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Survey of plant diversity at Jiufeng Mountain

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Abstract

Jiufeng mountain mining area is located in Inner Mongolia Baotou city, right banner, research and explore the vegetation type and causes for the research and protection of jiufeng mountain natural resources, and lay the foundation for the management and restoration of the mining area, provide information data support, the mining management and ecological restoration. There were five life types of plants in the survey area, namely dwarf high bud, ground shoots, ground bud, cryptic bud and annual plants. The number of ground shoots was the largest and cryptic shoots were the least. In the process of this plant investigation, the plant growth of different slopes has a significant influence. The number of plant families, genera and species in the N, EN and WN slopes is the largest, accounting for 66.67%, 66.67% and 62.50% of the total families, 43.14%, 47.06% and 41.18% of the total genera, 40.00%, 45.45% and 40.00% of all the species. The proportion of plant families, genera and species in N slope, EN slope and WN slope is significantly higher than that in S slope, ES slope and WS slope, and the families, genera and species of plants in S slope are the lowest value, which can intuitively show that the plant richness of Yin slope and semi-negative slope is significantly higher than that of Yang slope and semi-positive slope.

Keywords

Jiufeng Mountain, sample line survey, plant diversit.

1. Introduction

Jiufeng Mountain is located in the middle of Yinshan Mountain and about 10km north of Salazi Town, Baotou City, Inner Mongolia. It is a rare natural scenic spot in Inner Mongolia Plateau, and also an autonomous region level natural reserve and natural forest protection engineering area[1]. The region is rich in vegetation types, species, provides a lot of plant resources, research and explore the vegetation type and cause for the study and protection of natural resources, and lay the foundation for the management and restoration of the mining area, provide information data support, the mine management and ecological restoration.

2. Research area overview

Jiufeng Mountain mining area is located in Tumet Right Banner, Baotou City, Inner Mongolia Autonomous Region, in the middle part of Yinshan Mountain. Jiufeng Mountain Nature Reserve has a total area of more than 460 square kilometers, its geographical coordinates are 40°41 '-40°43' N, 110°43 '-110°45' E, 60 kilometers away from Baotou city, 80 kilometers away from Hohhot, adjacent to Jingremain Railway and 110 National Road in the south[2]. Jiufeng Mountain is the main peak of Yinshan Mountain, 2337.8 meters above sea level. The area has beautiful scenery, dense forests and good natural vegetation. Jiufeng Mountain is located in the temperate continental semi-arid monsoon climate zone; winter is long and cold and summer is warm[3]; The temperature difference between day and night is large, with annual average temperature 7℃, highest temperature 38.1℃ and lowest temperature-37℃; summer rainfall is obvious, precipitation is about 85% of the whole year; frost-free period is about 132 days,

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climate is suitable; the annual average evaporation is 2055 mm, maximum evaporation is from May to July, accounting for more than 50% of the annual evaporation. The soil type of Jiufeng Mountain belongs to the gray brown soil, which is divided into six types, namely, gray brown soil, chestnut calcium soil, meadow soil, wind and sand soil, salt soil and marsh soil. The soil is uneven in thickness, and some places have exposed rock[4]. Seasonal streams in Jiufeng Mountain area belong to the Meidigou water system[5]。

