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VEGETATION COVER OF THE WESTERN PART OF THE KYRGYZ ALATAU (MERKE, MOLALY, ASPARA)

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Abstract

The present study is based on monitoring the state of the natural vegetation cover in the western part of the Kyrgyz Alatau in order to identify major changes in vegetation from the perspective of natural regionalization, and to develop classification schemes for analyzing plant communities. Studying the composition and structure of vegetation in specific regions allows for the identification of floristic connections among various phyto-geographical areas.

In recent years, the flora of the western part of the Kyrgyz Alatau, within the territory of Kazakhstan, has been insufficiently studied. Despite occasional visits by botanists, the flora of the western Kyrgyz Alatau remains insufficiently researched. The species composition, ecology, and distribution of individual species within the region are not fully identified. Field research on the flora species of the western Kyrgyz Alatau was conducted from May to September in accordance with the schedule of expedition and fieldwork, and was also based on herbarium materials collected by the author and colleagues. The coordinates of the plant collection sites in the western part of the Kyrgyz Alatau were determined using the GPS navigation method. The primary research method was the route-survey method. Nine expedition routes covering the western part of the Kyrgyz Alatau were developed.

Due to the long-standing difficulties in studying the flora composition of these regions, the conducted research is aimed at inventorying the floristic diversity of the western part of the Kyrgyz range. A floral study of the vegetation of the Kyrgyz Alatau range was conducted, and based on the present study and existing literature 86 families, 501 genera and 1,471 species were identified.

In the Zhambyl region, the most vulnerable plant communities—steppe ecosystems—are the result of the combined impact of human and natural factors. Floristic research forms the foundation for any phyto-geographical analysis. The materials presented in this article are of practical importance for conducting scientific research in regions where issues related to changes in the natural environment and climate are especially relevant. Solving these issues is important not only for Kazakhstan, but also for the global community.

Key words: Aspara; Merki; Molaly; Autochthonous species; Allochthonous species; Botanical-geographical analysis.

Introduction

The first data on the vegetation cover of the eastern part of the Kyrgyz Range belong to (Semenov-Tianshansky *et al.,* 1948), who passed through this area in 1886 on his way to Issyk-Kul via the Kastek Pass (Assing *et al.,* 1967; Cherepanov, 1981).

In 1947, another well-known researcher of Central Asia, (Severtsov *et al.*,) noted the presence of beautiful meadow pastures on the northern slopes of the ridge and indicated that the lower limit of spruce distribution in the gorge of the Ysyk-Ata River was 6,300 feet, which is approximately 1,300 meters above sea level. Since 1916, when V.N. Sukachev established the first stationary site on Mount Shekul, numerous stationary studies of mainly fodder and geobotanical character have been carried out up to the present day. Over the years, these studies have covered various parts of the Kyrgyz Range: on the northern macro-slopes, E.V. Nikitina worked from 1935 to 1970, and Tkachenko from 1959 to 1982. Other researchers such as (Shalpikov *et al.,* 2021), (Nelina *et al.,* 1966), and others worked at the stationary sites studying vegetation in the Tatyr and Ulken-Kurshak gorges.

The result of many years of floristic work by E.V. Nikitina and her students was the 11-volume publication "Flora of the Kyrgyz SSR." This multi-volume work was completed with the participation of many botanists. The major monographs based on stationary plant research were prepared by (Rysalieva, 1975; Lebedeva *et al*., 1984).

Between the 1980s and 1990s, under the leadership and direct supervision of botanist and Doctor of Biological Sciences (Karmysheva *et al* 1973; 1982*)*, researcher N.V. Nelina from the Institute of Botany studied the woody and shrubby flora of the Kyrgyz Alatau Range (Nellina *et al.,* 1990).

Data on individual species of the woody and shrubby flora of the Kyrgyz Alatau on the territory of Kazakhstan were also provided by (Nikitina *et al.,* 1959).

The climate of Merke, Molaly, and Aspara gorges in Kazakhstan, is sharply continental with dry summers and high temperatures reaching +30–35°C. Winters are cold with little snow; in January–February, temperatures may drop to around 0°C and below. The elevation of the mountain–steppe zone of the region ranges from 1,000 to 1,200 m above sea level. According to long-term data from the Lugovoy and Merki meteorological stations, air

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temperatures may reach up to +40°C in July and fall to −43°C in February. The average annual precipitation in the foothill zone amounts to 343–465 mm, with mostly occurring in spring and autumn (67%), while summer and winter account for 16% and 18%, respectively.

The presented data indicate that the climate of the western part of the ridge is characterized by drier and hotter summers, colder winters, and precipitation levels that are approximately two times lower than those of the Ile Alatau and Western Tien Shan. Large areas of mountain slopes are occupied by rocks and stony surfaces. Comprehensive studies of the soils of the western Kyrgyz Alatau were conducted by Assing *et al*. (1967). The soil-forming parent materials consist of low-power, poorly sorted Quaternary deposits (eluvial, eluvial–deluvial, and glacial), with varying mechanical composition, predominantly clayey.

The intensive development of industry and agriculture-especially livestock farming and the recent increase in anthropogenic activities in the western part of the Kyrgyz Alatau have significantly affected the condition of the vegetation cover. The studied region has long been subjected to anthropogenic pressure. Livestock farming in Kyrgyzstan and Kazakhstan extensively utilizes vast pasture resources in the Zhambyl, Bishkek, Issyk-Kul, and Talas regions. During spring and summer, livestock graze on mountain pastures (jailaus) of the western Kyrgyz Alatau and in the valleys of the Chu and Talas rivers. Agricultural activities continue to expand into new foothill areas of the ridge, with large tracts plowed and cultivated, while suitable plots in deep gorges have been allocated for summer cottages and gardens.

