

## Ecological Significance of Life Forms of Plant Species of Floristic Complexes of the Ketpen Range

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### ABSTRACT

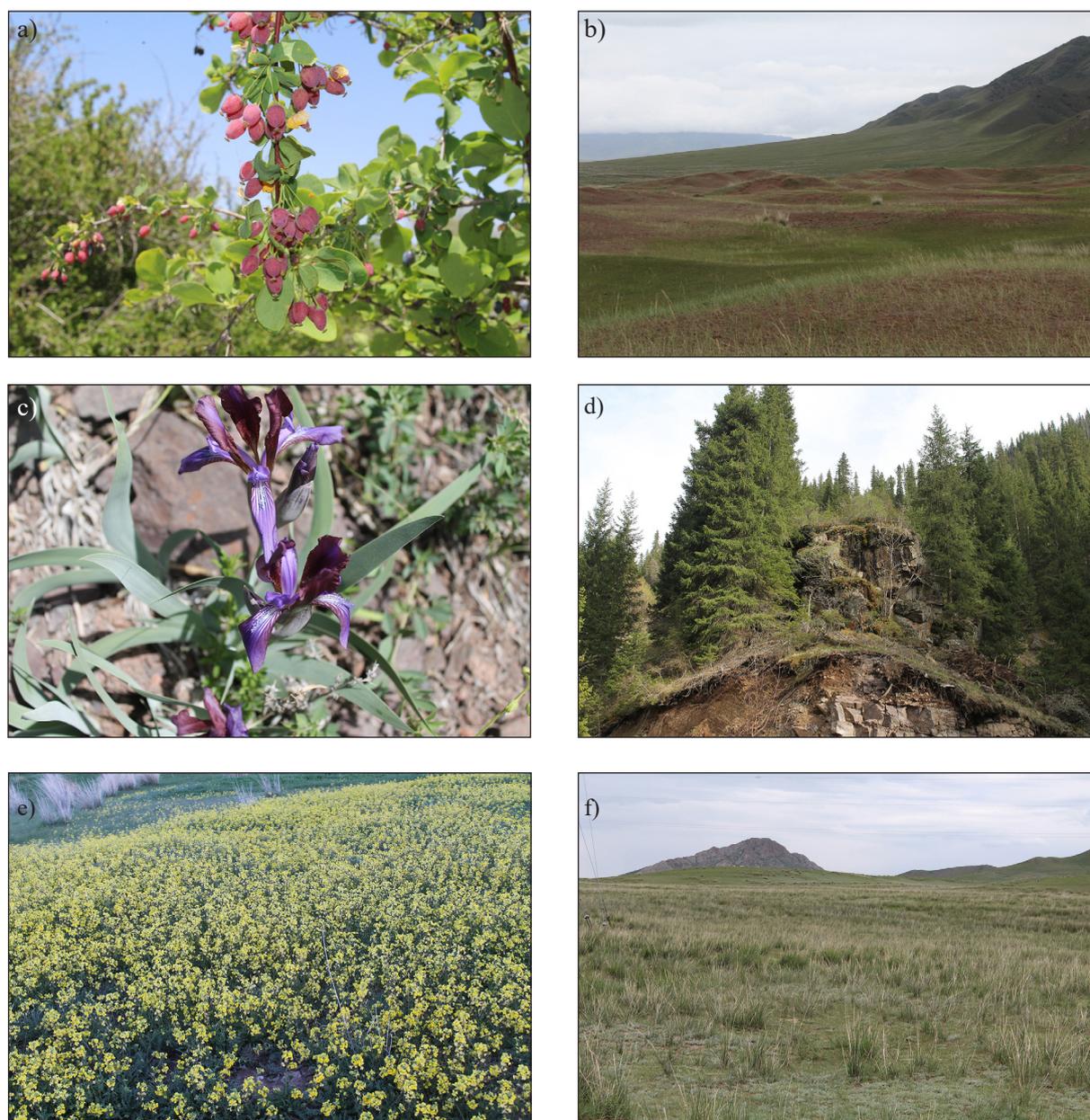
The article provides an analysis of life forms of 9 floristic complexes of the Ketpen ridge on the basis of many years of research materials, where life forms were studied in each floristic complex according to the systems of K. Raunkiaer and I.G. Serebryakov. An analysis of life forms according to the system of K. Raunkiaer established the dominance of hemicytophytes in cryophilic-meadow (74.8%), petrophilic (72.5%) and deciduous-forest (80.3%) floristic complexes of the Ketpen ridge, which accounted for the total number of species of complexes. The second large group in terms of the number of species corresponded to cryptophytes, which predominate in the cryophilic-meadow (65.3%) and psammophilic (45.9%) floristic complexes. Distribution of species according to life forms according to I.G. Serebryakov demonstrated a clear predominance of polycarpic in the meadow complex amounting to 82.5%, deciduous-forest – 81.7%, psammophilous – 75.9% and steppe – 79.4% floristic complexes of the total number of species of complexes. An analysis of the meadow floristic complex of the Ketpen ridge according to Serebryakov showed that taproot plants account for 128 species or 20.5%, short-rhizome – 18.4%, long-rhizome – 11.3%, turf-rhizomatous – 4.8%. An analysis of the life forms of the psammophilic floristic complex revealed the prevalence of therophytes (40.7%). It was found that the spectrum of life forms according to Raunkiaer and Serebryakov emphasizes the peculiarities of the floristic complexes of the Ketpen ridge.

