

喀喇昆仑山和昆仑山地区禾本科植物区系

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摘 要 喀喇昆仑山和昆仑山地区的禾本科植物除去栽培种类外共有 47 属, 含 161 种。分析表明: (1) 本区的禾本科植物主要是由北温带成分组成, 并兼有丰富的旧世界温带成分和其他温带成分, 温带性质明显。(2) 本区所分布的泛热带成分无一例外地都能够延伸到温带地区, 应属一类具有一定程度温带性质的泛热带分布类型。一些种类如蔗茅 (*Erianthus ravennae*) 的出现是从地中海地区经中亚分布到本区的。(3) 本区的禾本科植物绝大多数属于温寒地带分布类型, 因而具有明显的高原、高山植物区系的特征, 主要有固沙草属 (*Orinus*)、看麦娘属 (*Alopecurus*)、披碱草属 (*Elymus*)、三毛草属 (*Trisetum*)、扇穗茅属 (*Littledalea*)、偃麦草属 (*Elytrigia*)、冠毛草属 (*Stephanachne*) 和拟沿沟草属 (*Paracolpodium*) 等, 这是本区的高山特化和寒旱化适应现象在禾本科植物中的突出表现。(4) 本区无特有属, 特有种亦较少, 这种现象是有其自然和历史原因的。大多数的单种属和寡种属都是从它们各自广布的近缘属中衍生而来, 表明本区系是一个年轻的、衍生的区系。例如细柄茅属 (*Ptilagrostis*) 之从针茅属 (*Stipa*)、钝基草属 (*Timoria*) 之从芨芨草属 (*Achnatherum*) 等。(5) 本区系同周围区系的联系广泛, 但同西藏区系的关系最为密切。

关键词 喀喇昆仑山和昆仑山; 禾本科; 区系特征

The floristic of the family Gramineae of Karakorum and Kunlun area , China

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Abstract There are 47 genera and 161 species of Gramineae except the cultivated species in the area of the Karakorum and Kunlun Mountains. The results of research on the distribution of the genera and species of Gramineae in the Karakorum and Kunlun Mountains show that (1) The Gramineae mainly contains elements of North Temperate, rich Old World Temperate and other Temperate. It is obvious that the floristic nature of Gramineae in the Karakorum and Kunlun Mountains is the North Temperate; (2) All Pantropic genera can stretch to the Temperate Zone in this region, which all parts of the Pantropic type are the Temperate nature to a certain degree. For example, *Erianthus ravennae* from mediterranean to the Karakorum and Kunlun Mountains through the Central Asia; (3) As most genera of Grasses are the type of Temperate and the Frigid Zone, they have distinct floristic characteristics of mountainous and plateau flora such as *Orinus*, *Alopecurus*, *Elymus*, *Trisetum*, *Littledalea*, *Elytrigia*, *Stephanachne* and *Paracolpodium* etc. All of these indicate adaptive phenomenon of alpine specialization and cold-xerophilization on Grasses in this area; (4) Endemic genus of Gramineae is absent due to its nature and history and the endemic species are also rare in the Karakorum and Kunlun Mountains. Most of the genera with one or fewer species have originated from its relative and

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widespread genera, such as *Ptilagrostis* from *Stipa*, *Timouria* from *Achnatherum*, and so on; (5) Flora of the Karakorum and Kunlun Mountains is most closely related to the flora of Tibet, and is also extensively to its adjacent areas.

