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ARTICLE

Distribution of Species of the Genus Astragalus L. in Kyrgyzstan by Habitat Type

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ABSTRACT

According to literary data, there are 189 species of the genus *Astragalus that* inhabit the territory of Kyrgyzstan. The distribution of species of the genus *Astragalus* (Fabaceae) was studied by taking into account their occurrence in soil-climatic and relief types of plant habitats in the mountainous territories of Kyrgyzstan. The materials were collected during organized research expeditions to natural areas of plant habitats. The occurrence of species was studied by well-known methods. As a result of such analysis we have made the following conclusions for the first time: in the flora of Kyrgyzstan there are 189 species of the genus *Astragalus*, they are representatives of 7 subgenera of this genus; species occur in 24 types of plant habitats with soil and relief features, taking into account the altitudinal regularity of taxa distribution in mountain phytocenoses; subgenuses and specific species characterized by broad, smallest and intermediate sizes of habitats were identified; groupings of plant habitat types on the territory of Kyrgyzstan characterized by the largest, smallest and intermediate indicators on the number of subgenuses and species of the genus *Astragalus* were identified. The botanical description of each species has been supplemented with new information about the species as a taxonomic unit. The materials of our work can be successfully used in the field of systematics, evolution and ecology of plants.

Keywords: Species; Genus; Subgenus; Astragalus; Phytocenosis; Flora; Distribution; Highlands; Geographical Regions

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1. Introduction

The study of species diversity of vascular plants, identification of species with special features and properties, and development of methods for their effective protection and use in various sectors of the economy is one of the urgent topics in the current stage of science development. In this issue it is necessary to pay attention to species and subgenuses of the genus *Astragalus* L. (Fabaceae) of Kyrgyzstan, which are distinguished by the diversity of species that are widely found in various plant communities localized in all vertical belts of mountain systems. Also, the identification of regularities of distribution of subgenera and species in the natural vertical zones of Kyrgyzstan is an urgent issue of the present day. Here it is necessary to pay special attention to the peculiarity of the influence of soil-climatic indicators on the localization of each of the species inhabiting the sites of plant communities of mountains [1–5]. There is some information about the composition, geographical relationship and main stages of formation of the genus *Astragalus* L. of Tien Shan in the work of M.S.Baitenov [6]. The geographic distribution of species from sections *Macrocystis*, *Laguropsis* and *Chaetodon* of the genus *Astragalus* L. in the territory of the Mountain-Middle Asian province was studied by K.Sh. Tojibaev et al. They based on the analysis of all herbarium specimens stored in the largest herbaria of Central Asia (TASH, AA) and Russia (LE, MW), compiled a database using geographic information systems, and identified and mapped 47 species, 35 of which are endemics of the province, expanded the composition of *Astragalus* flora of Uzbekistan, identified new additions to the flora of Uzbekistan (*A. artemisiformis* Rassulova, *A. monanthemus* Boiss.) and some local floras, and determined the rarity status for most species according to IUCN criteria and categories [7]. Information about these works shows that it is necessary to indicate the influence of the type of habitat of species on the process of formation of the floristic composition of a specific mountain natural area. Species distribution peculiarities of the genus *Astragalus* L. and other genera of Fabaceae L., growing on high-mountain plant communities and on natural communities located in close proximity to sources of water in natural objects of the Kyrgyz Republic were studied by a number of authors and by us [8–12]. They noted several types of classifications of plant community types localized in natural landscapes of mountains. For example, the following types of plants were identified in relation to humidity: hygrophytes - species growing in places with excessive moisture; mesophytes – with sufficient moisture (species of meadow, forest habitats, crevices and shady rocks); mesoxerophytes – with periodically insufficient moisture and xerophytes - with sharp lack of moisture (species of zonal desert steppes and deserts, rocks, outcrops of mottled rocks, etc.). Due to the significant mosaicity of mountain plant communities, it is rather difficult to determine to which type of plant communities this or that species belongs, therefore, the distribution of species into plant communities is conditional and largely depends on the scientific approach of a particular researcher. Frequently noted vegetation types include juniper forests, mountain taiga and juniper steleys, semisavannas and Iranian-Turanian-type phryganoids, cryomesophilic herbaceous covers, tall herbaceous mountain semisavannas, grasslands, meadow-steppes, mesophilic mountain herbaceous grasses, mesophilic deciduous shrubs, mottled strata, petrophyte, relict coarse-grass beds, marshes, steppes, steppe shrubs, Turanian psammophyton, black forest, and others [13–16]. When performing our work, we have widely applied the terminology, which takes place in the definitions “Flora of the Kyrgyz SSR” [17] and “Central Asia Plant Definer” [18]. We are satisfied that the use of habitat types of specific species, which appear in the above-mentioned literary sources more or less accurately characterizes the features of plant communities localized in mountainous natural landscapes of the Kyrgyz Republic. Therefore, to indicate the place of localization of species with soil-climatic features, we used the phrase “type of plant habitats” taking into account the altitudinal belt and distribution of this or that species in the mountains.

Aims of the study: To study the distribution of species of the genus *Astragalus* L. (Fabaceae) taking into account their occurrence by soil-climatic and relief types of plant habitats in the mountainous areas of Kyrgyzstan.