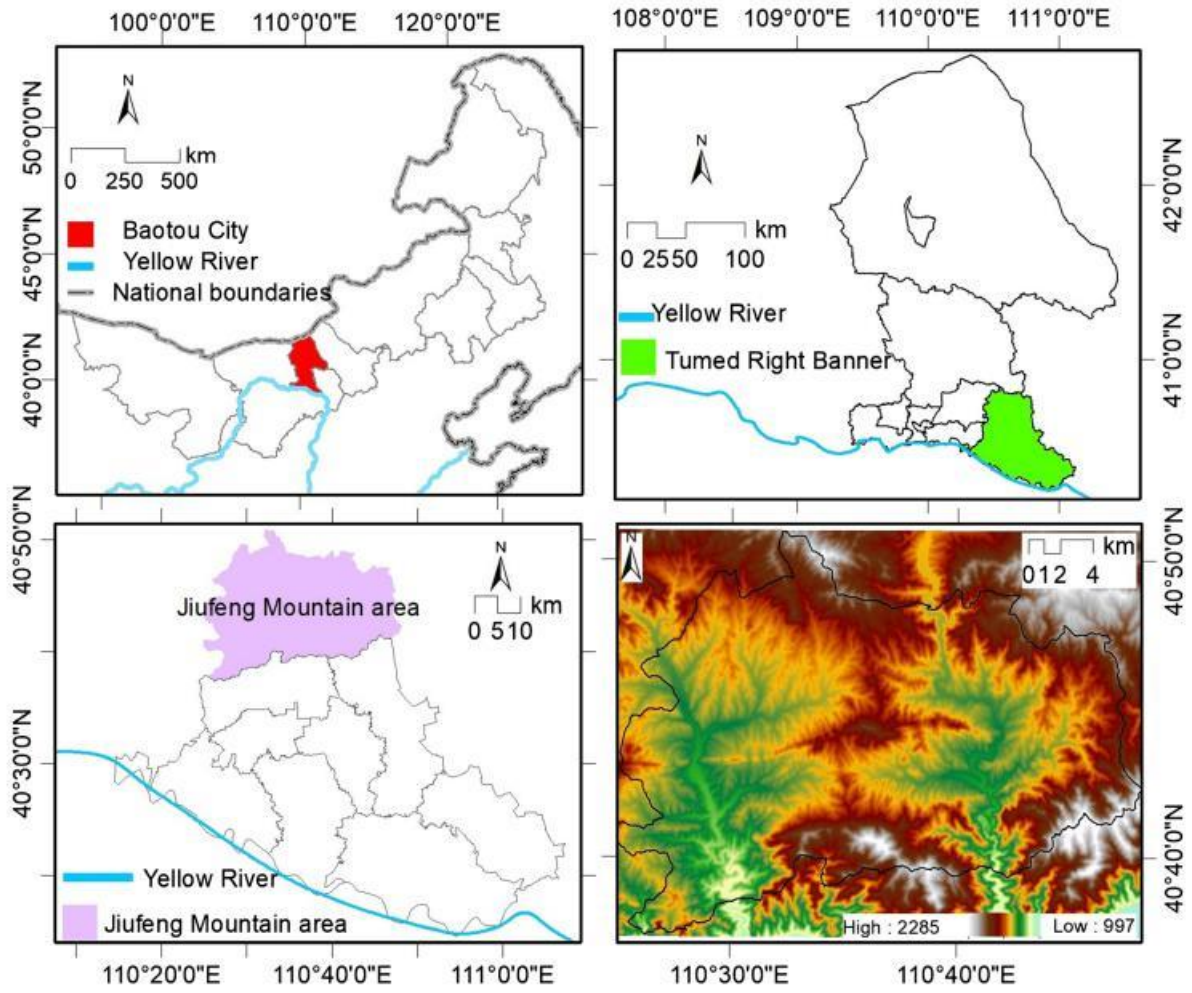

Figure 1: Location map of Jiufeng Mountain

3. Research technique

Site selection: according to the previous data refer to combining with jiufeng mountain nature reserve field vegetation growth and distribution, jiufeng mountain grassland mountain terrain, the terrain is the main factor of local habitat differences, given the survey area area is larger and according to the characteristics of the regional terrain type, we will be around the test site for the slope, south slope, southwest slope, northwest slope, southeast slope, northeast slope of mountain sampling survey.

Sample line setting: set a line (baseline) on one side of the section, then conduct GPS satellite positioning at the starting point, survey the starting point, and record the name, length and height of the vegetation within 0.5m of the sample line, and record the 1000:1 sample line and vegetation on coordinate paper, and collect plants and make specimens.

The sampling method. Samline method refers to the method of taking a straight line within a plant community or through several communities, recording the plants encountered along this line and analyzing the community structure. The traditional survey method is sampling by samples or strips. In terrestrial vegetation survey, the sample line method is mostly applied to

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large-scale vegetation community research, which can effectively balance the spatial heterogeneity of sample plots. Different line design method obtained different results on plant diversity, community structure and other factors in the same community, which affects the accuracy and reliability of plant diversity survey, and the efficiency of plant diversity survey will be affected due to the different time consumption and human input.

