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Floristic analysis of the evergreen broad-leaved forest community from Jiulianshan National Nature Reserve in Jiangxi Province, China

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Abstract Floristic composition of the evergreen broad-leaved forest in Jiulianshan Mountain was analyzed based on field investigations and community ecology. The community is rich in species diversity, with 144 spermatophyte families including 379 genera and 647 species, in which there are 6 gymnosperm families including 8 genera and 9 species, 21 monocotyledon families including 77 genera and 116 species, and 117 dicotyledon families including 294 genera and 522 species. Dominant families of the flora are Fagaceae, Lauraceae, Aquifoliaceae, Rosaceae, Ternstroemiaceae, Theaceae, Rubiaceae, Moraceae and Euphorbiaceae, most of which are of tropical & subtropical distribution. As for family systematic distribution, the ratio of tropical & subtropical to temperate genera is 100:62.8 in 142 genera of 16 families. As for generic distribution in field investigation data, the tropical & subtropical areal type accounts for the majority of genera, in which there are 205 genera belonging to the tropical & subtropical areal type, 131 genera belonging to the temperate areal type, 35 genera belonging to the cosmopolitan areal type and 8 genera belonging to the endemic-to-China areal type. The ratio of the tropical & subtropical to temperate genera was 100:63.9. Floristic

composition of the evergreen forest community in Jiulianshan and the typical species of the zonal flora will provide a scientific foundation for stand rehabilitation and stand establishment approximating a natural evergreen broad-leaved forest community. This study also indicates that the sample data based on community research are valid and convenient for floristic and environmental analysis of the evergreen broad-leaved forest community from the Jiulianshan Mountain.

Keywords Jiulianshan Mountain, flora, geographical components, areal type

1 Introduction

The sampling methods based on the selected quadrats, which were used for plant community ecology and element ecology, have been proven to be compendious and accurate in revealing the nature and characteristic of the flora or vegetation in plant communities (Wang, 1987; Wang, 1992; Yin et al., 2002; Wu et al., 2004; Dong et al., 2006). There have been some achievements in the research on the floristics, or composition of the flora, or the ecosystem (Li, 1987; Hideyuki et al., 2005; Yasuhide et al., 2005) of the Jiulianshan National Nature Reserve. The main achievements include: Ji et al. (1999) studied the medicinal pteridophyte in Mt. Jiulianshan, which showed that the number of species comprised 44.1% of the total species of the medicinal pteridophyte in Jiangxi Province; Chen et al. (2002) also studied the whole pteridophyte flora in the Jiulianshan National Nature reserve; Yao et al. (2002) surveyed the medicinal plants in the Jiulianshan National Nature Reserve; and Liu et al. (2002) summarized the seed plants and pteridophyte flora in Mt. Jiulianshan through his scientific survey. All of the above achievements, however, only studied the flora in Jiulianshan on the basis of the plants' specimens or lists available for Mt. Jiulianshan (Ji et al., 1991), often due to lack of analysis of its

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communities and environmental background. This paper adopted some community methods studying the main flora of the evergreen broad-leaved forest in the Jiulianshan National Nature Reserve; based on the data from field investigation and the plant list of Mt. Jiulianshan, combined with the geographical floristic and plant community ecology, aimed to reveal the composition of the flora, characteristic, population structure, and environmental background of the evergreen broad-leaved forest in the study area; and provided a scientific foundation on how to protect and assess biological diversity and the construction of the Jiulianshan National Nature Reserve.