Research objectives:

- To organize route expeditions to natural territories of Kyrgyzstan to study the current status of species of the

genus Astragalus in terms of their occurrence in soil-climatic and relief types of plant habitats in natural mountain landscapes of Kyrgyzstan.

- To study all kinds of literary sources, where there is some information about species of this genus, which represent the flora of Kyrgyzstan.
- To collect biological information about plant species in natural conditions of their growth and to complete the botanical description of each of the recorded species.
- To make original photo and ordinary herbarium specimens of each of the registered plant species.
- To make a comparative analysis of the obtained data on the recorded species of the genus in the aspect of taxonomic rank of subgenus.

2. Materials and Methods

Expeditionary survey has served as the main method for collecting information on plants for the identification of species with regard to their habitat features and altitudinal pattern of distribution. Usually it consists of the following consecutive stages: a) selection of species for study is made; b) necessary preparatory actions are carried out; c) an expedition is organized to carry out specific types of field studies on accounting and collection of necessary photographic and herbarium data of plant species; d) this is followed by cameral processing of obtained data, which were collected during the field study. Determination of species affiliation of taxon by herbarium and photographic herbarium specimens was carried out in the laboratory of plant systematics and herbarium fund of the Department of Botany of Osh State University. For designation of subgenera and species affiliation of the studied species and genera of the genus Astragalus L., the data of the "Flora of the Kyrgyz SSR" [17] "Central Asian Plant Identifier" [18], "Cadastre of the flora of Kyrgyzstan. Vascular plants" [19] and the latest achievements of botanical science of Kyrgyzstan, Central Asia and the world [20–24].

We used the methods of counting occurrence, where sample areas were laid for the purpose of general characterization of phytocenosis. Basically, we used oculometric methods of abundance counting, where the results of counting are expressed in conditional scores that estimate the abundance of a given species. Here, the occurrence of a species in a given phytocenosis, the so-called local occurrence, is expressed as a number showing how many sites out of the total number of laid sites the species under study occur. The occurrence of a species in several phytocenoses belonging to the same association, the so-called total occurrence, is expressed as a number representing the result of dividing the sum of local occurrences by the number of phytocenoses for which the local occurrence was determined. Relative plant occurrence is the ratio of the occurrence of a given species to the sum of the occurrence of all plant species in a phytocoenosis. In this case, the sum of the occurrence of all plants of a phytocenosis should not be taken for all sites in the phytocenosis, but only for those on which the species whose relative occurrence is determined occurred [25].

The digital material was processed on an IBM computer using the Microsoft Excel program.

3. Results

As a result of our study it was clarified that 189 species of leguminous plants (Fabaceae L.), representing the genus *Astragalus* L., which, according to the systematics, are representatives of 7 subgenus of this genus, inhabit the territory of the Kyrgyz Republic (**Table 1**).

We took into account the occurrence of species in natural landscapes of mountain systems, taking into account soil and relief features of plant habitats, as well as the altitudinal belt of taxa distribution in mountainous areas. Materials were collected in the process of research of species occurrence during route expeditions, which were organized from 1992 to 2024 in the natural landscapes of the Kyrgyz Republic. In parallel, the study of all kinds of literary data on species of this genus was carried out. Based on the analysis of the obtained data, we have identified 24 types of plant habitats with soil-climatic and relief features of mountainous natural landscapes, taking into account the vertical regularity of the distribution of taxa belonging to the genus *Astragalus*.

Table 1. Distribution of species and subgenera of the genus *Astragalus* L. of Kyrgyzstan by character of habitats taking into account vertical belt of mountainous territories.

	Subgenus Name	*Phaca* (L.) Bge.	*Carpinus* Bge.	*Hypoglottis* Bge.	*Trimeniaeus* Bge.	*Calycophysa* Bge.	*Cercidothrix* Bge.	*Calycocystis* Bge.	Total
	Number of species	**22**	**48**	**1**	**14**	**2**	**75**	**27**	**189**
Name of habitats with characteristic soil and relief features of the areas	Semideserts, steppes (33)								
	Sands, sandy ridges	-	1	-	1	1	2	-	**5**
	Semideserts and steppes	-	10	-	3	1	6	1	**21**
	Saline and slightly saline soil, saline and solonchak steppes	-	3	1	1	-	2	-	**7**
	Foothill zone (24)								
	Foothill plains, fallow fields, meadows, overlogs	-	7	-	5	-	3	1	**16**
	Gardens, crops, settlements	-	-	-	3	-	-	-	**3**
	By the ditches and roads	-	1	-	-	-	1	-	**2**
	Marshy meadows, loess-like areas	-	-	-	1	-	2	-	**3**
	Tree and shrub belt (301)								
	Pebbles, woody slopes, coastal sands	2	8	-	2	-	7	1	**20**
	Red chalky sandstones, variegated sandstones	-	5	-	-	-	5	1	**11**
	Near rivers and lakes, river floodplains	1	-	-	1	-	2	1	**5**
	River terrace bluffs, clay bluffs, tertiary sandstone outcrops, conglomerate outcrops	-	-	1	1	-	10	-	**12**
	Dry watercourse beds, river sediments	1	-	-	-	-	3	-	**4**
	Stony slopes and outcrops	9	10	-	2	1	33	14	**69**
	Rubble slopes, desert rubble plumes	6	16	-	6	-	29	12	**69**
	Fine-grained slopes	3	11	-	1	1	14	4	**34**
	Clay slopes	1	1	1	7	-	6	3	**19**
	Rocks, screes, moraines	1	5	-	-	-	7	2	**15**
	Forests and shrubbery	5	4	-	-	-	3	3	**15**
	Forest meadows and glades	4	3	-	-	-	-	-	**7**
	A thicket of juniper woods	3	11	-	-	-	4	3	**21**
	Subalpine and alpine belt (48)								
	Subalpine meadows, mountain high grass meadows, steppes and meadow-steppes	4	12	-	-	-	5	4	**25**
	Alpine meadows	4	4	-	-	-	2	1	**11**
	Shallow soddy typchak steppes, sedge-cobresia areas	3	6	-	-	-	2	1	**11**
	Near the snows and glaciers	-	-	-	-	-	1	-	**1**