Preparation materials: 100m measuring rope, measuring tape, GPS, coordinate paper, shovel, branch scissors, specimen clip, specimen paper.

Figure 2: Jiufeng Mountain

4. Results and analysis

4.1. Investigation of plant taxonomic composition

In the process of this survey, we selected the shrubs and herbs of the south slope, the north slope, the southwest slope, the northwest slope, the southeast slope and the northeast slope near the test site. According to the selected slope, the sample direction is numbered, and the GPS satellite positioning at the starting point of each group of sample lines is recorded. In the process of sampling, the crown amplitude and line distance of each shrub were measured by a tape measure. The plant communities in the survey area were Asteraceae (Dendrantema Morifolium) and Legaceae (Leguminosae sp.), Poaceae (Poaceae), Rosaceae (Rosaceae Juss.) Plants are mainly used, and the main plant species is iron-rod Artemisia (Artemisia gmelinii Web.ex Stecm.), Mahua head (Klasea centauroides (L.) Cass.), Crane lice (also known as Carpesium abrotanoides L.), Bean (Oxytropis ciliata Turcz.in Bull.Soc.Nat. Moscou), sweet clover (Melilotus officinalis (L.) Pall.), Hu Lizi (Lespedeza bicolor Turcz.), Small leaf brocade chicken (Caragana stenopylla Pojark.), Thyme (Tymus mongolicus Ronn), grass (Cleistogenes squarrosa (Trin.) Ken), Lai (Leymus secalinus (Georgi) Tzvel.), Ice grass (Agropyron cristatum (L.) Gaertn.), Leaves (Nepeta tenuifolia Bentam), motherwort (Leonurus artemisia (aur.)S.Y. U F), thyme (Tymus mongolicus Ronn), two split marigold (Potentilla bifurca), grassland xia grass (Gypsopila davurica Turcz.ex Fenzl), Xingan carnation (Diantus cinensis L.), Dry wheat bottle grass (Silene jenisseensis Willd.)。

A total of 457 plants were sampled from 24 families, 51 genera and 55 species. As shown in Table 1, in the statistics of families, Comaceae, Poaceae, Legaceae, Lamiaceae, Rosaceae, Caraceae and Trichoaceae accounted for 62.69%.

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Table 1 Statistical table of vegetation survey families and genera

scholarly honor won in imperial exams	The numb er of	Proportion of the total species number /%	scholarly honor won in imperial exams	The numb er of	Proportion of the total species number /%
Rosaceae	5	8.62%	sedge family	1	1.72%
Ulmaceae	1	1.72%	Chenopodiaceae	1	1.72%
Betulaceae	1	1.72%	Umbelliferae	1	1.72%
Leguminosae	5	8.62%	Verbenaceae	1	1.72%
the grass family	5	8.62%	Gentianaceae	1	1.72%
the composite family	10	17.24%	Dioscoreaceae	1	1.72%
Polygalaceae	2	3.45%	Scrpophulariace ae	2	3.45%
Labiatae	4	6.90%	Campanulaceae	2	3.45%
Ephedraceae	1	1.72%	Cyanozoa seedling family	2	3.45%
Crassulaceae	1	1.72%	Liliaceae	1	1.72%
Caryophyllaceae	3	5.17%	Ranunculaceae	4	6.90%
Onions	2	3.45%	Valerianaceae	1	1.72%

According to the plant type in the survey area, the Asteraceae are Artemia (Artemisia Linn.) Mainly reflects the characteristics of drought and barren; legume, grass and grass reflect the poor water conditions; Coraceae (Rosa L.) There are more plants, reflecting the characteristics of the Jiufengshan Mountain region. The overall characteristics of plants in the survey area were dominated by plant communities adapted to arid and barren mountain environment.

