IRSTI34.29.253. https://doi.org/10.26577/bb.2024.v100.i3.03

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DISTRIBUTION OF *ERANTHIS LONGISTIPITATA* REGEL IN THE TERRITORY OF CENTRAL ASIA

This manuscript gives an outline of the current growing sites of the endemic medicinal plant of Central Asia, *Eranthis longistipitata* Regel. Today, this plant garners significant interest from the global scientific community due to its remarkable anti-tumor, antioxidant, and anti-inflammatory properties. No analysis of herbarium collections had been performed before, so we took first step to analyze one of the largest herbarium collections in Central Asia – the Botanical Institute in Uzbekistan and the digital database GBIF. More than 100 herbarium labels were studied from 1916 to 2020. Based on the herbarium materials, 37 actual locations of *E.longistipitata* populations with GPS data were identified. As a result *E.longistipitata* populations were found on the territory of five Central Asian states – Kazakhstan, Uzbekistan, Kyrgyzstan, Turkmenistan, and Tajikistan. In Kazakhstan *E.longistipitata* was found in the three growing points located in the western Tien Shan, Pamir-Alay, and Karatau mountain ranges. The research allowed for the refinement and supplementation of information on the distribution range of *E.longistipitata* in Central Asia.

Key words: *Eranthis longistipitata* Regel, western Tien-Shan, ephemeroid, herbarium, endemic, Central Asia, geographic distribution, ontogenesis.

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Орталық Азия аумағында *E. longistipitata* regel өсімдігінің таралуы

E. longistipitata Regel – батыс Тянь-Шань тау бөктерінде өсетін Орталық Азияның эндемикалық өсімдігі. Бүгінгі таңда бұл өсімдік ісікке қарсы, антиоксидантты және қабынуға қарсы қасиеттерінің арқасында әлемдік ғылыми қауымдастықтың қызығушылығын тудырады. Бұрын гербарий коллекцияларына талдау жүргізілген жоқ, сондықтан біз алғаш рет Орталық Азиядағы алғашқы және ең ірі гербарий коллекцияларының бірін – Өзбекстан Республикасы Ғылым академиясының Ботаника институтын және GBIF базасының мәлеметтерін, әлемдік әртүрлілік туралы ғылыми ақпарат жинау үшін құрылған.. 1916 жылдан 2020 жылға дейінгі 100-ден астам гербарий үлгілері зерттелді. Гербарий үлгілері арқылы *E.longistipitata* популяцияларының 37 нақты нақты орны GPS координаттарымен анықталды.*E. longistipitata* популяциялары Қазақстан, Өзбекстан, Қырғызстан, Түрікменстан және Тәжікстан сияқты бес Орта Азия мемлекеттерінің аумағында табылды. Қазақстан аумағында Батыс Тянь-Шань, Памир-Алай және Қаратау тау бөктерінде өсімдік объектілері анықталды. Ұсынылып тұрған зерттеу Орталық Азиядағы *E. longistipitata* таралу аймағы туралы ақпаратты нақтылауға және толықтыруға мүмкіндік берді.

Түйін сөздер*: E.longistipitata* Regel, Батыс Тянь-Шань, эфемероид, гербарий, эндемикалық, Орталық Азия, географиялық таралуы, онтогенез.

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Распространение *E. longistipitata* regel на территории Центральной Азии

E.longistipitata Regel – эндемичное растение Центральной Азии, произрастающее преимущественно в предгорьях Западного Тянь-Шаня. На сегодняшний день, это растение вызывает значительный интерес у мирового научного сообщества благодаря своим значительным противоопухолевым, антиоксидантным и противовоспалительным свойствам. Ранее анализ гербарных коллекций не проводился, поэтому впервые мы проанализировали одну из первых и крупнейших гербарных коллекций в Средней Азии – Института ботаники Академии наук Республики Узбекистан и базу данных GBIF, созданную для сбора научной информации о мировом разнообразии. Было изучено более 100 гербарных образцов, датируемых с 1916 по 2020 год. С помощью гербарных образцов было идентифицировано 37 актуальных фактических местонахождений популяций *E.longistipitata* с указанием GPSкоординат. Популяции *E.longistipitata* были обнаружены на территории пяти Среднеазиатских государств: Казахстана, Узбекистана, Кыргызстана, Туркменистана и Таджикистана. На территории Казахстана растительные объекты обнаружены в предгорьях Западного Тянь-Шаня, Памиро-Алая и Каратау. Проведенное исследование позволило уточнить и дополнить информацию об ареале распространения *E.longistipitata* в Центральной Азии.