Key words Karakorum and Kunlun Mt.; family Gramineae; floristic characteristics

1 Natural Environments

The Karakorum and Kunlun Mountains are situated between latitudes 33°~40°N and longitudes 73°~102°E. It belongs to the alpine and highland region, extending to the most northwestern part and northern fringe of the Qinghai-Tibetan Plateau. The west, from the East Pamir Plateau and the Kungai Mountain where is located north of the east Pamir Plateau and is bounded by Tajikistan, Afghanistan, Pakistan, Kashmir, India and then east through Xinjiang, Xizang to the Southern Plateau of Qinghai, the distance is about 2 500 km. The north looks down at the Tarim Basin and the Qaidam Basin. The Yellow River rises on the East Kunlun Mountain. The administrative divisions of expeditional region consist of Wuqia, Kashi (Kaxgar), Akto, Taxkorgan, Shache (Yarkant), Yecheng (Kargilik), Pishan (Gurma), Moyu (Karakax), Hotan, Qira, Yutian (Keriya), Minfeng (Niya), Qiemo (Qarqan) and Ruoqiang (Qarkilik) in Xinjiang, Ritu (Rutog) in Xizang, and Zhiduo (Zhidoi), Qumalai (Qumarleb), Maduo (Madoi) in Qinghai Province.

The extremely high Qinghai-Tibet Plateau have both thermic and dynamic influences on the atmospheric circulations and climate over and around this area. In winter, the climate of the entire plateau is controlled by the westerly, with fine days and little snow. In the Karakorum and Kunlun Mts. region, the climate is of both alpine and continental type: frigid, arid, well transparency of air, intense radiation and conspicuous day-night temperature range, scanty precipitation, intense evaporation, strong wind of long duration, and so on.

In mountainous areas from 2 000 to 4 000 m asl, the mean temperature of the warmest month is 10 ~ 20 °C; while on the Qiangtang Plateau at an elevation of 4 800 ~ 5 000 m, the mean temperature of the warmest month is only 3 ~ 6 °C. The mean temperature of the coldest month is - 20 °C, the highest and lowest temper-

atures are 20 °C and - 35 °C respectively. Even in July, the lowest daily temperature often falls - 10 °C, and the average range of daily temperature goes up to 15 ~ 20 °C, especially high on the open plateau surface.

The Karakorum Kunlun Mountains region is extremely arid climatically with low precipitation. The annual precipitation is less than 50 ~ 100 mm on the piedmont plains of Kunlun Mountains, 100 ~ 400 mm at the elevations of 2 000 ~ 4 000 m asl., also less than 100 mm in the East Pamir Plateau and its eastern wide valleys, and more than 200 mm at the elevation of 4 000 ~ 5 000 m asl. In the Karakorum Mountains, there is great difference in precipitation between high mountains and valleys. For example, the annual precipitation is only 34 mm at Gilgit (1 488 m asl.), where is situated at a deep valley of the southern flank of the Karakorum Mountains, and is 37 mm at Kangxiwar (3 986 m asl.) in the Karakax River valley of the northern flank. According to calculation of water balance, the annual precipitation above the snow line may be as high as 800 ~ 2 400 mm in this area. On the Qiangtang Plateau there is very low precipitation, only 20 ~ 40 mm. The piedmont areas of high mountains have an annual precipitation of about 50 ~ 100 mm. In the southern parts of the Karakorum Kunlun Mountains region, e. g., Meimar Co and Domar, the annual precipitation slightly increases up to 100 ~ 150 mm or so^[1]. In Madoi area, situated at the Southern Plateau of Qinghai in East Kunlun Mountains, the mean annual temperature is - 4 °C, the mean temperature of the warmest July is 7.2 °C, and the mean temperature of the coldest January is - 17.3 °C, the difference of daily temperatures is from 22.9 °C to - 48.1 °C. The mean annual period of freezing rivers and lakes is 160 days. The longest period of freeze is 190 days. The mean annual precipitation is 299.6 mm. The mean annual evaporation is 1 304.6 mm, and the highest wind speed is 34 m/s^[2].

