Species Composition and Diversity of *Fagus longipetiolata* in Leigong Mountain, Guizhou Province

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Abstract [**Objectives**] To understand the species composition and diversity of *Fagus longipetiolata* community. [**Methods**] The *F. longipetiolata* community in Guizhou Province was investigated by typical plot method. [**Results**] There were 107 species of vascular plants belonging to 79 genera and 51 families in Leigong Mountain *F. longipetiolata* community, including 3 species of pteridophytes belonging to 3 genera and 3 families, 104 species of spermatophytes belonging to 76 genera and 48 families, including 3 species of gymnosperms belonging to 3 genera and 3 families, and 101 species of angiosperms belonging to 73 genera and 45 families. The types of Leigong Mountain *F. longipetiolata* community were divided into 7 formations, and the top 10 important species of each formation were Fagaceae, followed by Lauraceae and Ericaceae. The change trend of tree layer richness index was formation I > formation IV > formation VI > formation III > formation VII > formation II > formation V; the dominance index was formation I > formation IV > formation V > formation VI > formation VII > formation III > formation II; H diversity index was formation V > formation II > formation I > formation III > formation VII > formation VI > formation IV; the evenness index is formation II > formation III > formation VI > formation VII > formation IV > formation I > formation V; the total diversity index of the community, formation I (3.67) was the highest, formation V (2.74) was the lowest, manifested as formation I > formation III > formation VI > formation II > formation IV > formation VII > formation V. [**Conclusions**] The community stability is closely related to its species composition, and the background species is the basis for the survival of the community; the existence of rare species can further enhance the community diversity index and enhance the community stability.

Key words *Fagus longipetiolata*, Community type, Species composition, Species diversity, Leigong Mountain, Guizhou

1 Introduction

Fagaceae is an ancient tall arbor that has survived the Tertiary Period and belongs to the Eurasia – North America disjunct distribution type. It is an important constructive species of temperate forest vegetation in the Northern Hemisphere and disjunctively distributed in the subtropical mountains of the Northern Hemisphere[1-2]. *Fagus longipetiolata* community is a kind of zonal community in the mid-subtropical and subalpine regions. It often forms a mixed forest with the evergreen broad-leaved tree species forming the upper limit of the latitudinal zonal evergreen broad-leaved forest in the lower part of its vertical forest belt, such phenomenon is unique to China and has important scientific value[3]. Gao Xiangqin *et al.* [4-5] considered that *F. longipetiolata* community of Fanjing Mountain is rich in woody plant species, with complex flora, ancient and obvious tropical nature, which is unique in the world and has important world heritage value. *F. longipetiolata* is distributed in the south of Qinling Mountains and the north of the southern slope of Wuling Mountains in China, and grows in mountain mixed forests at an altitude of 300 – 2 400 m. *F. longipetiolata* community is a zonal community in Leigong Mountain, and it is distributed in the mountain weed forest at an altitude of 800 – 1 800 m, forming an original community. *F. longipetiolata* has a large crown, which is very important for soil and water conservation and plays a great role in the maintenance of ecological security in the region[6]. Li Dengjiang *et al.* [7] analyzed *F. longipetiolata* community in Yezhutang of Leigong Mountain from species composition, important value and species diversity of the community, and considered that *F. longipetiolata* occupied an absolute dominant position in the community and was the constructive species. Yang Lidan *et al.* [8] preliminarily analyzed the species diversity of *F. longipetiolata* community and the distribution pattern of *F. longipetiolata* and *Cyclobalanopsis glauca* in Leigong Mountainm, and found that *F. longipetiolata* community had high species diversity in the arbor layer and shrub layer, low diversity in the herbaceous layer, and higher species diversity in the community, and the population distribution pattern increased with the diameter level, and the population of *F. longipetiolata* transitioned from random distribution to cluster distribution, while the population of *C. glauca* transitioned from cluster distribution to random distribution. Yang Lidan *et al.* [9] further studied *F. longipetiolata* community characteristics and spatial distribution pattern, and considered that *F. longipetiolata* in *F. longipetiolata* community tree layer had the largest important value and was the constructive species; the important value of *F. Longipetiolata* was higher in all formations, and it was dominant in the community. The diameter classes of *F. longipetiolata* were distributed from class I to class V, and the number of class I and class V was large, showing a bimodal distribution. The *F. Longipetiolata* population was randomly distributed in I, II and III saplings, and with the increase in di-