Ключевые слова*: E.longistipitata*Regel, Западный Тянь-Шань, эфемероид, гербарий, эндемичный, Центральная Азия, географическое распространение, онтогенез.

Introduction

Eranthis Salisb. plants belong to the Ranunculaceae Juss. family, the Cimicifugeae Torrey & Gray tribe. The majority of *Eranthis* Salisb. species are predominantly found in the northern hemisphere and are characterized as perennial herbs [1].The genus *Eranthis* has been subdivided into two basic sections: *Eranthis* and Shibateranthis (Nakai) Tamura, which comprises 8–14 species growing in southern Europe and Central Asia [2-5]. *Eranthis* plants are characterized by annual tubers, yellow sepals and emarginate or slightly bilobate upper petal margins. Shibateranthis (Nakai) Tamura plants are characterized by enduring tubers, white sepals and two-lobed petal edges with enlargements [6,7].

The genus *Eranthis* Salisb. is characterized by thickened tuberous underground stems, separate palm-like basal leaves, a leafless stem with leaf-like sheeting on the upper part, and actinomorphic single flowers with an unusual petal structure.The genus *Eranthis* is a flowering herbaceous plant with thickened tuberous roots [8-11].

Figure 1 shows the diversity of plants of the genus *Eranthis* and their distribution areas.

The data in Figure 1 shows that the flowers of plants of the genus *Eranthis* can are white or yellow. Currently, the species diversity of plants of the genus *Eranthis* with white flowers is greater. Depending on the color of the flowers, this genus of plants is divided into 2 groups: E. sect. *Eranthis* and E. sect. *Shibateranthis* (Nakai) Tamura [12]. E. sect. *Eranthis* is identified by annual tubers, yellow sepals, and upper petals with emarginate or slightly bilobate margins lacking swellings (nectaries), while the E. sect. *Shibateranthis* comprises species with long-lived tubers, white sepals, and petals with bilobate or forked margins containing swellings [13].

The plants belonging to the tribe *Cimicifugeae* are among the most abundant sources of diverse active ingredients and beneficial substances for therapeutic and health-enhancing purposes. The efficacy of these constituents has been verified through extensive use in folk medicine practices in East Asian countries over many years [14-16].

The scope of this investigation was to systematize, refine, and supplement information regarding the presence and arrangement of the *E. longistipitata* in the Central Asia mountain system.