In **Table 1**, the numbers indicate the number of species that occur in a specific type of vegetation, taking into account their belonging to a particular subgenus of the genus Astragalus. As for the status of the species, it was left as in the Flora of the Kyrgyz SSR [17]. Representatives of such subgenuses as *Cercidothrix* Bge. (in 22 recorded land cover types) and *Carpinus* Bge. (18) occur quite frequently. These subgenuses constitute the first grouping in terms of species occurrence in the recorded land cover types. Subgenus *Calycophysa* Bge. (4) and *Hypoglottis* Bge. (3) have species occurring in only 3-4 land cover types. These subgenera represent the second grouping. Other subgenuses, such as *Calycocystis* Bge. (15), *Phaca* (L.) Bge. (14), *Trimeniaeus* Bge. (13), occupy an intermediate position between these two groupings by this indicator (**Figure 1**).

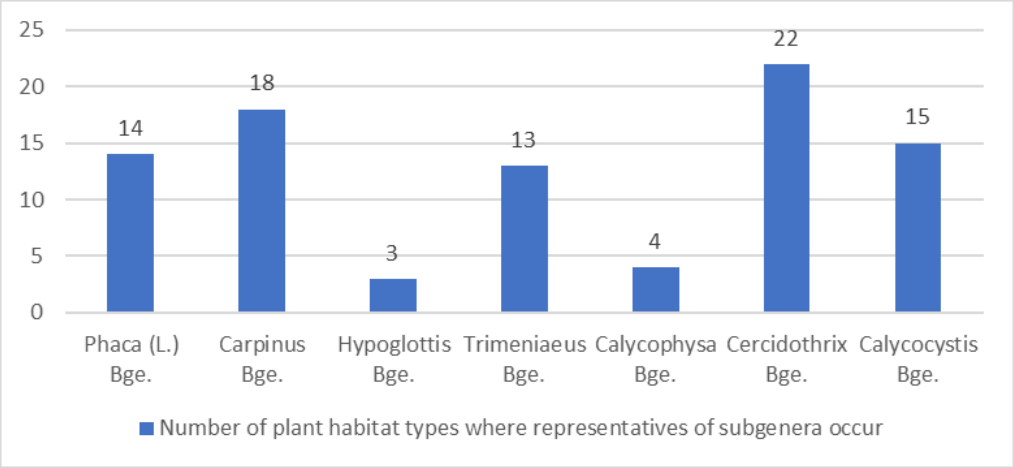

Figure 1. Occurrence of species of subgenuses *Astragalus* L. in the territory of a particular plant habitat type.

The largest number of species representing the genus Astragalus were recorded on rocky slopes and outcrops (69 species) and rubble slopes (desert rubble trails – 69 species) of mountainous areas. Quite a large number of species occur on habitat types such as fine-grained slopes (34), subalpine meadows, mountain tallgrass meadows, steppes and meadow-steppes (25), semi-deserts and steppes (21), gravels, woody slopes, coastal sands (20) and clay slopes (19). A single or very few species are represented in the following habitat types: near snow and glaciers - 1 species, near ditches and roads – 2 species, gardens, crops, settlements – 3 species, marshy meadows, loess-like areas – 3 species, dry watercourse beds, river sediments - 4 species. A moderate number of astragalus species was recorded in other habitat types: from 5 to 16 (**Figure 2**).

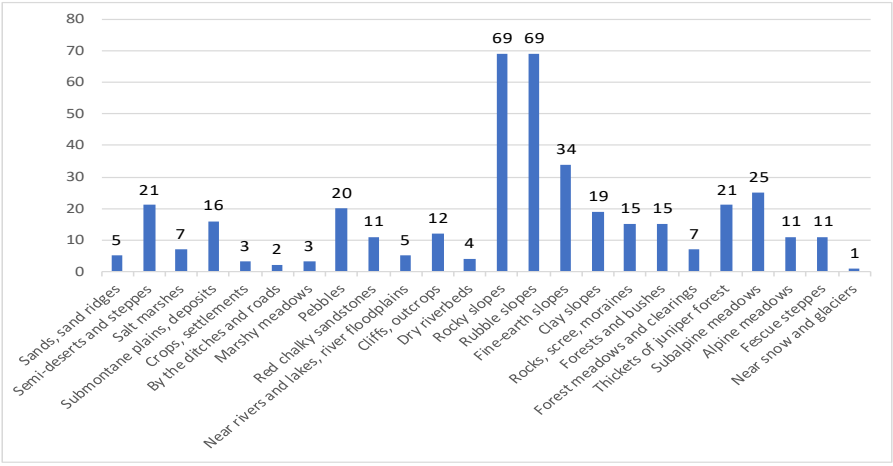

Figure 2. Quantitative indicators of the recorded species of the genus *Astragalus* L. in Kyrgyzstan by types of plant habitats.