Annual fires caused by carelessly thrown cigarettes and unattended tourist campfires affect large areas. One of the negative impacts of tourism is the irresponsible attitude toward nature in gorges and near medicinal springs, which causes serious damage to vegetation cover. For example, in the Merki Gorge, numerous groups of visitors seeking recreation and radon therapy set up tents, light fires, and pollute the surrounding environment. All of these have an adverse effect on the natural environment, especially on tree and shrub vegetation. The economic importance of mountain forests has long been recognized: they accumulate snow in winter, promote its uniform melting and entry into irrigation networks, protect mountain water sources from shallowing and drying, regulate river runoff, prevent soil and vegetation cover erosion, and serve as a forage base for wild animals. However, mountain forests and riparian woodlands have lost much of their former significance. In accessible areas of river valleys of the Kyrgyz Alatau, riparian forests have almost completely disappeared. Birch stands have suffered severely due to moisture deficiency, fires, logging, and mudflows. Roads constructed in floodplains usually lead to the complete destruction of pasture vegetation.

Urgent measures are required to conserve, restore, and propagate wild fruit plants. In this regard, the proposed list of plant species requiring special protection includes not only relict and endemic species listed in the Red Data Books of the USSR, Kazakhstan, and Kyrgyzstan, but also species for which the western part of the Kyrgyz Alatau represents an ancient center of distribution. These species are rapidly declining as a result of intensified anthropogenic pressure.

Monitoring vegetation cover in the Merke, Molaly, and Aspara regions is of great importance from a global and regional perspective. This area is distinguished by a high level of biodiversity and is rich in endemic and rare species. Vegetation monitoring makes it possible to assess ecosystem stability, the effects of climate change, and the consequences of anthropogenic pressure. In addition, these data contribute to comparative analyses of mountain and foothill steppe ecosystems of Central Asia and promote the development of floristic and geobotanical studies in accordance with international standards.

This work, unlike other works, is the first to specifically study the vegetation of Merke, Molaly, and Aspara in Kazakhstan and study its species composition. The phytogeographical elements of the studied area were identified, and their phytogeographical connections were revealed. A floristic checklist was compiled, and analyses were conducted based on taxonomic, geographical, ecological, and biomorphological aspects. The geographical elements of the studied area were highlighted and their geographical connections were shown.

Materials and Methods

Herbarium materials were collected and processed following the widely accepted methodology of (Skvortsov *et al.,* 1977). During the identification of herbarium specimens, major references such as the multi-volume Anon., (1934-1964), Anon., (1956-1966), Anon., (1969–1972 and others were used. To verify the species and generic names, the latest data by (Cherepanov *et al.,* 1981) and (Abdullina *et al.,* 1998) were employed.

The new names of all taxa were verified using the Plant of the World Online database (POWO, 2026). Plants were grouped according to ecological factors (humidity, light, temperature). In addition, annual and perennial plants were distinguished based on their life strategies.

Results

Expeditionary studies of the vegetation of the Merke, Molaly, and Aspara gorges were conducted. According to the planned expeditionary field work plan, it continued from May to September. The object of the study was the determination of the vegetation cover in the territories of Merki, Molaly, and Aspara. The vegetation cover of the ridge was represented by the Magnoliophyta division -1,448 species (98,44%), belonging to Equisetophyta, Polypodiophyta, Pinophyta (23 or 1,56%). The main research method used was the route-reconnaissance method. Nine expedition routes were developed, covering the western part of the Kyrgyz Alatau Range are shown in Fig. 1.

The plant groups of the Merki, Molaly, and Aspara gorges in the Kazakhstan part of the western Kyrgyz Alatau Range are presented in Table 1.

The ratio of systematic groups within the flora of the western part of the Kyrgyz Alatau located in Kazakhstan is shown in Fig. 2. Magnoliophyta accounts for 98.4%, Pinophyta for 0.8%, Polypodiophyta for 0.6%, and Equisetophyta for 0.2%.

