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Systematic Analysis of the Flora of the Western Part of the Kyrgyz Alatau

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***Abstract*— This study compiled and analyzed a list of all plants growing in the Merke, Araltobe, Sandyk, and Shaysandyk gorges, belonging to the western part of the Kyrgyz Alatau. Research of this kind is very important for updating the list of plant species in the territory and for agriculture since livestock walking and other work depend on the diversity of vegetation covered in certain areas. Eight hundred thirty-five species belonging to 78 families and four divisions were analyzed. Most of the species belonged to the division of flowering plants or angiosperms and consisted of 821 species. The most diverse in terms of the number of species was the Cereal family of the Angiosperms, which can be associated with a large percentage of stony, gravel, and sandy slopes and alpine and subalpine fields in the study area. This terrain is unsuitable for more fastidious species of other families, such as, for example, Rosaceae. The second place in terms of species diversity in the western part of the Kyrgyz Alatau is occupied by the legume family, in which many meadow grass species actively grow on the open slopes of the mountains. The dominant life form was perennial plants, followed by annuals, trees, biennial grasses, and shrubs. The predominance of perennial plants is associated with the specificity of the area of the study region. It is caused by low competition due to the relatively poor soil of the gorges.**

***Keywords*— Flora; mountain gorges; vegetation of specific habitats; Kyrgyz Alatau; Tien Shan Mountain system.**

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I. INTRODUCTION

Mountain regions have a unique environment and rich biological diversity, and the nature of this community provides a person with places for recreation and water [1]. Climate change and the expansion of the area occupied by buildings or agricultural land in the mountains significantly impact the ecosystem of the mountain community. For example, mountain regions' floristic diversity and forest coverage can be reduced and, in some cases, threatened by illegal logging and grazing [2]. At the same time, areas of abandoned agriculture in mountainous regions contribute to the expansion of the forest, especially on steep slopes, where land cultivation is a very labor-intensive process [3]. As for climate change, it can both contribute to the death of trees in some areas and expand forest areas in others [4]. In addition to the climate, the vegetation cover of mountains is also affected by dangerous meteorological phenomena, such as drought, especially in regions with reduced water supply [5]. Finally, climate change's relationship with agricultural transformations is one of the main factors influencing mountain regions' vegetation [6]. Thus, to identify the causes of changes in the biodiversity of vegetation cover in mountainous regions and control the abundance of plant species, it is necessary to have a complete list of all species with the distribution of each in a given territory.

The biodiversity of various plant species is observed in Central Asia [7]. This region has many sub-regions and a wide range of altitudinal belts and includes one of the highest mountain ranges in the world - the Tien Shan. The mountains of Central Asia are particularly noted for their high levels of biological diversity due to their wide range of ecosystems and unique geographic location.

The Tien Shan is one of the most important sub-regions of Central Asia and is a large mountain system stretching for 2500 km, from west to east, up to 400 km wide, from northern

Tajikistan to northern China [8]. The flora of the mountains of this subregion is quite rich but not well understood despite the large number of published studies since 1940 [9]. Over the past twenty years, floristic studies in the Tien Shan Mountain ranges have been carried out much more often and on a larger scale. According to their results, more than two dozen species new to science were found, new floristic records were made [10], [11], and GIS maps with the distribution of taxonomic groups and databases of local flora were supplemented and updated [12]. The Ferghana Valley and the surrounding mountains recorded the newest species. According to a previous study on the biodiversity of flora in Central Asia, in Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan, and Uzbekistan, there were a total of 9341 orders, represented by 161 families and 1288 genera [13]. This study aims to analyze the flora of the western part of the Kyrgyz Alatau, represented by the Sandyktas, Shaysandyk, and Molaly mountains of the Merken district of the Zhambyl region in Kazakhstan. The systematic analysis provides valuable insights into the distribution patterns, population dynamics, and ecological interactions of the flora in the Western part of the Kyrgyz Alatau. It sheds light on the adaptations of plant species to the region's challenging alpine environment, contributing to our understanding of evolutionary processes.

Furthermore, this research has practical implications for conservation efforts and sustainable land management. By identifying endangered or endemic species, conservationists can prioritize protection measures and develop strategies to mitigate human activities' impact on the Kyrgyz Alatau's delicate ecosystems. Systematic analysis is a vital foundation for future research, conservation planning, and regional environmental decision-making.

II. Materials and Methods

The list of plants of the western part of the Kyrgyz Alatau, represented by the mountains Sandyktas, Araltobe, Shaysandyk, and Molaly of the Merken district of the Zhambyl region in Kazakhstan, is based on the synopsis of the flora of the western part of the Kyrgyz Alatau. The abstract was compiled based on the collected herbarium material of recent years. The species affiliation of plants was determined according to three volumes of Pavlov's "Flora of Kazakhstan" and the list of plants was compiled based on the generally accepted system of Kesey, in the material of Ecological groups of plants [14].

