

G.A. Sadyrova<sup>1\*</sup> , T.A. Bazarbaeva<sup>1</sup> ,  
G.A. Mukanova <sup>1</sup>, S.M. Jamilova<sup>2</sup> 

<sup>1</sup>Al-Farabi Kazakh National University, Kazakhstan, Almaty

<sup>2</sup>Abay Kazakh National Pedagogical University, Kazakhstan, Almaty

\*e-mail: gulbanu-s@mail.ru

## ANALYSIS OF GYPSUM-HAMMAD AND VARIEGATED FLORISTIC COMPLEX OF THE KETPEN RIDGE

This article presents the results of many years of research on the gypsum-hammad and variegated flora of the Ketpen ridge. The paper presents an analysis of the gypsum-gamma and variegated floristic complex of the Ketpen ridge. The taxonomic diversity of the species composition of the gypsum-hammad and variegated floristic complex, the biomorphological analysis of life forms of gypsum-bearing-hammad and variegated species, as well as the belonging of gypsum-bearing-hammad and variegated species to different geographical types of habitats were revealed. A detailed floristic analysis of the gypsum-hammad and variegated flora made it possible to identify 250 species of vascular plants belonging to 132 genera and 32 families. There are 232 species of dicots, 17 species of monocots. The ratio of monocots to dicots is 1:13.6. The numerical ratio of the flora of the gypsum-hammad and variegated floristic complex is 32:132:250. On average, there are 1.9 species per genus. The species saturation of the families of gypsum-hammad and variegated flora is characterized by an average indicator and is 7.2. Analysis of the largest families of gypsum-hammad and variegated flora made it possible to identify 16 largest families according to the largest number of species, which contain 222 species in their composition. Analysis of the species richness of the genera of the gypsum-hammad and variegated flora of the Ketpen ridge shows that out of 132 genera, 8 genera are large (10 or more species). The polymorphic genera of the flora are *Zygophyllum*, *Astragalus*, *Lappula*, *Salsola*, *Caragana*, *Artemisia*, *Anabasis*, *Lagochilus*. The leading genera of gypsum-hammad and variegated flora account for 36.8%. Based on the analysis, the desert character of the gypsum-hammad and variegated flora is shown, and a large presence among the gypsum-hammad and variegated flora of Ketpen of mountainous Middle Asian, desert and Ancient Mediterranean species, with an area limited by the territories of Mountainous Middle Asia and the Ancient Mediterranean, was revealed.

**Key words:** Ketpen ridge, gypsum-hammad, variegated floristic complex, flora.

Г.А. Садырова<sup>1\*</sup>, Т.А. Базарбаева<sup>1</sup>, Г.А. Муканова<sup>1</sup>, С.М. Джамилова<sup>2</sup>

<sup>1</sup>Әл-Фараби атындағы Қазақ ұлттық университеті, Қазақстан, Алматы қ.

<sup>2</sup>Абай атындағы Қазақ ұлттық педагогикалық университеті, Қазақстан, Алматы қ.

\*e-mail: gulbanu-s@mail.ru

### Кетпен жотасының гипс-гаммадтық және түрлі-түсті флористикалық кешенін талдау

Жұмыста Кетпен жотасының гипс-гаммадтық және түрлі-түсті флористикалық кешенін талдау ұсынылған. Гипс-гаммадтық және түрлі-түсті флористикалық кешеннің түрлік құрамының таксономиялық әртүрлілігі, гипс-гаммадтық және түрлі-түсті түрлердің тіршілік формаларына биоморфологиялық талдау, сондай-ақ гипс-гаммадтық және түрлі-түсті түрлердің әртүрлі географиялық түрлеріне жататындығы анықталды. Гипс-гаммад және түрлі-түсті флораның егжей-тегжейлі флористикалық талдауы 132 тұқым мен 32 отбасына жататын тамырлы өсімдіктердің 250 түрін анықтады. Қосжарнақтылардың 232 түрі, біржарнақтылардың 17 түрі бар. Монокоттардың қосжарнақтарға қатынасы 1: 13,6. Гипс-гаммадтық және түрлі-түсті флоралық кешеннің флорасының сандық қатынасы 32:132:250 құрайды. Орташа алғанда, әр тұқымға 1,9 түр келеді. Гипс-гаммад және түрлі-түсті флора отбасыларының түрлік қанықтылығы орташа көрсеткішпен сипатталады және 7,2 құрайды. Гипс-гаммад және түрлі-түсті флораның ең үлкен отбасыларын талдау олардың құрамында 222 түрі бар түрлердің ең көп саны бойынша 16 ірі отбасын анықтауға мүмкіндік берді. Кетпен жотасының гипс-гаммадты және түрлі-түсті флорасы тұқымдастарының түр байлығын талдау, бұл 132 тұқымдастың ішінде үлкен (10 немесе одан да көп түр) 8 ұрпақ. Флораның полиморфты тұқымдары: *Zygophyllum*, *Astragalus*, *Lappula*, *Salsola*, *Caragana*, *Artemisia*, *Anabasis*, *Lagochilus*. Гипс-гаммад және түрлі-түсті флораның жетекші