2 Materials and methods

2.1 Study area

The Jiulianshan National nature reserve is located in the southern end of Longnan County, Ganzhou City, Jiangxi Province, China (24°29'18"–24°38'55"N, 114°22'50"–114°31'32"E), and connects with Lianpin County, Guangdong Province, China. The total area of the reserve is 13411.6 hm². Mt. Jiulianshan has a subtropical moist climate with an annual rainfall of 2155.6 mm, a mean annual temperature of 16.4°C (Li et al., 1991; Ji et al., 2001), and a mean annual evaporation value of 790.2 mm. Most plants in Mt. Jiulianshan could grow very well all year round on account of the special mountainous region terrain and special climate characteristics. It is also favorable for the growth of some evergreen broad-leaved plants in the study area. There are massive natural evergreen broad-leaved communities preserved in the overall area at different elevations from the valley 280 m high to the summit of the mountain at 1200 m. From low to high elevation, there are many different evergreen broad-leaved forests, that is the *Adinandra millettii* forest, *Castanopsis tibetana* forest, *Schima superba* forest, *Cyclobalanopsis glauca* forest, *Castanopsis fordii* forest, *C. carlesii* forest, *C. fargesii* forest, *C. eyrei* forest, *Castanopsis* sp. forest, *C. fabri* forest, *Michelia maudiae* forest, *Lindera communis elongata* forest, *Fagus* spp. forest, *Cyclobalanopsis nubium* forest, *Adinandra bockiana* forest, *Rhododendron simiarum* forest, mountainous coppice and etc. (Lin, 1981; Ye, 1986). There are also some ancient typical evergreen broad-leaved communities, such as the *Taxus mairei* forest, *Ginkgo biloba* forest, *Machilus thunbergii* forest, *Phoebe bournei* forest, *Toona ciliata* var. *pubescens* forest and etc. All the above are protected very well in the different elevations in the study area.

2.2 Sampling methods

We chose some typical evergreen broad-leaved forest community sites at different elevations with minor human

disturbance according to the different terrains and appearances of different communities. The quadrat methods were done using the classic laws of line sampling methods and field investigations in different community plots which could represent the characteristics of the flora (Zhao et al., 1990; Fu et al., 2006).

Twenty typical plots of evergreen broad-leaved forests surveyed in the core section of the Jiulianshan National Nature Reserve included Xiagongtang, Shanghu, Xiahu, Pinkeng, Fangtianao, Chishuigou, Hengkengshui, Xinkaijing, Longmen, Daqitian and other different places. There were 78 quadrats (each 10 m×10 m) in the reserve, and the total area was 7800 m². Table 1 shows the community and the environmental characteristics of each plot. The sampling methods were set as follows: the sampling plots were set by squares or rectangles, slope land sector was adjusted by compass and we converted the slope distance into contour intervals. Small quadrats were set as follows: four small quadrats (each 2 m×2 m) were set at each corner of each standard quadrat, and the shrub layer and the field layer under the tree layer were investigated in each standard quadrat of the different communities. Some parameters investigated in each plots included: 1) Some parameters such as DBH, height, crown of each tree in each standing timber were determined and recorded in each standard quadrat (10 m×10 m). 2) Frequency of each layer was investigated in terms of the occurrence of the major forest level, succession level and the renewal level. We also determined and recorded the main environmental factors and each species name, DBH, height and crown of the tree, etc.

3 Results

3.1 Appearance and structure characteristics of the communities

The appearance of the whole forest community is evergreen in the Jiulianshan National Nature Reserve all year round due to the evergreen species being the main components of the flora. Although there are a few heliophytes and deciduous species, such as *Liquidambar formosana*, *Alniphyllum* sp. in the communities, some light red appearance only adorns the community from December to February every year. The main color appearance of the entire forest in Mt. Jiulianshan is green but is mixed with red, white and yellow spots in the flowering period and deciduous season of the upper trees, because the majority of the plants flower in spring and summer and fruit in autumn. The coverage of the canopy in the communities is often greater than 75%, or even greater than 95%, and the stratification of the canopy in the forest is extraordinarily obvious. The average height of the communities is about 11.5 m, and the highest individual is often up to 40 m. The entire appearance of the forest looks