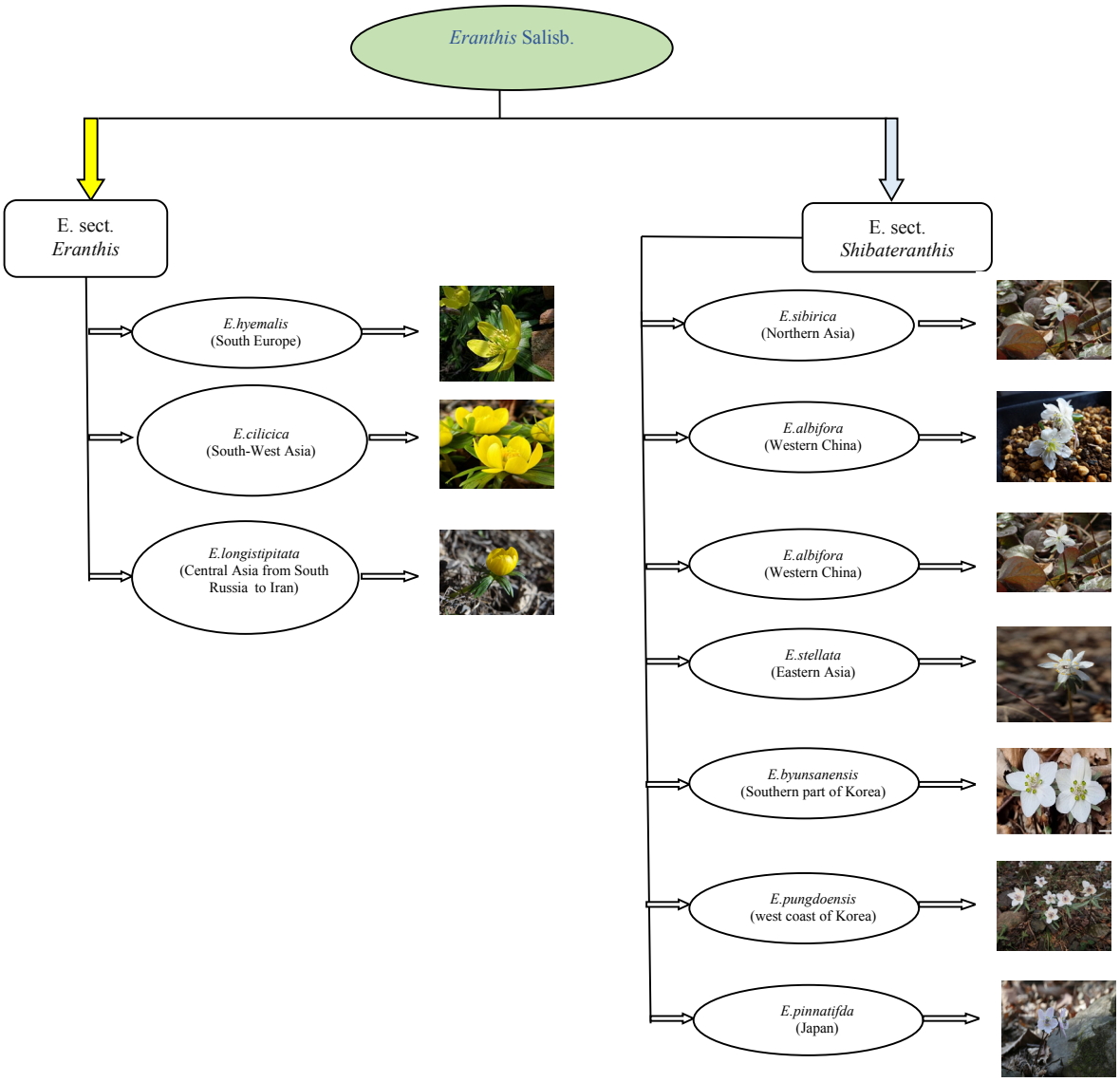

Figure 1 – Dissemination of *Eranthis* speciesworldwide

Materials and methods

E.longistipitata is a perennial plant with a globular tuber, 4-5-separated leaves and a aphyllous stem (3-25 cm) divided on the top to the linear segments (Figure 2).

Prevoius studies have indicated that *Eranthis* exhibits pharmacological activity. *Eranthis* sp. has been usedas a pharmacological natural agent at the treatment of urolithiasis and diuresis [17]. The tubers of *Eranthis* plants possess notable pharmacological properties. The tubers of *E.cilicica* contain triterpene glycosides belonging to the cycloartan and oleanane groups, as well as saponins. These compounds exhibit toxicity towards human promyelocytic leukemia cells (HL-60) [18]. Chromones isolated from the tubers of *E.cilicica* have been found to possess antioxidant and anti-inflammatory properties [19]. Kumar et al. in researches showed that the genus *Eranthis* possesses antibacterial and antiviral activity [20].

As it mentioned in the Fig.3 we explored populations of *E.longistipitata* in three locations: Taldybulak Gorge (42º 25’12N 70°28’28E), Zhetimsay Gorge (42º 24’41N 70°32’41E) and valley of the Irsu River (42º 21’33 N70˚22’28E).