тұқымдары 36,8% құрайды. Жүргізілген талдау негізінде гипс-гаммадты және түрлі-түсті флораның шөлді сипаты көрсетілді, таулы Орта Азия мен ежелгі Жерорта теңізі аумақтарымен шектелген диапазоны бар таулы Орта Азия, шөл және ежелгі Жерорта теңізі түрлерінің кетпен гипс-гаммадты және түрлі-түсті флорасы арасында үлкен қатысуы анықталды.

**Түйін сөздер:** Кетпен жотасы, гипс-гаммад, түрлі-түсті флористикалық кешені, флора.

Г.А. Садырова<sup>1\*</sup>, Т.А. Базарбаева<sup>1</sup>, Г.А. Муканова<sup>1</sup>, С.М. Джамилова<sup>2</sup>

<sup>1</sup>Казахский национальный университет им. аль-Фараби, Казахстан, г. Алматы

<sup>2</sup>Казахский национальный педагогический университет имени Абай, Казахстан, г. Алматы

\*e-mail: gulbanu-s@mail.ru

### Анализ гипсоносно-гаммадного и пестроцветного флористического комплекса хребта Кетпен

В данной статье приводятся результаты многолетних исследований гипсоносно-гаммадной и пестроцветной флоры хребта Кетпен. В работе представлен анализ гипсоносно-гаммадного и пестроцветного флористического комплекса хребта Кетпен. Выявлено таксономическое разнообразие видового состава гипсоносно-гаммадного и пестроцветного флористического комплекса, биоморфологический анализ жизненных форм гипсоносно-гаммадных и пестроцветных видов, а также принадлежность гипсоносно-гаммадных и пестроцветных видов к различным географическим типам ареалов. Детальный флористический анализ гипсоносно-гаммадной и пестроцветной флоры позволил выявить 250 видов сосудистых растений, относящихся к 132 родам и 32 семействам. Двудольных насчитывается 232 вида, однодольных 17 видов. Соотношение однодольных к двудольным 1:13,6. Численное соотношение флоры гипсоносно-гаммадного и пестроцветного флористического комплекса равно 32:132:250. В среднем на каждый род приходится 1,9 вида. Видовая насыщенность семейств гипсоносно-гаммадной и пестроцветной флоры характеризуется средним показателем и составляет 7,2. Анализ крупнейших семейств гипсоносно-гаммадной и пестроцветной флоры позволил выделить 16 крупнейших семейств по наибольшему числу видов, которые содержат в своем составе 222 видов. Анализ видового богатства родов гипсоносно-гаммадной и пестроцветной флоры хребта Кетпен, что из 132 родов крупными (10 и более видов) являются 8 родов. Полиморфными родами флоры являются: *Zygophyllum*, *Astragalus*, *Lappula*, *Salsola*, *Caragana*, *Artemisia*, *Anabasis*, *Lagochilus*. На ведущие рода гипсоносно-гаммадной и пестроцветной флоры приходится 36,8%. На основе проведенного анализа показан пустынный характер гипсоносно-гаммадной и пестроцветной флоры, выявлено большое присутствие среди гипсоносно-гаммадной и пестроцветной флоры Кетпен горно-среднеазиатских, пустынных и древнесредиземноморских видов, имеющих ареал, ограниченный территориями Горной Средней Азии и Древним Средиземноморьем.