**Keywords:** plants, life forms, floristic complexes.

### INTRODUCTION

The study of plant life forms as defined by I.G. Serebryakov reflects the external form of organisms that have adapted to their environment under the long-term influence of a complex of factors, that is, it is the external form of a species associated with the rhythm of development and adapted to modern as well as past environmental conditions (Serebryakov, 1962. 1964). As it is known, floristic diversity depends on the ecological conditions of existence, primarily on the climate and heterogeneity of the territory. At the

same time, different forms of plant life will respond differently to climate change (Ying Sun, et al., 2021). The severe centuries-old influence of environmental factors and the adaptive reactions of the plants of the Northern Tien Shan, including the Ketpen ridge, determined their life image. In this regard, of particular interest is the analysis of life forms of floristic complexes of the Ketpen ridge, which is the easternmost end of the Northern Tien Shan (Figure 1). Many works are devoted to the study of plant life forms (John J. Ewel & Seth W. Bigelow, 1996; Rafiee, F., Jankju, M., & Ejtehadi, H., 2015; Mohammad M. Sanjerehei,



**Figure 1.** Vegetation of the Ketpen range; (a). *Berberis sphaerocarpa* Kar. & Kir.; (b) relic sands in the valley of the Shalkudysu river at the foot of the Elchik-Uyryuk mountains, height 2200 m.; (c) *Iris glaucescens* Bunge; (d) forest belt (*Picea schrenkiana* Fisch. & C.A. Mey., height 2850 m.); (e). *Alyssum campestre* (L.) L. (f) *Achnatherum caragana* (Trin.) Nevski

2019; Basharat A. Dar et al., 2022; Castanho, C. T. et al., 2012; Yi Wang et al., 2021; Chang, S., 2018; Chen, J., et al., 2017; Erfanzadeh, R., et al., 2020; Li, B., et al., 1987).

## MATERIALS AND METHODS

The main factual material for the work was the data collected by the author during expeditionary research on the territory of the Ketpen ridge in 2001–2021. The object of the study corresponded

to the floristic complexes of the Ketpen ridge. The aim of the study was to study the life forms of floristic complexes in this region. In field studies, the method of route floristic survey was used. In this case, the classical ecological-geographical and morphological methods were employed. As a basis for the analysis of plant species by life forms, the classification of I.G. Serebryakov and K. Raunkiaer were used, developed in the most detail for angiosperms and conifers. [I. Serebryakov, 1962, 1964; K. Raunkiaer, 1934]. In each floristic complex, on the basis of twenty

years of research, life forms were studied according to the systems of Raunkiaer and Serebryakov.

## RESULTS AND DISCUSSION

On the basis of the results of many years of floristic research, the life forms of 9 floristic complexes of the Ketpen ridge were studied. On the Ketpen ridge, the following types of high-altitude landscape vegetation can be distinguished: desert, desert-steppe, meadow-forest, deciduous-forest, coniferous-forest, cryophilic-meadow, and shrub. Their selection as floristic complexes is quite natural, since these types of high-rise landscape vegetation are zonal for the study area, the vegetation cover, which is characterized by complexity and mosaic, i.e. the heterogeneity of the studied flora is obvious. In view of the foregoing, the following floristic complexes (FCs) are distinguished in the flora of the Ketpen ridge:

1. Desert floristic complex – (DFC).
2. Psammophilic floristic complex – (PsFC).
3. Steppe floristic complex – (SFC).
4. Meadow floristic complex – (MFC).
5. Deciduous-forest floristic complex – (DFFC).
6. Coniferous forest floristic complex – (CFFC).
7. Cryophilic-meadow floristic complex – (CMFC).
8. Petrophilic floristic complex – (PFC).
9. Wetland and coastal-aquatic floristic complex – (WCAFC).

The above-mentioned floristic complexes of the natural flora of the Ketpen Ridge unite species that, according to their ecological and cenotic characteristics and the nature of their distribution, tend to be botanically and geographically homogeneous natural territorial complexes (landscapes) (Table 1). An analysis of life forms

according to K. Raunkiaer (Raunkiaer, 1934) shows a clear predominance of hemicryptophytes, which make up 67.7% of the total number of plant species of the floristic complexes of the Ketpen ridge, where it was revealed that the biomorphic structure of the study area in descending order is as follows: Hc–K–T–Ph–Ch and in general does not differ from the structure of the entire Northern Tien Shan [Rubtsov, 1963], where the leading positions are occupied by perennial herbaceous forms, with the dominance of taproot species, and cryptophytes (C) account for 21.1%, therophytes (T) account for 5.4%, chamaephytes (Ch) – 3.0%, phanerophytes (Ph) – 1.5%. This ratio is typical for the mountainous regions of Middle Asia (Table 2).

