Brief Introduction

Central Asia, spanning almost 4 million km², is the core region of Eurasia, stretching from the Caspian Sea and the Volga River in the west to Northwest China in the east. This area comprises five countries: Kazakhstan (KZ), Kyrgyzstan (KG), Tajikistan (TJ), Uzbekistan (UZ), and Turkmenistan (TM). The southeastern part of Central Asia includes the Tianshan Mountains and Pamir Plateau, the Kazak hills in the north, the Turan plain, and the coastal plain of the Caspian Sea in the midwest, as well as the Karakum and Kyzylkum Deserts in the south (Chen, 2010). The highest peak in the southeast, Ismail Somoni in the Pamir-Alai mountain system, reaches 7495 meters (Jilili and Ma, 2015).

Central Asia is one of the world's largest arid regions in the Northern Hemisphere, characterized by a temperate continental arid climate (Jilili and Ma, 2015). The Tianshan Mountains and Pamir Plateau on the southeastern edge serve as a climatic division, intercepting moisture from the Indian and Pacific Oceans. Consequently, water vapor concentration is very low, leading to extremely uneven distribution of water resources. The southeast has become the sole water source for the five Central Asian countries, while the northwest is gradually becoming arid (Litvinsky et al., 1996; Brooke, 2014; Jia et al., 2018). Precipitation in most areas is less than 300 mm, although some mountainous regions receive up to 1000 mm. Arid and semi-arid areas, covering nearly three-quarters of Central Asia, are the predominant topographical features (Chen et al., 2008; Yu et al., 2019). This region boasts diverse vegetation, including gravel desert plants, sandy desert plants, sparse shrubs, and river valley forests (Korovin, 1961–1962). The altitudinal gradient ranges from desert to mountain shrubland, deciduous broad-leaved forest, dark coniferous forest, subalpine grassland, alpine meadows, and alpine cushion vegetation (Zhang et al., 2013, 2020).

Botanical investigation in Central Asia began in the 18th century and intensified in the latter half of the 19th century, leading to a wealth of specimens stored in herbaria across Central Asia and neighboring countries (Frodin, 2001). Notably, Alexander Bunge published contributions to the flora of Russia and Central Asia based on Alexander Lehmann's collections from 1839–1842. Subsequent significant works include "Flora of Pamir" (Fedtschenko and Fedtschenko, 1901), "Flora Srednej Azii" (Lipsky, 1902), and "Conspectus Florae Turkestanicae" (Fedtschenko and Fedtschenko, 1906–1916). The establishment of the University of Tashkent (now National University of Uzbekistan) in 1920 further spurred botanical explorations, culminating in the "Flora SSSR" project (Komarov, 1934–1964) and numerous flora books covering various regions and countries within Central Asia. Some flora books were published owing to the *Flora SSSR* project (Komarov, 1934–1964) after the establishment of the Soviet Union in 1922, such as *Conspectus Florae Asiae Mediae* (Kovalevskaya, 1968–1971; Bondarenko and Nabiev, 1972; Pakhomova, 1974–1976; Kamelin et al. 1981; Adylov, 1983, 1987; Nabiev, 1986; Adylov and Zuckerwanik, 1993; Khassanov, 2015) in region level; *Flora Turkmenii* (Fedtscihenko et al., 1932, 1937, 1948–1960), *Manual of Vascular Plants of Turkmenistan* (Nikitin and Geldykhanov, 1988), *Flora Uzbekistanica* (Vol. 1–6) (Schreder and Vvedenskyi, 1941–1962), *Flora Kirgizskoj SSR* (Vol. 1–11) (Shishkin and Vvedensky, 1950–1962) and their two supplements (Vykhodsev, 1967, 1970), *Flora Kazakhstana* (Vol. 1–9) (Pavlov, 1956–1966), *Flora of the Tajik SSR* (Vol. 1–10) (Ovchinnikov, 1957–1991) in country level; *Flora of Central Kazakhstan* (Pavlov, 1928–1938), *Plant Resources of South Kazakhstan* (Pavlov, 1947), *Flora and Vegetation of Zarafshan Valley* (Part 1–2) (Zakirov, 1955, 1961), *Flora and Vegetation of the Western*

Spurs of the Talas Alatau (Karmysheva, 1982), *Flora of the Dzhungarskiy Alatau (check-list and analysis)* (Goloskokov, 1984), *Flora of East Kazakhstan* (Baytulin, 1991), and *Opredelitel' Rastenij Devernogo Tadzikistana* (Komarov, 1967), *Flora of the South-Western Tian-Shan (within the Republic of Uzbekistan)* (Tojibaev, 2010) inner county.