**Ключевые слова:** Хребет Кетпен, гипсоносно-гаммадный, пестроцветный флористический комплекс, флора.

### Introduction

Recently, the study of the floras of mountainous areas is currently of great scientific interest. Especially important is the study of the flora of individual, little-studied regions located in areas of the desert zone, where one of such regions of the Northern Tien Shan is the Ketpen ridge. The Ketpen ridge is located on the territory of two states – Kazakhstan and China. Its eastern part, located on the territory of Kazakhstan, is called Ketpen; Western, Chinese is

called Temerlik. In-depth floristic studies of individual natural regions are also of particular relevance due to the excessive and prolonged exploitation of mountain pastures, which in some cases leads to irreversible changes in pristine biocenoses, a reduction in habitats and the disappearance of rare plant species. For the conservation and rational use of the plant wealth of a region, it is extremely important to identify, if possible, the full composition of its flora. The Ketpen ridge lies between 44° 00' N. 79° 30' E and 43° 20' N 85° 00' E (Fig. 1).

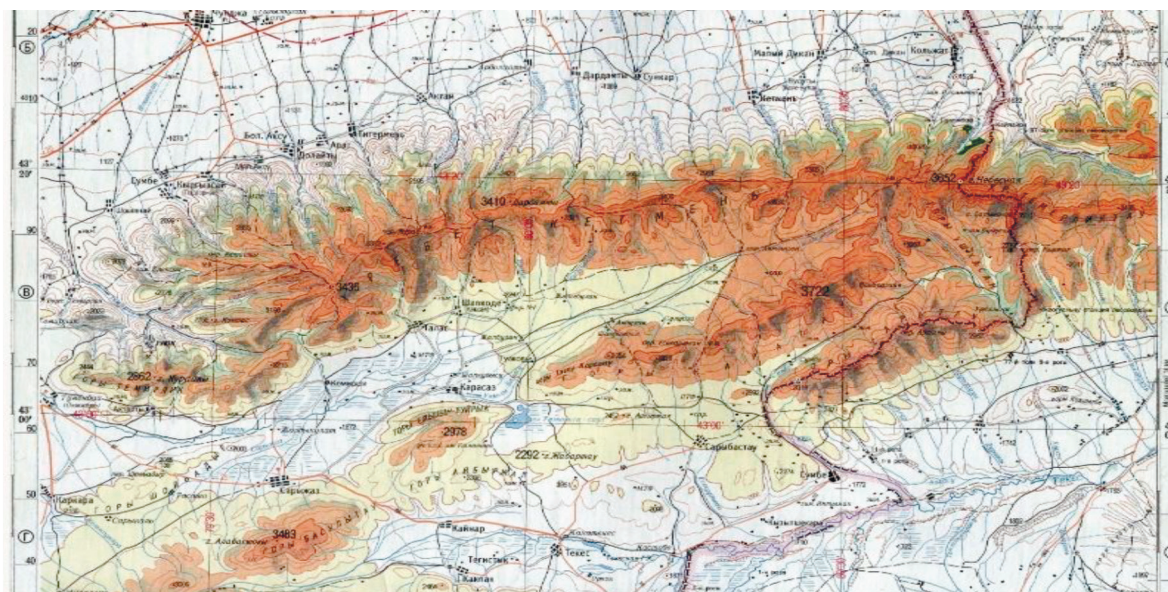


Figure 1 – Map of the Ketpen ridge

On the territory of Kazakhstan, the Ketpen ridge in the north borders on the Dzungarian Alatau, which is separated by the Ili depression, in the west on the Kungei Alatau, in the east it smoothly passes into Temerlik, where it merges with the Boro-Khoro mountain system. On the Chinese side, the Ketpen (Temerlik) ridge unites

a number of mountain ranges, descending to the east, and mountain depressions separating them (in the north, the Kuldzha depression, which separates the Boro-Khoro ridge from the Temerlik ridge, to the south – Kash and in the southeast – Tekes) [1]. In the south, the ridge borders on the Khalyktau mountains (Fig. 2).