The flora list classified families according to the phylogenetic grouping of angiosperms [15] and gymnosperms [16]. Taxa of lower rank - genus, species, and subspecies were arranged alphabetically. The nomenclature of all taxa was checked against information from the International Plant Name Index (ipni.org) and The Plant List (theplantlist.org) websites.

While describing plants, their ecological group was also considered. Ecological groups are divided according to the organism's habitat, which, in turn, is determined by environmental factors such as humidity, temperature, organisms living in it, and others. However, the boundaries between groups are relative, and one group can smoothly move to another, in which case the plants will belong to two or more ecological groups at once. Environmental factors are divided into two types. They are factors of inanimate nature (humidity, temperature, illumination) and factors of wildlife (other living organisms: plants, animals, fungi, etc.). Moreover, ecological groups of plants are divided into three parts.

1) *In relation to water:*

- Hydrophytes - aquatic plants, completely or partially (for example, only by roots) immersed in water.
- Mesophytes are terrestrial plants that grow in habitats with normal or high (but not excessive) humidity.
- Xerophytes are terrestrial plants that grow in habitats with arid or hot climates [17].

2) *In relation to light:*

- Heliophytes are photophilous plants growing in open habitats.
- Scioheliophytes are shade-tolerant plants that grow in shady and open habitats.
- Sciophytes are shade-loving plants growing in shaded habitats [18].

3) *Concerning temperature:*

- Megathermophytes are heat-loving and heat-resistant plants that grow in hot habitats.
- Mesothermophytes are heat-loving but not heat-resistant plants that grow in habitats with a tropical climate and without temperature changes.
- Microthermophytes are cold-resistant plants that grow in habitats with a temperate climate.
- Hekistothermophytes are extremely cold-resistant plants growing in habitats with constantly low temperatures or regularly dropping below zero [19].

Also, all flowering plants can be divided according to their main life cycle strategies into annuals (live and reproduce for one year) and perennials (live longer than one year and reproduce from once in a lifetime to annually). Generally, perennials are associated with specific habitats, while annuals are more common in different ones [20].

Flora analysis was carried out based on habitat and other characteristics of each species by groups. Species were combined into groups depending on their ecological group, type of habitat, and systematic position in the taxon. An analysis was also carried out based on the ranges of all analyzed species. The flora analysis in the studied region was conducted systematically, considering various factors such as habitat characteristics, ecological groupings, and taxonomic classification. This comprehensive analysis aimed to understand the distribution and characteristics of plant species based on their specific ecological requirements and their systematic placement within the taxonomic hierarchy.

To facilitate the analysis, the species were organized into groups based on their ecological characteristics. This grouping gave a deeper understanding of the relationships and interactions between plant communities and their habitats. It provided insights into the adaptations and preferences of certain species to specific environmental conditions. Additionally, the analysis considered the habitat types in which the species were found. By categorizing the plants based on their preferred habitats, such as alpine meadows, subalpine forests, or dry coniferous forests, researchers were able to identify patterns and trends in the distribution of flora across different habitat types. This information helps in

comprehending the ecological dynamics of the region and the factors influencing the composition and structure of plant communities.

Furthermore, the analysis considered the ranges of all the analyzed species. By examining the distribution patterns of species, researchers gained insights into the geographical spread of different plant taxa. This information is crucial for understanding the region's biogeography and identifying any unique or endemic species with restricted ranges.

Overall, this systematic flora analysis considered habitat characteristics, ecological groupings, and taxonomic classification, providing a comprehensive understanding of the plant species in the studied region. It allowed for the identification of ecological patterns, the exploration of species-habitat relationships, and the assessment of the distribution ranges of different plant taxa. Such information is valuable for conservation planning, ecosystem management, and further research in plant ecology.

III. Results and Discussion

In the investigated territory of the gorges of the western part of the Kyrgyz Alatau, plants belonging to 4 divisions were found: Horsetail (Equisetophyta); Ferns (Polypodiophyta); Gymnosperms (Pinophyta) and Angiosperms (Magnoliophyta). The horsetail division consisted of 2 species belonging to 1 family. Division Ferns - from 7 species belonging to 2 families. Division Gymnosperms of 5 species belonging to 3 families. The Angiosperms division was the largest regarding the number of families - 72 and the number of species - 821. The distribution of all plant species by their number in each division is shown in Figure 1. About 1500 plant species are in the western part of Kyrgyz Alatau. Thus, this article analyses half of the plants that make up the flora of this territory.

The division of Angiosperms was the most diverse regarding the number of species. This division constitutes an exceptionally large group of plants growing in various habitats. The division has over 3,000,000 recorded species worldwide, constituting one of the most diverse groups in the plant kingdom [21]. In temperate latitudes, the most common are perennial plants and trees of broad-leaved and mixed forests, grasses, and bulbous and tuberous plants of the steppe zone.