According to the index of herbaria (Thiers, 2017), there are approximately ten major herbaria in the five Central Asian countries, including those at the Institute of Botany and Phytointroduction, Ministry of Ecology and Natural Resources, Republic of Kazakhstan (AA), and the National Herbarium of Uzbekistan (TASH), which is the largest, containing over 1.5 million specimens. In total, nearly 3 million specimens are stored in Central Asian herbaria, with significant collections also housed in the Komarov Botanical Institute of the Russian Academy of Sciences (LE) and Moscow State University (MW).

Table 1 The key herbariums in Central Asia

Country	Herbarium code	Institution	Location	Specimens
Kazakhstan	UKSPI	S. Amanjolov East-Kazakhstan State University	Ust-Kamenogorsk	11,338
	AA	Institute of Botany and Phytointroduction, Ministry of Ecology and Natural Resources, Republic of Kazakhstan	Alma-Ata	300,000
	PPIU	M. Utemisov Western Kazakhstanian State University	Uralsk	340,000
	KG	Internatinal Phytochemistry Research and Production Institute	Alma-Ata	28,000
	KSPI	Kostanay State Pedagogical Institute	Kostanay	25,000
Kyrgyzstan	FRU	Institute of Biology and Soil, National Academy of Science, Kyrgyzstan	Bishkek	400,000
Tajikistan	TAD	Institute of Botany, Plant Physiology and Genetics, National Academy of Sciences of Tajikistan	Dushanbe	200,000
	KHOR	Pamir Biological Institute	Khorog	30,000
Turkmenistan	ASH	National institute of deserts, flora and fauna of the Ministry of nature protection of Turkmenistan	Ashkhabad	135,000
Uzbekistan	TASH	Institute of Botany, Academy of Sciences of the Republic of Uzbekistan	Tashkent	1,500,000

After gaining independence from the Soviet Union in 1991, the Central Asian countries established national scientific programs to modernize scientific activities (Li et al., 2020; Sennikov et al., 2016). Despite challenges, notable efforts include Kazakhstan's new Flora project and Uzbekistan's Flora project, which began in 2015 and has published five volumes to date. The "Conspectus Florae Asiae Mediae" (Volume 11) published in Tashkent is a comprehensive checklist of Central Asia, documenting 9341 species of vascular plants across 1245 genera and 161 families (Khassanov, 2015). Recent work also includes the first checklist of endemic vascular plants of the Central Asian part of the Tianshan Mountains, comprising 871 endemic species and subspecies (Tojibaev et al., 2020).

The mountains of Central Asia are particularly significant for biodiversity conservation and have been recognized as global biodiversity hotspots (Mittermeier et al., 2006). These hotspots are crucial for maintaining both natural and domesticated biodiversity (CEPF, 2017). They harbor ancestors of domestic varieties of fruits and nuts, including

apricots, plums, cherries, apples, pears, cherry plums, grapes, pistachios, almonds, walnuts, and pomegranates. Additionally, wild crop relatives of many herbaceous plants, such as wheat, barley, rhubarb, sorrel, anise, oats, onions, garlic, and tulips, are found in this region, with some listed on the International Union for Conservation of Nature Red List of Threatened Species, underscoring the area's importance as a reservoir of crop diversity (Zhang et al., 2020).

The first detailed and comprehensive checklist of the endemic vascular plants of the Central Asian part of the Tianshan Mountains was published by Tojibaev et al. (2020). This checklist is based on modern phylogenetic work at all taxonomic levels and represents a novel contribution for Central Asia as a whole. The research led to major rearrangements in some families and genera, adhering strictly to the principle of monophyly, except in cases where data were incomplete or inconclusive. According to the checklist, 4283 species and subspecies of plants are registered in the Central Asian part of the Tianshan Mountains (4080 of which are native), including 81 new nomenclatural combinations and 2 new nothogenera.