Thus, more than half of the therophytes species are represented in PsFC (40.7%). A significant percentage is typical for SFC (22.8%), PFC (21.2%), MFC (18.4%) and WCAFC (1.0%). The therophytes are especially richly represented in the families *Poaceae* (34 species), *Chenopodiaceae* (43 species), *Brassicaceae* (51 species), *Boraginaceae* (30 species), *Scrophulariaceae* (18 species), *Caryophyllaceae* (24 species) and *Asteraceae* (55 species). Cryptophytes dominate in CMFC – 65.3%, PsFC – 45.9%, WCAFC – 38.4%, DFFC (36.2%), MFC (34.4%), PFC (32.6%) are far behind). Cryptophytes are most well represented among bulbous (*Liliaceae* and *Alliaceae* – 58 species), tuberous (*Apiaceae* – 10 species, *Ranunculaceae* – 6 species), and submersible plants (*Potamogetonaceae* – 6 species). The largest percentage of hemicryptophytes is represented in CMFC (84.8%), PFC (83.5%), SFC (85.2%), CFFC (80.3%), MFC (79.2%), SFC (75.2%), WCAFC (81.5%). More than half of the hemicryptophyte species are represented in DFFC (66.8%), PsFC (55.4%). Among

**Table 1.** Taxonomic diversity and proportions of the flora of the Ketpen range

Name of floristic complexes	Absolute number families: genera: species	Proportions of flora family: genera: species	Average number of species in a genus
Deserted	35:125:236	1:3.5:6.7	1.88
Psammophilic	25:77:108	1:3.0:4.3	1.40
Petrophilic	69:298:845	1:4.3:12.2	2.83
Steppe	36:200:520	1:5.5:14.4	2.6
Deciduous-forest	35:94:184	1:4.2:12.0	2.81
Coniferous forest	54:159:315	1:3.5:8.7	2.47
Cryophilic-meadow	32:109:271	1:4.4:12.4	2.83
Meadow	47:230:624	1:5.0:13.2	2.71
Wetland and coastal-aquatic	39:101:211	1:1.5:4.0	2.58

**Table 2.** The ratio of life forms of plant species of floristic complexes of the Ketpen range according to K. Raunkiaer [Raunkiaer, 1905, 1934]

The name of the complexes	Percentage of the total number of species of the complex				
	Therophytes	Cryptophytes	Hemicryptophytes	Chamaephytes	Phanerophytes
DFC	14.4	26.2	27.7	9.3	15.7
PsFC	40.7	45.9	55.4	1.85	1.8
SFC	22.8	18.9	75.2	4.2	10.9
MFC	18.4	34.2	79.2	0.80	1.6
DFFC	9.4	36.2	66.8	2.1	33.1
CFFC	11.4	5.5	80.3	1.8	8.2
CMFC	3.2	65.3	84.8	0.9	3.3
PFC	21.2	32.6	83.5	13.8	9.7
WCAFC	1.0	38.4	61.5		

hemicryptophytes, three large groups of plants are distinguished: rhizomatous, soddy and rosette. They are well represented in the families *Poaceae* (136 species), *Cyperaceae* (49 species), *Caryophyllaceae* (66 species), *Ranunculaceae* (63 species), *Rosaceae* (53 species), *Apiaceae* (43 species), *Fabaceae* (97 species), *Lamiaceae* (70 species), *Scrophulariaceae* (40 species) and *Asteraceae* (234 species). Phanerophytes are richly represented in DFFC (33,1%) and DFC (15.7%). Nano and micro phanerophytes are widely represented in the families *Ranunculaceae* (5 species), *Berberidaceae* (3 species), *Ephedraceae* (3 species), *Salicaceae* (14 species), *Rosaceae* (25 species), *Fabaceae* (19 species), *Caprifoliaceae* (11 species), *Cupressaceae* (4 species), *Chenopodiaceae* (12 species). There are few Phanerophytes in the floristic complexes of the Ketpen ridge – 151 species (8.0% of the total flora), but they play an important environment-forming role

in many plant communities. Chamaephytes predominate in PFC – 21.5%.

The ratio of life forms according to I.G. Serebryakov (1962, 1964) showed the absolute dominance of herbaceous polycarpic represented in MFC (82.5%), CFFC (81.7%), SFC (79.4%), PsFC (75.9%), CMFC (74.8%), and PFC (72.2%) (Table 3). Among the polycarpic herbs, tap-root (caudex) plants prevail, which are characteristic of the climatic and edaphic conditions of the region, where most of them belong to the subclass of tap-root polycarpic (531 species; 28.1% of the total flora). It should be noted that tap-rooted polycarpic in the floristic complexes of the Ketpen ridge are very diverse. A small part of them develop turf, shortened shoots or have bright adaptive features in the structure of root systems. Thus, only 17 species have storage root thickenings. In second place is a group of life forms of herbaceous monocarpic, which are richly represented in PsFC (43.1%), a small percentage of

**Table 3.** The ratio of life forms of plant species, of floristic complexes of the Ketpen range according to I.G. Serebryakov [Serebryakov, 1962, 1964]