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ameter class, the *F. Longipetiolata* population transited from random distribution to cluster distribution. The dominant species *C. glauca* transited from cluster distribution to random distribution, while other dominant species were mostly random distribution. Zheng Demou *et al.*[10] studied the structural characteristics of *F. longipetiolata* community at different altitudes in Leigong Mountain Nature Reserve, and considered that *F. longipetiolata* is mainly distributed in the middle and high altitudes of 1 100 – 1 566 m. Altitude was not significantly negatively correlated with Simpson dominance index D, Shannon – Wiener diversity index He' and Pielou evenness index Je. *F. longipetiolata* community is a zonal community in Leigong Mountain, and its research has attracted attention in recent years. The composition and structure of different types of species of *F. longipetiolata* community have been studied, but not deep. In order to further understand the species composition and diversity of different types of plants in the *F. longipetiolata* community, we intended to provide a scientific basis for the protection and sustainable utilization of *F. longipetiolata*.

2 Study area

The study area is located in Leigong Mountain National Nature Reserve and Nangong Nature Reserve (26°24′ – 26°38′ N, 108°16′ – 108°29′ E) of Taijiang County, Guizhou Province. It is located in the watershed zone between the Yangtze River system and the Pearl River system, and is the birthplace and water supply area of the main tributaries of Qingshui River and Duliu River. The landform of this area belongs to the eroded low-middle mountain landform, with strong river erosion and cutting, and the landform is broken. The area is rich in water resources, and the climate is warm and humid, with an average annual temperature of 15 ℃, an average annual accumulated temperature of 3 500 – 4 500 ℃, and an average annual precipitation of 1 450 mm. The soil is mountain yellow soil with thin soil layer, but the content of organic matter, total nitrogen and total potassium is high, the soil is loose and the air permeability is good[11]. The native vegetation in this area is mid-subtropical humid evergreen broad-leaved forest, with good native forest vegetation, and the forest coverage rate is 86%. There are few human activities in the investigation area, and the vegetation is not strongly disturbed by human activities.

3 Research methods

3.1 Field survey On the basis of on-the-spot survey, with reference to related literature[7-13], 13 standard sample plots with an area of 30 m × 20 m were set up in the *F. Longipetiolata* distribution section. The basic situation of each sample plot is shown in Table 1. The standard plot was divided into six 10 m × 10 m quadrats, and the sample stake was set at the southwest corner vertex, and then the six quadrats were divided into four 5 m × 5 m small quadrats, which were used as the basic unit of field work. Then, we surveyed the species of tree layer (measured from the height ⩾ 5 m), recorded the tree species, number of trees, tree height, diameter at breast height (DBH), clear bole height (CBH), crown width, viability, *etc.*; we selected the small quadrat (5 m × 5 m) in each northwest corner as the shrub survey unit to investigate the shrub species, number of clumps, ground diameter, height, growth status, distribution status and coverage. Finally, a 1 m × 1 m quadrat was set up in the northwest corner of the shrub quadrat as the herbaceous plant observation area to investigate the herbaceous plant species, number of plants, crown diameter, height, growth and coverage.

3.2 Data processing

3.2.1 Calculation of important values. The species of the community were counted, and then the important value and species diversity of the tree layer, shrub layer and herb layer in the plot were calculated separately. For the calculation of important value, refer to the calculation method of Zhang Jintun[14], namely, Importance Value (IV) = (Relative density + Relative dominance + Relative frequency)/3.