All previous explorations, floristic data, flora books, monographs, papers, and specimens provide a solid foundation for future botanical research in Central Asian countries. However, it is undeniable that the floras of Central Asian countries are outdated. The volumes of "Flora Turkmenii" were published 64 to 92 years ago, and the 10th volume of the "Flora of the Tajik SSR," which was completed later than the national floras of other countries, was published more than 33 years ago (see Table 2). Since the publication of these works, the generic placement of many species has changed with the advancement of botanical research. Numerous new taxa and records have also been reported in Central Asia (Nobis et al., 2016, 2017; Kljuykov et al., 2018; Lyskov et al., 2019a, 2019b; Sytin and Lazkov, 2018; Tojibaev et al., 2018; Usmonov, 2017). Therefore, the checklist of vascular plants in Central Asia still needs to be updated.

Table 2 The key flora books and checklists in Central Asia

Countries and regions	Flora books and checklists	Publish date	Language
Kazakhstan	*Flora Kazakhstana* (Vol. 1–9)	1956–1966	Russian
	Checklist of Vascular Plants of Kazakhstan	1999	Russian
Kyrgyzstan	*Flora Kirgizskoj SSR* (Vol. 1–11), and its supplement 1–2	1950-1970	Russian
	Checklist of vascular plants of Kyrgyzstan	2011	Russian
	Checklist of vascular plants of Kyrgyzstan	2014	Russian
Tajikistan	*Flora of the Tajik SSR* (Vol. 1–10)	1957–1991	Russian
Uzbekistan	*Flora Uzbekistanica* (Vol. 1–6)	1941–1962	Russian
	Flora of Uzbekistan (Vol. 1–5)	2016–2022	Russian
Turkmenistan	*Flora Turkmenii* (Vol. 1–7)	1932–1960	Russian
	Manual of Vascular Plants of Turkmenistan	1988	Russian
Central Asia	*Conspectus Florae Asiae Mediae* (Vol. 1–11)	1968–1993, 2015	Russian

Central Asia is an important global biodiversity hotspot (Myers et al., 2000; Mittermeier et al., 2006). A significant number of species and genera are confined to this area, contributing to the floristic irreplaceability of Central Asia (Kamelin, 1971, 1990; Tahktajan, 1978; Zhang et al., 2013; Li et al., 2020; Tojibaev et al., 2020). The flora of the

Central Asian mountain ridge is notably rich, with approximately 7000 vascular plants distributed in the mountainous areas, accounting for over 75% of the region's total plant diversity (Zhang et al., 2013). Speciation of genera such as *Allium* (Khassanov and Tojibaev, 2010; Fritsch, 2016), *Tulipa* (Tojibaev and Kadirov, 2010; Tojibaev and Beshko, 2014; Tojibaev et al., 2020; Zonneveld and de Groot, 2012; Christenhusz et al., 2013), *Gagea* (Peterson et al., 2016), *Eremurus* (Tojibaev et al., 2014; Makhmudjanov et al., 2022), *Iris* (Khassanov and Rakhimova, 2016), and *Hedysarum* (Nafisi et al., 2019; Juramurodov et al., 2023) is believed to center in Central Asia. Many species in Central Asia are utilized for food, medicine, industry, environmental protection, construction, and plant germplasm.

According to previous surveys on Central Asian plant diversity, there are 9341 taxa represented by 161 families and 1288 genera occurring in Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan, and Uzbekistan (Khassanov, 2015). The number of species (9341) and genera (1245) are similar to the results of Zhang et al. (2013), which recorded 9346 species of vascular plants across Central Asia, belonging to 1279 genera and 127 families. After cleaning the previous data from Floras, Checklists, and Databases, we identified 139 families, 1198 genera, and 9643 species of vascular plants in Central Asian countries based on PPG I (2016), Christenhusz et al. (2011), and APG IV (2016). Among these, there are 70 lycophytes and ferns, 36 gymnosperms, and 9537 angiosperms. The top 10 families with the most abundant species in Central Asia are Asteraceae (1635 species), Fabaceae (1203 species), Poaceae (570 species), and Lamiaceae (508 species), Brassicaceae (487 species), Apiaceae (476 species), Amaranthaceae (353 species), Rosaceae (352 species), Caryophyllaceae (348 species) and Amaryllidaceae (298 species) (Figure 1). All species in those 10 families (6230 species) account for 64.61% of total species in Central Asia. The top 10 genera with the abundant species are *Astragalus* (647 species), *Allium* (286 species), *Cousinia* (248 species), *Oxytropis* (194 species), *Taraxacum* (151 species), *Artemisia* (143 species), *Silene* (120 species), *Jurinea* (117 species), *Carex* (112 species) and *Ferula* (105 species), with 2123 species in total accounting for 22.02% of the total species in Central Asia (Figure 1).