Figure 2 – *E.longistipitata* in nature habitat, A – in the beginning of flowering (end of the February), B – in the flowering period (March)

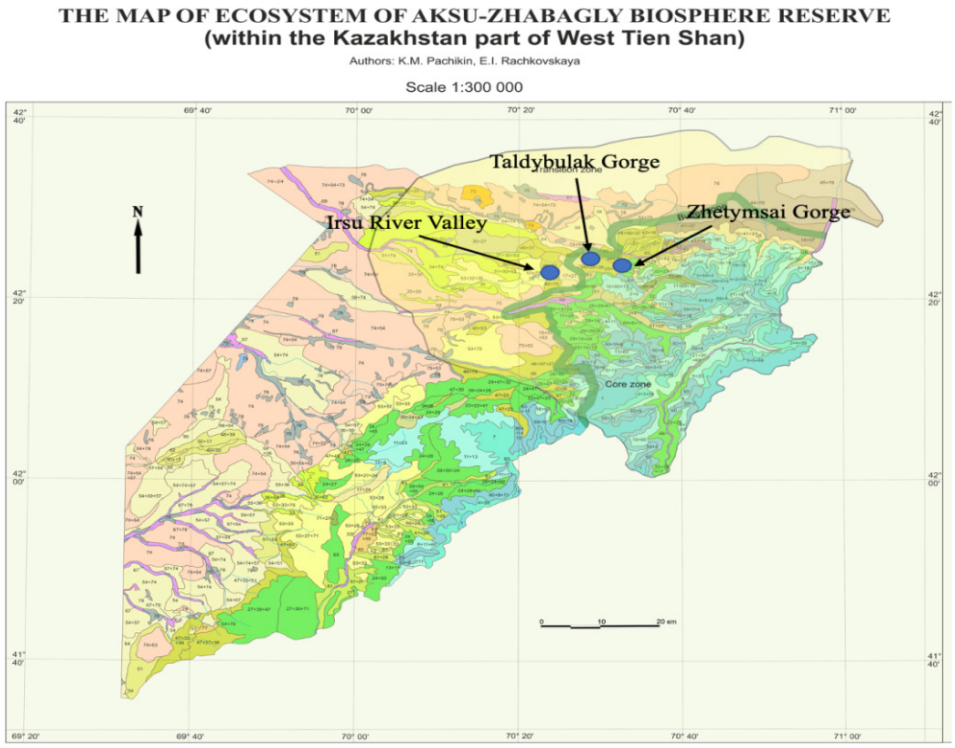

Figure 3 – Location of *E.longistipitata* populations in Kazakhstan part of Western Tien Shan

To further refinement the contemporary distribution of *E. longistipitata*, an inventory of herbarium material dated from 1916 to 2020 was conducted. Materials stored in the main repositories were processed for species synopses. These repositories include the Botany Institute in Uzbekistan, which holds 105 herbarium labels, and the digital herbarium of Moscow State University (MSU) – "Noah's Ark" Living Systems Repository, which contains 22 herbarium labels and data from the GBIF database[21].The herbarium fund of the Institute of Botany of Uzbekistan is one of the largest in the world, considering the volume of the flora collection. The TASH foundation holds more than 1.4 million plant samples; the first herbarium labels were created at the beginning of the XIX century [22]. The collections of this herbarium fund are of great value, as they help scientists obtain data on species distribution and ecological occurrence.

Results and discussion

In March 2023, we conducted a botanical expedition in the Aksu Jabagly Nature Reserve during the flowering period of *E.longistipitata* to estimate the current state of populations. To create a herbarium label were collected tubers and leaves of *E.longistipitata*. Plant material was dried naturally by air and crushed by a laboratory mill. Our previous studies [23] found that populations of *E.longistipitata* growing in the Irsu River valley contain a more significant number of valuable flavonoids in their composition. In the Fig.4 is shown a herbarium label of *E.longistipitata* collected during the expeditions (Figure 4).

The individuals found in the Irsu River valley are characterized by a left-sided age spectrum, i.e. individuals of virginal age and especially juvenile plants significantly predominate, this fact indicates a high viability of seeds (Figure 5).