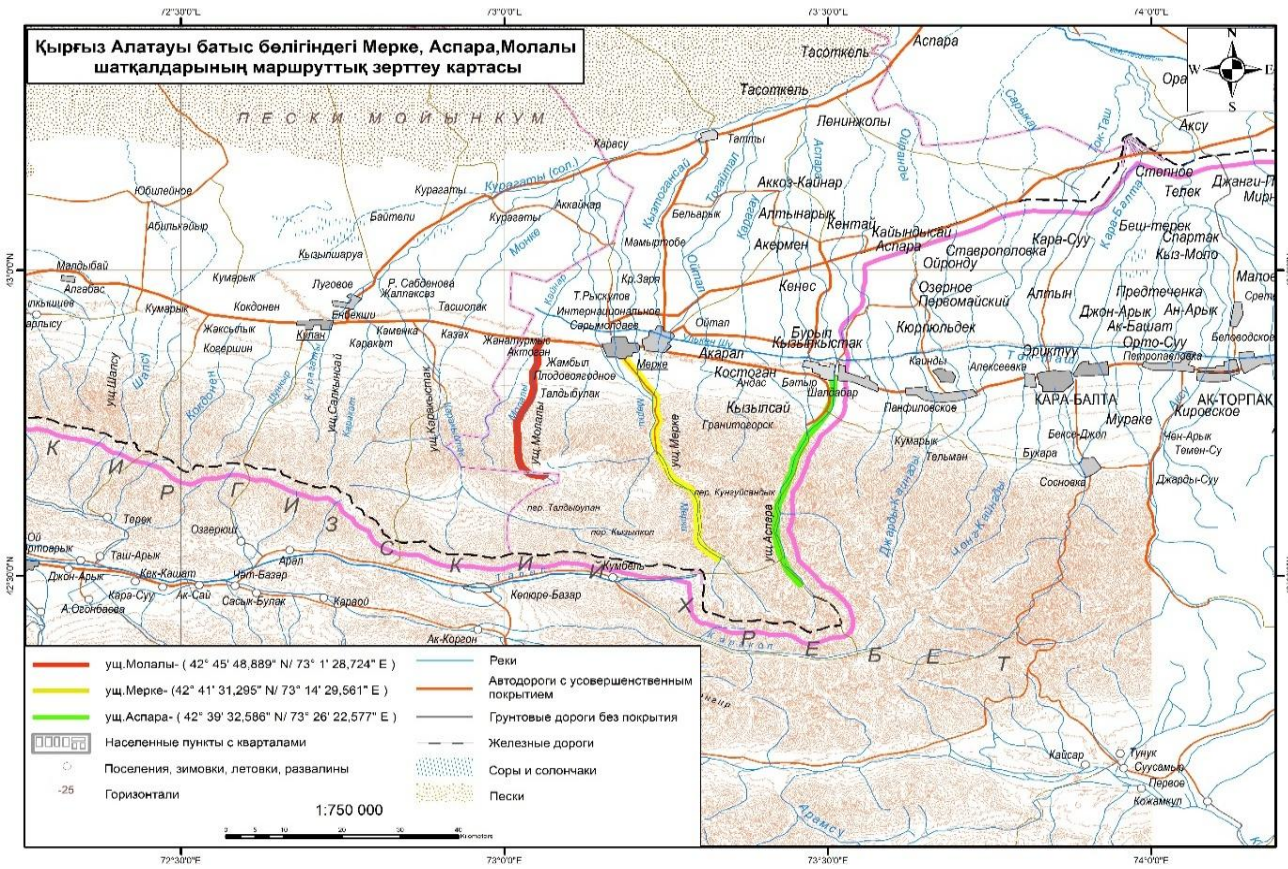

Fig. 1. Diagram of the routes laid out in the study area.

Table 1. Plant groups of the Merki, Molaly, and Aspara gorges.

Systematic categories	Number		
	Family	Genus	Species
Equisetophyta	1	1	3
Polypodiophyta	5	6	9
Pinophyta	3	3	11
Magnoliophyta:	71	491	1448
monocots	20	85	282
eudicots	51	406	1166
polypetalous	41	326	858
sympetalous	30	165	590
Total	**80**	**501**	**1471**

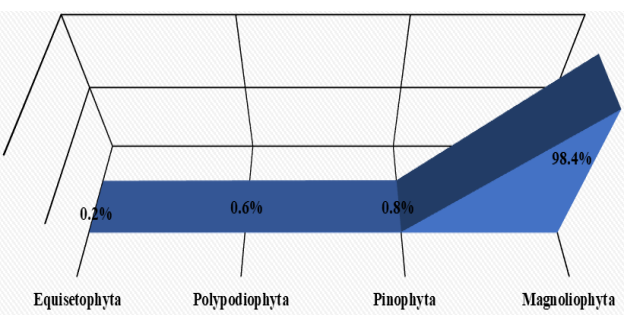

Fig. 2. The ratio of systematic groups of flora in the western part of the Kyrgyz Alatau.

In general, the flora of the western part of the Kyrgyz Alatau consists of 80 families, 501 genera, and 1471 species, as shown in Table 2. Among them, monocotyledons comprise 85 genera and 282 species, while dicotyledons include 406 genera and 1166 species. The study of the main families of the vegetation cover in the Merke, Molaly, and Aspara gorges allowed us to identify a maximum of 27 major families (Table 3).

According to our research, the largest families in the territory of Merke, Molaly, and Aspara are **Asteraceae** with 231 species (18%), **Poaceae** with 156 species (12,73%) and **Fabaceae** with 113 species (8,8%), respectively. These three major families, which together include more than 500 species, account for **33,9%** of the total flora of the western part of the Kyrgyz Alatau. If we also include the remaining 24 families listed in Table 3, they account for just over half (53,1%) of all species and 9,9% of genera of the vegetation cover of the Kyrgyz Ridge. The remaining 67 families make up only **190 species (12, 8%)** and **82 genera (5, 5%)** [41]. The leading families of the vegetation cover in the Merke, Molaly, and Aspara gorges of Kazakhstan are shown in Fig. 3.

Based on the classification of groups according to the relationship of plants to soil moisture, 6 species groups are identified as a result of ecological analysis. These groups are shown in Fig. 4.

Mesophytes-species growing in conditions of moderate humidity such as *Crataegus korolkovii*, *Betula tianschanica*, *Salix cinerea*, *S. tenuijulis*, *Lonicera stenantha*, *Rubus idaeus* and *Atragene sibirica*.

Xerophytes are species growing in xeric conditions such as *Spiraea hypericifolia*, *Celtis caucasica*, *Cerasus tianschanica*, *Helianthemum songaricum*, *Pyrus regelii, Ephedra intermedia* and *Caragana leucophleoa*.

Xeromesophytes are species that grow in conditions of temporary moisture deficiency such as *Delphinium consolida, Stellaria graminea* and *Silene nutans*.

Table 2. Comparative floristic spectrum of the western part of the Kyrgyz Alatau Range.