Figure 2 – Ketpen ridge

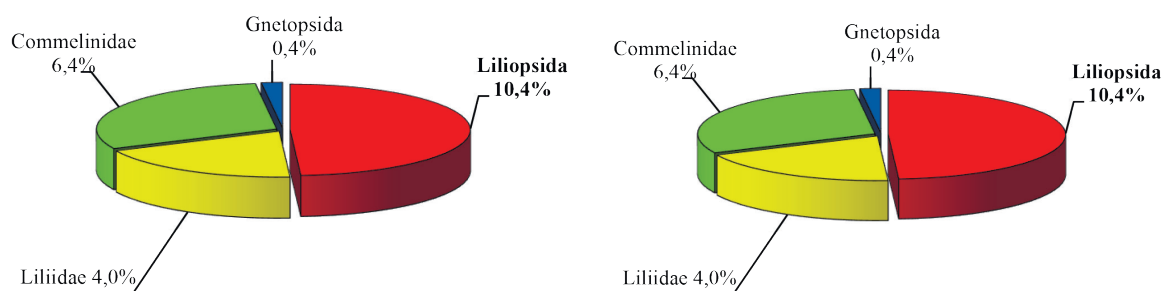
## Materials and research methods

The main methods for studying plants of the species of the forest belt of the Ketpen ridge were generally accepted classical methods of botanical and floristic research and traditional methods of geobotanical research: in the field, the traditional route-reconnaissance method was used. The collection and processing of herbarium material was carried out according to the generally accepted method. Specimens of forest plant species were collected in herbarium folders with descriptions of collection sites, date, and collector. At points fixed on the ground by a GPS device, a detailed geobotanical description of the plant communities present was carried out. Office processing, identification of species were carried out in the laboratory: after field work, the material was subjected to additional drying and viewing with binocular loupes and distributed into systematic groups. The collection and processing of herbarium material was carried out according to the generally accepted method of A.K. Skvortsov [2]. In the process of determining the herbarium, multi-volume reports were used as sources: “Flora of the USSR” [3], “Flora of Kazakhstan” [4], “Plants of Central Asia” [5], “Key to plants of Central Asia” [6], “Illustrated guide to plants Kazakhstan” [7] and others. To clarify the specific and generic names, the latest reports by S.K. Cherepanova, S.A. Abdulina [8.9]. Types of life forms are carried out according to the classifications of K. Raunkier and I.G. Serebryakov [10].

## Results and their discussion

### *Taxonomic analysis of gypsum-hammad and variegated floristic complex*

The total number of species recorded in the gypsum-hammad and variegated floristic complex is 250 species. They belong to 132 genera and 32 families. There are 232 species of dicots, 17 species of monocots. The ratio of monocots to dicots is –1:13.6. The numerical ratio of the flora of the gypsum-hammad and variegated floristic complex is 32:132:250. On average, there are 1.9 species per genus. The species saturation of the families of gypsum-hammad and variegated flora is characterized by an average indicator and is 7.2. Autochthonous trends in the development of gypsum-hammad and variegated flora in the study area are well expressed, as evidenced by the presence of five endemic and ten subendemic species (6.0%). The presence of average genera and the negative value of the autonomy index (-0.592) indicates a significant autochthonous trend in the development of the gypsum-hammad flora. According to A.L. Takhtadzhyan [11], the floristic spectrum of the gypsum-hammad and variegated flora of the Ketpen ridge consists of eight subclasses, of which two subclasses (*Liliidae*, *Commeliniidae*) belong to *Liliopsida* and six (*Ranunculidae*, *Caryophyllidae*, *Rosidae*, *Lamiidae*, *Dilleniidae*, *Asteridae*) – to *Magnoliopsida*. Of the 6 subclasses of *Magnoliopsida*, the subclasses *Dilleniidae*, *Rosidae*, *Caryophyllidae*, *Lamiidae*, *Asteridae* turned out to be the richest in species composition, and of the two subclasses of *Liliopsida*, those were *Commeliniidae* and *Liliidae* (Fig. 3).