We noted that species of subgenus *Cercidothrix* Bge**.** and *Carpinus* Bge. are found in most types of vegetation cover of mountainous territories. Representatives of subgenuses *Hypoglottis* Bge., *Trimeniaeus* Bge. and *Calycophysa* Bge. inhabit the types of vegetation cover that occupy the lower zone of mountain territories. Species of the subgenus *Calycocystis* Bge. are characteristic of plant habitat types that are localized in the upper part of the tree-shrub belt and the subalpine belt of the mountains. As for the species of subgenus *Phaca* (L.) Bge., they are characteristic of the vegetation cover types that are located in the upper zone of mountain territories.

The subgenus *Phaca* (L.) Bge. in the flora of Kyrgyzstan is represented by 22 species. These species, which belong to the genus Astragalus, are found in various types of plant habitats in mountainous areas, ranging from the middle belt (e.g., pebbles, gravelly slopes, coastal sands) to fine-turf fescue steppes and sedge-kobresia areas in the upper belt. The greatest number of representatives of this subgenus are localized on rocky slopes and outcrops, including species such as *A. olgae* Bge., *A. dictamnoides* Gontsch., *A. lithophilus* Kar. et Kir., *A. kuschakewiczii* B. Fedtsch., *A. beketowii* B. Fedtsch., *A. kenkolensis* B. Fedtsch., *A. densiflorus* Kar. et Kir., *A. leptostachys* Pall., and *A. pseudomacropterus* Karmyscheva. These species are also found on scree slopes and desert scree trails (e.g., *A. olgae* Bge., *A. dictamnoides* Gontsch., *A. lithophilus* Kar. et Kir., *A. kuschakewiczii* B. Fedtsch., *A. leptostachys* Pall., *A. pseudomacropterus* Karmyscheva) as well as in forests and among thickets of shrubs (*A. aksuensis* Bge., *A. aflatunensis* Bge., A. *laceratus* Lipsky, *A. leptostachys* Pall., *A. pseudomacropterus*). In other types of mountain plant habitats, the number of species from this subgenus is lower compared to the aforementioned natural landscapes.

Representatives of the subgenus *Carpinus* Bge. (48 species) are more or less evenly distributed across all recorded types of plant habitats in the mountainous areas of Kyrgyzstan. However, it should be noted that among the recorded species of this subgenus there are species that live exclusively in high-mountain habitat types (*A. litvinowianus* Gontsch*., A. aksaricus* Pavlov*, A. tianschanicus* Bunge*, A. merkensis* Kamelin et Kovalevsk*., A. korotkovae* Kamelin et Kovalevsk*., A. subbarbelatus* Bunge*, A. devestitus* Pazij et Vved.). Such species as *A. sieversianus* Pall*., A. orbiculatus* Ldb*, A. lasiopetalus* Bge*., A. lanuginosus* Kar. et Kir*., A. flexus* Fisch*., A. floccosifolius* Sumn*., A. mucidus* Bge*, A. substipitatus* Gontsch*., A. atrovinosus* M. Pop*., A. macronyx* Bge. are found only in plant habitats located in the lower part of mountainous areas. Among them, *A. flexus* is found only on sands, sandy ridges; *A. floccosifolius* Sumn*., A. atrovinosus* M. Pop*., A. macronyx* Bge. – in semi-deserts and steppes; *A. mucidus* Bge and *A. substipitatus* Gontsch. – on foothill plains, fallow lands, and field boundaries,. In habitat types such as gardens, crops, settlements, sooty meadows, loess-like areas, near rivers and lakes, river floodplains, cliffs of river terraces, clay cliffs, outcrops of tertiary sandstones, outcrops of conglomerates, dry river beds, river sediments, near snow and glaciers, representatives of this subgenus are absent. The greatest number of species of the subgenus *Carpinus* are found in the following types of plant habitats:

Stony slopes, desert stony trails (16 species): *A. anisomerus* Bge., *A. talassicus* M.Pop., *A. lentilobus* Kamelin et Kovalevsk., *A. alatavicus* Kar. et Kir., *A. alaicus* Freyn., *A. titovii* Gontsch., *A. commixtus* Bunge, *A. pseudoamygdalinus* Popov, *A. sarytavicus* Popov, *A. syreitschikovii* Pavlov, *A. adpressipilosus* Gontsch., *A. spinescens* Bge., *A. bactrianus* Fisch., *A. pterosephalus* Bunge., *A. flexilispinus* Boriss, *A. asaphes* Bunge.