Taxa	Number of genera	Number of species
1	**2**	**3**
MAGNOLIOPHYTA		
MAGNOLIOPSIDA		
Magnoliidae		
Ranunculaceae	16	57
Berberidaceae	2	6
Hypericaceae	1	1
Paeoniaceae	1	2
Papaveraceae	7	19
Caryophyllaceae	16	48
Amaranthaceae	17	36
Polygonaceae	12	41
Plumbaginaceae	2	7
Betulaceae	1	4
Primulaceae	4	8
Violaceae	1	6
Salicaceae	2	19
Capparaceae	1	1
Brassicaceae	47	88
Malvaceae	3	5
Ulmaceae	1	1
Santalaceae	1	1
Cistaceae	1	1
Urticaceae	1	1
Euphorbiaceae	1	7
Crassulaceae	7	17
Saxifragaceae	3	12
Rosaceae	25	97
Onagraceae	1	6
Lythraceae	1	2
Fabaceae	23	113
Sapindaceae	1	1
Rutaceae	2	2
Zygophyllaceae	2	3
Nitrariaceae	2	3
Anacardiaceae	1	1
Linaceae	1	6
Biebersteiniaceae	1	1
Geraniaceae	2	12
Balsaminaceae	1	2
Polygalaceae	1	1
Celastraceae	2	3
Rhamnaceae	1	2
Elaeagnaceae	1	1
Tamaricaceae	3	9
Apiaceae	39	72
Caprifoliaceae	7	27
Oleaceae	1	1
Rubiaceae	5	11
Gentianaceae	3	13
Solanaceae	3	8
Convolvulaceae	1	5
Boraginaceae	17	30
Scrophulariaceae	6	37
Plantaginaceae	1	5
Verbenaceae	1	1
Lamiaceae	28	68
Campanulaceae	3	5
Asteraceae	72	231
Total dicotyledons:	406	1166
LILIOPSIDA		
Butomaceae	1	1
Alismataceae	2	3
Juncaginaceae	1	2
Potamogetonaceae	3	9
Hydrocharitaceae	1	1
Iridaceae	5	10
Asparagaceae	4	21
Asphodelaceae	1	5
Amaryllidaceae	1	27
Ixioliriaceae	1	1
Araceae	1	1
Orchidaceae	2	4
Juncaceae	2	10
Cyperaceae	7	29
Poaceae	52	156
Typhaceae	1	2
Total monocots:	85	282
GNETOPSIDA		
Ephedraceae	1	4
GYMNOSPERMAE		
PINOPHYTA		
Pinaceae	1	1
Cupressaceae	1	6
POLYPODIOPHYTA		
Polypodiaceae	1	2
Cystopteridaceae	1	1
Aspleniaceae	2	4
Polypodiaceae	1	1
Ophioglossaceae	1	1
EQUISETOPHYTA		
Equsetaceae	1	3
Total spore-bearing plants	10	23
TOTAL:	**501**	**1471**

Table 3. Number of species in the major families of the flora of the western part of the Kyrgyz Alatau.

Family	Genus number	Species number	Percentage of total species
Asteraceae	72	231	18
Poaceae	52	156	12,73
Fabaceae	23	113	8,8
Rosaceae	25	97	7,6
Brassicaceae	47	88	6,8
Apiaceae	39	72	5,6
Lamiaceae	29	68	5,3
Ranunculaceae	16	57	4,4
Caryophyllaceae	16	48	3,7
Polygonaceae	12	41	3,2
Scrophulariaceae	6	37	2,8
Amaranthaceae	16	35	2,7
Boraginaceae	17	30	2,3
Cyperaceae	7	29	2,2
Alliaceae	1	27	2,1
Liliaceae	3	19	1,5
Salicaceae	2	19	1,5
Crassulaceae	7	17	1,3
Caprifoliaceae	2	16	1,2
Papaveraceae	5	16	1,2
Gentianaceae	3	13	1,0
Rubiaceae	5	11	0,8
Iridaceae	5	10	0,77
Tamaricaceae	3	9	0,70
Primulaceae	4	8	0,6
Potamogetonaceae	2	8	0,6
Solanaceae	3	8	0,6
Total	**422**	**1283**	**100**