Table 1 Distribution of genera of Gramineae in Karakorunr Kunlun Mountains

Genera	Number of species in this area	Number of species in China	Number of species in genus	Genera	Number of species in this area	Number of species in China	Number of species in genus
Cosmopolitan	31	155	930 +	25. <i>Avena</i>	1	7	25
1. <i>Phragmites</i>	1	2	10	26. <i>Hierochloe</i>	1	4	20
2. <i>Poa</i>	20	100	400	27. <i>Alopecurus</i>	2	9	50
3. <i>Agrostis</i>	5	29	220	28. <i>Deyeuxia</i>	6	43	100
4. <i>Digitaria</i>	5	24	300	29. <i>Calamagrostis</i>	4	6	15
Pantropic	14	62	551 +	30. <i>Backmannia</i>	1	1	2
5. <i>Polypogon</i>	3	3	6	31. <i>Stipa</i>	9	23	200
6. <i>Chloris</i>	1	4	50	32. <i>Eragrostis</i>	2	29	300
7. <i>Cynodon</i>	1	2	10	33. <i>Echinochloa</i>	1	9	30
8. <i>Aristida</i>	3	11	150	Old World Temperate	19	92	192 +
9. <i>Setaria</i>	2	15	130	34. <i>Roegneria</i>	13	70	120
10. <i>Pennisetum</i>	1	11	140	35. <i>Elytrigia</i>	3	6	40
11. <i>Erianthus</i>	1	8	30	36. <i>Achenatherum</i>	1	14	20
12. <i>Bothriochloa</i>	2	8	35	37. <i>Crypsis</i>	2	2	12
North Temperate	84	316	1 519 +	Temperate Asia	1	5	5
13. <i>Catabrosa</i>	2	3	10	38. <i>Ptilagrostis</i>	1	5	5
14. <i>Festuca</i>	14	30	100	Mediterranean , Western Asia and Central Asia	5	11	37
15. <i>Puccinellia</i>	12	40	100	39. <i>Paracolpodium</i>	1	2	4
16. <i>Bromus</i>	3	40	150	40. <i>Eremopyrum</i>	1	4	8
17. <i>Agropyron</i>	2	5	15	41. <i>Schismus</i>	1	1	5
18. <i>Elymus</i>	3	12	40	42. <i>Aeluropus</i>	2	4	20
19. <i>Leymus</i>	7	11	32	Central Asia	7	11	15
20. <i>Hordeum</i>	5	15	30	43. <i>Eremopoa</i>	1	1	4
21. <i>Koeleria</i>	2	3	50	44. <i>Littledalea</i>	3	3	4
22. <i>Trisetum</i>	3	10	70	45. <i>Timouria</i>	1	1	1
23. <i>Deschampsia</i>	3	6	60	46. <i>Stephanachne</i>	1	3	3
24. <i>Helictotrichon</i>	1	10	80	47. <i>Orinus</i>	1	3	3

The vegetation in the Karakorunr Kunlun Mountains region includes alpine desert with the constructive species *Ceratoides compacta*, mountain deserts with the constructive species *Reaumuria kaschgarica* and *Sympagma regelii* etc., alpine desert-steppe with the constructive species *Artemisia parvula* etc., alpine steppe with the constructive species *Carex mocroftii*, *Stipa purpurea*, *S. glareosa*, *S. breviflora* and *Festuca sulcata* etc., alpine shrub with the constructive species *Salix oritrepha*, and *Potentilla fruticosa* etc., alpine swamp meadow with the constructive species *Kobresia tibetica*, the alpine meadow with constructive species *Kobresia* spp. and the alpine gravel slopes with sparse vegetation^[2]. The mountain coniferous forests appear only

at elevations of 2 800 ~ 3 400 m asl. In west of Kunlun Mountains, *Picea schrenkiana*, of 10 ~ 12 m high^[1] appears on the shady mountain slopes, and *Sabina vulgaris* var. *jarkendensis* on the sunny slopes.

The soil in this area mainly includes alpine desert soil, mountain desert soil, cryogenic soil, alpine steppe soil, alpine meadow soil, bog soil and winds-sand soil etc.

2 Distributive Types of Genera

The family Gramineae is one of the largest cosmopolitan families. There are more than 660 genera and 10 000 species in the world, and 225 genera and more than 1 200 species in China^[3]. As one of the largest

families on flora in Karakorum and Kunlun Mountains , Gramineae contains 47 genera and 161 species except the cultivated species.