The name of the complexes	Percentage of the total number of species of the complex			
	Herbal horsetail and ferns	Monocarpic herbs	Polycarpic herbs	Wood forms
DFC		16.8	50.8	15.7
PsFC		43.1	75.9	1.85
SFC		27.1	79.4	9.42
MFC		19.0	82.5	2.40
DFFC	0.54	9.2	66.8	33.2
CFFC	6.35	15.9	81.7	8.2
CMFC		24.9	74.8	3.3
PFC	1.96	25.3	72.5	23.5
WCAFC		22.8	53.5	

monocarpic falls on SFC (27.1%), PFC (25.3%), CMFC (24.9%), WCAFC (22.8%). Among them, annuals of long vegetation stand out – 252 species (13.3% of the total flora). At the same time, most of the annuals are concentrated mainly in the low mountains and foothills. In the dicotyledonous subclass, the presence of annuals with succulent leaves and stems is interesting – 15 species (0.8% of the total flora). A small percentage of life forms falls on trees, shrubs, semi-shrubs. They are fairly well represented in DFFC (33.2%), PFC (23.5%), DFC (15.7%). Herbal horsetails are represented by only 4 species, which are represented only in CFFC (6.35% of the whole complex), PFC (1.96%), and in DFFC (0.54%).

The Desert Floristic Complex (DFC) of the Ketpen ridge forms 35 families, 125 genera, and 236 species. An analysis of the life forms of species of the desert floristic complex according to Raunkiaer showed the dominant predominance of hemicryptophytes - 116 species (27.7% of the species of the complex), cryptophytes are in second place in terms of the number of species – 26.2%, phanerophytes are in third and fourth place – 15.7%, therophytes which make up 14.4%. Chamaephytes make up only 9.3%; thus, DFC is dominated by hemicryptophytes and cryptophytes. The analysis of DFC life forms according to Serebryakov showed the predominance of polycarpic herbaceous plants – 180 species, 50.8% of the total number of species of the complex, where taproot herbaceous plants are the dominant group - 34 species (14.4%). The following groups of polycarpic are turf-rhizome grasses (3.0%), long-rhizome (2.5%), short-rhizome (0.84%). The second place among DFC life forms is occupied by monocarpic grasses, which make up 16.8% of the total number of species of the complex, among which annual long-term vegetative plants predominate – 14.7%. The monocarpic are followed by the type of semi-woody plants (15.7%), with a clear dominance of semi-shrubs, which make up 9.3% of the total number of plant species of this complex. Most of the shrubs are represented in the families *Chenopodiaceae* (12 species), *Asteraceae* (7 species), *Cistaceae* (1 species), *Fabaceae* (1 species) and others. They are followed by the type of woody plants (15.7%), among which vegetatively immobile erect shrubs predominate – 9.1% of the number of woody plant species. Shrubs predominate in families *Fabaceae* (7 species), *Tamaricaceae* (4 species), *Chenopodiaceae* (8 species), *Polygonaceae* (4

species), *Ephedraceae* (3 species), *Nitrariaceae* (1 species), *Rhamnaceae* (1 species). The desert floristic complex is represented in the study area by rubble-sandy pebble deserts. The species of this complex are distributed on desertified trails of foothill and foothill plains, rising to the lower belt (*Artemisia terrae-albae*, *A. sublessingiana*, *A. heptopotamica*, *Anabasis salsa*, *Nanophyton erinaceum*, *Kochia prostrata*, *Haloxylon aphyllum*, *Krascheninnikovia ceratoides*).

The psammophilic floristic complex (PsFC) has a limited distribution, represented by relict sands in the Kegen and Saryzhaz valleys at an altitude of 2200 m above sea level in the western part of the Ketpen range and represents a local type of vegetation. The psammophilous floristic complex forms 25 families, 77 genera, 108 species. An analysis of life forms according to K. Raunkiaer shows a clear predominance of hemicryptophytes, which make up 55.4% of the total number of species of the complex. Cryptophytes are the next group in terms of the number of species, accounting for 45.9%. The third group is 44 species of therophytes or 40.7%. A significant proportion of therophytes is explained by the consequence of the influence of anthropogenic impact on sandy cenoses. Chamaephytes (1.85%) and phanerophytes (1.8%) are represented by single species. Distribution of plant species of the psammophilic floristic complex (PsFC) by life forms I.G. Serebryakov showed the dominance of polycarpic herbaceous plants, which make up 75.9% of the species of the entire complex, the second place is occupied by monocarpic herbs (43.2%), and a small percentage is made up of tree and shrub forms – 1.8%. The vegetation cover of relict sands is dominated by *Elymus giganteus*, which occupies the tops and slopes of sand mounds, and *Medicago falcata*, which occupies depressions between mounds. Xerophilic shrubs and subshrubs characteristic of the desert type of vegetation are practically absent, except for rare and single specimens of *Kochia prostrata* and *Krascheninnikovia ceratoides*. The central part of the sandy massif is noticeably higher than its periphery. Sandy ridges, sometimes up to 10 m high, are elongated from east to west, their slopes are steep. The natural arrangement of the ridges is disturbed by the deflation of the sands, which occurs under the influence of intensive grazing from nearby villages. As a result of deflation, sandy ridges overgrown with vegetation are deformed into bare or almost bare sand mounds of various sizes. The