The horsetail (Equisetophyta) division includes two species belonging to the same family of horsetails (Equisetaceae): Eguisetum arvense (Field horsetail) and Eguisetum hiemale (Wintering horsetail). Both species are perennial plants found throughout Kazakhstan, with some exceptions. E. arvense grows on the banks of rivers, wet meadows and swampy areas and is most common in northern Kazakhstan. While E. hiemale grows on dry pine and sandy slopes along riverbanks, it is distributed in all natural areas except deserts. Both species are among the most common in the Northern Hemisphere and belong to the only currently existing genus Eguisetum. The wide distribution of this group of plants is associated with their resistance to most conditions. The Ferns (Polypodiophyta) division includes 2 families: Grozdovnikovye (Botrychiaceae) and Centipedes (Polypodiaceae). In the first family, there is only 1 species - the lunar vine (Botrychium lunaria).

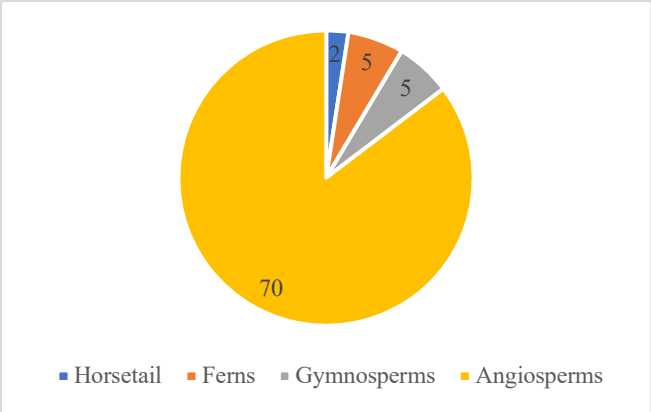

Fig. 1 Distribution of the number of species by division

A perennial plant growing on the meadow slopes of the mountains, in low meadows, and in rocky areas of the alpine belt. It occurs throughout the territory of the Kyrgyz Alatau and the Western part of the Tien Shan Mountain range. The second family has six species belonging to 4 genera: Polypodium (Centipede); Asplenium (Kostenets); Dryopteris (Shieldweed); and Cystopteris (Bubble). The common centipede (P. vulgare) grows in rock crevices and on moss covers in the forest. It is a perennial plant found throughout the territory of the Kyrgyz Alatau and in the Western part of the Tien Shan Mountain range. Hairy kostenets (A. trichomanes) also grow in rock crevices and other wet places on rocky slopes. Like the previous view, K. is wall mounted. (A. ruta-muraria) grows in rock crevices but can also be found in shaded areas of the subalpine mountain belt. K. Hairy (A. Trichomanes) grows in rock cracks in shaded places of the subalpine belt of mountains. Both species are perennial plants found throughout the Kyrgyz Alatau and in the Western part of the Tien Shan Mountain range. The swamp shield tree (D. Thelypteris) grows in scrub (shrub) swamps and swampy lakes. Like most representatives of the department, it is among the perennial plants. It occurs throughout Kazakhstan, except for the desert zone. Male rosehip (D. Filix. Mas) grows on rocky and gravelly slopes in the upper part of the mountains and belongs to the group of shrubs. The last species in the department, Bubble brittle (D. Filix-fragilis), grows in mountain forests and shrubs, under shady rocks and along riverbanks in all zones except the desert. Like the previous species, it is a perennial plant. Representatives of this order prefer either shaded or wet habitats, which is why they can be found in the gorges of the mountains.

In the gymnosperms (Pinophyta) division, the analyzed plants belonged to three families: Conifers (Ephedraceae), Pine (Pinaceae), and Cypress (Cupressaceae). The first family included representatives of two species of the same genus Ephedra (Ephedra L.). In the second family, there is only 1 genus and 1 species - Spruce (Picea). In the third family, there are 2 species of the same genus - Juniperus (Juniperus). Ephedra regel (E. regeliana) grows on rocky and gravelly slopes in the upper part of the mountains and belongs to the group of shrubs. It occurs in the Northern and Western parts of the Tien Shan, as well as in the territory of the Kyrgyz Alatau. X. horsetail (E. equisetina) also grows on the rocky slopes of the mountains but is already in the lower and middle parts. It is, similar to the previous species, a shrub found

throughout the territory of Alatau, in the Chu-Ili highlands, the Kyrgyz Alatau, Karatau, and the Western Tien Shan. Schrenk spruce (P. schrenkiana) is a tree growing in the mountains of the Kyrgyz Alatau and in the Western part of the Tien Shan. Turkestan juniper (J. turkestanica) grows on the alpine and subalpine mountain belts and on the edge of the forest. It is a tree that grows throughout the Dzungarian and Kyrgyz Alatau and the Western part of the Tien Shan Mountain range. Juniper Zarafshan (J. seravschanica) grows in the lower and middle parts of the mountains, usually in dry areas. This tree can be found in the Chu-Ili mountains, on the Kyrgyz Alatau, Karatau, and Western Tien Shan territory.