3.2.2 Calculation of species diversity. The calculation formula of specifies diversity is as follows:

Gleason richness index (E): $E = S/\ln A$

Gimpson diversity index (D): $D = 1 - \sum_{i=1}^{s} \frac{N_i(N_i-1)}{N(N-1)}$

Shannon – Wiener diversity index (H): $H = -\sum_{i=1}^{s}(P_i \ln P_i)$

Pielou evenness index (J_{sw}): $J_{sw} = H/\ln S$

where S is the number of species, A is the unit area, N_i is the number of individuals of the i^{th} species, N is the total number of individuals of all species, and P_i is the frequency, *i.e.*, $P_i = N_i/N$. Total diversity index of community (W): $W = \Sigma W_i \times D$, where W_i is the weight of the i^{th} growth form[15] (the weight is the proportion of the coverage of the i^{th} growth form to the total coverage of the community and the half of the average thickness of the leaf layer of the i^{th} growth form to the sum of the average thickness of the leaf layer of the community); D_i is the diversity index of the i^{th} growth form. SPSS 25.0 software was used for mathematical statistics and analysis.

4 Results and analysis

4.1 Composition of community species Through survey, it is found that *F. Longipetiolata* community includes 107 species (including infraspecific taxa) of vascular plants belonging to 79 genera and 51 families, of which pteridophytes had 3 species belonging to 3 genera and 3 families, spermatophytes had 104 species belonging to 76 genera and 48 families, and gymnosperms had 3 species belonging to 3 families, 3 genera and 3 species, and angiosperms had 101 species belonging to 45 families and 73 genera. They are dominated by Fagaceae with 5 genera and 7 species, Lauraceae with 4 genera and 7 species, Rosaceae with 5 genera and 7 species, Ericaceae with 2 genera and 6 species. These 4 families contain 16 genera and 27 species, separately accounting for 20.25% of the total genera and 25.23% of the total species, so they are the dominant families in the community. It can be seen from Table 1 that there are 28 families with one species, accounting for 54.90% of the total number of families; there are 59 gene-

ra with one species, accounting for 74.68% of the total number of genera; the community is dominated by single-species families and single-species genera. In general, the species composition of *F. longipetiolata* community is complex. There are 44 species in the tree layer of *F. longipetiolata* community, taking up 41.12% of the total species, of which Fagaceae is the most abundant. The constructive species of the tree layer include *F. longipetiolata*, *Cyclobalanopsis glauca*, *Schima wallichii*, *Carpinus pubescens*, *C. multinervis*, *followed by Schima superba*, *Castanopsis eyrei*, *Lithocarpus glaber*, *Acer davidii*, *Populus adenopoda*, *Cunninghamia lanceolata*, *Dendrobenthamia hongkongensis*, *Platycarya strobilacea*, *Elaeocarpus japonicas*, and other species are less. There are 81 species in the shrub layer of the *F. longipetiolata* community, accounting for 75.70% of the total species. In the plot, *C. glauca*, *F. longipetiolata*, *Rhododendron microphyton*, *Lithocarpus hancei* are dominant species, followed by *Diospyros* kaki var. silvestris, *Eurya loquaiana*, *C. pubescens*, *Eurya muricata*, *Rhododendron rivulare*, *Rhododendron bachii*, *Symplocos anomala*, *Machilus ichangensis*, *Cyclobalanopsis multinervis*, and other species are less. There are 14 species in the herbaceous layer of *F. longipetiolata* community, accounting for 13.08% of the total species, of which *Oplismenus compositus*, *Ophiopogon bodinieri* are dominant species, followed by *Goodyera velutina*, *Lophatherum gracile*, and *Pteris cretica*, and *Cymbidium ensifolium*, and *Liparis japonica* have sporadic distribution.