By Professor Wu Zhengyi^[4,5], the Chinese genera of seed plants were divided into 15 areal-types. According to Wu's division, the genera of Grasses in Karakorum and Kunlun Mountains can be divided into 7 distributive types. The distributive type of genera is primarily the North Temperate elements consisting of 21 genera (48.8% of the total genera that except the Cosmopolitan elements, the same below) and 84 species (64.6% of the total species). The second is the Pantropical elements including 8 genera (18.6% of the total) and 14 species (10.8% of the total). The old world Temperate elements consist of 4 genera (9.3% of the total), and 19 species (14.6% of the total). The Central Asia elements consist of 5 genera (11.6% of the total), and 7 species (5.4% of the total). The Mediterranean and Western Asia to Central Asia elements consist of only 4 genera (9.3% of the total) and only 15 species (11.5% of the total). The Temperate Asia elements have only 1 genus (2.3% of the total) and 1 species (0.77% of the total). (See Table 1.)

The family Gramineae is a large family of cosmopolitan distribution, but only 4 cosmopolitan genera distribute in this area. Among them, *Poa*, *Agrostis* and *Digitaria* are large genera and widespread. In this areal-type, the small genus is *Phragmites*, the constructive plant of marshland, water vegetation and some fixed dunes that appears in the oasis in basin desert.

The temperate elements contain 35 genera and have a percentage of 83.7% of total genera. It is quite evident that the properties of Grasses in this area are mainly the Temperate Zone. Among them, the North Temperate elements occupy an important place. As the geographical situation and natural environment of this area, it should have this distribution pattern.

However, the Pantropic elements consist of 8 genera and occupy the second place in quantity. The genera of this areal-type mainly distribute in the tropics of both hemispheres, but some species also extend to the warm Temperate and the Temperate regions, which the-

sespecies are distributed in Karakorum and Kunlun Mountains. All of these genera are small- and middle-genera that include 8 genera (18.6% of the total genera) that only consist of 14 species. On the one hand, the occurrence of Pantropic genera results from their ecological conditions and causes of history and geography, which this area have the historical origins of Mediterranean. On the other hand, the distribution of Pantropic genera demonstrates that these genera have nature of Temperate to a certain extent. In other words, besides their history and geography, these genera of Pantropic type distributed in this area are themselves have the Temperate properties.

So far as this significance, we can even consider that all of the Grasses in this area have the properties of the Temperate except the Cosmopolitan regions. Among them, the *Erianthus* and *Aristida* are the typical kind that are distributed in the Tropics arid area. *Erianthus* including 30 species total. Among them, 28 species are distributed in Tropical America, southeastern to eastern Asia, Indo-Malaysia and Polynesia etc., 1 species in the Sahara, and 1 species in Madagascar. In this area, only *Erianthus ravennae* from Mediterranean is distributed in this area through the Central Asia. The arid and hot climate of the basin desert in this area is adaptive for this species. All of these show clearly that the flora of this area had relationship with Mediterranean and Central Asia on history and geography.

Among the Temperate types in this area, the North Temperate elements include the most genera and species. Most of them are distributed in Temperate and Frigid Zone, and plateau, high mountains and the pole. The genera of many species distributed in this area are *Festuca* (14 species), *Puccinellia* (12 species) and *Stipa* (9 species) etc. that are the constructive or dominant species on alpine steppe and forest fringe. *Stipa purpurea* is the characteristic species of alpine steppe.

The North Temperate in this area has 2 varieties. 5 genera have discontinuous distribution of the North Temperate and the South Temperate including *Puccinellia*, *Bromus*, *Koeleria*, *Trisetum* and *Helictotrichon*. The 2 genera *Leymus* and *Alopecurus* belong to discontinuous

distribution of the Eurasia and the South America Temperate. *Leymus* including 32 species is mainly distributed in the Temperate and Frigid Zone in the Northern Hemisphere. Most species of *Leymus* grow in Central Asia and Europe, and 11 species are distributed in the north of China. As 7 species are distributed in this area, it is obvious that this region is one of the areas that have the most species of *Leymus* in China.

