: عضو هیات علمی مؤسسه شیمی آلی *A.S. Sadykov*، آکادمی علوم جمهوری ازبکستان

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بگدولااوا گلوناز سلطانبااونا: دانشگاه ایالتی کاراکالپاک، برداخ، جمهوری ازبکستان

در این مقاله لیست گونه‌های جنس Asparagus در منطقه آرال جنوبی ارایه می‌گردد. این بررسی شامل گزارش شش گونه از این جنس است که نتیجه عملیات صحرایی و جمع آوری نمونه‌ها و مطالعات و بررسی نمونه‌های هرباریومی در هرباریوم‌های تاشکنت، مسکو، مادرید و کلکیسون شاخه کاراکالپاک آکادمی علوم ازبکستان می‌باشد. گونه‌های Asparagus breslerianus، A. inderiensis و A. turkestanicus در رویشگاه‌های جدید در منطقه دریای آرال شناسایی گردیدند که از میان آنها گونه A. turkestanicus انحصاری آسیای مرکزی هست. پراکندگی جغرافیایی و فراوانی گونه‌های منطقه جنوبی دریای آرال برای مناطق فیتوجغرافیایی محاسبه شدند. مختصات جغرافیایی بر اساس برنامه Google Earth, ArcGIS 10.6.1 تعیین گردیدند. برای تهیه نقشه‌ها از سیستم جهانی The World Geodetic System استفاده شد. نقشه پراکندگی جغرافیایی گونه‌ها برای منطقه دریای آرال جنوبی در ازبکستان (Karakalpakstan) تهیه گردید.

INTRODUCTION

The current ecological state of the Aral Sea remains an important problem affecting the general state of ecosystems in the Central Asian region. Thus, the study of plant species of new flora at the bottom of the Aral Sea, the determination of the current state, and protection are urgent problems in terms of biodiversity conservation.

Based on this, an in-depth study of the flora of the South Aral Sea region (individual families or genera) makes it possible to study the theoretical and practical aspects of the flora of Karakalpakstan, as well as Central Asia. Therefore, the study of the species of the genus *Asparagus*, which have medical significance (Bhattarai 2002, Goyal & al. 2003, Dutta 2007) and grow in the territory of the Southern Aral Sea region, is an important and necessary task.

The genus *Asparagus* has been recently moved from the subfamily Asparagae in the family Liliaceae to a newly created family Asparagaceae. The first edition of the "Flora of Uzbekistan" (Vvedenskiy 1941) recorded six species of *Asparagus*, two species of which (*Asparagus turkestanicus* Popov, *Asparagus breslerianus* Schult.f.) are present in the territory of Karakalpakstan. Subsequently, Paziy (Pazi 1971) listed 13 species of *Asparagus* for the flora of Middle Asia. According to B. Sherbaev (Sherbaev 1988), six species of the genus of *Asparagus* are distributed in the territory of Karakalpakstan.

The study of the species of *Asparagus* is part of the research projects "The system of dicotyledonous plants of the natural flora of Uzbekistan" (2017-2020) and "Formation of a modern list of flora based on an in-depth study of the vegetation of the dried bottom of the Aral Sea, the creation of a digital database and a collection of their gene pool" (2022).

MATERIALS AND METHODS

The study was undertaken as a part of the revision of the genus of *Asparagus* for the Flora of Karakalpakstan (Fig.1). To compile the present checklist, multiple information sources were examined and combined. A list of 6 species was obtained of the "Flora and vegetation of Karakalpakstan" (1988).

The list was cheeked using data: 63 specimens of 4 species from the National Herbarium of Uzbekistan (TASH) and 1 specimen of 1 species of St. Petersburg (LE), Almaty (AA), Madrid (MA), 2 specimens of 1 species of Moscow (MW), 8 specimens of 4 species of herbarium from Karakalpak SRI of natural sciences.

Overall, a list of 76 records was produced, on which a thorough refinement procedure was performed through a Microsoft Excel 2010 spreadsheet.