Formation II: *F. longipetiolata* + *C. pubescens* formation, including No.4 and No.8 plots, the altitude is 1 020 – 1 100 m, the slope position is in the middle and upper part, and the slope direction is sunny slope. The constructive species is *F. longipetiolata* and *C. pubescens*, with the total coverage of the community 50% –80%. The height of the arbor layer is 4 – 28 m, and the coverage is 35% –70%. Other dominant species in the arbor layer are *S. superba*, *P. strobilacea*, *C. multinervis*, *Prunus clarofolia*, *D. hongkongensis*, *etc.* The dominant species in the shrub layer include *C. pubescens*, *E. loquaiana*, *F. longipetiolata*, *C. multinervis*, *S. superba*, *P. clarofolia*, *C. angustifolia*. In the herbaceous layer, O. compositus is dominant species, and other species include *O. bodinieri* and *L. gracile*. Most of the species in this formation are near-mature forests, which are common formation of *F. longipetiolata* community in Leigong Mountain.

Table 1 Basic information of *Fagus longipetiolata* community plots in Leigong Mountain

Plot	Place	East longitude	North latitude	Altitude m	Aspect	Origin	Community appearance
1	Wangjiang Village, Nangong Town, Taijiang County	108°21′47″	26°32′41″	1 280	Eastern	Natural	Deciduous broad-leaved forest
2	Wangjiang Village, Nangong Town, Taijiang County	108°21′51″	26°32′34″	1 320	Northeastern	Natural	Deciduous broad-leaved forest
3	Yangkai Village, Nangong Town, Taijiang County	108°23′36″	26°32′33″	1 240	Southwestern	Natural	Deciduous broad-leaved forest
4	Heishan, Wangjiang Village, Nangong Town, Taijiang County	108°23′32″	26°32′46″	1 100	Eastern	Natural	Deciduous broad-leaved forest
5	Heishan, Wangjiang Village, Nangong Town, Taijiang County	108°23′27″	26°32′40″	1 040	Southeastern	Natural	Evergreen and deciduous broad-leaved mixed forest
6	Niujiaopo, Jiaobao Village, Nangong Town, Taijiang County	108°21′09″	26°26′39″	1 210	Southwestern	Natural	Coniferous and broad-leaved mixed forest
7	Nanniu Village, Nangong Town, Taijiang County	108°21′28″	26°26′38″	1 150	Southwestern	Natural	Evergreen and deciduous broad-leaved mixed forest
8	Jidao in Wangjiang Village, Nangong Town, Taijiang County	108°20′04″	26°32′38″	1 020	Southeastern	Natural	Deciduous broad-leaved forest
9	Shangnan Village, Paiyang Township, Taijiang County	108°17′12″	26°30′53″	1 510	Southeastern	Natural	Deciduous broad-leaved forest
10	Shihuihe Village, Nangong Town, Taijiang County	108°16′52″	26°29′44″	1 790	Eastern	Natural	Deciduous broad-leaved forest
11	Shihuihe Village, Nangong Town, Taijiang County	108°17′36″	26°29′49″	1 210	Southwestern	Natural	Evergreen and deciduous broad-leaved mixed forest
12	Hongyang Village, Taigong Street, Taijiang County	108°29′49″	26°56′09″	1 710	Northwestern	Natural	Deciduous broad-leaved forest
13	Dongkang Village, Nangong Town, Taijiang County	108°39′20″	26°46′43″	1 060	Western	Natural	Evergreen and deciduous broad-leaved mixed forest

4.2 Type and habitat of *F. longipetiolata* community The important values of tree species in the tree layer of *F. longipetiolata* community were used to form a data matrix, and SPSS 25.0 software was used to cluster the survey data of 13 sample plots with the average binding method between groups. The formation was divided according to the naming principle of *Vegetation in China* and the viewpoints of Gao Xianming *et al.* [16], Lang Xuedong *et al.* [17] and Wang Guohong *et al.* [18]. The species of *F. longipetiolata* community in Leigong Mountain was divided into 7 formations, and composition of each type of species is shown in Table 2.