Consider the division of Angiosperms in more detail. The greatest species diversity was observed in the Asteraceae family - 141 species belonging to 51 genera. In second place in terms of the number of species is the Cereal family (Poaceae.) - 104 species. In third place is the legume family (Fabaceae) - 65 species. The remaining families were less rich in species diversity, but their contribution to biocenosis will also have its place.

In the Hornwort family (Capparidaceae) – 1; in Buttercup (Ranunculaceae) - 36; Smokey (Fumariaceae) - 7; Barberries (Berberidaceae) - 4; Peony (Paeoniaceae) - 2; Poppy (Papaveraceae) - 9; Kalampyrlar (Caryophyllaceae) - 41; Chenopodiaceae (Chenopodiaceae) - 12; Buckwheat (Polygonaceae) - 22; Plumbagaceae (Plumbaginaceae) – 1; Birch. (Betulaceae) - 3; Primulaceae (Primulaceae) - 6; Violets (Violaceae) - 4; Tamarisk (Tamaricaceae) - 1; Willow (Salicaceae) - 5; Keuelder (Capparidaceae) -1; Cruciferous (Brassicaceae) - 32; Cistaceae (Cistaceae) - 1; Linden (Tiliaceae) - 1; Malvaceae (Malvaceae) - 4; Cannabis (Ulmaceae Mirb.) – 1; Nettles (Urticaceae) – 1; Euphorbia (Euphorbiaceae) - 3; Crassulaceae (Crassulaceae) - 14; Saxifragaceae (Saxifragaceae) – 7; Belozoraceae (Parnassiaceae) – 2; Gooseberries (Grossulariaceae) - 3; Rosaceae (Rosaceae) - 22; Looseberry (Lythraceae) – 1; Fireweeds (Onagraceae) - 4; Maple (Aceraceae) - 9; Horse chestnut (Hippocastanaceae) – 1; Rutaceae (Rutaceae) – 2; Parnolistnikovye (Zygophyllaceae) - 1; Anacardiaceae (Anacardiaceae) - 2; Flax (Linaceae) - 4; Geraniaceae (Geraniaceae) - 3; Balsamic (Balsaminaseae) - 2; Source (Polygalaceae) – 1; Euonymous (Celastraceae) - 1; Santal (Santalaceae) - 1; Buckthorn (Rhamnaceae) – 1; Suckers (Elaeagnaceae) – 1; Umbelliferae (Apiaceae Lindley.) – 23; Honeysuckle (Caprifollaceae) - 10; Valerian (Valerianaceae) - 7; Tears (Dipsacaceae) - 4; Madder (Rubiaceae) - 9; Gentian (Gentianaceae) - 8; Nightshade (Solanaceae) - 6; Bindweeds (Convolvulaceae) - 2; Borage (Boraginaceae) - 25; Figwort (Scrophulariaceae) - 37; Plantains (Plantaginaceae) - 2; Verbena (Verbenaceae) - 1; Lamiaceae (Lamiaceae) - 30; Bellflowers (Campanulaceae) - 2; Asteraceae (Asteraceae) - 141; Susak (Butomaceae) – 1; Chastukhaceae (Alismataceae) - 3; Reeds (Juncaginaceae) - 2; Juncaceous (Juncaceae) - 6; Podaceae (Potamogetonaceae) – 8; Nayads (Najadaceae) -1; Iris (Iridaceae) - 5; Onion (Alliaceae) - 14; Orchids (Orchidaceae) - 5; Sedge (Cyperaceae) - 15; Duckweed (Lemnaceae) - 1; Head-headed (Sparganiceae) -1; Cattails (Typhaceae) - 2.

The family of Cereals (Poaceae) is one of the largest in the plant kingdom: at the moment, it has about 620 genera and more than 10,000 species. This inventory of plants serves as a valuable tool for researchers, conservationists, and land managers. It facilitates assessing the study area's species distribution, endemism, and ecological patterns. Moreover, it aids in the identification of rare or endangered species that require special attention and protection measures.

Furthermore, this comprehensive list has practical implications for land use planning, ecological restoration, and conservation strategies. By incorporating the information from the list into environmental impact assessments and management plans, policymakers and stakeholders can make informed decisions that balance development with preserving the unique flora in the western part of the Kyrgyz Alatau.
In conclusion, the list of plants from the western part of the Kyrgyz Alatau, based on the synopsis of the region's flora, represents a valuable scientific resource that enhances our knowledge of the local plant diversity, informs conservation efforts, and supports sustainable land management practices.