Subalpine meadows, mountain tall-grass meadows, steppes and meadow-steppes (12 species): *A. subinduratus* Gontsch., *A. schanginianus* Pall., *A. aksaricus* Pavlov, *A. tianschanicus* Bunge, *A. korotkovae* Kamelin et Kovalevsk., *A. andaulgensis* B. Fedtsch., *A. lentilobus* Kamelin et Kovalevsk., *A. pauper* Bge., *A. alatavicus* Kar. et Kir., *A. titovii* Gontsch., *A. sarytavicus* Popov and *A. taldicensis* Franch.

Juniper forest thickets (11 species): *A. nuciferus* Bge., *A. turkestanus* Bge., *A. aphanssjevii* Gontsch., *A. lentilobus* Kamelin et Kovalevsk., *A. alaicus* Freyn., *A. severtzowii* Bge., *A. titovii* Gontsch., *A. pseudoamygdalinus* Popov, *A. adpressipilosus* Gontsch., *A. pterosephalus* Bunge and *A. asaphes* Bunge.

Fine-grained slopes (11 species): *A. camptoceras* Bunge, *A. lasiosemius* Boiss., *A. merkensis* Kamelin et Kovalevsk., *A. lentilobus* Kamelin et Kovalevsk., *A. kirghisorum* Gontsch., *A. globiceps* Bunge, *A. pseudoamygdalinus* Popov, *A. sarytavicus* Popov, *A. syreitschikovii* Pav-

lov, *A. bactrianus* Fisch. and *A. pterosephalus* Bunge.

Semi-deserts and steppes (10 species): *A. sieversianus* Pall., *A. nuciferus* Bge., *A. turkestanus* Bge., *A. orbiculatus* Ldb., *A. lanuginosus* Kar. et Kir., *A. aphanssjevii* Gontsch., *A. floccosifolius* Sumn., *A. schanginianus* Pall., *A. atrovinosus* M.Pop. and *A. macronyx* Bge.

Rocky slopes and outcrops (10 species): *A. anisomerus* Bge., *A. subinduratus* Gontsch., *A. talassicus* M.Pop., *A. lasiosemius* Boiss., *A. alaicus* Freyn., *A. pseudoamygdalinus* Popov, *A. sarytavicus* Popov, *A. taldicensis* Franch., *A. bactrianus* Fisch., *A. pterosephalus* Bunge. and *A. asaphes* Bunge.

The smallest number of species of the subgenus *Carpinus* were noted in the following habitat types, such as sands, sandy ridges (1 species – *A. flexus* Fisch.), near irrigation ditches and roads (1 species – *A. lasiopetalus* Bge.), clay slopes (1 species – *A. commixtus* Bunge). Other types of plant habitats occupy an intermediate position between the above-mentioned groupings according to this indicator.

In Kyrgyzstan, the subgenus *Hypoglottis* is represented by only one species, *A. tibetanus* Benth., which has been recorded in such plant habitats as saline, slightly saline soils, ssaline-alkaline steppes, river terrace cliffs, clay cliffs, tertiary sandstone outcrops, conglomerate outcrops, and clay slopes.

Representatives of the subgenus *Trimeniaeus* Bge. are found in plant habitats that are located in the middle and lower parts of mountainous areas. They are absent from habitat types that are localized in mountainous areas from the tree-shrub belt to the highlands inclusive. The greatest number of species of this subgenus were noted in the territories of clay slopes (*A. campylorrhynchus* Fisch. et Mey., *A. vicarius* Lipsky, *A. stalinskyi* Sir., *A. filicaulis* Fisch. et Mey., *A. oxyglottis* Stev., *A. tribuloides* Delile., *A. dipelta* Bge.), rubble slopes and desert rubble trails (*A. campylorrhynchus* Fisch. et Mey., *A. compositus* Pavlov, *A. stalinskyi* Sir., *A. uninodus* Popov. et Vved., *A. oxyglottis* Stev., *A. tribuloides* Delile.), foothill plains, fallow lands, field boundaries, fallow lands (*A. campylorrhynchus* Fisch. et Mey., *A. schmalhaisenii* Bge., *A. vicarius* Lipsky, *A. filicaulis* Fisch. et Mey., *A. dipelta* Bge.). In other types of plant habitats in mountainous areas, the number of species belonging to this subgenus is small (from 1 to 3 species). In such habitat types located in the lower belts of mountainous areas, such as along irrigation ditches and roads, on red chalk sandstones, variegated formations, dry stream beds, and river sediments, representatives of this subgenus are absent.

The subgenus *Calycophysa* Bge. is represented by two species. Of these, *A. alopecias* Pall. is found only in the semi-desert area, and the other species *A. eximius* Bge., occurs on rocky slopes and outcrops, fine-earth slopes in the middle part of the mountainous area.