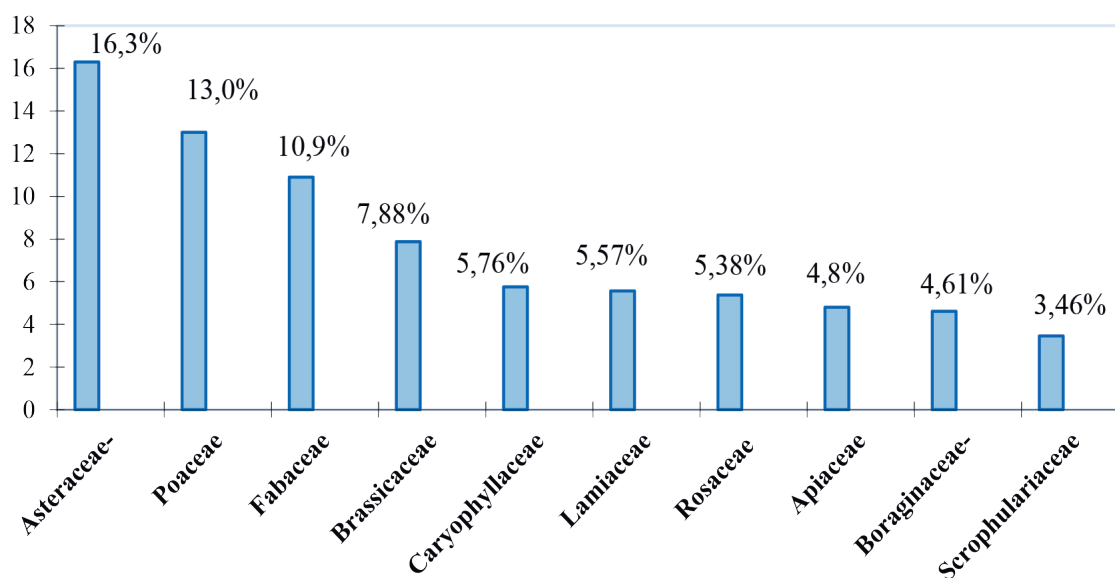


**Figure 3** – The ratio of the main systematic groups in the gypsum-hammad and variegated floristic complex of the Ketpen ridge

**Table 1** –The largest families of gypsum-hammad and variegated flora of the Ketpen ridge

Families	Number of genera	Number of species	% of total number of species
1. <i>Chenopodiaceae</i>	21	37	14,8
2. <i>Brassicaceae</i>	21	35	14,0
3. <i>Asteraceae</i>	20	29	11,6
4. <i>Fabaceae</i>	7	26	10,4
5. <i>Boraginaceae</i>	8	21	8,4
6. <i>Poaceae</i>	12	16	6,4
7. <i>Lamiaceae</i>	5	12	4,8
8. <i>Apiaceae</i>	5	11	4,4
9. <i>Zygophyllaceae</i>	2	10	4,0
10. <i>Limoniaceae</i>	4	8	3,2
11. <i>Polygonaceae</i>	2	5	2,0
12-13. <i>Euphorbiaceae</i>	1	4	1,6
12-13. <i>Liliaceae</i>	2	4	1,6
12-13. <i>Alliaceae</i>	1	4	1,6
<b>Total:</b>	<b>111</b>	<b>222</b>	<b>95,6</b>

Table 1 shows that the largest families in terms of the number of species are *Chenopodiaceae* (37 species, or 14.8%), *Brassicaceae* (35; 14.0%), *Asteraceae* (29; 11.6%), *Fabaceae* (26; 10.4%), *Boraginaceae* (21; 8.4%), *Poaceae* (16; 6.4%), *Lamiaceae* (12; 4.8%), *Apiaceae* (11; 4.4%), *Zygophyllaceae* (10; 4.0%), *Limoniaceae* (8; 3.2%) (Fig.4). The first three families contain 40.4%, the top ten families – 82.0%. Twelve families contain from 5 to 2 species (35; 14.0%), ten families contain 1 species each (4.0%).

**Figure 4** – The ratio of the leading families of gypsum-hammad and variegated flora of the Ketpen ridge

As can be seen from Figure 4, the following families turned out to be leading in terms of the number of genera: *Chenopodiaceae* (21 genera, or 8.4%), *Brassicaceae* (21; 8.4%), *Asteraceae* (20; 8.0%), *Poaceae* (12; 4.8 %), *Boraginaceae* (8; 3.2%), *Fabaceae* (7; 2.8%), *Lamiaceae* (5; 2.0%),

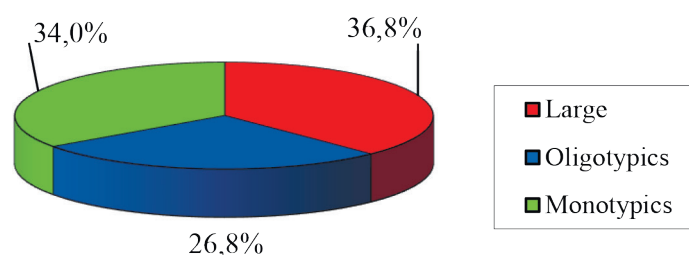
*Apiaceae* (5; 2.0%), *Limoniaceae* (4; 1.6 %). Of the largest genera, the richest in terms of the number of species are: *Zygophyllum* (9; 3.6%), *Astragalus* (9; 3.6%), *Lappula* (9; 3.6%), *Salsola* (7; 2.8%), *Caragana* (7; 2.8%), *Artemisia* (7; 2.8%), *Anabasis* (6; 2.4%), *Lagochilus* (6; 2.4%) (table 2).