Representatives of the species of this family have been found in all parts of the world where plant life is possible. This is due to the pickiness of the representatives of the Cereal family, some of which were found even in extreme arctic or alpine conditions, while others were found in the hottest and most arid deserts. However, as a rule, cereals love the sun, and most species prefer to settle in open spaces [22]. The distribution of the number of species according to their habitats was as follows: on stony soil - 10 species; on sandy - 19; on the rocks - 1; in the steppe and steppe regions - 10; mountain deserts - 14; in the meadows - 19; in the forest - 6; in humid habitats -5; along the banks of water bodies - 20. Based on the analysis of the most popular habitats among representatives of the species of the Poaceae family, it can be concluded that most of them can be attributed to scioheliophytes and xerophytes, similar to what was said earlier based on the study of Clay and Hubbard [8]. The life form of most species is a perennial plant (76), and annual grasses are in second place (28). Many land animals eat cereals, and for some birds, mammals, and insects, representatives of this family are the only source of food. Some species are also actively used by humans, for example, corn, wheat, barley, oats, rice, rye, bamboo, and sugar cane. In addition to nutritional value, many species are also useful for other agricultural purposes [23].

The legume family (Fabaceae) species also have a wide distribution area and are among the top ten largest families. Particular importance is attached to wild cultivated species of this family since they have a high biological and ecological value [24]. Their fruits are rich in protein, which is why they are widely used as an agricultural food resource for feeding livestock and an alternative to meat food in humans. The distribution of the number of species according to their habitats was as follows: on stony soil - 20 species; on sandy - 6; on the rocks - 5; in the steppe and steppe regions - 3; clay plains -5; in the meadows - 6; in the forest - 9; in floodplains - 9; along the banks of water bodies - 2. Analyzing species distribution over different habitats, we can conclude that representatives of the Fabaceae family prefer rocky or gravel soil and willingly grow in wet places near water bodies. Consequently, most of the species of this family can be considered annual plants, and 42 as perennials.

The Asteraceae family, also known as the Compositae family, is a remarkable and expansive group of flowering

plants. With a staggering 32,913 recognized species, it is one of the world's largest and most widespread plant families. These species are further classified into 1,911 genera and 13 subfamilies, highlighting the immense diversity within the family.

One distinctive feature of the Asteraceae family is the presence of a wide range of biologically active compounds with medicinal properties in the plants' generative and vegetative parts. These compounds contribute to their importance in traditional medicine and pharmaceutical research. Many species within this family have been utilized for their therapeutic properties, with applications ranging from anti-inflammatory and antimicrobial to analgesic and anti-cancer activities.

Another striking aspect of the Asteraceae family is the remarkable variety of life forms exhibited by its members. The family encompasses plants with diverse growth habits, including annuals, perennials, herbs, shrubs, and even some small trees. This adaptability to different ecological niches allows Asteraceae species to thrive in various habitats worldwide, from grasslands and meadows to deserts and alpine regions.

The Asteraceae family's ecological success and global distribution can be attributed to its remarkable adaptations and reproductive strategies. The characteristic flower head, consisting of numerous small individual flowers tightly packed together, is a key feature of the family. This unique structure, often called a composite or capitulum, enhances pollination efficiency and increases the chances of successful reproduction [27]. The distribution of the number of species according to their habitats was as follows: on stony soil - 33 species; on the rocks - 12; in the steppe and steppe regions - 10; in the meadows - 22; in the forest - 12; along the banks of reservoirs - 4; in floodplains of rivers - 14, in mountainous stony soil - 24; on sandy - 7; in humid habitats – 3. Representatives of the Asteraceae family are found everywhere; however, the analyzed species still preferred rocky soil and open spaces and were regularly located near water bodies. Thus, this family's representatives are scioheliophytes, heliophytes, and mesophytes. Most species are perennials (106), some are annuals (21), only eleven are biennials, and three are shrubs.

The Clove family (Caryophyllaceae) is divided into three subfamilies and includes 80 genera with more than 2600 species. Representatives of species of this family are widely distributed in temperate zones, which include the western part of the Kyrgyz Alatau. Plants from this family produce secondary metabolites that are very important from an ecological point of view. Also, some of these metabolites have health-promoting activities, which is why Clove members are used in the pharmaceutical industry [25]. The distribution of the number of species according to their habitats was as follows: on stony soil - 14 species; in the steppe and steppe regions - 3; in meadows - 8; in the forest - 5; along the banks of reservoirs - 2; in floodplains - 9. Most species of the family Caryophyllaceae prefer to settle in open spaces and dry forests. In this connection, they can be classified as helophytes and xerophytes; however, some species still belong to scioheliophytes and mesophytes. Like the previous families, most species belong to perennial plants - 27, a smaller part to annuals - 11, in third place - biennial 3.

Depending on the environmental factors affecting each species, several habitats were identified. The most common habitats were alpine and subalpine mountain belts, various mountain slopes (gravel, rocky, sandy), and wet and swampy areas near water bodies [29]. Representatives of different families preferred different environmental conditions, but it should be noted that almost all species can be attributed to microthermophytes and hekistothermophytes. However, concerning shade tolerance and humidity, the differences between species occur at the levels of families and genera since they depend on the physiology of the plant itself.