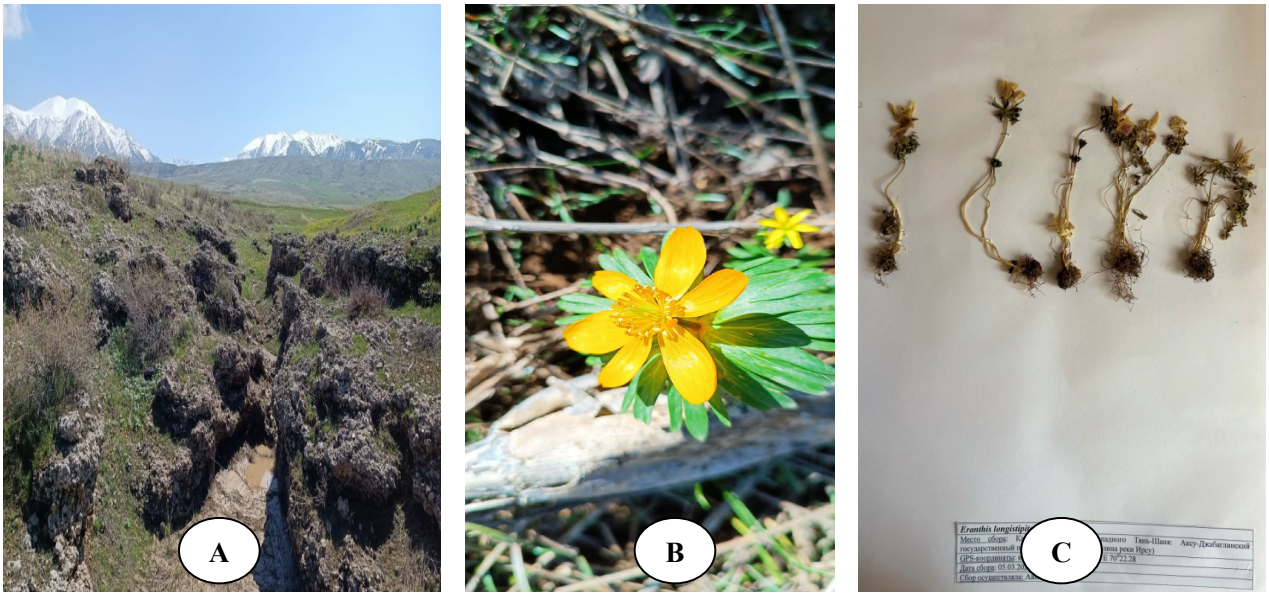

Figure 4 – A – Irsu River valley in the Aksu Jabagly State Nature Reserve,
B – *E.longistipitata* in the nature habitat in the flowering period, C – *E.longistipitata* herbarium label

Figure 5 – Populations of *E.longistipitata* native to the Irsu River valley

The numerical number of populations of *E.longistipitata* decreases every year due to the free grazing of ungulates in the protected area. The shoot of *E. longistipitata* is multifunctional and has played an adaptive role during evolution. The presence of two forced types of rest (summer and winter) is associated with the adaptation of organs to self-survival and preservation. The vital activity of the apex in *E.longistipitata* undergoes a short aboveground and a long underground development. In the unique conditions of the foothill zone of Southern Kazakhstan, this ephemeroid geophyte, E. *longistipitata*, blooms in a fascinating manner. It springs to life immediately after the snowfall, in sync with other ephemeroids of the region. The growing season is a mere 30-46 days, and by the third decade of May, the aboveground part withers away, while the underground part enters a forced summer rest, a truly remarkable adaptation.

The studied herbarium labels of *E.longistipitata* in the Botany Institute in Uzbekistan, the digital herbarium of Moscow State University, and data from the GBIF database were found on the territory of four modern Central Asian states: Kazakhstan, Uzbekistan, Turkmenistan, and Tajikistan (Table 1).