vegetation of the sandy massif “Kum-Tekey” is represented by the following types: *Elymus giganteus*, *Astragalus rubtzovii*, *Medicago falcata*, *Artemisia sieversiana*, *Lappula microcarpa*, *Stipa capillata*, *Festuca ganeschini*, *Carex turkestanica*, *Allium pallasii*, *Salsola collina*, *Kochia prostrata*, *Corispermum hyssopifolium*, *Melandrium viscosum*, *Arenaria serpyllifolia*, *Delphinium iliensis*, *Berberis sphaerocarpa*, *Meniocus linifolius*, *Potentilla orientalis*, *Astragalus scabrissetus*, *A. karkerensis*, *Cynoglossum officinale*, *Scutellaria sieversii*, *Thymus marschallianus*, *Linaria bungei*, *Orobanche caesia*, *Scorzonera inconspicua*, *Heteropappus canescens*, *Scabiosa ochroleuca*. The basis of the herbage is *Elymus giganteus*, *Stipa capillata*, *Festuca valesiaca* are widespread; from forbs on the sands are present *Scabiosa ochroleuca*, *Scutellaria sieversii*, *Thymus marschallianus*, *Thymus stepposus*, *Linaria bungei*, *Allium pallasii*, *Aster canescens* and others. The herbage is heavily infested with species such as *Artemisia sieversiana*, *Lappula microcarpa*, *Capsella-bursa-pastoris*, *Secale silvestre*.

Steppe floristic complex. Steppe floristic complex (SFC) is represented on the Ketpen ridge by steppe and mountain-steppe eco-geographical groups, the species of which are distributed mainly in the foothills, low mountains, middle and upper mountain belts, which is explained by the variety of orographic and soil-climatic conditions in the mountains. The steppes are occupied by macro-slopes of southern exposure, and also the southern slope of the Ketpen ridge. The Tien Shan steppes are more ancient in relation to the flat Kazakh steppes, as they already existed in the Paleogene peneplain of the Tien Shan, while most of the flat Kazakhstan was covered by the sea. The steppes in the Northern Tien Shan were formed in the Pleistocene on the basis of a cryophilic floristic and coenotic complex as well as constitute an independent center for the formation of steppe vegetation [Rubtsov, 1954]. The total number of species registered in the SFC is 520, which belong to 200 genera and 36 families. The analysis of life forms according to Raunkiaer showed the predominance of hemicryptophytes (75.2%) and

therophytes (22.8%). Cryptophytes account for 18.9%, phanerophytes account for 10.9% of the species of the complex, and chamaephytes account for 4.2% of the flora of the complex (Table 4).

Such a ratio of life forms of chamaephytes and therophytes in the steppe complex of the Ketpen range brings this steppe complex closer to the desert flora, where a high proportion of these groups is characteristic of arid zones (*Poa bulbosa*, *Colpodium humile*, *Carex pachystylis*, *Tulipa kolpovskiana*, *T. biflora*, *Euphorbia rapulum*, *Leontice incerta*, *Eremopyrum orientale*, *Trigonella arcuata*, *Strigosella africana*, *Tetracme quadricornis*, *Allysum desertorum*, *Meniocus linifolius*, *Lepidium perfoliatum*, *Koelpinia linearis*). As it can be seen from the data (Table 4), vegetatively mobile herbaceous plants clearly predominate in the steppe complex, which is associated with the conditions of their existence, with the characteristics of soil, air, and water regimes. The share of shrubs (10.9%) and semi-shrubs (4.2%) is small. Shrubs are well represented in families *Rosaceae* (16 species), *Fabaceae* (14 species), *Caprifoliaceae* (7 species), *Polygonaceae* (5), *Berberidaceae* (4), *Rhamnaceae* (3), *Ephedraceae* (3), subshrubs are contained in families *Asteraceae* (12 species), *Lamiaceae* (2). Trees are contained in only two families: *Rosaceae* (5 species) and *Elaeagnaceae* (1). Annuals predominate in families *Caryophyllaceae* (12 species), *Boraginaceae* (16 species), *Poaceae* (12 species), *Scrophulariaceae* (8 species), *Asteraceae* (25 species), *Fabaceae* (9 species), *Brassicaceae* (29 species), *Fumariaceae* (2), *Crassulaceae* (2), *Apiaceae* (3), *Lamiaceae* (4 species). The life forms of the steppe complex are characterized by a large variety of annual long-term vegetative plants, an abundance of shrubs and semi-shrubs, with the dominance of taproot polycarpic, which is explained by the complexity and diversity of vegetation, as well as the botanical and geographical originality of the study area (*Festuca salcata*, *Phleum phleoides*, *Centaurea ruthenica*, *Lathyrus pratensis*, *Poa angustifolia*, *Koeleria gracilis*, *Vicia tenuifolia*, *Stipa regeliana*, *Stipa kirghisorum*, *Hedysarum krylovii*).