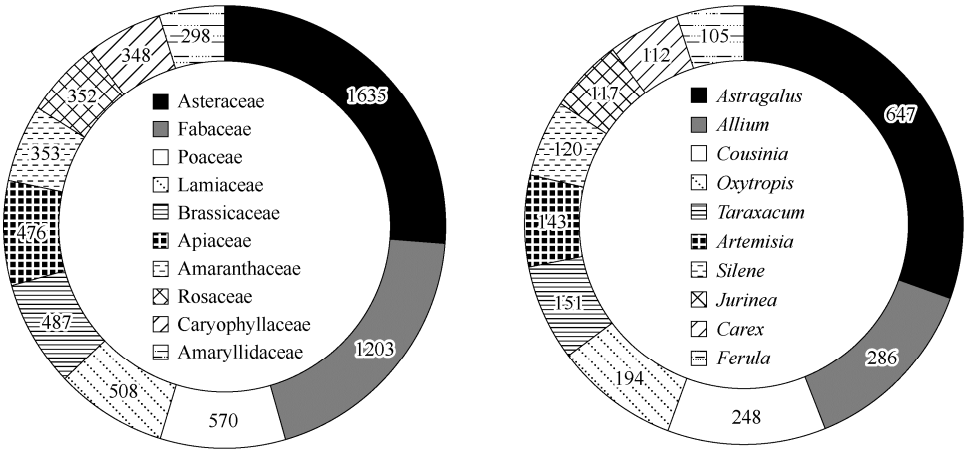
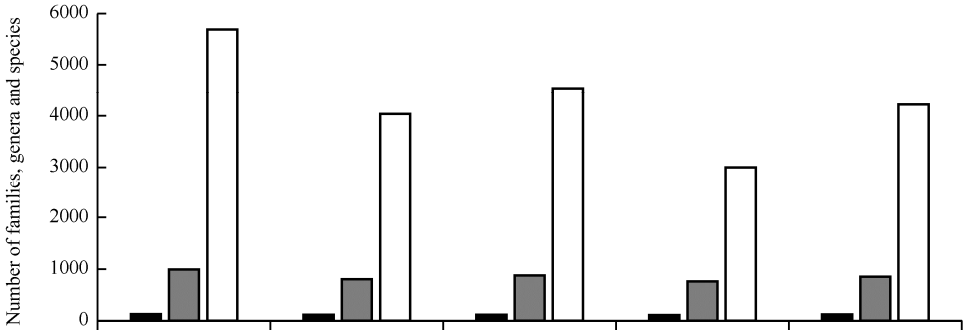


Figure 1 The top ten families and genera of vascular plants in Central Asia
The data in the figure are the number of species in the corresponding family and genus

Of the five Central Asian countries, Kazakhstan is the largest and has the highest number of vascular plants, with 5695 species. This number exceeds the count in the "Flora Kazakhstana" (Vol. 1–9) (5631 species) (Pavlov, 1956–1966) and the "Checklist of

Vascular Plants of Kazakhstan" (5658 species) (Abdulina, 1999) due to the addition of newly described species in recent years. Tajikistan, the smallest country, has the second largest number of vascular plants (4542 species), followed by Uzbekistan (4222 species), Kyrgyzstan (4036 species), and Turkmenistan (3005 species) (Figure 2).



	Kazakhstan	Kyrgyzstan	Tajikistan	Turkmenistan	Uzbekistan
Family	129	115	118	110	123
Genus	992	805	873	758	852
Species	5695	4036	4542	3005	4222

Figure 2 The number of families, genera and species of five Central Asian countries