4.2. Analysis of investigated plants

Among the 24 families, as shown in Table 2, more than 5 genera include Chrysanthemum (Dendrantema Morifolium) and Poaceae (Poaceae), containing 15 genera, accounting for 29.41% of the total genera in the survey area and 8.33%; families containing 2-5 genera include Lamaceae (Labiatae) and hairy (Ranunculaceae Juss.), Rosaceae (Rosaceae Juss.), aceae (Caryopyllaceae Juss.), Xuanshen Department (Scropulariaceae Juss.), Legume (Leguminosae sp.), 16 genera of 6 families, accounting for 31.37% of the total plants in the survey area and 25.00% of the total families; only one genus includes lily (Anemarrena aspodeloides Bunge), sauce (Patrinia scabiosaefolia), scallion (Alliaceae) birch (Ostryopsis davidiana Decne.), Jingtentec (Orostacys fimbriatus (Turcquez.) Berger), and platinaceae (Adenopora stricta Miq.), Quindiaceae (Cenopodium aristatum L.), Gentiaceae (Gentiana scabra Bunge), ephedrine (Epedra sinica Stapf), Verbenaceae (Caryopteris mongolica Bunge), seedling (Geranium wilfordii Maxim.), Umbrella aceae (Bupleurum cinense DC.), Cyclicaceae (Cyperaceae Juss.), Potato family (Discorea nipponica Makino), elm family (Ulmus pumila L.), Far Zhi Department (Polygala sibirica L.), Accounting for 33.33% of all plant genera in the survey area, but accounting for 66.67% of all families. In addition, among the 24 families, more than 5 species are Asteraceae (Dendrantema Morifolium), Poaceae (Poaceae), legaceae (Leguminosae sp.), Rosaceae (Rosaceae Juss.), There are 25 species of plants, accounting for 45.45% of the total plants investigated and 16.67% of all families, namely 16.67% of families, including 45.45% of plant species; including 2-5 species, lip (Labiatae) and hairy (Ranunculaceae Juss.), aceae (Caryopyllaceae Juss.), Xuanshen Department (Scropulariaceae Juss.), Allium (Alliaceae), Platycodon grandiflorum (Adenopora stricta Miq.), Cattle (Geranium wilfordii Maxim.), Far Zhi Department (Polygala sibirica L.), Eight families and 16 genera, accounting for 38.18% of all the surveyed plants and 33.33% of all the families; only one species were lily (Anemarrena

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aspodeloides Bunge), sauce (Patrinia scabiosaefolia), scallion (Alliaceae) birch (Ostryopsis davidiana Decne.), Jingtentec (Orostacys fimbriatus (Turcquez.) Berger), including 12 families and 12 genera, accounting for 21.82% of all the total surveyed plants and 50% of the total families.

Table 2 Characteristics of family, genera, and species combinations of plants

Family belongs to the species composition	quantity	Accounting for all departments /%	contains the genus number	It accounts for all genera /%	Containing species number	Accounting for all species /%
The family> 5 genera	2	8.33%	15	29.41%	15	27.27%
Families containing 2 – 5 genera	6	25.00%	16	31.37%	20	36.36%
> 5 Species of families	4	16.67%	24	47.06%	25	45.45%
Families containing 2-5 species	8	33.33%	16	31.37%	21	38.18%
The family containing only one genus	16	66.67%	17	33.33%	19	34.55%
It contains only one family	12	50.00%	12	23.53%	12	21.82%

4.3. Investigation of plant life ability

Life is the external manifestation of biological adaptability to the external environment. The same life is a species, which is not only similar in posture, but also in its adaptive characteristics are similar. There are many research works on plant life type. This time, the famous Danish ecologist Raunkiaer life system was selected. According to this standard, Raunkiaer land plants are divided into five life, respectively for high plants (phanerophytes) (and divided into four subcategories: large high buds, high buds, small high plants), ground plants (chamaephytees), ground plants (hemicryptophytes), hidden plants (cryptophytes), annual (therophytes).

As shown in Table 3, there were five life types of plants in the survey area, including dwarf shoots, aboveground shoots, ground shoots, cryptic plants, and annuals. The number of ground shoots was the largest and cryptic shoots were the leas.

4.4. Different line plant statistics

4.4.1. Statistical analysis of different line plant family species

The area of this plant survey is located in the southwest of Jiufeng Mountain Nature Reserve, Tumet Right Banner, Baotou City, Inner Mongolia Autonomous Region. The vegetation restoration based on the coal gangue yard is mostly located in the gully of mountainous valleys. This vegetation community survey is mainly concentrated within 3km near the experimental site. The survey method is sample line method. Six peaks of different slope directions were selected for plant investigation, and 12 shrub and herb sample lines were investigated. Statistics of plant families, genera, and species with different lines are shown in Table 4.