**Table 4.** The ratio of life forms of plant species in the steppe floristic complex of the Ketpen ridge according to K. Raunkiaer (Raunkiaer, 1934)

The name of the life forms	Percentage of the total number of species of the complex				
	Therophytes	Cryptophytes	Hemicryptophytes	Chamaephytes	Panerophytes
	22.8	18.9	75.2	4.2	10.9

Meadow floristic complex (MFC). The meadow complex is well developed in the mountainous area and is widely represented in the upper and middle belts, where meadow vegetation is especially rich and diverse in the river valleys of the piedmont plains of the Ketpen ridge. This complex includes a number of families whose representatives are associated exclusively with meadow habitats. The meadow floristic complex is formed by 47 families, 230 genera, and 624 species. The biomorphological spectrum according to Raunkiaer shows a clear dominance of 2 types of life forms: hemicryptophytes, which make up 79.2% of the total number of species of the complex, and cryptophytes, 34.2%. Analysis of herbaceous forms according to Serebryakov's classification showed the dominance of herbaceous polycarpic (494; 82.5%), which is typical for temperate floras. Herbaceous monocarpic play a lesser role in the composition of the flora (115 species; 19.0%). Of the polycarpic taproots, there are 128 species or 20.5%, rhizomatous – 76 species (12.1%), short-rhizomatous – 115 species (18.4%), long-rhizomatous – 71 species (11.3%), turf-rhizomatous – 30 species, or 4.8%, tuberous – 17 species, or 2.7%, onion – 7 species, or 1.1% (*Mentha asiatica*, *Plantago depressa*, *Adenophora lilifolia*, *Erigeron violaceus*, *Oxytropis platysema*, *Geranium pratense*, *Agrostis gigantea*, *Hordeum brevisubulatum*, *Hordeum bogdani*, *Alopecurus songarica*, *Alopecurus pratensis*, *Agrostis gigantea*, *Elytrigia repens*, *Phleum pratense*). Perennials dominate families *Asteraceae* (77 species), *Fabaceae* (50 species), *Cyperaceae* (29 species), *Poaceae* (30 species), *Rosaceae* (32 species), *Ranunculaceae* (26 species), *Brassicaceae* (16 species), *Lamiaceae* (19 species), *Caryophyllaceae* (23 species), *Apiaceae* (19 species), *Scrophulariaceae* (15 species), *Saxifragaceae* (8 species), *Polygonaceae* (13 species), *Rubiaceae* (8 species), *Primulaceae* (5 species), *Violaceae* (5), *Crassulaceae* (5 species). Annuals predominate in families *Asteraceae* (21 вид), *Poaceae* (8 species), *Gentianaceae* (3 species), *Scrophulariaceae* (9 species), *Caryophyllaceae* (17 species), *Fabaceae* (5 species), *Geraniaceae* (2), *Dipsacaceae* (2), *Brassicaceae* (28 species), *Polygonaceae* (5 species).

Most of the mid-mountain and floodplain meadows of the piedmont plains of the Northern Tien Shan, including the Ketpen ridge, are secondary, resulting from human activities. Mid-mountain meadows appeared on the site of

reduced forests or shrubs, floodplain meadows also arose as a result of the destruction of forests and shrubs in the floodplains. The wide development of meadow vegetation on the Ketpen ridge is associated with its geographical position: it is the northernmost end of the Northern Tien Shan, where climatic conditions are most favorable for the development of meadow cenoses. The historical moment is also important here – the boreal invasions that occurred during the Pleistocene period, where boreal floristic relationships are most clearly manifested in the composition of the northern Tien-Shan meadow vegetation [Rubtsov, 1965].

Cryophilic-meadow floristic complex. The cryophilic-meadow floristic complex (CMFC) is characteristic of the upper belt (alpine and partially subalpine) of the Ketpen ridge. It is represented by landscapes of mountain Kobresia cryophilic meadows and cryophilic forb alpine lawns. The cryophilic-meadow complex is an ancient, primary formation in comparison with the meadow-forest complex that arose in the quaternary, and possibly at the end of the tertiary period. The entire cryophilic complex of the Tien Shan vegetation in its origin is largely associated with the high uplands of Asia. This is especially true for cryophilic cushion plants, the geographic and genetic analysis of which clearly indicates high-mountain regions as one of the main centers of development of life forms. The plant researcher of Middle Asia E.P. Korovin [Korovin, 1961] notes the boreal invasion, stating that the alpine meadows in Middle Asia arose, as in other ridges of alpine folding, on the basis of the exchange of arcto-alpine flora, while the alpine meadows of Middle Asia contain a significant admixture of their own endemic autochthonous species. Further development of the type of alpine meadows, after laying them in Middle Asia, took place in the form of an ever-progressing process of development of the steppes as a result of xeromorphosis of plants, and also by migration to the high-altitude zones of xerophytic forms from the dry regions of the lower zones of the mountain ranges of Central Asia [Rubtsov, 1965]. An analysis of Serebryakov's life forms showed that the cryophilic-meadow flora is characterized by the dominance of herbaceous plants (257 species; 74.8%), the vast majority of them belong to herbaceous polycarpic (237; 67.4%), which is typical for temperate floras. Herbaceous monocarpic play a much