**Table 2** – The largest genera of the gypsum-hammad and variegated flora of the Ketpen ridge

Genera	Number of species	% of total number of species
1-2. <i>Zygophyllum</i>	9	3,6
1-2. <i>Astragalus</i>	9	3,6
1-2. <i>Lappula</i>	9	3,6
2-3. <i>Salsola</i>	7	2,8
2-3. <i>Caragana</i>	7	2,8
2-3. <i>Artemisia</i>	7	2,8
4-5. <i>Anabasis</i>	6	2,4
4-5. <i>Lagochilus</i>	6	2,4
6-7. <i>Atraphaxis</i>	4	1,6
6-7. <i>Lepidium</i>	4	1,6
6-7. <i>Sisymbrium</i>	4	1,6
6-7. <i>Euphorbia</i>	4	1,6
6-7. <i>Trigonella</i>	4	1,6
6-7. <i>Seseli</i>	4	1,6
6-7. <i>Ferula</i>	4	1,6
6-7. <i>Allium</i>	4	1,6
<b>Total:</b>	<b>92</b>	<b>36,8</b>

*Atraphaxis*, *Lepidium*, *Sisymbrium*, *Euphorbia*, *Trigonella*, *Seseli*, *Ferula*, *Allium* contain 4 species each (1.6%). In general, 16 genera contain 92 spe-

cies (36.8%). 31 genera contain from 3 to 2 species (67; 26.8%) and 85 genera contain 1 species each (34.0%) (Fig. 5).



**Figure 5** – The ratio of large, oligotypic and monotypic genera gypsum-hammad and variegated flora of the Ketpen ridge

In the floristic complex under consideration, there are 36 true species characteristic only for it. The main true species include: *Convolvulus fruticosus*, *C. tragacanthoides*, *Helianthemum song-*

*oricum*, *Reaumuria soongorica*, *Brachanthemum titovii*, *Caragana leucophloe*, *C. kirghisorum*, *C. pleiophylla*, *Iljinia regelii*, *Simpegma regelii*, *Arthropytum longibracteatum*, *Salsola orientalis*, *S.*

*laricifolia*, *Phlomoidea zenaidae*, *Plagiobasis*, *centauroides*, *Zygophyllum rosovii*, *Z. kegenae*, *Limonium michelsonii*, *L. semenovii*, *Allium setifolium*, *Cleistogenes songorica*, *Goniolimon orthocladum*, *Pyrethrum semenovii*, etc. As notes V.P. Goloskokov, these representatives of the xerophytic flora of the Tien Shan are undoubtedly of autochthonous origin. The facts of a botanical and geographical nature point to the autochthonous development in the Tien Shan of not only low-mountain xerophytic desert flora, but also a number of representatives

of mountain floras, cryophilic and meadow-forest [12].

#### Biomorphological analysis

An analysis of biomorphs showed that in the life forms of the gypsum-hammad and variegated flora, herbaceous plants dominate (196; 78.0%), of which the vast majority belong to herbaceous polycarpics (105; 41.6%), which is typical for temperate floras. Herbaceous monocarpics play a less significant role in the composition of this flora (91; 36.4%) (Fig. 6).