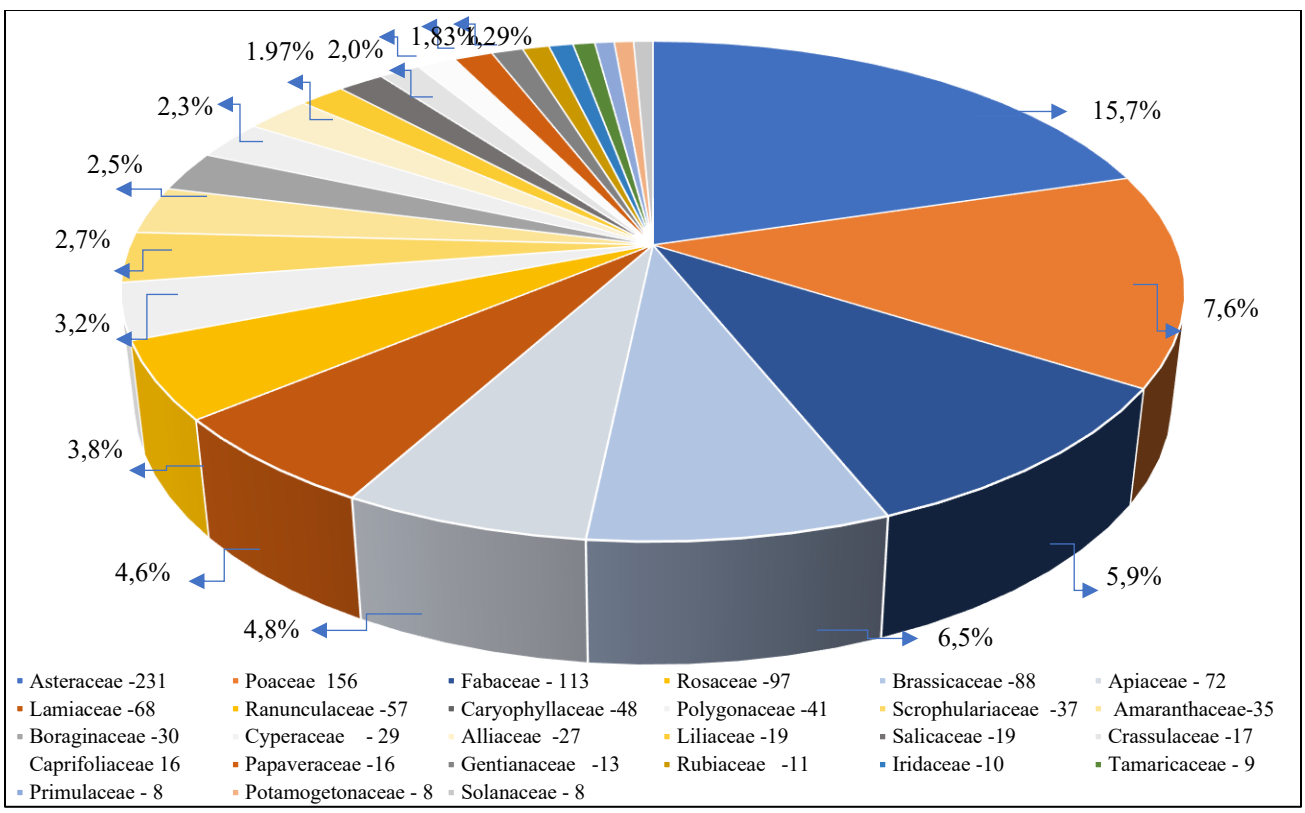

Fig. 3. The spectrum of the leading plant families of the vegetation cover in the Merke, Molaly, and Aspara gorges in Kazakhstan (as a percentage of total species).

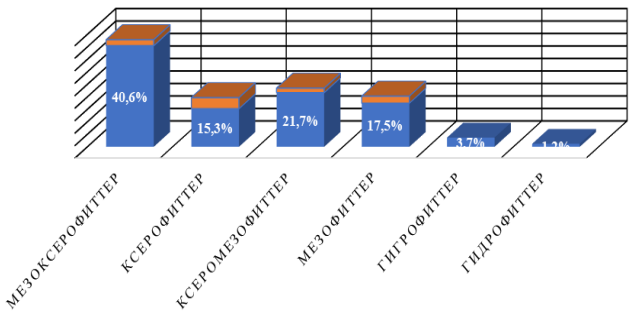

Fig. 4. Ecological spectrum of the flora of the western part of the Kyrgyz Alatau.

Hygrophytes are species that live in conditions of high soil and air humidity such as *Salix caesia, S. wilhelmsiana, S. Niedzwiekii, Myricaria squamosa, M. Bracteata* and *Hyppophae rhamnoides*.

Hydrophytes are species that are attached to the soil and only their lower parts are submerged in water. Hydrophytes live on the banks of rivers, lakes, ponds and seas, as well as in swamps and marshy meadows. Some hydrophytes grow as weeds in wet areas. For example, sedge, reed, etc.

Mesoxerophytes - species that are characteristic of humid environments, but can also partially tolerate drought like *Spiraea hypericifolia, Astragalus neo-lipskyanus, Crataegus turkestanica, Clematis songarica, Juniperus semiglobosa, Atraphaxis pyrifolia* and *Lonicera microphylla*).

Ecological spectrum of the flora of the western part of the Kyrgyz Alatau, mesoxerophytes prevail – 40,6%, xeromesophytes – 21,7%, mesophytes – 17,5% and xerophytes – 15,3%. The remaining species make up less than 10% of the total flora including hygrophytes – 3,7%, hydrophytes – 1,2%.

Discussion

One of the important stages in understanding the characteristics of the studied flora is its comparison with other similar floras. The results of such comparisons allow an objective assessment of the florogenetic distinctiveness of floristic dynamics and current development trends. According to (Tolmacheva, 1948), the main purpose of comparative studies of the plant world is to identify their originality and botanical-geographical features; this approach makes it possible to interpret the physiognomy of a flora not as a mechanical assemblage of species, but as a naturally formed complex (Tolmacheva, 1948). In this regard, a comprehensive comparison of the richness of various mountain floras of Kazakhstan is of considerable interest.

First, it was important to determine how rich the flora studied compares with the floras of other mountainous regions of Kazakhstan. According to published data, the vast territory of the foothill uplands of Central Kazakhstan contains 1471 species (Zhailybayeva *et al.,* 2025). The flora of the Zhetysu (Dzungarian) Alatau includes 2168 species (Goloscokov *et al.,* 1984). The flora of the eastern part of the Kungey Alatau Range is represented by 1662 species (Mukhtubayeva *et al.,* 2000). The Ketpen Range flora comprises 1890 species (Sadyrova *et al.,* 2019), while the total number of vascular plant species in Kyrgyzstan reaches 3927 (Lazkov *et al.,* 2014).

The spectrum of leading families of the flora of the western part of the Kyrgyz Alatau corresponds closely to that of the Northern Tien Shan (Table 4).

When comparing the floristic spectra of the leading families in the western part of the Kyrgyz Alatau and Northern Tien Shan, it became evident that the first four major families are represented at a similar level. The Rosaceae family ranks 4th (6.6%) in the flora of the western Kyrgyz Alatau. The following families occupy subsequent positions: Brassicaceae (5.9%), Apiaceae (4.9%), and Lamiaceae (4.6%). Ranunculaceae ranks 8th (3.8%), Caryophyllaceae 9th (3.2%), Chenopodiaceae 10th (2.3%), and Scrophulariaceae 11th (2.5%).

In the flora of the Tarbagatai Range, the first 4 families occupy similar positions; Rosaceae (5,8%) moves to 5th and 6th positions, and Ranunculaceae (4,8%) ranks 6th and 8th in the flora of the Kyrgyz Alatau (Zhailybayeva et.al., 2024). In the Kyrgyz Alatau flora, Caryophyllaceae (4.4%) and Lamiaceae (3.7%), which occupy 5th–7th positions, shift to 7th–8th positions. In the flora of the Ketpen Range, the first 4 positions are occupied by individual families; Amaranthaceae (6,0%) moves to 5th place; Rosaceae (4,5%) ranks 6th; Caryophyllaceae (4,2%), Ranunculaceae (4,2%), and Scrophulariaceae (4,0%) occupy 7th, 8th, and 9th positions, corresponding to 5th, 8th, and 9th positions in the Kyrgyz Alatau flora. Finally, the 10th position is held by Lamiaceae (2,9%) in the western Kyrgyz Alatau flora, which occupies 7th place there.