Formation I: *F. longipetiolata* + *C. glauca* formation, including plots 1, 3, 9 and 10, the altitude is 1 240 – 1 510 m, the slope position is in the middle or upper part, the slope direction is sunny slope or semi-sunny slope, and the constructive species is *F. longipetiolata* and *C. glauca*, with the total coverage of the community 60% –90%. The height of tree layer is 4 – 25 m, and the coverage is 50% –80%. Other dominant species of tree layer are *C. multinervis*, *S. superba*, *A. davidii*, *L. glaber*, *etc.* The

dominant species in the shrub layer are *C. glauca*, *F. longipetiolata*, *C. multinervis*, *S. superba*, *E. loquaiana*, *A. davidii*, *C. angustifolia*. In the herbaceous layer, *O. compositus* is dominant species, and other species include *O. bodinieri* and *P. aquilinum*. There are also rare species (*K. pubescens* and *C. wilsonii*) in this formation[19-20] (rare species are generally defined as species with density ≤ 1 plant/ha). Most of the species in this formation are mature forests more than 100 years old, which is the most common formation of *F. longipetiolata* community in Leigong Mountain.

Table 2 Species composition of *Fagus longipetiolata* community in Leigong Mountain

Type No.	Formation name	Species composition			Q'ty of species	Rare species
		Tree layer (top 10 species of important value)	Shrub layer (top 10 species with important values)	Herbaceous layer		
I	*F. longipetiolata* + *C. glauca*	*F. longipetiolata*, *C. glauca*, *C. multinervis*, *Schima superba*, *A. davidii*, *L. glaber*, *D. hongkongensis*, *M. ichangensis*, *R. microphyton*, *Symplocos lancifolia*	*C. glauca*, *F. longipetiolata*, *C. multinervis*, *S. superba*, *E. loquaiana*, *A. davidii*, *C. angustifolia*, *M. ichangensis*, *S. lancifolia*, *C. pubescens*	*O. compositus*, *O. bodinieri*, *P. aquilinum*, *E. involucratum*	97	*Keteleeria pubescens*, *Cinnamomum wilsonii*
II	*F. longipetiolata* + *C. pubescens*	*F. longipetiolata*, *C. pubescens*, *S. superba*, *L. glaber*, *P. strobilacea*, *C. multinervis*, *Prunus clarofolia*, *D. hongkongensis*, *P. adenopoda*, *C. lanceolata*	*C. pubescens*, *E. loquaiana*, *F. longipetiolata*, *C. multinervis*, *S. superba*, *P. clarofolia*, *C. angustifolia*, *C. eyrei*, *L. glaber*, *E. muricata*	*O. compositus*, *O. bodinieri*, *L. gracile*, *P. aquilinum*, *L. japonica*	83	
III	*F. longipetiolata* + *S. superba*	*F. longipetiolata*, *S. superba*, *C. eyrei*, *C. glauca*, *L. glaber*, *R. microphyton*, *P. clarofolia*, *C. pubescens*, *A. davidii*, *E. japonicus*	*C. angustifolia*, *R. microphyton*, *L. hancei*, *E. loquaiana*, *S. superba*, *C. multinervis*, *F. longipetiolata*, *Cornus controversa*, *S. anomala*, *M. chienkweiensis*	*O. bodinieri*, *L. gracile*, *P. aquilinum*, *G. velutina*	76	*K. pubescens*
IV	*F. longipetiolata* + *S. wallichii*	*F. longipetiolata*, *S. wallichii*, *C. multinervis*, *D. hongkongensis*, *C. multinervis*, *S. superba*, *R. microphyton*, *C. glauca*, *L. glaber*, *M. chienkweiensis*	*E. loquaiana*, *L. glaber*, *D. kaki var. silvestris*, *F. longipetiolata*, *P. clarofolia*, *C. angustifolia*, *S. superba*, *M. chienkweiensis*, *C. pubescens*, *S. wallichii*	*O. bodinieri*, *L. gracile*, *P. aquilinum*, *E. involucratum*	79	
V	*F. longipetiolata* + *C. lanceolata*	*F. longipetiolata*, *C. lanceolata*, *A. davidii*, *D. hongkongensis*, *M. chienkweiensis*, *M. ichangensis*, *P. strobilacea*, *P. clarofolia*, *C. glauca*, *S. superba*	*A. davidii*, *S. superba*, *E. loquaiana*, *F. longipetiolata*, *L. glaber*, *S. anomala*, *P. strobilacea*, *C. glauca*, *M. ichangensis*, *Clethra delavayi*	*L. gracile*, *E. involucratum*, *P. aquilinum*, *Carpesium abrotanoides*	71	
VI	*F. longipetiolata* + *C. eyrei*	*F. longipetiolata*, *C. eyrei*, *C. multinervis*, *C. pubescens*, *S. superba*, *M. chienkweiensis*, *D. hongkongensis*, *C. glauca*, *R. microphyton*, *Elaeocarpus japonicus*	*C. multinervis*, *S. superba*, *E. loquaiana*, *F. longipetiolata*, *P. clarofolia*, *C. eyrei*, *R. microphyton*, *C. glauca*, *A. davidii*, *C. angustifolia*	*O. compositus*, *P. aquilinum*, *E. involucratum*, *L. gracile*	81	*C. wilsonii*
VII	*R. calophytum* + *F. longipetiolata*	*R. calophytum*, *F. longipetiolata*, *R. microphyton*, *L. glaber*, *Rhododendron stamineum*, *C. pubescens*, *C. multinervis*, *M. ichangensis*, *R. rivulare*, *Tetracentron sinense*	*C. angustifolia*, *R. rivulare*, *C. eyrei*, *M. ichangensis*, *F. longipetiolata*, *Pittosporum tobira*, *R. microphyton*, *S. anomala*, *C. multinervis*, *Euonymus alatus*	*P. aquilinum*, *E. involucratum*, *L. gracile*	73	