The subgenus *Cercidothrix* Bge. has the largest number of species among the subgenera of the genus *Astragalus*, found in Kyrgyzstan. Representatives of this subgenus mainly live in the types of plant habitats in mountainous areas that lie to some extent in the tree-shrub belt. The greatest number of species were recorded in habitat types such as:

Rocky slopes and cliffs (33 species): *A. maverranagri* M.Pop., *A. michaelis* Boriss., *A. schachdarinus* Lipsky, *A. dianthus* Bunge, *A. corydalinus* Bunge, *A. hypogaeus* Lebed., *A. managildensis* B.Fedtsch., *A. petkoffii* B.Fedtsch., *A. pseudoscoparius* Gontsch., *A. kronenburgii* B.Fedtsch., *A. dschangartensis* Sumn., *A. nematodes* Bge., *A. trichanthus* Golosk., *A. sarbasnensis* B. Fedtsch., *A. ferganensis* B.Fedtsch., *A. rarissimus* Popov, *A. heptapotamicus* Sumn., *A. saratagius* Bge., *A. pachyrhizus* M.Pop., *A. popovii* Pavl., *A. isphairamicus* B.Fedtsch., *A. borissianus* Gontsch., *A. rupifragiformis* M.Pop., *A. testiculatus* Pall., *A. stenocarpus* Gontsch., *A. namanganicus* M.Pop., *A. variegatus* Franch., *A. neolipskyanus* M.Pop., *A. duanensis* Saposhn., *A. falcigerus* M.Pop., *A. spryginii* M.Pop., *A. macrotropis* Bge., *A. ortholobiformis* Sumn.

Rubble slopes, desert rubble trails (29 species): *A. maverranagri* M.Pop., *A. michaelis* Boriss., *A. vassilczenkoanus* Golosk., *A. schachdarinus* Lipsky, *A. corydalinus* Bunge, *A. petkoffii* B.Fedtsch., *A. pseudoscoparius* Gontsch., *A. kronenburgii* B.Fedtsch., *A. nematodes* Bge., *A. stenanthus* Bge., *A. petraeus* Kar. et Kir., *A. ferganensis* B.Fedtsch., *A. rarissimus* Popov, *A. skorniakovii* B.Fedtsch., *A. pachyrhizus* M.Pop., *A. popovii* Pavl., *A. irisuensis* Boriss., *A. keminensis* Isakov, *A. projecturus* Sumn., *A. alberti* Bge., *A. borodinii* Krassn., *A. chomutowii* B.Fedtsch., *A. tekessicus* Bajt., *A. platyphyllus* Kar. et Kir., *A. stenocarpus* Gontsch., *A. variegatus* Franch., *A. duanensis* Saposhn., *A macrotropis* Bge., *A. xipholobus*

M.Pop.

Fine-grained slopes (14 species): *A. maverranagri* M.Pop., *A. michaelis* Boriss., *A. ugamicus* Popov., *A. schachdarinus* Lipsky, *A. taschkendicus* Bunge,, *A. kronenburgii* B.Fedtsch., *A. stenanthus* Bge., *A. skorniakovii* B.Fedtsch., *A. tekessicus* Bajt., *A. namanganicus* M.Pop., *A. neolipskyanus* M.Pop., *A. duanensis* Saposhn., *A. lorinserianus* Freyn., *A. nikitinae* B.Fedtsch.

Cliffs of river terraces, clay cliffs, outcrops of tertiary sandstones, and conglomerate outcrops (10 species): *A. managildensis* B.Fedtsch., *A. angustissimus* Bge., *A. dschangartensis* Sumn., *A. petraeus* Kar. et Kir., *A. caespitosulus* Gontsch., *A. projecturus* Sumn., *A. namanganicus* M.Pop., *A. aulieatensis* M.Pop., *A. lorinserianus* Freyn., *A. dianthoides* Boriss.

In such types of plant habitats as along irrigation ditches and roads, fine-turf fescue steppes, sedge-kobresia areas, and near snow and glaciers, only one species each lives, representing this subgenus of the genus *Astragalus*. The remaining types of plant habitats in mountainous areas for this indicator for the subgenus *Cercidothrix* occupy an intermediate position between the above-mentioned groups. As for the territory of plant habitats such as gardens, forests, then representatives of this subgenus of the genus *Astragalus* are absent.

The subgenus *Calycocystis* Bge. of the genus *Astragalus* in the flora of Kyrgyzstan is represented by 27 species. They are characteristic of the types of plant habitats that are localized in the upper part of the tree-shrub belt and the subalpine belt of the mountains. Exceptions include *A. allotricholobus* Nab., *A. excelsior* M.Pop., *A. nivalis* Kar. et Kir., *A. semideserti* Gontsch. and *A. lavrenkoi* Kamelin, which descend below the aforementioned belts; notably, *A. excelsior* and *A. semideserti* Gontsch. are typical representatives of semi-deserts, steppes and foothill plains. The greatest number of species are found in such types of plant habitats as rocky slopes and cliffs (14 species), stony slopes, desert stony trails (12). In other types of mountain habitats, representatives of this subgenus are less frequently encountered.

Some species representing subgenuses *Hypoglottis* Bge., *Trimeniaeus* Bge. and *Calycophysa* Bge. are found on types of vegetation cover located on plain and foothill zones: sands, sandy ridges, semi-deserts and steppes, saline and slightly saline soils, saline and saline steppes. These species can be characterized as inhabiting hot, dry, foothill zones. On the types of vegetation cover, which are located in the upper zone of mountainous areas—from the tree and shrub belt to alpine meadows, including fine sodded tipchak steppes—species representing the subgenus *Phaca* (L.) Bge. are found. However, we noted that representatives of subgenus *Carpinus* Bge. (96 times), *Cercidothrix* Bge. (132) and *Calycocystis* Bge. (50) are the most frequently encountered in this territory, representatives of other genera mentioned here are rarely observed in this territory. As for other species of these genera, they together with representatives of genera whose species do not occur in the aforementioned types of vegetation cover occupy intermediate position between these groupings.