Table 1 Community characteristics and environmental factors of each plot

quadrat no.	community type	elevation/m	aspect/°	slope/°	soil type
A01	<i>Castanopsis carlesii</i>	629	125	21	mountain yellow and red soil
A02	<i>Cryptomeria fortunei</i>	620	325	19	mountain yellow and red soil
A03	<i>Castanopsis fabri</i>	630	315	10	mountain yellow and red soil
A04	<i>Taxus mairei</i>	840	265	28	yellow soil
A05	<i>Plyllostachys pubescens</i>	844	265	3	yellow soil
A06	<i>Castanopsis fargesii</i>	624	45	29	yellow and red soil
A07	<i>Liquidambar formosana</i>	440	202	13	yellow and red soil
A08	<i>Pterocarya stenoptera</i>	495	112	2	arenous soil
A09	<i>Tsoongiodendron odorum</i>	612	45	30	yellow and red soil
A10	<i>Cunninghamia lanceolata</i>	609	338	30	mountain yellow and red soil
A11	<i>Castanopsis fargesii</i>	628	7	23	mountain yellow and red soil
A12	<i>Machilus thunbergii</i>	785	312	16	mountain yellow and red soil
A13	<i>Schima superba</i>	720	330	18	yellow soil
A14	<i>Castanopsis eyrei</i>	732	330	30	mountain yellow soil mountain
A15	<i>Alniphyllum fortunei</i>	610	0	6	yellow and red soil
A16	<i>Castanopsis lamontii</i>	630	20	8	mountain yellow and red soil
A17	<i>Castanopsis fordii</i>	620	225	21	mountain yellow and red soil
A18	<i>Sloanea sinensis</i>	801	90	6	mountain yellow soil
A19	<i>Manglietia chapensis</i>	900	0	20	mountain yellow and red soil
A20	<i>Rhododendron simiarum</i>	1020	45	35	coal mud

like a screen but is a little disordered. Board root phenomenon is another important characteristic of the forest in the Jiulianshan National Nature Reserve, and the characteristics of abundant interlamellar plants in the communities are also supernatural, especially in the valley of Xiagongtang where the core section of the Jiulianshan National Nature Reserve is. The population of *Cyclobalanopsis disciformis* is very ancient and has board root phenomenon which reflects the characteristics of the tropical forest. In a word, all the forests in Mt. Jiulianshan are provided with the natural characteristics of the evergreen broad-leaved forest at mid-subtropical and south subtropical.

The main familial components of the flora in the evergreen broad-leaved forest in Mt. Jiulianshan are Fagaceae, Lauraceae, Rhododendron, Theaceae, etc. Meanwhile, some secondary deciduous broad-leaved components and heliophyte families such as Styracaceae, Altingiaceae, Magnoliaceae, Rosaceae and Aceraceae and etc., are in the stage of development or are mellow. Thus, the ecological characteristic of the forest is that there are a number of big trees of this kind of species in the communities but their density is still low. The leaves of this kind of species are medium-sized, which are entire or toothed in the edges, and are smooth or hard on the surface.

Mt. Jiulianshan is located in the low elevation, and the evergreen broad-leaved forest distributes in the whole area. The natural broad-leaved forest was protected very well in the core section of the protected area. The formations are

abundant and multiple, and the vertical structure is complicated. Further, stratification in the forest is very obvious, which is often composed of four layers including a tree layer, shrub layer, herb layer and low surface layer. The tree layer is often disordered and obviously stratified, especially in the valley of the core section of the protected area where the evergreen broad-leaved forest could be divided into several sub-layers, with the height of the first layer often varying from 10 to 25 m, the height of the second layer often from 5 to 10 m and the height of the third often from 4 to 6 m. The height of the shrub level is often from 2 to 3 m. All plants in the shrub layer are intensive, are often composed of shade-tolerant species, and are also composed of some heliophyte species such as *Alniphyllum fortunei*, *Liquidambar formosana* and etc.