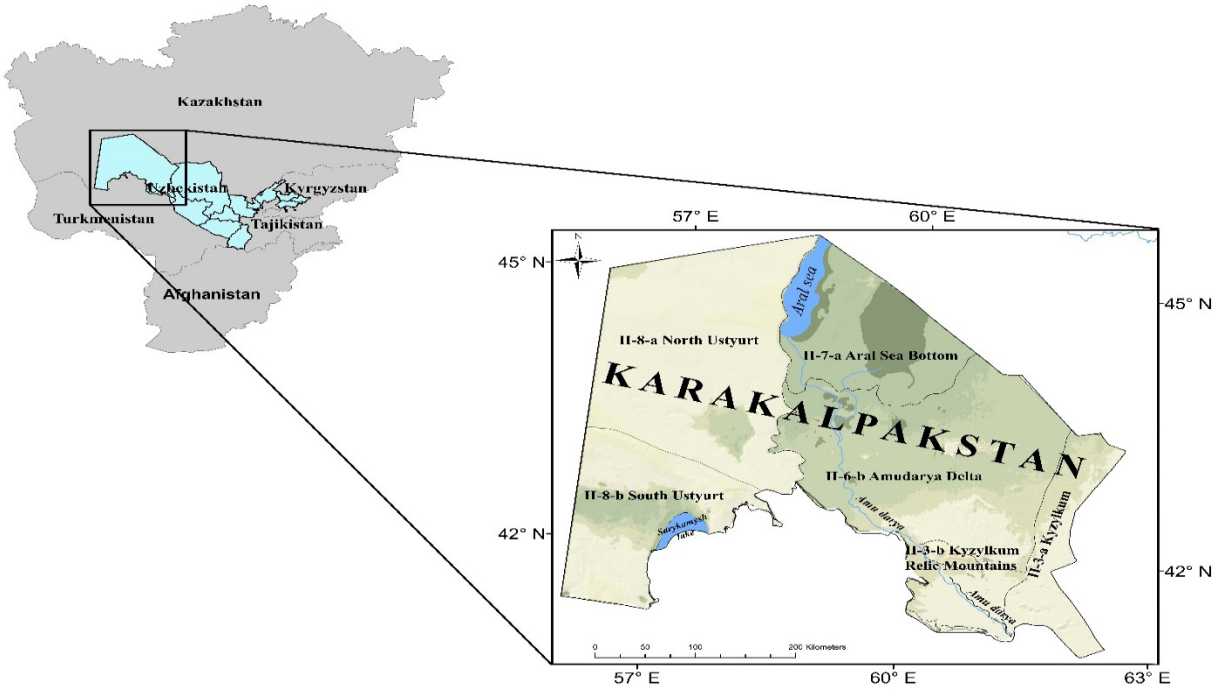

Fig. 1. The map of the territory of the Southern Aral Sea region.

All records were organized by family rank, based on the classification system proposed by APG IV (2016) for the angiosperms. Taxonomic plant names were verified and validated with international reference databases: POWO (2019) and IPNI (2019).

Geographic coordinates were determined based on Google Earth, ArcGIS 10.6.1 programs. The World Geodetic System 1984 projection was used to create the maps. The AWGS84 Geographic coordinate system was used as the reference point. The distribution of species and species richness in the Southern Aral Sea region were calculated for phytogeographical areas (Tojibaev & al. 2017). Digitized herbarium samples were obtained by scanning with a HerbScanTM 224 þ EpsonExpression 10000 XL.

RESULTS AND DISCUSSION

According to the current data, during the work on the genus *Asparagus*, six species were identified in the flora of the Southern Aral Sea region. The morphological traits of the species are summarized in Table 1 and the images of herbarium specimens of the species are presented in Fig. 2.

Identification key to *Asparagus* species in the Southern Aral Sea region

1. Cladodes absent ..... 6. ***A. turkestanicus***
- Cladodes conspicuously present 2
2. Cladodes obliquely directed upwards, close together in a bunch and somewhat pressed to the branch ..... 4. ***A. officinalis***
- Cladodes in a bundle diverging and usually deflected from the branch 3
3. Medium stem leaves without spur, instead of a tubercle less than 1 mm long 4
- Medium stem leaves with spur 1-5 mm long 5
4. Cladodes are subulate, thick, and prickly. Peduncles 2-4 mm long, articulated below the berry. Stems are strongly spreading, branched, and geniculate ..... 2. ***A. breslerianus***
- The cladodes are rounded or flattened, sharp but not prickly. Peduncles 5-11 mm long, articulated above the middle. Stems are erect, slightly sinuous, sometimes with drooping or sinuous tips ..... 3. ***A. inderiensis***
5. Cladodes, branches, and twigs gristly finely toothed ..... 1**.** ***A. brachyphyllus***
- Cladodes, branches slightly, but not broken, twisting ..... 5. ***A. persicus***

Table 1. The morphological traits of species of *Asparagus*.