The recorded types of plant habitats are more or less concentrated in the following vertical zones of vegetation localization in mountain landscapes: the zone of semi-desert and steppe vegetation; the zone of foothill vegetation; the tree-shrub zone; the zone of subalpine and alpine meadows. We identified the largest number of astragalus species in the tree-shrub belt (301), the smallest number in the foothill zone (24), and other vertical vegetation localization belts recorded in this indicator occupy intermediate positions between the above-mentioned belts.

4. Discussion

The genus *Astragalus* is characterized as a rich taxon (189 species, 7 subgenera) in the flora of Kyrgyzstan. Species representing this genus are more or less widespread and grow in diverse soil-climatic and relief conditions of plant habitats (24 types in total). Representatives of the subgenus *Cercidothrix* inhabit 22, *Carpinus* - 18 such vegetation types, which characterizes them as genera with a wide habitat range. As for *Calycophysa* (4) and *Hypoglottis* (3), these genus have the smallest range of distribution in natural phytocenoses of Kyrgyzstan. Other subgenera occupy an intermediate position between these two groups of subgenera by this indicator.

The distribution areas of specific species in the territories of the recorded types of vegetation cover of mountainous areas differ quite markedly. For example, of the recorded species of the genus Astragalus L. *A. lentilobus* Kamelin

et Kovalevsk. is found in the territory of 7 types of vegetation cover of mountain landscapes, *A. leptostachys* Pall., *A. lentilobus* Kamelin et Kovalevsk., *A. bactrianus* Fisch., *A. pterosephalus* Bunge., *A. pseudoamygdalinus* Popov – on the territory of 6 types of vegetation cover of mountain territories, *A. pseudomacropterus* Karmyscheva, *A. tribuloides* Delile., *A. namanganicus* M.Pop. - on 5 types. These species have the largest distribution areas in the mountain plant communities. *A. aksuensis* Bge., *A. chionanthus* Popov, *A. lepsensis* Bge., *A. kokandensis* Bge., *A. Abramovii* Gontsch, *A. schugnanicus* B. Fedtsch., *A. fetissowii* B. Fedtsch., *A. imetensis* Boriss., *A. Litvinowianus* Gontsch., *A. flexus* Fisch, *A. floccosifolius* Sumn., *A. mucidus* Bge., *A. tianschanicus* Bunge, *A. merkensis* Kamelin et Kovalevsk., *A. korotkovae* Kamelin et Kovalevsk., *A. globiceps* Bunge, *A. devestitus* Pazij et Vved., *A. campylotrichus* Bge., *A. sesamoides* Boiss., *A. ammophylus* Kar. et Kir., *A. mailiensis* B.Fedtsch., *A. vassilczenkoanus* Golosk., *A. bosbutooensis* Nikitina et Sudn., *A. gontscharovii* Vass., *A. angustissimus* Bge., *A. angustissimus* Bge., *A. infractus* Sumn., *A. pseudotetrastichus* Abdull., *A. irisuensis* Boriss., *A. kugartensis* Boriss., *A. keminensis* Isakov, *A. rupifragiformis* M.Pop., *A. involutivus* Sumn., *A. borodinii* Krassn., *A. brachyrachis* M.Pop., *A. falcigerus* M.Pop, *A. aulieatensis* M.Pop, *A. spryginii* M.Pop., *A. ortholobiformis* Sumn., *A. reverdattoanus* Sumn., *A. angreni* Lipsky., *A. dianthoides* Boriss., *A. pseudodianthus* Nab., *A. caudicosus* Galk. et Nab., *A. nikitinae* B.Fedtsch., *A. excelsior* M.Pop, *A. khassanovii* Podlech, *A. semideserti* Gontsch., *A. lavrenkoi* Kamelin, *A. alabugensis*, *A. sandalaschensis* Nikitina, *A. sphaerocystis* Bge., *A. abolinii* M.Pop. are characterized as species with a very narrow range among the recorded legume species of the Kyrgyz flora. For the remaining species, the ranges are characterized as moderately to broadly distributed.

In terms of the occurrence of species of the genus *Astragalus* on the territory of the recorded types of vegetation cover, a special place is occupied by stony slopes and outcrops (69 species) and rubbly slopes (desert rubbly plumes - 69 species) of mountain territories, where the greatest number of species representing the genus *Astragalus* was recorded. Fine-grained slopes (34 species), subalpine meadows, mountain high-grass meadows, steppes and meadow-steppe (25 species), semi-deserts and steppes (21 species), juniper forest thickets (21 species), gravels, trebly slopes, coastal sands (20 species) and clay slopes (19 species) are rather densely saturated with species of this family. These mentioned types can be noted as a group where representatives of the genus *Astragalus* L. are more or less frequently found in the vegetation cover. As for the types near snow and glaciers (1 species), near ditches and roads (2 species), gardens, crops, settlements (3 species) and marshy meadows, loess-like areas (3 species), they are characterized as the poorest among them and form a special group. According to this indicator, other types occupy an intermediate position between these groupings as a special group.