The mountains of Central Asia boast a diverse vegetation cover, predominantly falling within the alpine and subalpine meadows belt, along with dry coniferous forests, flourishing at elevations ranging from 1300 to 3800 meters above sea level. These high-altitude ecosystems are characterized by unique plant communities that have adapted to the challenging mountainous terrain and harsh climatic conditions.

In the immediate Tien Shan Mountain range and the Alatau ranges. However, there are distinct areas where the vegetation transitions towards desert and semi-desert species. This phenomenon is attributed to several factors, including lower precipitation levels, greater exposure to solar radiation, and the specific microclimatic conditions in these regions. These arid and semi-arid zones showcase a shift in plant species composition, favoring those adapted to aridity, such as drought-tolerant shrubs, grasses, and xerophytic plants.

The transition from alpine and subalpine meadows to desert and semi-desert vegetation in certain parts of the Tien Shan and Alatau ranges represents a fascinating ecological gradient. It highlights the dynamic nature of mountain ecosystems, where diverse environmental factors contribute to variations in vegetation cover. These changes also have implications for biodiversity, as different plant communities support distinct faunal assemblages, including specialized insect, bird, and mammal species adapted to specific habitats. Understanding the dynamics and patterns of vegetation cover in Central Asian mountains is crucial for effective land management, conservation planning, and ecosystem health monitoring. It provides valuable insights into the responses of plant communities to climate change, grazing pressures, and human activities, ultimately guiding sustainable practices that ensure the preservation of these unique and fragile mountain ecosystems.

This is because all the mountains of Central Asia have altitudinal zonality. Each belt has its vegetation and conditions [26]. Of all the analyzed plants, perennial species accounted for the majority - 67.14% (558 species); annuals, as a rule, herbs were in second place 19.92% (166 species), then biennials - 3.23% (27 species); shrubs (distinguished in a separate group from perennials) - 4.31% (36 species) and trees (also allocated in a separate group) 1.91% (16 species) (Figure 2). Perennial plants are more unpretentious, and therefore, their prevalence in the mountains is explained by the poverty of the soil on the territory of stony, gravel, and sandy slopes, as well as in the forest-steppe and steppe zones.

On the territory of the Kyrgyz Alatau, 554 species of all the analyzed plants are found, 368 - on the Dzungarian Alatau and 272 on the Kungei Alatau. There are 206 species on the territory of the Tarbagatai mountain range, 176 species in the

Chu-Ili mountains, and 404 in the Western part of the Tien Shan. Most of the plants that make up the flora of the gorges of the western part of the Kyrgyz Alatau are distributed throughout the entire Kyrgyz Alatau; however, some species grow, as a rule, on other mountain ranges, for example, on the Dzungarian Alatau or the Chu-Ili mountains; however, these species were found and on the territory of the Kyrgyz Alatau. A wide variety of species, as well as the expansion of their range, is associated with the low level of knowledge of this mountain range and the similarity of the ecological conditions of different mountain ranges. In most cases, one species was distributed in several places at once, such as Litvinovia tenuissima from the Cruciferous family, the distribution range of which included the Karadag mountain range in the Caucasus, the Zaisan mountain in Kazakhstan, the Mangyshlak peninsula, the Betpak-Dala desert, the Turkestan Range, the mountain ranges of the Dzungarian, Kirghiz and Kungei Alatau, the Chu-Ili mountains and the Western part of the Tien Shan[30].

IV. Conclusion

The analyzed plants could be divided into four divisions: horsetail; ferns; Gymnosperms, and Angiosperms. In the Horsetail department, there was one family consisting of 2 species. In the Ferns department, there are two families consisting of 6 species. In the Gymnosperms department, there are three families consisting of 5 species. In conclusion, the systematic analysis of the flora in the western part of the Kyrgyz Alatau has provided valuable insights into the plant diversity and distribution in the region. The analyzed plants have been classified into four divisions: horsetail, ferns, gymnosperms, and angiosperms, each exhibiting distinct characteristics and ecological roles.

The horsetail division comprises a single family with two species, while the ferns division encompasses two families with six species. The gymnosperms division consists of three families and five species. However, the most significant division is the angiosperms, which include a remarkable diversity of plant life. It comprises 72 families and an impressive 819 species, showcasing the region's abundance and richness of flowering plants.

The findings from this analysis shed light on the taxonomic relationships and ecological adaptations of the analyzed plant species. The distribution of families within the angiosperms division, such as Hornworts, Ranunculaceae, Peony, Poppy, Clove, and Gauze, further exemplifies the region's diverse flowering plants.

This systematic analysis is a foundation for further research, conservation initiatives, and land management strategies in the western part of Kyrgyz Alatau. Identifying different divisions, families, and species provides a baseline for understanding plant communities, their ecological roles, and their responses to environmental changes. It aids in the identification of endangered or endemic species that require special conservation attention.