Formation III: *F. longipetiolata* + *S. superba* formation, including No. 5 and No. 7 plots, with altitude of 1 040 – 1 150 m, slope position in the middle and upper part, slope direction in the sunny slope. The constructive species is *F. longipetiolata* and *S. superba*, with the total coverage of the community 60% – 95%. The height of tree layer is 4 – 23 m, and the coverage is 55% – 90%. Other dominant species in the tree layer include *C. eyrei*, *C. glauca*, *L. glaber*, *R. microphyton*, *P. clarofolia*, *C. pubescens*, *etc.* The dominant species in the shrub layer are *C. angustifolia*, *R. microphyton*, *Lithocarpus hance*, *E. loquaiana*, *S. superba*, *C. multinervis*, and *F. longipetiolata*. In the herbaceous layer, *O. bodinieri* is the dominant species, and other species include *L. gracile* and *P. aquilinum*. In this formation, *K. pubescens* is rare species. Most species in this formation are mature forests over 100 years old. This formation is a common formation of *F. longipetiolata* community in Leigong Mountain.

Formation IV: *F. longipetiolata* + *S. wallichii* formation, including No. 2 plot, with altitude of 1 320 m, the slope position is the upper part, and the slope direction is the sunny slope. The constructive species are *F. longipetiolata* and *S. wallichii*, with the total coverage of the community 90%. The height of tree layer is 4 – 25 m, and the coverage is 85%. Other dominant species in the tree layer include *C. multinervis*, *D. hongkongensis*, *C. multinervis*, *S. superba*, *R. microphyton*, *C. glauca*, *etc.* In the shrub layer, the dominant species are *E. loquaiana*, *L. glaber*, *Diospyros kaki var. silvestris*, *F. longipetiolata*, *P. clarofolia*, *C. angustifolia*, *S. superba*, *etc.* In the herbaceous layer, *O. bodinieri* is the dominant species, and other species include *L. gracile* and *P. aquilinum*. Most species in this formation are mature forests over 100 years old. This formation is a rare for-

mation of *F. longipetiolata* community in Leigong Mountain.