smaller role in the composition of the cryophilic-meadow flora (20 species; 7.3%) The share of shrubs (3.3%) is quite small, the share of semi-shrubs (1.8%) is even lower. There are no trees in the cryophilic-meadow complex. Shrubs are found in families *Caprifoliaceae* (2 species), *Salicaceae* (3 species), *Rosaceae* (2 species), *Fabaceae* (2 species), subshrubs are contained in families *Lamiaceae* (4). Of the perennials or polycarpic, taproot species, there are 73 species (27.0%). The predominance of short-rhizome (66; 24.3%) and long-rhizome (53; 19.5%) species reflects the mesophytic conditions of the cryophilic-meadow flora of the Ketpen ridge. There are 37 species of turf-rhizomatous plants or 13.6%, only 1 species of tuberous plants or 0.96%, onion plants – 19 species or 7.0%. Annuals predominate in families *Gentianaceae* (10 species), *Scrophulariaceae* (2 species), *Asteraceae* (1 species), *Primulaceae* (4), *Brassicaceae* (3 species). Perennials dominate the families *Asteraceae* (46 species), *Fabaceae* (18 species), *Poaceae* (10 species), *Ranunculaceae* (18 species), *Brassicaceae* (8 species), *Lamiaceae* (7 species), *Caryophyllaceae* (11 species), *Scrophulariaceae* (13 species), *Saxifragaceae* (5 species), *Crassulaceae* (4 species), *Boraginaceae* (2 species). (*Kobresia humilis*, *K. persica*, *K. capilliformis*, *K. stenocarpa*, *Carex pycnostachia*, *C. inervis*, *C. caucasica*, *C. perfusca*, *C. melanantha*, *Luzula sibirica*, *Stellaria alata*, *Thylacospermum caespitosum*, *Silene graminifolia*, *Trollius lilacinus*). Characteristic elements of the vegetation cover in the cryophilic-meadow complex are open, open groups of rocks and scree, where, along with lichens, flowering plants settle. These are very small undersized plants with roots and rhizomes penetrating cracks with large bright flowers (*Gentiana*, *Campanula*, *Potentilla*). In the cryophilic-meadow complex, high-mountain alpine meadows belong to the primary meadows, which are considered as a long-term native vegetation type in the upper part of the high-mountain belt of the mountains of Middle Asia. Genetically, the alpine forms of plants turn out to be quite diverse in their origin, but in their overwhelming majority they gravitate towards the arctotertiary floristic complex. Most of the genera to which the majority of characteristic components of alpine formations belong are of Asiatic origin. They are secondary elements of mountainous mesophilic vegetation of various types (light forests, meadows, stony and rocky cliffs, etc.), which originally existed in a forest environment [Rubtsov, 1965].

### Wetland and coastal-aquatic floristic complex (WCAFC)

The species of the wetland and coastal-aquatic floristic complex are confined to water bodies, along the banks and valleys of rivers, where they form aquatic, wetland and meadow (coastal-aquatic) ecological-geographical groups. On the Ketpen ridge, this assemblage is also richly and diversely represented; it includes a number of families where representatives of this assemblage are associated exclusively with aquatic and coastal aquatic habitats. The total number of species registered with the WCAFC is 211 species, which belong to 101 genera and 39 families. The ratio of life forms of WCAFC species according to K. Raunkiaer demonstrates the absolute predominance of hemicryptophytes, which accounted for 61.5% of the total number of species of the complex, and cryptophytes (38.4), which is typical for aquatic and coastal aquatic communities. The ratio of life forms according to Raunkiaer and Serebryakov emphasizes the peculiarities of the floristic complexes of the Ketpen ridge.

### Petrophilic floristic complex

Petrophilic floristic complex (PFC) is quite widespread and well represented on the stony slopes, pebbles, and scree of the Ketpen ridge. The total number of species registered in the PFC is 845 species, which belong to 298 genera and 69 families. An analysis of the life forms of species of the petrophilic floristic complex according to Raunkiaer showed the predominance of hemicryptophytes – 83.5% of the species of the complex. In second place in terms of the number of species are cryptophytes – 32.6%, therophytes – 21.2%. chamaephytes make up 13.8% and phanerophytes 9.7%; thus, the PFC is dominated by hemicryptophytes and cryptophytes. Analysis of PFC life forms according to Serebryakov established the predominance of polycarpic herbaceous plants – 526 species; 72.5% of the total number of species of the complex. Of the type of polycarpic herbs, the dominant group is taproot herbaceous, characterized by the powerful development of underground plant organs, which number 230 species (27.2%). The following groups of polycarpic are short-rhizome 72 species (8.5%), long-rhizome (7.1%), turf-rhizome (4.0%), onion – 39 species (4.6%), tuberous – 12 species (1.4%). The second place among PFC

life forms is occupied by herbaceous monocarpic, which play a much smaller role in the composition of the petrophilic flora – 180 species, accounting for 25.3% from the total number of species of the complex, among which annual long-vegetating plants predominate – 17.3%. Monocarpic are followed by the type of semi-woody plants (23.5%), with a clear dominance of shrubs and semi-shrubs making up 13.8% of the total number of plant species of this complex (*Rhamnus cathartica*, *Ephedra equisetina*, *E. Intermedia*, *Cerasus tianshanica*, *Juniperus sabina*, *Atraphaxis frutescens*). Shrubs are presented in families *Rosaceae* (19 species), *Fabaceae* (17 species), *Chenopodiaceae* (7 species), *Salicaceae* (7 species), *Polygonaceae* (5 species), *Grossulariaceae* (4 species), *Ephedraceae* (4 species). Subshrubs are contained in families *Lamiaceae* (6 species), *Asteraceae* (21 species), *Convolvulaceae* (2), *Fabaceae* (1) and others.