	Stem (cm)	Leaves	Flowers	Fruit
A. brachyphyllus	50-150	Middle and upper stem leaves with a more-less long spur	Arranged on stems and branches	Red, globular, 5-7 mm
A. breslerianus	15-30-(50)	Without spur or with very short spurs	Arranged on stems and branches	Globular, blackening, 5–7 mm
A. inderiensis	20-50	Middle stem leaves without spur	Arranged on stems	Red, globular, blackening, 6–7 mm
A. officinalis	70-150	Middle and upper stem leaves with a short spur	Arranged on stems and branches	Red, globular, 7–8 mm
A. persicus	60-120	Middle and upper stem leaves with a more-less long spur	Arranged on stems and branches	Red, globular, 6-7 mm
A. turkestanicus	50-80	Without spur	Arranged on branches	Blackish, spherical, with a short nose

Synopsis of species of the genus of *Asparagus*

Genus *Asparagus* L., Sp. Pl. 1: 313 (1753).

1. *Asparagus brachyphyllus* Turcz., Bull. Soc. Imp. Naturalistes Moscou: 13: 78 (1840).

Syntypus: [China] in montosis Chinae borealis, 1831, [fl.] [I. Kuznetzov]. Mis D.Turczaninow 1832. Hb. Meyer (LE).

Flowering and fruiting time: May-July.

Habitat: Salt marshes, saline meadows.

Distribution: China, Europe, Siberia, and Central Asia (the entire desert part).

Distribution in the southern Aral Sea region: II-6 South Aral district. II-6- b Amudarya Delta region (Badaytugay, 11.05.1963, *Avezmuratov* & all. (TASH)). II-8 Ustyurt district. II-8-a North Ustyurt region (Ustyurt, 09.05.1964, *Koybagarov* (Karakalpak SRI of natural sciences).