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Table 4 Statistics of different line plant families, genera and species

Sample line name	The family number	genus number	The number of	Sample line name	The family number	genus number	The number of
JFK-S001	2	2	2	JFKS001	2	2	2
JFK-S002	1	2	2	JFKS002	6	9	9
JFK-S003	2	3	3	JFKS003	8	11	11
JFK-S004	1	3	3	JFKS004	9	11	12
JFK-S005	2	3	3	JFKS005	8	12	12
JFK-S006	3	4	4	JFKS006	7	9	9
JFK-N007	2	3	3	JFKS007	5	8	8
JFK-N008	2	4	4	JFKS008	10	10	10
JFK-N009	2	3	3	JFKS009	10	12	13
JFK-N010	2	4	4	JFKS010	6	10	10
JFK-N011	2	3	3	JFKS011	8	10	10
JFK-N012	1	2	2	JFKS012	10	12	12

Note: JFS-S00X and JFS-N00X are sampled for shrubs; JFKS00X is sampled for herbaceous plants.

Because we respectively selected the slope for south slope, north slope, southwest slope, northwest slope, southeast slope, northeast slope mountain sampling survey, different slope light intensity, temperature, humidity have significant differences, so in the process of the plant survey, the plant growth of different slope also has a significant influence. As shown in Table 5, the number of plant families, genera and species in N, EN and WN slopes are the largest, accounting for 66.67%, 66.67%, 62.50%, 43.14%, 47.06% and 41.18% of the total families, and 40.00%, 45.45% and 40.00% of all specie.

Table 5 Statistics of different slope plant families, genera and species

aspect	The family number	Accounting for all departments /%	genus number	It accounts for all genera /%	The number of	Accounting for all species /%
N	16	66.67%	22	43.14%	22	40.00%
EN	16	66.67%	24	47.06%	25	45.45%
WN	15	62.50%	21	41.18%	22	40.00%
S	11	45.83%	17	33.33%	17	30.91%
ES	13	54.17%	16	31.37%	16	29.09%
WS	11	45.83%	16	31.37%	16	29.09%

Different slope to plant family, genus, species percentage value as a trend figure, as shown in figure 1, can intuitively see N slope, EN slope, WN slope plant family, genus, species proportion significantly higher than S slope, ES slope, WS slope, and S slope plant are the lowest families, genus, species, which can intuitively explain the Yin slope, half Yin slope plant richness is significantly higher than Yang slope and half Yang slope.

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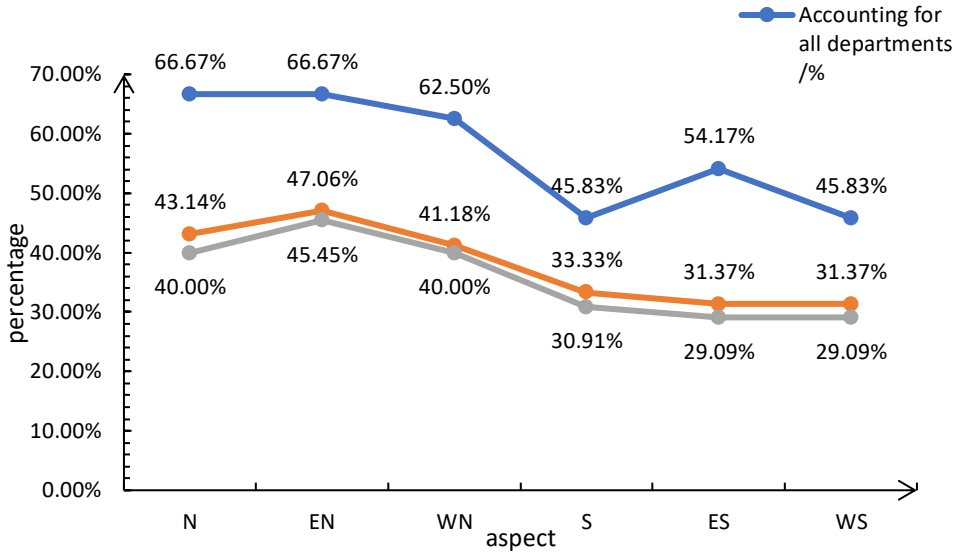