Table1 – *E.longistipitata*herbarium labels

№	Country or area	Coordinates	Event date	Dataset
1	Uzbekistan	40.5N, 66.9E	24.03.2024	iNaturalist Research-grade Observations
2	Uzbekistan	40.6N, 66.7E	23.03.2024	iNaturalist Research-grade Observations
3	Kyrgyzstan	42.8N, 74.6E	19.03.2023	iNaturalist Research-grade Observations
4	Uzbekistan	41.6N, 69.6E	26.03.2023	iNaturalist Research-grade Observations
5	Uzbekistan	38.3N, 67.3E	30.03.2023	iNaturalist Research-grade Observations
6	Uzbekistan	37.8N, 66.7E	14.03.2023	iNaturalist Research-grade Observations
7	Uzbekistan	41.4N, 69.8E	28.03.2023	iNaturalist Research-grade Observations
8	Kazakhstan	43.6N, 69.7E	11.04.2023	iNaturalist Research-grade Observations
9	Kazakhstan	42.8N, 70.7E	14.11.2023	iNaturalist Research-grade Observations
10	Kazakhstan	42.8N, 69.9E	22.05.2023	iNaturalist Research-grade Observations
11	Uzbekistan	38.4N, 67.4E	16.05.2023	Living Collection of the Gothenburg Botanical Garden
12	Kazakhstan	42.5N, 70.6E	28.03.2021	iNaturalist Research-grade Observations
13	Kazakhstan	43.3N, 74.8E	04.04.2021	iNaturalist Research-grade Observations
14	Kazakhstan	42.7N, 71.0E	02.04.2021	iNaturalist Research-grade Observations
15	Uzbekistan	40.7N, 66.6E	26.02.2020	iNaturalist Research-grade Observations
16	Kazakhstan	43.0N, 70.4E	29.03.2019	iNaturalist Research-grade Observations
17	Uzbekistan	38.1N, 67.3E	01.03.2019	iNaturalist Research-grade Observations
18	Kazakhstan	42.8N, 71.0E	20.03.2020	iNaturalist Research-grade Observations
19	Uzbekistan	39.3N, 67.1E	15.03.2019	iNaturalist Research-grade Observations
20	Kazakhstan	43.3N, 74.9E	16.04.2018	iNaturalist Research-grade Observations

Continuation of the table

№	Country or area	Coordinates	Event date	Dataset
21	Uzbekistan	41.5N, 70.1E	20.06.2018	iNaturalist Research-grade Observations
22	Kyrgyzstan	40.9N, 73.2 E	08.04.2014	iNaturalist Research-grade Observations
23	Kyrgyzstan	41.6N, 72.6E	04.04.2014	iNaturalist Research-grade Observations
24	Kazakhstan	43.7N, 68.9E	25.04.2013	iNaturalist Research-grade Observations
25	Uzbekistan	40.5N, 66.8E	26.03.2012	iNaturalist Research-grade Observations
26	Kyrgyzstan	40.5N, 72.8E	04.04.2012	iNaturalist Research-grade Observations
27	Kazakhstan	43.4N, 77.4E	21.04.2009	iNaturalist Research-grade Observations
28	Turkmenistan	-	28.03.2001	Tropicos MO Specimen Data
29	Uzbekistan	41.7N, 70.1E	01.05.1992	International Nucleotide Sequence Database Collaboration Sequences
30	Kazakhstan	43.6N, 68.6E	28.04.1984	Colección de plantasvasculares del herbario de la Universitat de València (VAL)
31	Uzbekistan	40.4N, 66.5E	26.04.1979	Moscow University
32	Tajikistan	-	28.02.1978	Meise Botanic Garden Herbarium (BR)
33	Tajikistan	37.8N, 69.6E	28.02.1978	Masaryk University – Herbarium BRNU
34	Tajikistan	-	28.02.1978	Moscow University Herbarium (MW)
35	Kazakhstan	-	08.05.1973	Moscow University Herbarium (MW)
36	Kazakhstan	-	24.04.1969	Moscow University Herbarium (MW)
37	Uzbekistan	-	30.04.1963	Moscow University Herbarium (MW)

As mentioned above, the systematic study of Central Asia's unique flora began with complex soil and geobotanical expeditions in 1908-1916. And it was from this period that the TASH herbarium fund was created. The first herbarium specimens of *E.longistipitata* are marked by this period. Plant diversity in Central Asia was not studied at that time, and expeditions were carried out in large numbers in the mountainous regions. It is from there that a large number of *E. longistipitata* specimens are concentrated.

Table 1 shows data on herbarium collections, which had data on GPS coordinates, the rest of the data is not given, since they date from 1908 and may not be relevant today.

Based on the findings of our previous researches of herbarium specimens of *E.longistipitata*, we have compiled a map of the location of this species (Figure 5).