There are 4 genera and 19 species in the Old World Temperate Zone similarly. Most of them are also distributed in the Temperate and Frigid Zone. In this type, the genus *Roegneria* not only is the typical element but also include the most species. The plants of this genus have a quite well distribution in Eurasia including 120 species. Because the Karakorum and Kunlun Mountains are situated in the Central region of Asian, this area should be a region where the plants of *Roegneria* may be suitable to expand. The extremely adverse environments such as the elevation etc. make lot of species difficult to distribute and expand, only the species having the characteristics of cold-resistant and drought-enduring can grow and develop in this area. Another typical element of this type is the genus *Achenatherum* consisting of only 1 species. *A. splendens* is distributed below the sun slopes, valley, drought flood land along 2 000 ~ 4 400 m asl., which this species composes the single community of steppe.

The Temperate Asia only includes the genus *Ptilagrostis* in this area. This genus is mainly distributed in Northern Asia to Himalayas. There are 5 species in China, only 1 species of *Ptilagrostis* is distributed in alpine shrubs, alpine meadows, shady slopes and flood grasslands of this area. The genus *Ptilagrostis* is originated from *Stipa*. The genus *Stipa* is mainly distributed in steppe and alpine steppe. However, the genus *Ptilagrostis* has developed in alpine region of the Temperate and Frigid Zone, and its habitat of alpine shrubs, alpine meadow and flood grassland etc. are more damp than those of *Stipa*, which this character clearly shows the evolutionary track and direction of the genus *Ptilagrostis*. If *Stipa* has developed in steppe of Eurasia and alpine steppe with the characteristics of typical xerophyte and

cold resistance xerophyte, *Ptilagrostis* are evidently with the characteristics of damp and cold resistance.

The elements of the Mediterranean, West Asia to Central Asia type in Karakorum and Kunlun Mountains, are also found in Eurasia including three monotypic genera and one small genera with 5 species. Among them, the genus *Paracolpodium* has 4 species that are distributed in Caucasus Mountains, Siberia and the middle part of Asia. Evidently, the genus *Paracolpodium* originated from the genus *Catabrosa* with North Temperate on meadow or under the forest by the environments of alpine and cold-arid area. The genus *Catabrosa* has 2 species in China, and they are distributed in Xizang (Tibet) and Xinjiang. There is 1 subspecies *P. alataicum* subsp. *leucolipis* in the Karakorum and Kunlun Mountains area, which it is the first time to find in Qiemo (Qarqan), southern Xinjiang, China. This subspecies is not distributed in east of Qiemo.

The elements of the Central Asia type include 5 genera and 7 species. It's clearly that they are the results of differentiation and development from the elements of North Temperate and the Tethys Sea in the Central Asia mountainous region. This type is a young element in high mountains and plateaus in Asia inland. Among them, the genus *Littledalea* has well developed in the Qinghai-Tibetan Plateau including 4 species that are 1 species in the Central Asia, and 3 species in China. All of them not only distribute in the Qinghai-Tibetan Plateau, but also especially centralize in Tangguta area and its adjacent zone, and spread Xizang, Gansu, Sichuan province of China and adjacent counties such as Nepal etc. The *Littledalea racemosa* becomes the another characteristic species and constructive species of alpine steppe over 4 200 m asl. In view of the above-mentioned facts, it is to be considered that the genus *Littledalea* is the endemic type of alpine steppe in the Qinghai-Tibetan Plateau. Among other 4 genera, *Timouria* is the monotypic genus with young element which derived from the genus *Achenatherum* belonging to the Old World Temperate type. In this area, the genus *Timouria* is distributed in mountainous region of western Tarim Basin. Among other 3 genera, only 1 species is

distributed in this area in every genera. The genus *Orinus* have 2 geographical substitute species that are distributed in Qinghai and mountainous region of Sichuan province, China. In this area, *Orinus thoroldii* occurs in the more arid place and grows in gravelly mountainous slopes and fixed dune from Rutog to Shiquanhe (Gar) where are situated at southeast fringe of Karakorum Mountain. It is to be considered that this genus maybe belongs to the genus of uninterrupted evolution in the environments of mesic and middle xeric from east along the frigid and arid basin to west.