Figure 3: Percentage of species in different slope directions

4.5. Analysis of plant diversity

4.5.1. Analysis of plant importance values

Important values are important indicators when calculating, assessing species diversity, indicating the relative importance of plant species in communities with comprehensive values[6]. This survey calculates the plant importance value by calculating the following formula:

$$\text{Significant value} = \text{relative density} + \text{relative coverage} + \text{relative frequency} \quad (1)$$

$$\text{Where: density} = (N)\ 2\ /\ (\text{sample length } M); \quad (2)$$

$$\text{relative density} = \text{number of 100 species} / \text{number of all plants}; \quad (3)$$

$$\text{cover} = 100\ (\text{total L of plant length along the direction of a plant}) / \text{total length of sample line}; \quad (4)$$

$$\text{relative cover} = 100\ \text{cover} / \text{sum of all species}; \quad (5)$$

$$\text{frequency} = \text{number of 100 sections} / \text{total number of sample sections}; \quad (6)$$

$$\text{relative frequency} = \text{frequency of 100 species} / \text{sum of frequency of all species}. \quad (7)$$

The data results shown in Table 6 are obtained by calculating the plants in this survey. In the investigated plots, the highest significant value, 14.13%, the latter, 3.83% and the relatively low important plants, 1.14%. In shrubs, the highest value is the rose, accounting for 36.42%; the plants second only to the rose is almond, accounting for 21.97%. In shrubs, the plants accounted for 0.72%.

Table 6 investigated the plant importance value statistics

Herbaceous plant importance value (top ten species)		Shrub plant importance value	
Plant name	importance value	Plant name	importance value
Kirschner Sylflux (Stipa krylovii Roshev)	9.11	Huang mei (Rosa xanthina Lindl.)	23.49
Brown grass (Cleistogenes squarrosa)	2.47	Tonsils (Amygdalus communis L.)	14.17
Thyme (Thymus mongolicus Ronn)	2.36	Tiger hazelnut (Ostryopsis davidiana Decne.)	1.53
E. aria (Oxytropis ciliata Turcz)	1.93	Elm trees (Ulmus pumila L.)	1.16

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Wild chrysanthemum (Chrysanthemum indicum L.)	1.85	Tanju (Spiraea salicifolia L.)	0.82
Wasson (Orostachys fimbriatus)	1.37	Sarrow leaf golden chicken (Caragana stenophylla Pojark.)	0.47
ephedra (Ephedra sinica Stapf)	1.09		
Nikyokan (Carex pediformis)	1.07		
Arrod (Artemisia sacrorum Ledeb.)	0.88		
Tangpine grass (Thalictrum petaloideum L.)	0.73		

4.5.2. Analysis of plant diversity

Plant diversity index is usually used to determine the stability of communities or ecosystems, and different indices express diversity from different aspects[7]. The Margalef index, Simpson index, Pielou index, Shannon-Weiner index and Pielou index of the investigated plants were analyzed respectively, and the formula is as follows:

$$\text{The Margalef-Index (R)} = \frac{S-1}{\ln N} \tag{8}$$

$$\text{The Simpson-Index (D)} =,1-\sum_{i=1}^{s} Pi^2 \quad Pi = ni/N \tag{9}$$

$$\text{The Shannon-Weiner Index (H ')} =,-\sum_{i=1}^{s}(P_i * \ln P_i) \quad Pi = ni/N \tag{10}$$

$$\text{The Pielou-Index (J)} = \left(-\sum_{i=1}^{s}(P_i * \ln P_i)\right)/\ln S \tag{11}$$