#### Coniferous forest floristic complex (CFFC)

The total number of species registered with the CFFC is 315 species, which belong to 159 genera and 54 families. The coniferous-forest complex (CFFC) was formed on the basis of Turgai, much more complex, polydominant forest cenoses, by differentiation and some simplification of them under the influence of later cooling and continentalization of climatic conditions. Spruce forests of the Tien Shan are a mountainous Middle Asian variant of taiga forests. Their separation from the general complex forest Turgai complex occurred simultaneously with the pleistocene uplift of the Tien Shan. The coniferous-forest complex of the Ketpen ridge is represented by boreal species, which is 80.3% of their total number. In the spectrum of life forms of the coniferous-forest complex, according to Serebryakov is dominated by herbaceous taproot plants – 253 species, accounting for 70.0% of the total number of species. The second place in terms of the number of species is followed by short-rhizomatous plants, represented by 101 species (32%). Long-rhizome plants are represented by 40 species (12.6%), turf plants by 15 species (4.7%). There are 9 types of tubers (2.8%), onions – 8 types (2.53%) (12.5%). The third place in terms of the number of species is occupied by shrubs – 19 species or 8.2%. These include species common on the slopes *Juniperus turkestanica*, *Lonicera altmannii*, *Rosa alberti* and others.

#### Deciduous forest floristic complex (DFFC)

The origin of mountain deciduous forests in Middle Asia dates back to the beginning of the Tertiary period, in the Oligocene. At the same time, the type of deciduous forests was formed due to the Turgai invasion and, to a greater extent, due to migration from East Asia, which could have occurred by the end of the Tertiary period, by the time of the Alpine orogeny [Rubtsov, 1956]. The deciduous-forest floristic complex on the Ketpen ridge is represented by boreal species, where floristic elements of the boreal type play a significant role: mountain middle-asian, mountain central-asian, palearctic, holarctic, which is 96.6% in DFFC. The formation of forests with the participation of *Populus tremula* L. in the Tien Shan is associated with vegetation migrations in the pleistocene. The formation of forests from *Malus sieversii* (Ledeb.), *M. Roem.*, *Armeniaca vulgaris* Lam., and a small fragment of walnut forests (*Juglans regia* L.) are older and autochthonous in origin. The relict nature of these forests is proven by the fragmentation of their geographical area, species composition, geographical, ecological and floristic connection with the relict forests of the Western Tien Shan [Rubtsov, 1956]. The total number of species registered in the Deciduous-forest floristic complex (DFFC) is 184 species. They belong to 94 genera and 35 families. The share of shrubs in the deciduous-forest complex is 24.4% (45 species), the share of trees is 8.7% (16 species). Shrubs are richly represented in families *Rosaceae* (20 species), *Salicaceae* (7 species), *Fabaceae* (12 species), *Caprifoliaceae* (4 species), *Tamaricaceae* (2), *Grossulariaceae* (4), *Celastraceae* (1), *Rhamnaceae* (3). Trees are represented by families *Rosaceae* (6 species), *Rhamnaceae* (1), *Salicaceae* (4), *Elaeagnaceae* (1). Shrubs are represented by such species as: *Crataegus songarica*, *Crataegus altaica*, *Berberis sphaerocarpa*, *Cotoneaster multiflora*, *Cotoneaster melanocarpa*, *Lonicera tatarica*, *Rosa spinosissima*, *Rosa platyacantha* and others. The study of DFFC life forms according to the classification of K. Raunkiaer (1934) showed a clear predominance of hemicryptophytes – 66.8% of the total number of species of the complex, constituent cryptophytes – 36.2% and phanerophytes – 33.1%. The remaining types are represented by an insignificant number of species: chamephytes – 2.1%, therophytes – 9.4%. The analysis of life forms according to Serebryakov for deciduous-forest flora

showed the predominance of herbaceous plants (123; 70.6%). Of these, the vast majority belong to herbaceous polycarpic (106; 66,8%), which is typical for the floras of the temperate zone. Herbaceous monocarpic play a much smaller role in the composition of the flora (17 species; 9.4%).

## CONCLUSIONS

Thus, the analysis and comparison of life forms of floristic complexes of plant species of the Ketpen ridge is heterogeneous, which reflects the specifics of floristic complexes, showing the features of plant adaptation to changing soil and climatic conditions during florogenesis. The ratio of life forms according to Raunkiaer and Serebryakov emphasizes the peculiarities of the floristic complexes of the Ketpen ridge. The basis of the flora of the Ketpen ridge is hemicryptophytes, which corresponds to the modern climate of the territory and the mountainous Middle Asian nature of the flora. The high content of cryptophytes, chamaephytes and therophytes shows the influence of arid ancient Mediterranean elements. An insignificant number of phanerophytes is explained not only by hydrothermal, climatic and geological conditions that limit the distribution as well as formation of coniferous-forest and deciduous-forest vegetation in the mountains of the Ketpen ridge, but also by human economic activity, which led to the destruction of forests. An analysis of the floristic complexes of the Ketpen ridge showed that the formation of floristic complexes, especially of the coniferous-forest, cryophilic-meadow, deciduous-forest upper and middle belts, proceeded for a long time. The flora of the Ketpen ridge occupies an intermediate position, between the mountain Middle Asian and Siberian-Altai flora, while a large percentage of boreal elements, on the one hand, indicates its connection with Siberia, western Altai, and, on the other hand, with Western and Central Asia. The settlement of plants in the study area proceeded from the north, northeast, and from the south.

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