2. *Asparagus breslerianus* Schult.f., Syst. Veg., ed. 15 bis [Roemer & Schultes] 7(1): 323 (1829).
Note: The species was described based on the specimen from Schreber's herbarium most part of which is in M (Stafleu & Cowan, 1985). The locality is not mentioned in the protologue. According to the Flora of USSR (Iljin, 1935: 431-432), the type material could be originated from Iran.
Flowering and fruiting time: June-July.
Habitat: Meadows, salt marshes, and sands.
Distribution: Southern Europe, Mediterranean, Caucasus, Central Asia (desert part).
Distribution in the southern Aral Sea region: II-7 Aral district. II-7- a Aral region (1 km to the west of the Aral Sea, 5.06.2022, *Rahimova, Tajetdinova, Abdirahimova A0455, A0456*). II-8 Ustyurt district. II-8-a North Ustyurt region (Ustyurt, 3 km norther of Uru, 02.05.1949, *Momotov*; 40 km north-wester of Uru; 16.08.1960, *Sedov*, *Tajetdinov*; 15-17 km norther of the village of Zhaslyk, 08.06.2010, *Tajetdinova*; Ustyurt, Zharynkuduk, 23.05.2011, *Shomurodov*. All in TASH.
3. *Asparagus inderiensis* Blume ex Ledeb, Fl. Altaic. [Ledebour]. 2: 44 (1830).
Type: [Bashkortostan] in subsalsis ad fl. Irtysch usque ad mont.Arkaul (M.) Fl. Majo.
Flowering and fruiting time. May-July.
Habitat. Salt marshes, sands, chalk outcrops.
Distribution. South of European Russia, Central Asia (Ustyurt, Mangyshlak,Kyzylkum).
Distribution in the southern Aral Sea region. II-7 Aral district. II-7- a Aral region (1-1,5 km to the west of the Aral Sea, 5.06.2022, *Rahimova, Tajetdinova, Abdirahimova A0303, A0304, 305*). II-8 Ustyurt district. II-8-a North Ustyurt region (Eastern Ustyurt, to the East from the Kassarma tract, 20.06.1940, *Granitov 320, 325*; Ustyurt, 10.09.1949, *Ioffa*; 2 km norther of Urga, 21.06.1960, *Ovchinnikov, Zaripov 73*; Beleuli, 11.06.2010, *Tajetdinova*; Ustyurt, 14.05.2012, *Tajetdinova*; Ustyurt, 29.05.2012, *Tajetdinova*; Eastern Chink of Karakalpak Ustyurt, 07.05.2014, *Tajetdinova*); II-8-b South Ustyurt region (Southern part of the eastern chink of Ustyurt, 31.05.2011, *Tajetdinova*). All in TASH.
4. *Asparagus officinalis* L., Sp. Pl. 1: 313 (1753).
Lectotypus: [Europae] in Europae arinosis." RCN: 2460. Herb. Linn. 434/1 (LINN) (Jarvis, Order out of Chaos: 325. 2007) (LINN).
Flowering and fruiting time: June-August.
Habitat: Meadows, salt marshes, and sands.
Distribution: Europe, Caucasus, Western Siberia, Central Asia (Balkhans, Karakum, Kyzylkum, Ustyurt, Balkhash).
Distribution in the southern Aral Sea region: II-6 South Aral district. II-6- b Amudarya Delta region (Badaytugay, 02.07.1970, *Bakhiev*). All in Karakalpak SRI of natural sciences.
Distribution in the southern Aral Sea region: II-6 South Aral district. II-6- b Amudarya Delta region (Badaytugay, 02.07.1970, *Bakhiev*). All in Karakalpak SRI of natural sciences.
5. *Asparagus persicus* Baker, J. Linn. Soc., Bot. 14: 603 (1875).
Type: [Iran] ad radices montis Demavend prope pagum Ask, 1841, Kotschy 365 (KEW).
Flowering and fruiting time: May-July.
Habitat: Saline meadows, meadow salt marshes, tugai thickets, coastal thickets of gorges, chalk outcrops.
Distribution: Europe, Caucasus, Iran, Siberia, Central Asia: desert part.
Distribution in the Southern Aral Sea region: II-6 South Aral district. II-6- b Amudarya Delta region (Badaytugay, 11.10.1996, *Treshkin 82,* (Karakalpak SRI of natural sciences)); Badaytugay, 18.09.1970, *Turemuratov, Saparniyazov 57* (Karakalpak SRI of natural sciences)). II-8 Ustyurt district. II-8-a North Ustyurt region (Ustyurt plateau. On the way from Tabynsu to Allan, 21.10.1944, *Pyataeva 249*; Barsa-kermes, neighborhood Allan, on the way the well Tabynsu, 20.08.1945, *Pratov, Saparov*; Allan, 19.06.1948, *Sergeeva, Krasnopolsk*; between wells Berniyaz and Allan, 20.08.1945, *Korovin, Arifkhanova 228, 229, 230*; 50 km to the south-east of Aktumsyk, 10.17.1969, *Saribaev 18*; 12 km north-easter of KS-7, 11.10.1969, *Saribaev 9*; 26 km north-easter of KS-7, 05.07.1968, *Saribaev*). Unmarked storage location – TASH.
6. *Asparagus turkestanicus* Popov in B. Fedtsch. & al., Fl. Turkm. I: 312 (1932).
Paratypes: [Uzbekistan] in Sultan-Uiz-Dag, gravelly foothills, near the ruin of Kyzyl-Kala, 02.05.1913, *Popov 69,* TASH00574 (Fig. 1); Sultan-Uiz-Dag, gravelly sandy foothills, 02.05.1913, *Popov 564* TASH00575*,* (TASH).
Flowering and fruiting time. May-July.
Habitat: Gravelly slopes outliers, variegated, saline sands.
Distribution: Central Asia (Balkhans, Karakum, Kyzylkum, Ustyurt, Balkhash).
Distribution in the Southern Aral Sea region: II-3 Kyzylkum district. II-3-a Kyzylkum region (II-3 Kyzylkum. II-3- b Kyzylkum relic mountains region (Prope montes Sultanuizdagh. 23-29.04. 1928, *Krascheninnikov* et *Russanov* (MW)); East slope of Sultanuvais, 17.05.1971, *Sherbaev 134* (MA)); Sultanuvais,11.05.2009, *Khasanov, Shomuradov, Esemuratova*; Sultanuvais, Kazantau, 13.05.2010, *Khasanov, Esemuratova 220*; Sultanuvais, between Gavurkhala and Djanpykkhala, h=95, 16.05.2015,

Beshko; II-6 South Aral district**.** II-6- b Amudarya Delta region (Takhtakupyr region, Beltau, 17.05.1952, 37, *Vernik*; Kenes region, 22 km norther of Kuralpa, 05.06.1952, *Vernik 141*); II-7 Aral district. II-7- a Aral region (1 km to the west of the Aral Sea, 5.06.2022, *Rahimova, Tajetdinova, Abdirahimova A0441, A0442*). II-8 Ustyurt district. II-8-a North Ustyurt region (Ustyurt, slope of Chink, descent Azhibay, 03.07.1968, *Butov, Saribaev*; Beleuli, 11.06.2010, *Tajetdinova*; Northern part of the Eastern Chink, 29.05.2012, *Tajetdinova*). Unmarked storage location – TASH.