Formation V: *F. longipetiolata* + *C. lanceolata* formation, including No. 2 plot, with altitude of 1 210 m, the slope position is middle part, the slope direction is a shady slope. The constructive species are *F. longipetiolata* and *C. lanceolata*, with the total coverage of the community 85%. The height of tree layer is 4 – 20 m, and the coverage is 75%. Other dominant species in the tree layer include *A. davidii*, *D. hongkongensis*, *M. chienkweiensis*, *M. ichangensis*, *P. strobilacea*, *etc.* In the herbaceous layer, *L. gracile* is the dominant species, and there are other species including *E. involucratum* and *P. aquilinum*. This formation is near-mature forest and is a rare formation of *F. longipetiolata* community in Leigong Mountain.

Formation VI: *F. longipetiolata* + *C. eyrei* formation, including No. 11 and No. 13 plots, with altitude of 1 060 – 1 210 m. The slope position is the upper part and the slope direction is the shady slope. The constructive species are *F. longipetiolata* and *C. eyrei*, with the total coverage of the community 90%. The height of tree layer is 4 – 25 m, and the coverage is 85%. In the tree layer, other dominant species include *C. multinervis*, *C. pubescens*, *S. superba*, *M. chienkweiensis*, *D. hongkongensis*, *C. glauca*, *etc.* In the shrub layer, the dominant species are *C. multinervis*, *S. superba*, *E. loquaiana*, *F. longipetiolata*, *P. clarofolia*, *C. eyrei*, *R. microphyton*, *C. glauca*, *etc.* In the herbaceous layer, *O. compositus* is the dominant species, and other species include *E. involucratum* and *P. aquilinum*. This formation has rare species *C. wilsonii*. This formation belongs to mature forests and is a common formation of *F. longipetiolata* community in Leigong Mountain.

Formation VII: *R. calophytum* + *F. longipetiolata* formation, including No. 12 plot, with altitude of 1 710 m. The slope position is the upper part and the slope direction is the shady slope. The constructive species are *R. calophytum* and *F. longipetiolata*, with the total coverage of the community 95%. The first layer of tree layer is *F. longipetiolata* with a height of 18 m and coverage of 25%, and the second layer is composed of various rhododendrons with the height of 7 m and the coverage of 60%. *R. calophytum* takes a slight dominance, and other species include *R. microphyton*, *Rhododendron stamineum*, and *R. rivulare*. The dominant species include *L. glaber*, *C. pubescens*, and *M. chienkweiensis*. In the shrub layer, the dominant species are *C. angustifolia*, *R. rivulare*, *C. eyrei*, *M. ichangensis*, and *F. longipetiolata*. In the herbaceous layer, the dominant species is mainly *P. aquilinum*. Other species include *E. involucratum* and *L. gracile*. This formation is mature forest, and is a relatively common formation of *F. longipetiolata* community in high altitude area of Leigong Mountain.

4.3 Diversity of the community species Through statistics of species in all formations of *F. longipetiolata* community, we found that formation I has the most species (97 species), followed by formation II (83 species), and formation V has the least species (71 species), as shown in Table 3.

Table 3 Species diversity index of *Fagus longipetiolata* community in Leigong Mountain

Community	Layer	Richness index (E)	Simpson index (D)	Shannon – Wiener index (H)	Pielou evenness index (J_{sw})	Total diversity index (W)
I	Tree layer	3.35	0.97	0.47	0.188	3.67
	Shrub layer	6.44	0.36	0.18	0.047	
II	Tree layer	2.64	0.82	0.52	0.247	3.14
	Shrub layer	5.92	0.33	0.22	0.061	
III	Tree layer	2.89	0.85	0.39	0.244	3.62
	Shrub layer	5.76	0.47	0.16	0.082	
IV	Tree layer	3.17	0.94	0.31	0.217	3.06
	Shrub layer	6.57	0.38	0.11	0.053	
V	Tree layer	2.63	0.92	0.64	0.186	2.74
	Shrub layer	6.72	0.43	0.27	0.046	
VI	Tree layer	2.94	0.88	0.36	0.236	3.28
	Shrub layer	5.81	0.51	0.14	0.054	
VII	Tree layer	2.77	0.86	0.37	0.224	2.97
	Shrub layer	6.17	0.49	0.19	0.049	