Ultimately, this analysis contributes to our broader understanding of the flora in the western Kyrgyz Alatau, supporting efforts to protect and sustainably manage the unique plant diversity and ecosystems in this region.

Families included in the department Angiosperms: Hornworts; Ranunculaceae; Peony; poppy; clove; Gauze; Buckwheat; plumbags; birch; primroses; violet; Tamarisk; willow; capers; cruciferous; Cistus; Linden; Malvaceae; hemp; Nettles; Euphorbia; Crassula; Saxifrage; Belozorovye; Gooseberries; Derbennikovye; Rosaceae; Cypress; legumes; horse chestnut; maple; rue; parnolistnikovye; Anacardia; Flax; Geraniums; Balsam; source; Euonymous; Santal; Buckthorn; suckers; Umbrella; honeysuckle; Valerian; Villus; Rubiaceae; Gentian; Nightshade; Convolvulus; Borage; Figwort; Plantain; Verbena; Lamiaceae; Bellflowers; Astrovye; Susakovs; Chastukhovye; Juncaceous; Pods; Nayads; Iris; Onion; Orchid; sedge; cereals; duckweed; Cattails[28]. The largest number of species (141) was in the Astrov family, followed by Cereals (104) species, followed by Legumes - 65 species, Carnations - 41 species each, Norichaceae - 37, Ranunculaceae - 36 species, Cruciferous - 32, Lamiaceae - 30 species. All other families contained less than thirty species.

In this study, the shape of each plant species was also determined. A total of 5 groups were identified: annual and biennial herbs, shrubs, trees and perennials. Most of the species belonged to perennial plants. According to the habitat conditions, the species were divided into several small groups growing in open spaces (heliophytes): rocky slopes - 46 species; meadow - 11; steppe - 76; gravel - 106; on the sand - 131; in the desert - 18; alpine meadows - 26, and in closed spaces (scioheliophytes and sciophytes): shrubs - 17; in swampy areas - 33 species; in humid places - 29; along the banks of reservoirs - 33; at the side of the road - 18; in the garden - 8; forest - 41. Also, many plants grew in the alpine belt - 128 and the subalpine - 88. In addition to the above, there were other, smaller ecological groups. It is worth noting that the same species could be in several groups at once.

Thus, the family of Cereals of the flowering plant's department was the most common. Moreover, the total number of certain plant species was 833, families - 78, divisions - 4. Based on the most preferred habitats, it was concluded that most of the species of all analyzed plants are light-loving, moisture-loving, cold-resistant, and perennial.

References

[1] Sytin, A.K., Lazkov, G.A. Astragalus issykkulensis (Fabaceae) is a new species from Kyrgyzstan. *Turczaninowia*. https://www.researchgate.net/publication/326177941_Astragalus_issykkulensis_Fabaceae_a_new_species_from_Kyrgyzstan, 2019.

[2] Bhatta, K.P., Grytnes, J.A., Vetaas, O.R. Downhill shift of alpine plant assemblages under contemporary climate and land-use changes. *Ecosphere*, 9(1), e02084, 2019.

[3] Buchner, J., Yin. h., Frantz, D., Kuemmerle, T., Askerov, E., Bakuradze, T. Land-cover change in the Caucasus Mountains since 1987 based on the topographic correction of multi-temporal Landsat composites. *Remote Sensing of Environment*, 248, 111967, 2020.

[4] Chase, M.W., Christenhusz, M.J.M., Fay, M.F., Byng, J.W., Judd, W.S., Soltis, D.E. An update of the Angiosperm Phylogeny Group classification for the orders and families of flowering plants: APG IV. *Botanical Journal of the Linnean Society*, 181(1), 2019, pp 1-20.

[5] Cherniavskih, V.I., Dumacheva, E.V., Lisetskii, F.N., Tsugkiev, B.G., Gagieva, L.C. *Floral variety of Fabaceae Lindl. family in gully ecosystems in the south-west of the Central Russian Upland.* 2019. https://www.researchgate.net/publication/335397339_Floral_variety_of_Fabaceae_Lindl_family_in_gully_ecosystems_in_the_south-west_of_the_Central_Russian_Upland.

[6] Christenhusz, M.J., Reveal, J.L., Farjon, A., Gardner, M.F., Mill, R.R., Chase, M.W. A new classification and linear sequence of extant gymnosperms. *Phytotaxa*, 19, 2021, pp 55-70.