Fig. 2. Images of herbarium specimens of *Asparagus* species. A, *Asparagus brachyphyllus*; B, *A. breslerianus*; C, *A. inderiensis*; D, *A. turkestanicus*; E, *A. officinais*; F, *A. persicus*.

Distribution of species of the genus Asparagus: In the Southern Aral Sea region, the species of *Asparagus* were present in five phytogeographical districts out of six (83.3%). By comparing different phytogeographical districts of the Southern Aral Sea region, it was revealed that the most aspectual regions are North Ustyurt and South Ustyurt according to their distribution patterns. However, the most aspectual and general regions are Amudarya Delta and Kyzylkum Relic Mountains. It turned out that it does not occur in the Kyzylkum region. In addition, found the new localities of *A. breslerianus A. inderiensis* and A. *turkestanicus* in the Aral Sea region (Fig 3), of them *Asparagus turkestanicus* is endemic to Central Asia and is distributed in the Kyzylkum and Ustyurt districts of the Southern Aral Sea region.

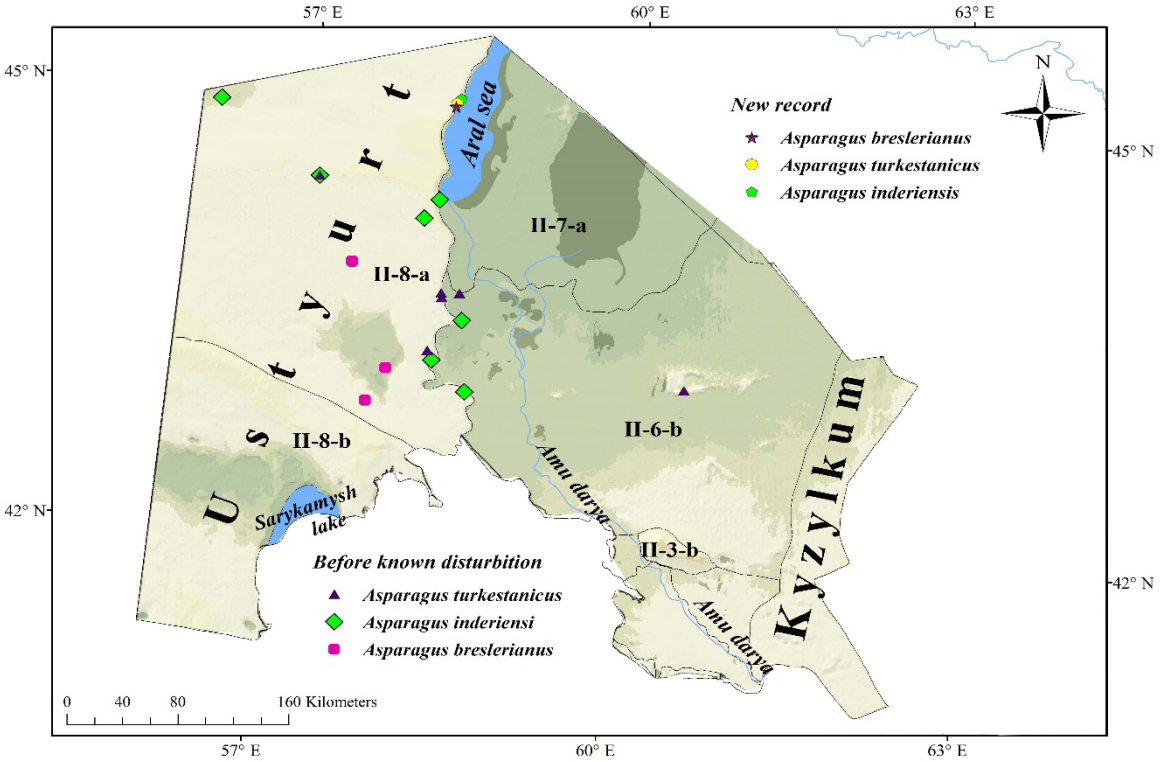

Fig. 3. The new distribution map of the species of *Asparagus* in the Southern Aral Sea region.