A comparison of the richness of the ridge's vegetation cover at the species and family levels showed the following results. The proportion of species in the vegetation cover can be an indicator of autochthonous and allochthonous trends in flora development (Table 5). From the presented data, it can be observed that autochthonous processes are most pronounced in the floras of the Tarbagatai and Zhetysu Alatau. In contrast, autochthonous processes are weakly expressed in the flora of the eastern part of the Kungei Alatau, the Ketpen Range, and the Kyrgyz Alatau Range.

A. Tolmachev's formula was used to determine the quantitative characteristics of the mountain flora of Kazakhstan (Tolmachev *et al.,* 1974).

$$I_a = \frac{A - B}{A + B}$$

I_a – autonomy index
A – number of autochthonous (native) species
B – number of allochthonous (alien) species
$I_a > 0$ → the flora is dominated by local (autochthonous) species
$I_a < 0$ → **high proportion of alien (allochthonous) species**
$I_a \approx 0$ → the proportion of the two groups is approximately
– 0.020 → the proportion of allochthonous elements is slightly higher or approximately
+0.142 → there is a predominance of autochthonous (local) species

Table 4. Spectrum of the leading plant families of the Northern Tien Shan and the western part of the Kyrgyz Alatau.

№.	Family	Northern Tien Shan	№.	Family	Western part of the Kyrgyz Alatau
1.	Asteraceae	254	1.	Asteraceae	231
2.	Fabaceae	232	2.	Poaceae	156
3.	Poaceae	211	3.	Fabaceae	113
4.	Brassicaceae	140	4.	Rosaceae	97
5.	Amaranthaceae	112	5.	Brassicaceae	88
6.	Rosaceae	101	6.	Apiaceae	72
7.	Ranunculaceae	99	7.	Lamiaceae	68
8.	Liliaceae	92	8.	Ranunculaceae	57
9.	Caryophyllaceae	84	9.	Caryophyllaceae	48
10.	Apiaceae	84	10.	Polygonaceae	41
11.	Cyperaceae	78	11.	Scrophulariaceae	37
12.	Lamiaceae	59	12.	Amaranthaceae	35
13.	Scrophulariaceae	55	13.	Boraginaceae	30
14.	Boraginaceae	48	14.	Cyperaceae	29
15.	Polygonaceae	37	15.	Alliaceae	27
16.	Alliaceae	36	16.	Liliaceae	19

Table 5. Quantitative characteristics of the floras of some mountain regions of Kazakhstan.

Regions	Number of species	Number of genera	Number of families	Average number of species	Autonomy index
Kyrgyz Alatau	1471	501	80	3.18	- 0.020
Zhetysu Alatau	2168	622	112	3.48	+ 0.046
the eastern part of the Kungey Alatau Range	1662	547	99	3.03	- 0.0060
Tarbagatai	1640	492	80	3.33	+ 0.142
Ketpen Range	1890	593	120	3.18	- 0.010

Table 6. Climatic conditions of the Zehtysu Alarau.

Name of weather indicators	Sarkand district								
	2015	2016	2017	2018	2019	2020	2021	2022	2023
Average annual temperature	9,5	8,9	8,7	7,4	8,9	14,2	11,2	12,9	12,4
The absolute maximum	41,0	36,1	39,2	36,0	38,2	25,5	25,4	25,0	26,8
The absolute minimum	-23,2	-20,4	-19,6	-31,2	-25,4	-10,6	-12,0	-11,2	-10,4
Precipitation, mm	26,3	48,1	20,8	26,0	21,4	32,6	43,1	47,6	39,6
	Usharal district								
Average annual temperature	9,1	8,4	8,3	7,4	8,3	13,1	13,1	13,6	13,3
The absolute maximum	41,8	40,0	41,8	38,2	38,9	24,5	25,2	24,0	25,4
The absolute minimum	-33,9	-27,0	-28,4	-34,5	-28,2	-11,8	-12,2	-10,9	-11,3
Precipitation, mm	27,9	32,0	17,7	18,9	17,6	23,4	27,8	26,6	23,1
	Aksu district								
Average annual temperature	9,9	8,8	8,9	7,3	8,9	25,5	13,4	14,0	13,8
The absolute maximum	41,8	41,0	42,9	39,1	40,4	25,5	25,4	24,8	27,3
The absolute minimum	-32,8	-26,5	-27,5	-37,7	-29,5	-12,4	-14,0	-13,5	-12,2
Precipitation, mm	19,2	50,3	18,3	31,2	12,5	12,6	20,9	21,0	28,5

The presented data show that the composition of the vegetation cover in the Merke, Molaly, and Aspara gorges is much closer to the natural flora of the Ketpen ridge. In contrast, it differs significantly from the flora of the eastern part of the Kungey Alatau, the Tarbagatai Range, and even the Jungar Alatau, reflecting substantial differences in climatic and orographic conditions.

The composition of species in the floristic complex is significantly influenced by climatic conditions. Climate changes over geological periods have been the main cause of extinction, transformation, and ultimately the emergence of new floras, stimulating the extinction of some species and the emergence of others. At the same time, they have caused progressive and regressive changes in the ranges of the species that make up the flora (Sadyrova *et al.,* 2019).

The climate of the Ketpen Range varies depending on its geographical location, altitudinal zones, and natural and geographical features. Climatic characteristics depend on height, slope orientation, and seasonal changes (Eriskovskaya *et al.,* 1985).