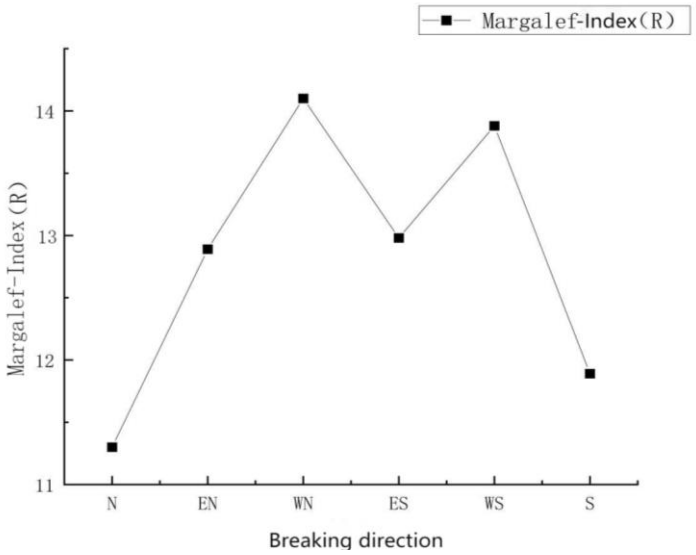

Figure 4: Margalef analysis diagram of different slope plants

Where s is the number of species in the sample, i is the i species, the number of individuals in the i species in the ni line, N is the number of individuals in all species in the sample, and the number of individuals in the i species in the Pi line in the number of individuals in all species.

The Margalef index reflects the species richness of a community, which refers to the number of species in a community or an environment, and also represents the index of the species richness

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in the biota cluster (or sample)[8]. By performing Margalef index statistics for different slope directions, the results are shown in Figure 2. With the transition of slope from Yin slope to Yang slope, the overall trend of the community species richness is the first increase after decrease, in WN slope reached the maximum of 14.1, from WS slope to S slope conversion Margalef index dropped sharply, from WS slope 13.88 to S slope of 11.89, which can be seen the size of different slope species richness: half Yin slope> half Yang slope> Yin slope> Yang slope.

The Simpson index describes the probability that the number of individuals obtained from two consecutive sampling of a community species belongs to the same species. The larger the Simpson index value, the smaller the dominant species, and the higher the singularity[9]. According to the Simpson index statistics of the plants with different slopes in Figure 3, the highest Simpson index is N slope, Simpson index value is 0.84, the lowest is S slope and Simpson index value is 0.36. It can be seen that the sunshine time of the plants on the Yin slope is shorter compared with the sunny slope, the rain is abundant, and the growth potential is generally good. All kinds of plants do not frequently have a particularly obvious dominance, which also makes the singularity higher, increases its diversity, and makes the population more stable. As the overall trend of species dominance in the community gradually decreases with the transition from negative slope to positive slope, the value decreases sharply during the transition from semi-positive slope to sunny slope. It can be seen that the size of species dominance in different slope is: negative slope> half negative slope> half-positive slope> Yang slope.

The Shannon-Weiner index reflects the community species diversity based on the number of species: the increase of biological species in the community represents the increased complexity of the community, and the more information the community contains[10]. According to the Shannon-Weiner index of different slopes of the plants in this survey, the trend of the Shannon-Weiner index and the Simpson index, while the Shannon-Weiner index is the EN slope, the Shannon-Weiner index is 2.12; but the lowest value is still S slope, and the Shannon-Weiner index is 1.22. The overall trend of species diversity in the community gradually decreased with the Shannon-Weiner index of the transition from negative slope to sunny slope, and the value decreased sharply during the transition from semi-negative slope to semi-positive slope. It can be seen that the dominant degree of species in different slope directions was: semi-negative slope> semi-positive slope> semi-positive slope> semi-positive slope.

Pielou Index reflects the community evenness: use the species singularity to estimate the evenness of the distribution of species in the community[10]. As can be seen from Figure 3, the EN slope has the highest Pielou index and the highest value of 0.52, indicating that the plants are most evenly distributed in this slope. Different from the above indexes, the Pielou index of WS slope is low with the lowest value of 0.31, while the Pielou index of S slope is relatively higher than the plants of WS slope and ES slope, the species singularity of S slope is relatively high and the plant density of S slope is relatively high, so the uniformity is high. It can be seen that the species uniformity of different slopes is respectively: semi-negative slope> negative slope> sunny slope> semi-positive slope.

According to the above calculation results, the standard Simpson index of dominance gives the order of dominant species from more to less as: Yin slope> half Yin slope> half Yang slope> Yang slope. According to the richness standard Margalef index, the species richness of green land was ranked from high to low as: half negative slope> half Yang slope> Yin slope> Yang slope. According to the complexity standard Shannon-wiener index, the complexity of green space was ranked from high to low as: semi-Yin slope> Yin slope> semi-Yang slope> Yang slope. According to the standard Pielou index of uniformity, the order of green land plants uniform from high to low is: semi-negative slope> Yin slope> Yang slope> semi-Yang slope. After the overall evaluation, the diversity of the survey sites was ranked from high to low as: half-negative slope> negative slope> half-negative slope> half-positive slope> sunny slope.