There is no endemic genus in this area due to nature and history and the conditions of intense frigidness and aridity. Moreover, among all 47 genera of family Gramineae, the 36 genera with less than 3 species occupy absolutely dominant position, which these genera has 76.6% percent of total genera in this area, and some genera have a few or a single species. Although some other genera have lots of species, only several species are distributed in this area. Apparently these distributions are undoubtedly restricted by historical and ecological conditions, and the unique natures of flora ecology of the family Gramineae is also reflect. Due to these unique natures, some wide distribution genera that have wide ecological amplitude and include more specie are difficult to distribute in this area. Additionally, the monotypic genera and some narrow distribution genera are originated from their related wide distribution genera. These facts show that the flora of the Karakorum and Kunlun Mountains is a young and derivative flora.

3 Eco-Geographical Distribution of Species

In the Karakorum and the west part of Kunlun Mountains are divided by the Sangzhu River in Pishan of Xinjiang (about west of 78°50' E). Due to the mountain ranges rising and falling intensely in the western part of this area, the mountains are lofty and precipitous, and have a relative height of 4 000 ~ 5 000 m than the valley. The warm and humid microclimate forms between the mountains and valleys. Because of this local environment, some patches of coniferous forest are distributed in this area that is mainly deserts. The ecological

conditions of the forest are suitable for lots of plants to grow. There are 112 species in the western part of this area. Among them, 52 species (46% of the total) disappear in eastern Kunlun Mountains. Most of species belong to the Central Asian species, especially alpine species, such as: *Festuca alata*, *F. kryloviana*, *Trisetum altaicum*, *Ptilagrostis mongholia*, *Timouria saposhnikowii*, *Eragrostis collina*, *Erianthus ravennae*, and so on. The Central Asia elements have a considerable proportion except wide distribution taxa among Gramineae in the western part of this area.

In the eastern part of this area from east of the Sangzhu River to the source of the Yellow River in Qinghai Province, the species of the east are less than that of west, although eastern part of this area is larger than that of western. There only occur 110 species. These distributions are caused by the vast and open plateau surface that is more easily affected by strong wind, and the habitat of the east is harsher than that of the west. Among the 110 species, 50 species that are about 45% percent of the total species in eastern area, are not distributed in western Kunlun Mountains. Most of these species belong to the Qinghai-Tibetan Plateau elements, such as: *Puccinellia multiflora*, *Littledalea przewalskyi*, *L. tibetica*, *L. racemosa*, *Trisetum tibeticum*, *Orinus thoroldii*, *Elymus nutans*, *Deyeuxia tibetica* var. *prezvalskyi*, and so on. The majority of these species are distributed over the alpine zone, and more than 50% are distributed over 4 000 m asl. These distributions clearly show that the plants of Gramineae in eastern part of the Karakorum and Kunlun Mountains mainly include elements of the Qinghai-Tibetan Plateau except wide distribution taxa in all areas. Besides, the pantropical elements chiefly consist of xerophilous type of desert plants in lower altitudes.

4 Analysis of Endemic Species

There are 25 Chinese endemic species of Gramineae in the Karakorum and Kunlun Mountains. Among them, 6 species, 1 subspecies and 2 varieties are endemic to this area, such as *Leymus pishanica*; *Leymus rouqianguensis*; *Poa arjinshanensis*; *Poa festucoides*; *Poa festur*