The climate of the Ketpen Range is continental in nature, but there are climatic differences between its northern slopes and the southern slopes facing the Issyk-Kul Basin. These differences directly affect the amount of precipitation and temperature regime (Mazirov *et al.,*2013).

The rocks of the Kungei Alatau are composed of limestone, granite, and sometimes tuff. As the altitude increases, the soil moisture increases, its stonyness increases, and the thickness of the humus and fine-grained layers decreases.

The climatic features of the Kungei Alatau are subject to altitudinal zonal patterns. The exceptional diversity of climatic conditions in the mountainous regions is due to the strong fragmentation of the relief, the presence of glaciers and permanent snow, the exposure and steepness of the slopes, and other factors. The climate of the Kungei Alatau is sharply continental. The highest summer temperatures are observed at relatively high altitudes - around 1850–1900 m (in Kegen and Narynkol - up to 35°C). Due to the altitudinal zonation, the temperature conditions in the mountains differ from those in the plains depending on the seasons. In winter, it is much warmer at medium altitudes than in the plains, and vice versa in summer (Roldugin *et al*., 1989). The climate of the Kungei Alatau, along with the general patterns characteristic of the Ili Alatau, has its own characteristics due to the relief and altitudinal zonation, and on the southern slope - due to the presence of a deep lake that does not freeze in winter. The climate of the Kungei Alatau is sharply continental. The highest summer temperatures are observed at high altitudes - around 1850–1900 m (up to 35°C in Kegen and Narynkol). Due to the altitudinal zonation, temperature conditions in the mountains differ from those in the plains in terms of seasons. In winter, it is significantly warmer at medium altitudes than in the plains, and in summer, on the contrary (Roldugin *et al.,* 1989).

Meteorological data for the Zhetysu region for 2015-2023. The climatic conditions of the Zhetysu Alatau are presented in Table 6 (Taldybay *et al.,* 2025).

Conclusion

The species composition of the Merki, Molaly, and Aspara gorges was studied for the first time. As a result of the study, 80 families, 501 genera, and 1471 species of vascular plants — including Equisetophyta – **1 families**, **1 genera,** 3 **species,** Polypodiophyta – **5 families**, **6 genera,** 9 **species,** Pinophyta – **3 families**, **3 genera,** 11 **species** and Magnoliophyta **– 71 families**, **491 genera**, **1448 species are reported**.

The flora of the Merke, Molaly, and Aspara gorges consists mainly of angiosperms, which belong to the division **Magnoliophyta**, totaling **1448 species (98,44%)**. A much smaller proportion — **23 species (1,56%)** — belongs to the divisions **Equisetophyta, Polypodiophyta,** and **Pinophyta.** The flora of the western Kyrgyz Alatau was found to include **27 major families** and **26 leading genera** in terms of species richness. Analysis of the major families allowed us to identify the **27 most species-rich families** in the flora of the region.

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References

Abdulina, S.A. 1998. *Vascular Plants of Kazakhstan*. Almaty. 188.

Anonymous. 1934-1964. *Flora of the USSR* (Vol. 1). *Moscow–Leningrad*.29-30.

Anonymous. 1956-1966. *Publishing House of the Kazakh SSR [Flora Kazahstana. Alma-Ata. Izd-vo AN KazSSR].* 1-9.

Anonymous. 1969-1972. Alma-Ata: Academy of Sciences of the Kazakh SSR, 1969-1972. Vols. 1-2.

Assing, I., M. Orlova, S. Serpikov, S. Sokolov and D. Storozhenko. 1967. *Soils of the Zhambyl region.* Alma-Ata: *Nauka.* 367.

Cherepanov, S.K. 1981. *Vascular plants of the USSR.* Leningrad. 505-509.

Eriskovskaya L.A., N. Kasatkin and K. Makarevich. 1985. Characteristics of the weather and regime of the central Tuyuksu glacier in the northern Tien Shan*" Hydromet. Ecol.,* 3(62): 66-72.

Flora of the Kyrgyz SSR. 1950–1966. *Flora of the Kyrgyz SSR* (Vols. 1–11). Frunze: *Ilim.* 18-22.

Goloscokov, V.P. 1972. Generic endemism in the flora of Kazakhstan. In *History of the flora and vegetation of Eurasia. Alma-Ata: Nauka.* 145-155.

Goloscokov, V.P. 1979. Rare and relict plant species of the Northern Tien Shan at the extreme edge of their range. In *Conservation of the plant world of Kazakhstan*. *Alma-Ata: Nauka*, 48-53.

Goloscokov, V.P. 1984. *Flora of the Dzungar Alatau.* Alma-Ata: Nauka. 221. Illustrated key to the plants of Kazakhstan. 1962-1975. *Illustrated key to the plants of Kazakhstan* (Vols. 1–2). *Alma-Ata*., 105-107.

Karmysheva, N.H. 1973. *Flora and vegetation of the Aksu-Dzhabagly Reserve*. Alma-Ata: *Nauka*, 277-278.

Karmysheva, N.H. 1982. *Flora and vegetation of the western spurs of the Talas Alatau*. Alma-Ata: *Nauka*, 177.

Lazkov, G.A., and B. Sultanova. 2014. *Flora cadastre of Kyrgyzstan. Vascular plants*. Bishkek, 1-166.

Lebedeva, L.P.1984. *Dynamics and productivity of subalpine meadows of the northern macroslope of the Kyrgyz ridge. Frunze: Ilim.* 367.

Mazirov M.A., I.I. Vasenev and A. Ilahun. 2013. Agroecological, soil and climatic evaluation of the Tien Shan mountain system. *Achi. Sci. Technol.,* 32-34.

Mukhtubayeva, S.K. 2000. *Flora of the eastern part of the Kungay Alatau ridge (Candidate of Biological Sciences dissertation abstract). Alma-Ata*., 22-23.