As shown in Table 3, among all formations of *F. longipetiolata* community, the richness index of tree layer is the highest for formation I (3.35) and the lowest for formation V (2.63). The trend is formation I > formation IV > formation VI > formation III > formation VII > formation II > formation V. The highest dominance index is formation I (0.97), and the lowest is formation II (0.82), and the trend is formation I > formation IV > formation V > formation VI > formation VII > formation III > formation II. The highest H diversity index is formation V (0.64) and lowest is formation IV (0.31), and the trend is formation V > formation II > formation I > formation III > formation VII > formation VI > formation IV. The highest evenness index is formation II (0.247), and the lowest is formation V (0.186), and the trend is formation II > formation III > formation VI > formation VII > formation IV > formation I > formation V. In the tree layer, the species richness of formation I is the highest, and the species richness of formation V is the lowest.

In the shrub layer of *F. longipetiolata* community, the highest richness index is formation V (6.72), and the lowest is formation III (5.76). The trend is formation V > formation IV > formation I > formation VII > formation II > formation VI > formation III. The highest dominance index is formation VI (0.51), and the lowest is formation II (0.33) and the trend is formation VI > formation VII > formation III > formation V > formation IV > formation I > formation II. The highest H diversity index is formation V (0.27), and the lowest is formation IV (0.11), and

the trend is formation V > formation II > formation VII > formation I > formation III > formation VI > formation IV. The highest evenness is formation III (0.082), and the lowest is formation V (0.046), and the trend is formation III > formation II > formation VI > formation IV > formation VII > formation I > formation V. These indicate that the species richness of formation V is obvious, and the species richness of formation III is low. From the total diversity index of the community, formation I (3.67) is the highest, and formation V (2.74) is the lowest. It appears as formation I > formation III > formation VI > formation II > formation IV > formation VII > formation V.

5 Conclusions and discussion

Through survey, it is found that there were 107 species of vascular plants belonging to 79 genera and 51 families in Leigong Mountain *F. longipetiolata* community. The species composition is complex and rich. The types of Leigong Mountain *F. longipetiolata* community were divided into 7 formations. The species composition of each formation is complex and abundant. In terms of the species composition of each formation, Fagaceae ranked the top 10, followed by Lauraceae and Ericaceae, which are the background species of *F. longipetiolata* community in Leigong Mountain and are very important to maintain the survival and function of the community. The diversity of the community not only reflects the development stage and stability of the community, but also reflects the habitat characteristics of the community. The higher the diversity index in the succession process, the more stable the community is, and the more suitable the habitat is for the survival of the community[21]. The total diversity index of the community was formation I > formation III > formation VI > formation II > formation IV > formation VII > formation V. It can be seen that the formation with abundant Fagaceae species and quantity ranked in the top 10 of the important value has a high diversity index, while the formation with less Fagaceae species and quantity ranked in the top 10 of the important value has a high diversity index. This indicates that the more abundant the background component species associated with it, the higher the diversity index, the more stable the community, and the more suitable the habitat for the survival of the community. The background composition is rich in species, and it is easier to recover when disturbed (such as snow damage, wind damage). Our survey found that there were more seedlings and saplings in formation I, and the regeneration was good, indicating that the population was faster after disturbance. In addition, it can be seen that the existence of rare species in the community can further improve the diversity index of the community and enhance the stability of the community. In general, the community stability is closely related to its species composition, and the background species are the basis of community survival and the continuation of community development; the existence of rare species can further improve the community diversity index and enhance the community stability.

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