[7] Chupachin, V.M. Physical Geography of Tian-Shan. *Academic Scientific Press*.,2018 https://www.biotaxa.org/Phytotaxa/article/view/phytotaxa.464.2.1.
[8] Clay, H.F., Hubbard, J.C. Gramineae (Grass Family). *In the Hawai'i Garden*.,2021, doi: 10.1515/9780824846145-004.
[9] Europe's Ecological Backbone. *Recognising the True Value of our Mountains*. Copenhagen: European Environment Agency EEA, 2019.
[10] Friedman, J. The evolution of annual and perennial plant life histories: Ecological correlates and genetic mechanisms. *Annual Review of Ecology, Evolution, and Systematics,* 2020. https://www.annualreviews.org/doi/abs/10.1146/annurev-ecolsys-110218-024638.
[11] Gellrich, M., Zimmermann, N.E. Investigating the regional-scale pattern of agricultural land abandonment in the Swiss mountains: a spatial statistical modelling approach. *Landscape and Urban Planning*, 79(1), 2019, pp 65-76.
[12] International Plant Name Index. 2021. https://www.ipni.org/.
[13] Jakimiuk, K., Wink, M., Tomczyk, M. Flavonoids of the Caryophyllaceae. *Phytochemistry Reviews*., 2021. doi:10.1007/s11101-021-09755-3.
[14] Kesey, Y.M.A. *Ecological groups of plants*, 2021. https://botany.org/userdata/IssueArchive/issues/originalfile/PSB_2021_67_2.pdf .
[15] Khassanov, F.O. *Conspectus Florae Asiae Mediae.,* 2019. https://www.researchgate.net/publication/312578777_conspectus_florae_asiae_mediae.
[16] Kulakowski, D., Bebi, P., Rixen, C. The interacting effects of land use change, climate change and suppression of natural disturbances on landscape forest structure in the Swiss Alps. *Oikos*, 120(2), 2021, pp216-225.
[17] Lazkov, G.A., Sennikov, A.N. *Euphorbia talassica, a new species of leafy spurges from the Western Tian-Shan*. 2019. https://bioone.org/journals/annales-botanici-fennici/issues.
[18] Lazkov, G.A., Sultanova, B.A. *Cadastre of the Flora of Kyrgyzstan*. Bishkek: Vascular Plants, 2019.
[19] Lipper, L., Thornton, P., Campbell, B.M., Baedeker, T., Braimoh, A., Bwalya, M. Climate-smart agriculture for food security. *Nature Climate Change*, 4(12), 2019, pp 1068-1072.
[20] Lyubinska, L.G., Mudrak, O.V., Andrusiak, D.V., Mudrak, G.V., Dushanova, T.V. The current state of flora in the National Nature Park "Podilski Tovtry" (Ukraine). *Ukrainian Journal of Ecology*, 11(1), 2021, pp 218-233.
[21] Mountains of Central Asia Biodiversity Hotspot. 2019. http://aarhus.kg/wp-content/uploads/2017/11/2_eng.pdf.
[22] Myers, N., Mittermeier, R.A., Mittermeier, C.G., Da Fonseca, G.A., Kent, J. Biodiversity hotspots for conservation priorities. *Nature*, 403(6772), 2019, pp 853-858.
[23] Oliver, T.H., Morecroft, M.D. Interactions between climate change and land use change on biodiversity: attribution problems, risks, and opportunities. *Wiley Interdisciplinary Reviews: Climate Change*, 5(3), 2021, pp 317-335.
[24] Patel, R.B., Tatu, K., Kamboj, R.D. 2020. *Diversity of Angiospermic Plants in estuarine and Adjoining Riparian Areas of Sabarmati and Mahi Rivers*,2020. https://www.researchgate.net/publication/348353769_Diversity_of_Angiospermic_Plants_in_estuarine_and_Adjoining_Riparian_Areas_of_Sabarmati_and_Mahi_Rivers_Gujarat_India.
[25] Rustaiyan, A., Faridchehr, A. Constituents and biological activities of selected genera of the Iranian Asteraceae family. *Journal of Herbal Medicine,* 25, 100405, 2021.
[26] Sarbu, A., Janauer, G.A., Exler, N., Sarbu, I., Anastasiu, P. The potential sensitivity to climate change of selected endangered and important Natura 2000 Habitats and plants from Bucegi Natural Park, Romania. *Notulae Botanicae Horti Agrobotanici Cluj-Napoca*, 48(1), 2020, pp 456-479.
[27] Singh, A., Vivek, A.T., Kumar, S. AlnC: An extensive database of long non-coding RNAs in angiosperms. *Plos One*, 16(4), 2021, doi: 10.1371/journal.pone.0247215.
[28] The Plant List. 2021. https:// www.theplantlist.org/.
[29] Tojibaev, K.S., Jang, C.G., Lazkov, G.A., Chang, K.S., Sitpayeva, G.T., Safarov, N. An annotated checklist of endemic vascular plants of the Tian-Shan Mountains in Central Asian countries. *Phytotaxa*, 464(2), 2020, pp 117-158.
[30] Tojibaev, K., Karimov, F., Oh, B.U., Oh, S.H., Jang, C.G. A checklist of the geophytes of Fergana Valley, Middle Asia − a monocotyledonous plant and biogeographical analysis. *Journal of Asia-Pacific Biodiversity*, 11(3), 2018, pp 431-441.