Nellina, N.V. 1966. On the geography of the species *Alfredia nivea* Kar. et Kir. In: *Vegetation and regulation of its life activities.* 31-32.

Nellina, N.V. 1990. *Analysis of woody-shrub flora of the Kyrgyz Alatau* (Candidate of Biological Sciences dissertation abstract). *Almaty*. 88-89.

Nikitina, E.V. 1935. Brief characteristics of some types of hayfields and pastures of the Kyrgyz SSR based on studies at the 1932-1933 station in the Kyrgyz Alatau. *Works of the Kyrgyz Research Institute*, 181-219.

Nikitina, E.V. 1957. Genus *Pistacia* L. Pistachio. In *Flora of the Kyrgyz SSR* (Vol. 7). *Frunze: Publishing House of the Academy of Sciences of the Kyrgyz SSR*. 541.

Nikitina, E.V. 1959. *Flora and vegetation of pastures and hayfields of the Kyrgyz Alatau ridge.* Moscow: *Publishing House (exact publisher unknown.* 44-45.

Nikitina, E.V. 1960. *Materials on the flora of the northern slope of the Kyrgyz Alatau ridge.* Frunze: Publishing House of the Academy of Sciences of the Kyrgyz SSR. 181-219.

Nikitina, E.V. 1964. *Wormwood of Kyrgyzstan and their economic significance*. Frunze: Publishing House of the Academy of Sciences of the Kyrgyz SSR. 132-134.

Nikitina, E.V. 1970. Western Tien Shan elements in the flora and vegetation of the Kara-Archa River basin in the Kyrgyz Alatau. *Flora of the Kyrgyz SSR*., 2: 37-44.

Plants of the World Online. 1999. *Plants of the World Online*. Royal Botanic Gardens, Kew. https://powo.science.kew.org/ (accessed 29 January 2026).

Roldugin, I.I. 1989. Pine forests of the Northern Tien-Shan (flora, classification and dynamics). *Nauka KazSSR.* 304.

Rysalieva, A.V. 1975. *Seasonal dynamics of steppe, meadow-steppe, and meadow communities of the northern macroslope of the Kyrgyz Alatau. Frunze: Ilim.* 239.

Sadyrova, G.A. 2019. Biodiversity of floristic complexes in the Ketpen–Temerlik ridge. *Bulletin of KazNU. Biol. Series*, 78(1): 46-57. https://doi.org/10.26577/eb-2019-1-1403

Sadyrova, G.A. 2019. Biodiversity of floristic complexes in the Ketpen-Temirlik ridge. *Kazakh National University of Agriculture. Biology Series,* 78(1): 46-57. https://doi.org/ 10.26577/eb-2019-1-1403

Semenov-Tianshansky, P.P. 1948. *Travels in the Tien Shan in 1856–1857.* Moscow: *State Publishing House of Geographical Literature.* 150.

Severtsov, V.A. 1947. *Travels in the Turkestan region.* Moscow: *Publishing House of Geographical Literature (OGIZ).* 304.

Shalpikov, K.T., N. Rogova, A. Dolotbakov, O. SultanGaziev and B. Tagaev, 2021. Resource assessment of rosehip (*Rosa canina* L.) fruit stocks in nut-fruit forests of southern Kyrgyzstan. *Int. J. App. Fund. Res.,* DOI: https://doi.org/ 10.17513/mjpfi.13176

Skvortsov, A.K. 1977 Herbarium. Manual techniques and technology. *"Nauka" Gerbarij. Posobie po metodike i tehnike. M. «Nauka».* 199.

Sukachev, V.N. 1916. *Stationary geobotanical studies on Mount Shekul (Altai region)*. Unpublished field reports, archival materials.

Taldybay, A. 2025. The current state of useful plants of the Zhetysu Alatau and ways of their rational use. *(Abstract of PhD dissertation).* 16-17.

Tkachenko, V.I. 1959. A new honeysuckle from the Kyrgyz ridge. *Proceedings of the Academy of Sciences of the Kyrgyz SSR. Biol. Series*, 3(1): 147-159.

Tkachenko, V.I. 1962. New species in the collection of the Frunze Botanical Garden. *Bulletin of the USSR Academy of Sciences*, 45, 55-59.

Tkachenko, V.I. 1966. *Central Asian roses introduced into the Botanical Garden of the Academy of Sciences of the Kyrgyz SSR*. Frunze: Ilim, 256.

Tkachenko, V.I. 1979. New species of roses from Central Asia. *Bot. J.*, 64(2): 218-230.

Tkachenko, V.I. 1981. Roses of the Tien Shan and Pamir-Alay introduced by the Botanical Garden of the Kyrgyz SSR Academy of Sciences. *Bulletin of the Main Botanical Garden of the USSR Academy of Sciences*, 122: 19-26.

Tkachenko, V.I. 1982. New taxa of woody plants from the Tien Shan and Pamir-Alay mountains. *Bulletin of the Main Botanical Garden of the USSR Academy of Sciences*, 126: 32-35.

Tkachenko, V.I. and I. Assorina. 1978. *Rare and endangered species of the natural flora of Kyrgyzstan*. Frunze: Ilim. 59-60.

Tkachenko, V.I., I. Vorobieva and L. Andreychenko. 1976. *Shrubs in landscaping of Kyrgyzstan*. Frunze: Ilim. 32.

Tolmachev, A.I. 1948. Paths of vegetation formation in high-mountain landscapes. *Bot. J. USSR Acad. Sci.*, 33(2): 174-180.

Tolmachev, A.N. 1974. Method of floristic research. - L.: *Nauka*., 184.

Zhailybayeva, T. 2025. Analysis of the flora of the western part of the Kyrgyz Alatau. *(Abstract of PhD dissertation)*. 28-29.