coides subsp. *kunlunensis*; *Poa scabristemmed*; *Poa poophagorum* var. *hunczilapensis*; *Puccinellia multiflora*. They all are discovered in recent years in this area. Most of them are the result of differentiation from the large and middle-genera that are distributed in the North Temperate region or the cosmopolitan in this area. Among them, some species are the Old World Temperate elements. On the one hand, the occurrence of these endemic plants shows that a unique natural geographical region that has gradually formed by the uplift of the Qinghai-Tibetan Plateau since the Late Cenozoic era. Although the flora of the Karakorum and Kunlun Mountains is young and derivative, the differentiation of some species in Gramineae has taken place by the ecological environment. For this reason, some new taxa are originated. This also shows that this area has relationships with adjacent areas on history and geography, such as *Leymus pishanica* and *Leymus rouqiangensis* have the close relationships to *Leymus aemulans* and *Leymus ramosum* of Europe, the Central Asia and Siberia. This character of simple spikelet on each node of rachilla is first time discovered in the genus *Leymus* in China. Moreover, among 25 Chinese endemic species, there are 3 species only occur in west of the Sangzhu River. There are 12 species occur the eastern part of this area, where 10 species are also distributed in the Qinghai-Tibetan Plateau and is 40% percent of the endemic species. It is obvious that there are the close relationships between the flora of the Qinghai-Tibetan Plateau and this area. The occurrence of endemic species in this area shows clearly that Grasses has the activity on specialization.

Table 2 The comparison of common genera and species of Gramineae from the Karakorum Kunlun Mts. and its adjoining area

Adjoining area	Common genera	Similar coefficient of genera	Common species	Similar coefficient of species
Xizang (Tibet) ^[10]	40	93.0	80	49.7
North India ^[9]	31	72.1	42	26.1
Tian Shan Mt. ^[8]	37	86.0	70	43.5
Tajikistan ^[7]	34	79.1	47	29.2
Himalayas ^[6]	22	51.2	17	10.6

5 Comparing With Flora of Adjacent Area

Because the Karakorum Kunlun Mountains are connected with the Tian Shan Range, the Pamir Plateau, the Hindu Kush Mountains, the Himalayas Range and the Qinghai-Tibetan Plateau in geographical position, the reflection on the flora elements has the some connections with adjacent areas. This phenomenon is reflected by the common genera and species between the floras of this area and adjacent places. (See Table 2).

In this area, there are 22 common genera and 17 common species with the Himalayas^[6] and they have the separate coefficient of similarity 51.2 in genera and 10.6 in species, and they chiefly are the genera of the North Temperate type, such as *Festuca*, *Elymus*, *Deyeuxia*, and so on. Some genera and species are only distribute in this area but not in the Himalayas, and mainly occur in lower elevation region and xeric types of the Central Asia, the Old World Temperate and the Mediterranean, the West Asia to the Central Asia types such as *Timouria*, *Stephanachne*. There are 34 common genera and 47 common species with Tajikistan^[7] and they have the separate coefficient of similarity 79.1 in genera and 29.2 in species. The genera and species are not distributed in Tajikistan, and mainly distributed in lower elevation and xerothermic region of the Central Asia and the Pantropic type such as *Chloris* and *Bothriochloa*. This area has 37 common genera and 70 common species with the Tian Shan Mountain^[8] and they have the separate coefficient of similarity 86.0 in genera and 43.5 in species. All genera of the North Temperate and the Old World Temperate types are common with this area. The genera are not distributed in the Tian Shan Mountain, and consist of *Littledalea* and *Orinus* of the Central Asia type, and *Erianthus*, *Pennisetum* of the Pantropic type, and *Paracolpodium* that is distributed in Caucasus, the Central Asia, the middle part of Asia and Siberia etc. This area has 31 common genera and 42 common species with northern India^[9] and they have a coefficient of similarity 72.1 in genera and 26.1 in species. The genera are not distributed in northern India, and consist of *Littledalea*, *Timouria* and *Stephanachne*, and so on. This distribution shows that

the climate of the Karakorum Kunlun Mountains is more frigid and arid than that of northern India because of the separation of the Himalayas.