Based on the GPS data of *E.longistipitata* growth sites presented in Figure 5, we have compiled a diagram of quantitative data on the detection of this species within different countries (Figure 6).

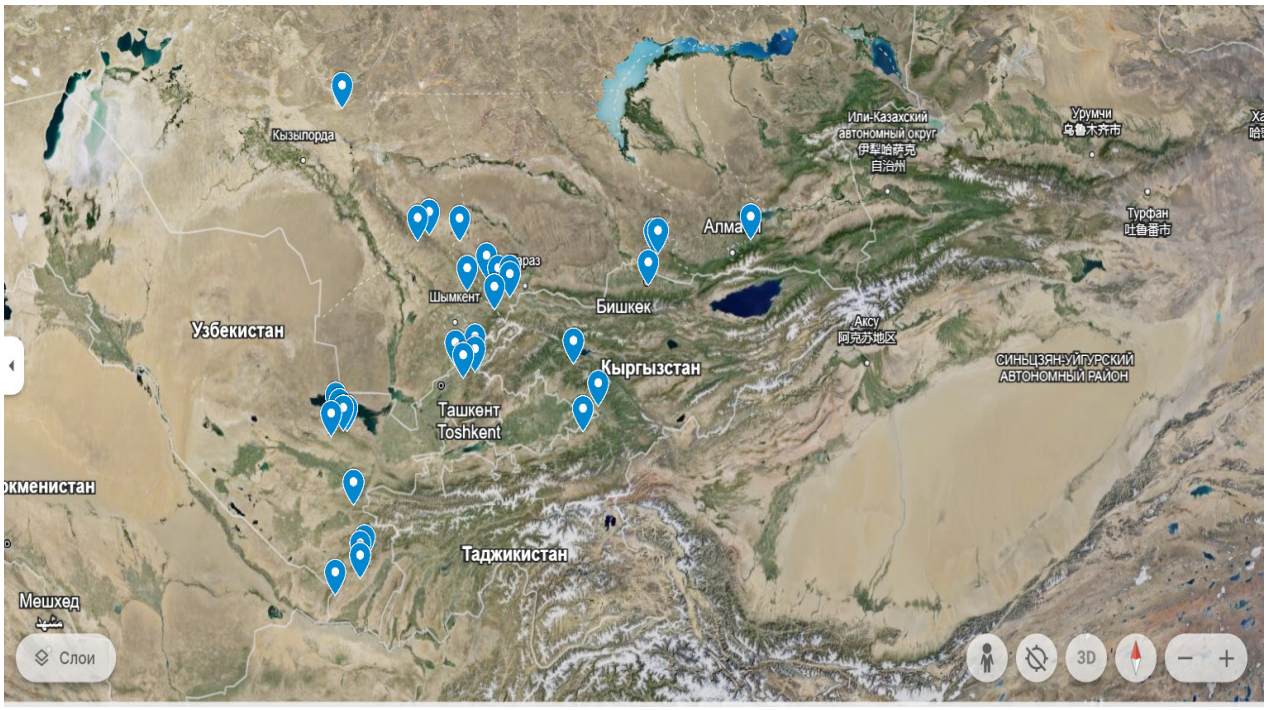

Figure 5 – *E.longistipitata***g** rowth areas in Central Asia

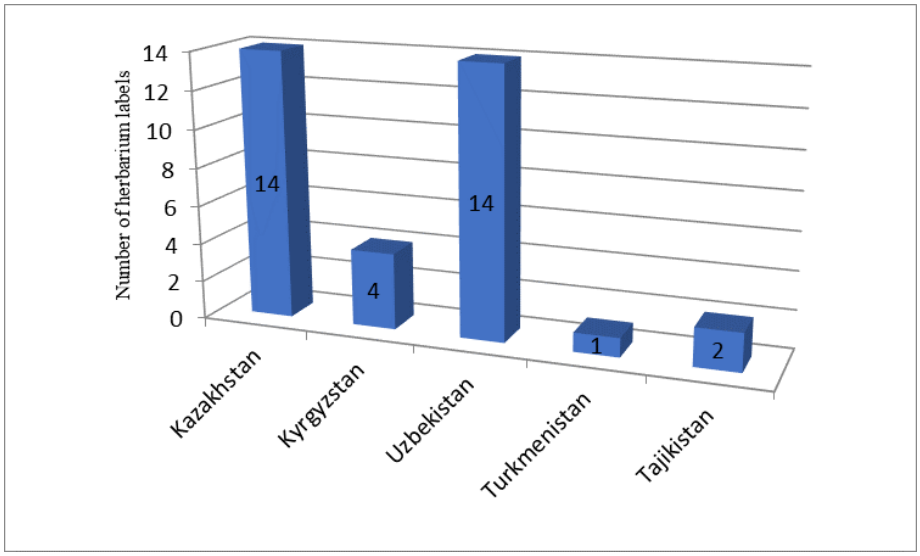

Figure 6 – Distribution of the number of herbarium labels (37) by countries

The maximum number of *E.longistipitata* populations was found on the territory of two Central Asian states – Kazakhstan and Uzbekistan (Figure 6).

The mountain systems of Central Asia and Kazakhstan are characterized by tectonic activity, high seismicity, young mountainous terrain, and high altitudes (absolute and relative). They belong to the drainage basin of Eurasia, where the Tien Shan and Pamir reach heights of 5000-7500 m, and the marginal systems – 3000 m. They are characterized by mountain glaciations [24-25].

By meticulously analyzing the collected geographical data on the GPS coordinates of the TASH type collection and comparing them with the botanical and geographical districts of Uzbekistan,

we made a fascinating discovery. Populations of *E.longistipitata*, a plant known for its unique characteristics, were found in all mountainous floristic districts: West Tianshan (8), Kuhistan (1), West Hissar (1), Ferghana-Alai (2) and Nuratinsk (2). This distribution pattern presents a captivating puzzle for us to unravel.

In general, the flora of the Western Tianshan District is characterized by significant generic endemism of many Central Asian plants. The discovered populations of *E.longistipitata* are primarily located in the Pritashkent district, north of Tashkent city (between the Arys and Keles rivers). This area is almost entirely within the borders of Kazakhstan. Uzbekistan includes only a part of the anthropogenic landscape (near the Bozsu Canal and the border area).