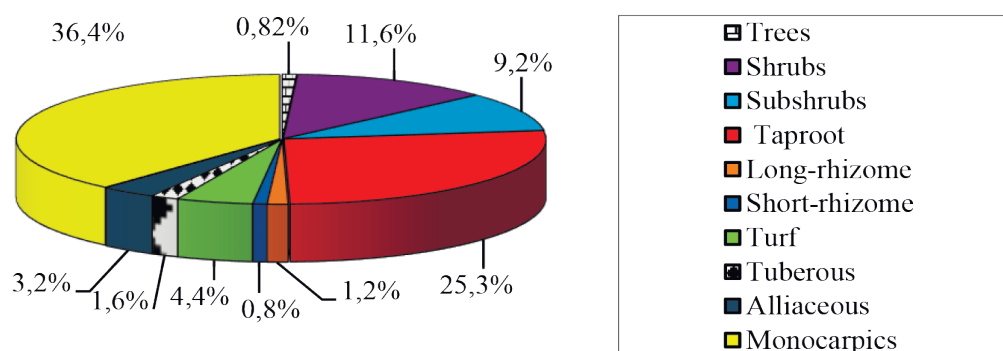


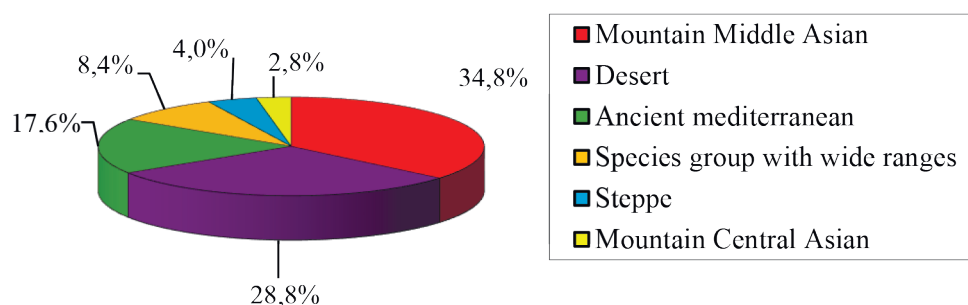
Figure 6 – Distribution of life forms in the gypsum-hammad flora of the Ketpen ridge

The share of shrubs and shrubs (29; 11.6%), semi-shrubs and semi-shrubs (23; 9.2%) is small. The proportion of trees is even smaller - 2; 0.82%. Shrubs are represented in the families Chenopodiaceae (7 species), Polygonaceae (5), Linoniaceae (1), Tamaricaceae (3), Nitrareaceae (1), Rhamnaceae (1), Fabaceae (9), Ephedraceae (1). Subshrubs and subshrubs are contained in the family Chenopodiaceae (8 species), Convolvulaceae (2), Linoniaceae (1), Frankeniaceae (1), Asteraceae (9). Trees are represented by only 2 species that are contained in the Salicaceae family (2). Of the taproot polycarpics, there are 128 species (51.2%), short-rhizome – 2 species (0.80%), long-rhizome – 3 species (1.2%), tussock – 11 species (4.4%), tuberous – 4 species (1.6%), Alliaceous – 8 species (3.2%). Annuals dominate in the families Chenopodiaceae (17 species), Asteraceae (10), Fabaceae (8), Brassicaceae (31), Caryophyllaceae (1), Thymelaeaceae (1), Zygophyllaceae (1), Cynomoreaceae (1), Apiaceae

(1), Frankeniaceae (1), Boraginaceae (15), Scrophulariaceae (1), Lamiaceae (3). Perennials dominate in the families Asteraceae (10 species), Fabaceae (19), Chenopodiaceae (5), Poaceae (11), Linoniaceae (6), Brassicaceae (5), Lamiaceae (9), Apiaceae (10), Euphorbiaceae (4), Boraginaceae (5). The remaining families contain 1.2 species each. The largest number of taproot plants is concentrated in the families Asteraceae (6 species), Fabaceae (19), Convolvulaceae (2), Apiaceae (9), Boraginaceae (5). Turf plants are concentrated exclusively in the families Asteraceae (2 species), Poaceae (9). In relation to humidity, xerophytes dominate, of which there are 222 species (88.8%) and xeromesophytes – 28 species (11.2%).

#### Geographic Analysis

As part of this floristic complex, 28 geographical elements were identified, united in 6 groups of areas (Fig. 7).



**Figure 7** – Distribution of species of gypsum-hammad and variegated flora of the Ketpen ridge in groups of habitats

**Table 3** – Distribution of species of gypsum-hammad and variegated flora of the Ketpen ridge by types of habitats

Area name	Number of species	% of the total number of species
1. Holarctic	5	2,0
2. Palearctic	11	4,4
3. East Palearctic	5	2,0
4. Ancient Mediterranean	20	8,0
5. East Ancient Mediterranean	21	8,4
6. Pontic-Old Mediterranean	3	1,2
7. European-Old Mediterranean	3	1,2
8. Eurasian	4	1,6
9. Pannono-Kazakhstan	3	1,2
10. Mountain Middle Asian	30	12,0
11. Mountain Middle Asian-Iranian	7	2,8
12. Altai-Himalayan	1	0,40
13. Mountain Middle Asian-Central Asian	6	2,4
14. Tien Shan	18	7,2
15. Mountain siberian-Tianshan	5	2,0
16. North Tien Shan	12	4,8
17. Altai-Tianshan	3	1,2
18. Tarbagatai-Tianshan	4	1,6
19. Altai-Ketmen	2	0,80
20. Ketpen	5	2,0
21. Ketpen-Terskey	1	0,40
22. Ketpen-Zailian	6	2,4
23. Ketpen-Dzungar	3	1,2
24. Turan	27	10,8
25. Turan-Iran	20	8,0
26. Northern Turan	6	2,4
27. North Turano-Central Asian	1	0,40
28. Turano-Central Asian	18	7,2
<b>Total:</b>	<b>250</b>	<b>100</b>