On the botanical geography, this area is closer to the Qinghai-Tibetan Plateau by the comparison of common genera and species from both areas. This area has 40 common genera and 80 common species^[10], and has the separate coefficient of similarity 93.0 in genera and 49.7 in species with Xizang (Tibet). It is quite evidence that the coefficient of similarity reaches the peak in above areas that participate in comparison. In view of above compared result, and the similar and connection on botanical geography climate, the grasses in the Karakorum and Kunlun Mountains have an extensive relationships with its adjacent floras, but are the most closely related to the flora of the Qinghai-Tibetan Plateau.

6 Floristic Characteristics and Areal Area

Analysis of the distribution of the genera and species of Gramineae in the Karakorum and Kunlun Mountains Indicates: (1) The Gramineae chiefly contains the North Temperate elements and is also rich in the Old World Temperate elements and other Temperate elements as well. It is clear that the floristic nature of Gramineae in the Karakorum and Kunlun Mountains belongs to the North Temperate; (2) all Pantropic genera can stretch to the Temperate Zone. They are all part of the Pantropic type with the Temperate nature to a certain degree. For example, *Erianthus ravennae* from Mediterranean area through the Central Asia to the Karakorum and Kunlun Mountains area; (3) the majority of Grasses belong to the type that are distributed in the Temperate and the Frigid Zone, and have distinctive feature of highland and alpine flora such as *Orinus*, *Alopecurus*, *Elymus*, *Trisetum*, *Littledalea*, *Elytrigia*, *Stephanachne* and *Paracolpodium*, which it is obvious characteristics of adaptation to alpine specialization and cold-xeromorphilization on Grasses in this area. (4) Endemic genus of Gramineae is not distributed the Karakorum and Kunlun Mountains and the endemic species are also a few. This phenomenon has its natural and histori-

cal reasons. Most of the genera with single or fewer species have originated from its close relative genera that are widely dispersed such as *Ptilagrostis* from *Stipa*, *Timouria* from *Achnatherum*, and so on; (5) The flora of the Karakorum and Kunlun Mountains is closely related to the flora of Tibet, and extensively to its surrounding areas.

About the flora region, Professor Wu Zhengyi (1983) divided this area into the Qinghai-Tibetan Plateau subregion, the Pamir-Kunlun-Tibetan Area (the Qiangtang Subarea and the Pamir-Kunlun Subarea). However, Grobov (1963) divided this area into the Asian Central Subregion, the Tibetan Province (the Tibetan Subprovince and the Pamir Subprovince). By our the expedition, the statistics, analysis and study on the flora elements of Grasses, we think that this flora is closely related with the Qinghai-Tibetan Plateau Subregion according to the flora of Grasses. In the view of the geographical location, although this area situated at the north border district of the Qinghai-Tibetan Plateau, it obviously belongs to the part of the Qinghai-Tibetan Plateau from the east to west and from the south to north as a whole. In addition, it is the same on elevation of mountainous region and the climate such as cold, arid, strong wind, and so on between the two places. Moreover, the typical vegetation such as alpine desert, alpine steppes and alpine meadows etc. of the Qinghai-Tibetan Plateau also occupy main position in this area. Especially, the coefficient of similarity of genus peaks between the flora of this area and Xizang that is a representative of the Qinghai-Tibetan Plateau Subregion, and it sufficiently shows the close relationship between the two floras. Most of the Chinese endemic species in this area belong to the Qinghai-Tibetan Plateau. As stated above, the results of analysis support our views that are identical with that of Professor Wu Zhengyi (1983) who divided this area to the Qinghai-Tibetan Plateau Subregion. On the Pamir-Kunlun-Tibetan Area we think this area may be divided into two parts by the Sang Zhu River near 78°50' E, the western belongs to the Pamir-West Kunlun Subarea, the eastern belongs to the Qiangtang, Middle-East Kunlun Subarea. It is properly that this di-

vision can display more naturally dividing line of the geographical range of flora. The analysis of the family Gramineae, Cruciferae, whole flora and vegetation type clearly show that the Sang Zhu River is a dividing line of subarea of flora.

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