On the territory of the Republic of Kazakhstan, populations of *E.longistipitata* were found in 14 locations. Most of these are in the Aksu–Jabagly Nature Reserve territory. This reserve is unique not only for the duration of the established protection regime (it is the oldest in Central Asia and is a UNESCO World Heritage Site), the diversity of flora and fauna represented, and the uniqueness of its geographical location and relief. It occupies a marginal position within the orogens of Central Asia, on the border with the most extensive inland plains. The relief-forming processes there are typical for the mountains of Central Asia. Populations of *E.longistipitata* within the Republic of Kazakhstan have been found in the foothill plains, the low mountains, and the lower part of the middle categories of savannoids. This West Tienshan sub-provincial covers the southern microcline of the Talas ridge and a group of Karzhantau and Ugamsky ridges extending from it. The foothills of the mountains are occupied by low-grass savannoids, which are replaced by tall-grass ones above (*Elytrigia trichophora* and *Hordeum bulbosum*).

Conclusion

The analysis of the Institute of Botany (TASH)'s herbarium material and the digital herbarium database GBIF has identified 37 actual places of *E. longistipitata* growth in Central Asia with GPS coordinates. It has been ascertained that *E.longistipitata*is widespread in all floristic areas in the Western Tien Shan and Pamir-Alai. The populations of *E. longistipitata found* by us in the Irsu River valley are characterized by a left-sided age spectrum, i.e., individuals of virginal age and especially juvenile plants significantly predominate. This fact indicates a high viability of seeds.

Since it was previously noticed that *E.longistipitata* is an endemic medicinal plant of the Central Asia (Western Tien-Shan mountain systems), the studies carried out made it possible to systematize, clarify and supplement information on the presence and distribution of *E.longistipitata* in various floristic regions of Central Asia.

Funding

This research was supported by the Ministry of Science and Higher Education of the Republic of Kazakhstan [AP15473152].

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Received May 2, 2024
Re-uploaded July 23, 2024
Accepted August 20, 2024