Recorded types of vegetation covers occupying certain areas of mountainous territories are more or less clearly characterized by the participation of species in the formation of their species diversity, representing genera of Fabaceae. For example, in the composition of species diversity of vegetation types located in plain and foothill zones: sands, sandy ridges, semi-deserts and steppes, saline and slightly saline soils, solonetz and solonchak steppes from among leguminous plants some species of subgenus *Carpinus*, *Trimeniaeus* and *Cercidothrix* predominate. As for the vegetation types located in the uppermost zone of mountain territories—alpine meadows, fine-turf typechak steppes, sedge-cobrezium areas, near snows and glaciers—the species diversity of astragalus representatives includes species of subgenus *Phaca*, *Carpinus*, *Cercidothrix* and *Calycocystis*. It is necessary to emphasize that representatives of genus *Carpinus* (22 times) and *Phaca* (11) are very often found on these vegetation types. Representatives of other subgenera and other species of the above-mentioned genus are part of the species diversity of vegetation types of mountainous areas located between vegetation types, which are located on the lowest and highest part of vertical belt, and form a special grouping.

The recorded types of vegetation cover are more or less concentrated in the following vertical zones of vegetation cover localization in mountainous areas: the semi-desert and steppe zone; foothill zones; the tree-shrub vegetation zone; the subalpine and alpine belt. We recorded the largest number of species in the territory of the tree-shrub vegetation belt (301), the smallest number in the foothill zone (24), other vertical belts of vegetation localization re-

corded in this indicator occupy intermediate positions between the indicated territories.

The obtained data from our research will make a significant contribution to the solution of the issues related to regional ecology of plants, thereby improving environmental protection measures on the ground. They will serve as a source of information on the species of the genus Astragalus L. in the territory of Kyrgyzstan for the rational use of the resource potential of a particular species and the entire vegetation cover.

5. Conclusions

The genus *Astragalus* L. is one of the richest genera of Fabaceae that represent the floras of Kyrgyzstan. Its species inhabit very diverse soil-climatic and relief types of plant habitats in natural mountain landscapes. Compared to neighboring regions, the flora of the genus in Kyrgyzstan is characterized by a large number of high-mountain species, clearly expressed vertical zonality and genetic uniqueness. These features emphasize the importance of preserving the mountain ecosystems of Kyrgyzstan as an important center of biodiversity in Central Asia.

The subgenus *Cercidothrix* and *Carpinus* are characterized by a wide range of habitats. As for the representatives of the subgenus *Hypoglottis*, *Trimeniaeus* and *Calycophysa*, they have the smallest range of distribution. According to this indicator, the remaining subgenera occupy an intermediate position between the above-mentioned groups of subgenus and are characterized by moderately wide ranges of habitats.

Among the species of the genus *Astragalus* L. *A. lentilobus*, *A. leptostachys*, *A. lentilobus*, *A. bactrianus*, *A. pterosephalus*, *A. pseudoamygdalinus*, *A. pseudomacropterus*, *A. tribuloides*, *A. namanganicus* have the largest distribution areas in the mountain phytocenoses of Kyrgyzstan.

Among the recorded types of vegetation, the largest number of species representing the genus *Astragalus* L. occur on rocky slopes, outcrops and rubble slopes (desert rubble trails) of mountainous areas. Legumes are quite common in the vegetation cover of fine-grass slopes, subalpine meadows, mountain tall-grass meadows, steppes and meadow-steppes, semi-deserts and steppes, juniper forest thickets, gravel, woody slopes, coastal sands and clay slopes. The smallest number of species was recorded in pastures near settlements, near snow and glaciers, near irrigation ditches and roads, gardens, crops, settlements, sooty meadows, and loess-like areas. Other types of vegetation cover occupy an intermediate position between these groups according to this indicator.

In the composition of the species diversity of plant cover types located in the plain and foothill zones mainly species of the subgenus *Hypoglottis*, *Trimeniaeus* and *Calycophysa* predominate among the astragals. The species composition of the territory of plant types, which are located in the uppermost zone of mountainous territories from among the astragals is represented by the subgenus *Phaca*, *Carpinus*, *Cercidothrix* and *Calycocystis*. It should be especially emphasized that representatives of the subgenus *Phaca* are not found in the vegetation of the lower zone.

The largest number of *Astragalus* species was found in the tree-shrub vegetation belt (301), the smallest number was found in the foothill zone (24), other vertical belts of vegetation localization recorded for this indicator occupy intermediate positions between the indicated territories.

To determine the involvement of a particular species of the genus *Astragalus* in mountainous areas, it is necessary to study the morphological and anatomical features of the structure of their organs. A more detailed analysis of species common in mountainous areas can make a certain contribution to solving the issues of species migration in the mountainous areas of Central Asia and beyond.

Author Contributions

All authors made significant contributions to this study. O.M. developed the study concept; O.K. developed the methodology; O.M. and Z.E. contributed to data collection and resources; K.A. supervised the data; Z.E. prepared the initial draft; O.M. and O.K. reviewed and edited the manuscript; O.M. supervised the study. All authors have read and approved the final manuscript.

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Conflict of Interest

All the authors also declare that there is no conflict of interest in relation to the research, authorship, and publication of this study.

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