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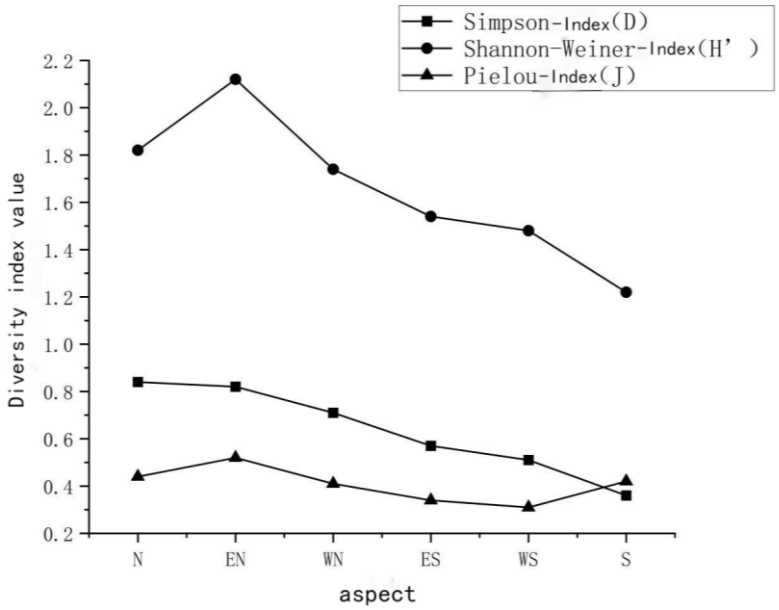

Figure 5: Analysis of plant diversity in different slopes

5. Discuss

A total of 457 plants were sampled from 24 families, 51 genera and 55 species. Plant type in the survey area, Asteraceae with Artemia (Artemisia Linn.) Mainly reflects the characteristics of drought and barren; legume, grass and grass reflect the poor water conditions; Coraceae (Rosa L.) There are more plants, reflecting the characteristics of the Jiufengshan Mountain region. The overall characteristics of plants in the survey area were dominated by plant communities adapted to arid and barren mountain environment.

There were five life types of plants in the survey area, namely dwarf high bud, ground shoots, ground bud, cryptic bud and annual plants. The number of ground shoots was the largest and cryptic shoots were the least. In the process of this plant investigation, the plant growth of different slopes has a significant influence. The number of plant families, genera and species in the N, EN and WN slopes is the largest, accounting for 66.67%, 66.67% and 62.50% of the total families, 43.14%, 47.06% and 41.18% of the total genera, 40.00%, 45.45% and 40.00% of all the species. The proportion of plant families, genera and species in N slope, EN slope and WN slope is significantly higher than that in S slope, ES slope and WS slope, and the families, genera and species of plants in S slope are the lowest value, which can intuitively show that the plant richness of Yin slope and semi-negative slope is significantly higher than that of Yang slope and semi-positive slope.

For the analysis of plant survey diversity, the Margalef index decreased sharply from WS slope to S slope, from 13.88 in WS slope to 11.89 in S slope. It can be seen that the species richness of different slopes is respectively: semi-negative slope> semi-positive slope> negative slope> Yang slope. According to the standard Simpson index of dominance, the order of dominance species from more to less is: Yin slope> half negative slope> half Yang slope> Yang slope. According to the richness standard Margalef index, the species richness of green land was ranked from high to low as: half negative slope> half Yang slope> Yin slope> Yang slope. With the Shannon-wiener index by the complexity criteria[11]It is concluded that the complexity of green space is ranked from high to low: half-negative slope> Yin slope> half-positive slope> sunny slope. According to the standard Pielou index of uniformity, the order of green land plants uniform from high to low is: semi-negative slope> Yin slope> Yang slope> semi-Yang slope. After the overall evaluation, the diversity of the survey sites was ranked from high to low as: half-negative slope> negative slope> half-negative slope> half-positive slope> sunny slope

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