Most parts of the Southern Aral Sea region are climatically suitable for *Asparagus* species, where they are widely distributed. However, there is no phytogeographical district with all 6 species of *Asparagus*. The Ustyurt districts are distinguished by the greatest diversity of species (four species grow here). Moreover, only four of them are also found in the territory of the North Ustyurt and one of them in the South Ustyurt, but very few occur in the Kyzylkum district, Asia (Fig. 4).

The present study provides information on the diversity, distribution, and endemism of species of *Asparagus* in the Flora of the Southern Aral Sea region (Karakalpakstan, Uzbekistan). The *Asparagus turkestanicus* is endemic to the flora of Central Asia (Uzbekistan). *Asparagus persicus*, *Asparagus brachyphyllus,* and *Asparagus officinalis* are recorded for the first time in the Aral Sea region. The analyses presented here showed that the genus *Asparagus* is distributed mostly in the Turan province in Uzbekistan. The species can be found in different zones ranging from arid Ustyurt regions to the Kyzylkum desert area in the Southern Aral Sea region. The only limiting condition for its distribution may be the low temperatures occurring in the temperate mountains.

The use of the geographic locations of the collection sites in combination with the GIS software allowed the prediction of the distribution and estimation of species richness for the genus *Asparagus* in the Southern Aral Sea region. The species distribution maps based on GIS using data from the last century can provide valuable information about where species (populations) may have disappeared because of anthropogenic impact and provide an important tool for species conservation.

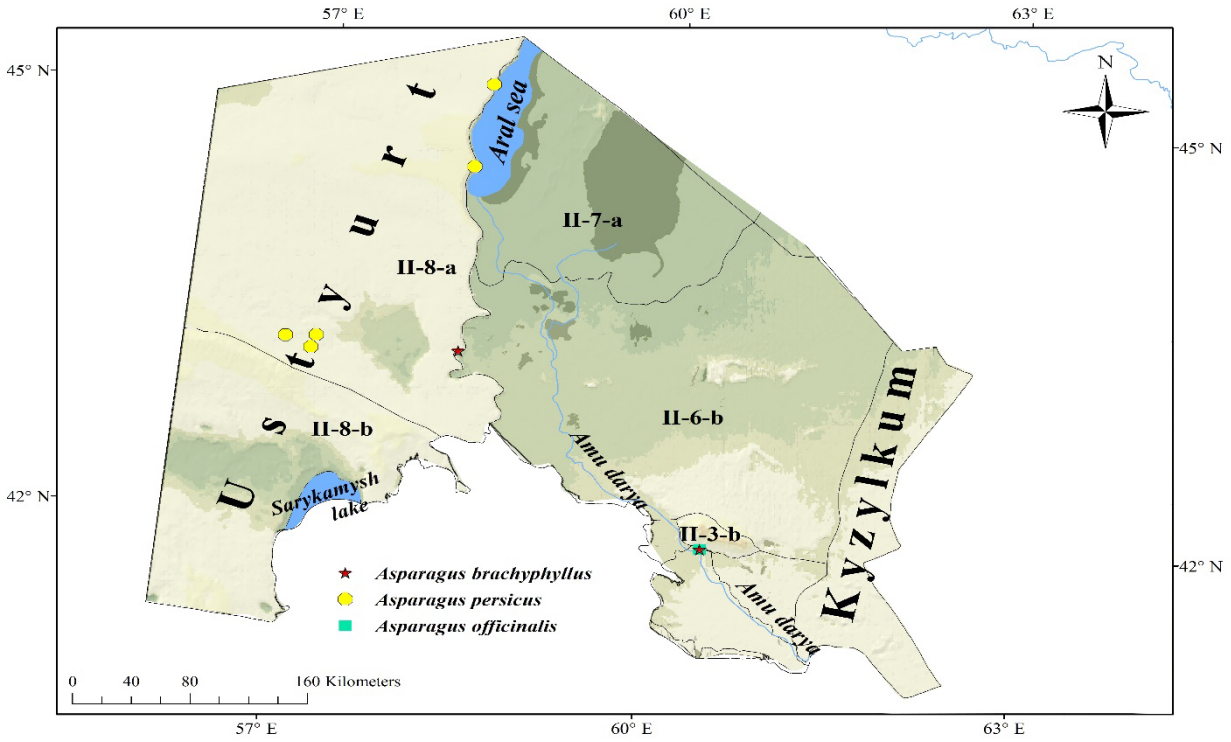

Fig. 4. Distribution map of the species of *Asparagus* by phytogeographical regions of the Southern Aral Sea region.

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