Analysis of the composition of the gypsum-hammad and variegated floristic complex by types of habitats (table 3) showed that the largest percentage of species (203; 81.2%) falls on the mountain-

ous middle asian, desert and ancient mediterranean groups of habitats, which are leading in the composition of the gypsum-hammad floristic complex. In the mountainous middle asian group, there are 30



(12.0%) mountainous middle asian species proper, and 7 species in the mountainous Middle Asian-Iran group. The Tien Shan subgroup is also represented by a large number (45 species; 18.0%), which includes 18 species of Tien Shan, 5 species have links with Siberia, Altai and Tarbagatai, 12 species of northern Tien Shan, 5 Ketpen endemics, Ketpen – Trans-Ili – 6, Ketpen-Terskey – 1, Ketpen -Dzhungar – 3. Next, in terms of the number of constituent species, the Ancient Mediterranean group follows – 44 species, or 17.6%, of which with ranges throughout the Ancient Middle-earth – 20 species, in its eastern parts – 21 species. The next largest is the group of species with wide ranges – 21, or 8.4%. The steppe group is represented by only ten species

(4.0%). The Mountain Middle Asian group is represented by a small number – 7 species, or 2.8%.

### Conclusion

Thus, on the Ketpen ridge, species of the gypsum-hammad and variegated floristic complex are distributed on gravel-sandy pebbly gypsum-bearing soils composed of Tertiary deposits: both Paleogene and Neogene unconformably overlying them. Species of the gypsum-hammad and variegated floristic complex in the study area are distributed in the lower parts of the low mountains and in the foothill and foothill plains of the Ketpen ridge.

### References

1. “Atlas Kazakhskoy SSR. Prirodnyye usloviya i resursy [Atlas of the Kazakh SSR. Natural conditions and resources]”. Almaty, (1982): 81.
2. Skvortsov A.K. “Gerbariy [Herbarium]”. Moscow, (1977): 199. (In Russian).
3. “Flora SSSR [Flora SSSR]”. M.: L., (1934 – 1964). Vol.1–30. (In Russian).
4. “Flora Kazakhstana [Flora of Kazakhstan]”. Alma-Ata, (1956-1966). Vol.1-9. (In Russian).
5. “Rastenia Tsentralnoi Azii [Plants of Central Asia]”. M.: L., (1963 -1989). Vol. 1-9. (In Russian).
6. “Opredelitel rastenii Srednei Azii [The determinant of plants in Central Asia]”. Tashkent, (1968 – 1993) Vol.1-10. (In Russian).
7. “Illyustrirovannyi opredelitel’ rastenii Kazakhstana [Illustrated determinant of plants of Kazakhstan]”. Alma-Ata, (1962 – 1975). Vol. 1-2. (In Russian).
8. Cherepanov S.K. “Sosudistye rastenia Rossii i sopredelnykh gosudarstv, v predelakh byvshego SSSR [Vascular plants of Russia and neighboring states, within the former USSR]”. SPb., (1995): 990. (In Russian).
9. Abdulina S.A. “Sosudistye rastenia Kazakhstana [Vascular plants of Kazakhstan]”. Almaty, (1998): 188. (In Russian).
10. Serebryakov I. G. “Ekologicheskaya morfologiya rasteniy [Ecological morphology of plants]”. Moscow, (1962): 378. (In Russian).
11. Takhtadzhyan A.L. “Sistema magnoliofitov [Magnoliophyte system]”. M.: L., (1987): 439. (In Russian).
12. Goloskokov V.P., Kubanskaya Z.V. “Formirovaniye simpegmy na Tyan’-Shane [Sympegma formation in the Tien Shan]” Proceedings of the Institute of Botany. Alma-Ata, Vol. 18 (1964): 3 – 30. (In Russian).