3.2 Floristic composition of the communities

According to the statistical results from the investigated data in the sampling sites, the composition of ferns in the communities from the study area included 16 families, 19 genera and 30 species. The seed plants are composed of 144 families, 379 genera, and 647 species, included gymnosperm (6 families, 8 genera and 9 species), dicotyledon (144 families, 379 genera and 647 species) and monocotyledon (21 families, 77 genera and 116 species). According to the characteristics of the composition, the communities are mainly composed of woody plants, lots of herbage, abundant vine plants and

interlamellar plants. Table 2 shows the floristic composition of the communities.

3.3 Diversity of the families and genera in the communities

The seed plants are composed of 144 families, 379 genera and 647 species in the study area, which comprises 90.6% of the total number of families, 95.7% of the total genera and 97.0% of the total species. However, the species of each genus is insufficient, and there are only 36 genera which have more than 4 species in each genus, and are the most important components of the flora in the study area. In the 144 families, there are 6 families of gymnosperm, which comprises 3.8% of the total number of families and 1.7% of the total species; there are 138 families and 638 species of angiosperms, which occupies 86.7% of the total number of families and 95.7% of the total species. All these angiosperms are the main floristic compositions of the evergreen broad-leaved forest in the study area. The woody plants are composed of 336 species, which comprises 50.4% of the total species; the herbage plants are composed of 273 species, which represents 40.9% of the total species; the vine plants are composed of 58 species, which is about 8.7% of the total species. In all these species, dicotyledon plants are composed of 317 species, which is 94.3% of the total number of woody plants.

Pteridophyta are the main components in the communities, and there are 16 families, which occupied 10.0% of the total families. The main families include Selaginellaceae, Pteridaceae, Gleicheniaceae, Dryopteridaceae, Polypodiaceae, Dicksoniaceae, Dyatheaceae, Angiopteridaceae, Osmundaceae, Lygodiaceae and etc., which are the common families in the herb layer of the communities.

There are 88 families which have only one genus in each community of the study area, and cover 55.0% of the total number of families; 31 families have 2 genera in each, occupying 19.4% of the total number of families; 12 families have 3 genera in each, occupying 7.5% of the total number of families, and 29 families have 4 or more genera in each, occupying 18.1% of the total number of families. There are 16 families which have 10 or more species and cover 10% of the total number of families, 36.6% of the total genera and 42.8% of the total species in the flora of the communities. Most of the 16 families have

obvious action in the flora except for Gramineae, Asteraceae and Cyperaceae. According to the number of species in each family, the order of the dominant families is Rosaceae (31 species), Fagaceae (25 species), Papilionaceae (22 species), Lanraceae (17 species), Ilex (17 species), Sankoh (15 species), Ternstroemia branch (14 species), Rubiaceae (14 species), Ericaceae (13 species), Myrsinaceae (11 species), Euphorbiaceae (10 species), Magnoliaceae (9 species), Theaceae (8 species) and etc. These seed plants are the main components of the flora, and the dominant families can reflect the natural characteristics of the flora in the particular area. The number of the genera of the species in one family could not reflect the position or the advantage of the family in the flora. It is very important that the ratio of the genera or species in one family in China or in the local area should be considered (Wu, 1991; Su et al., 1994). For example, Gramineae, Asteraceae and Cyperaceae are abundant and distribute all over the world, and also have more species in the communities, but they are not important in the flora. Although the Fagaceae family does not have a lot of species in the forest, it is still the most important dominant family in the flora. Table 3 shows the dominant seed plant families and their areal distribution type in the evergreen forest community in the study area.

There are 142 genera in the dominant families, which comprise 37.7% of the total genera of the seed plants in the sampling sites, and 304 species which comprise 47.0% of the total species. The dominant families play an important role in the flora of the seed plants in Mt. Jiulianshan, including Fagaceae, Lauraceae, Magnoliaceae, Theaceae, Ericaceae, Ilex, Ternstroemiaceae, Rosaceae, Moraceae and Euphorbiaceae, which are the main families of the different formations. According to the characteristics of the geographical distribution of areal types, most of the families are components of the tropical or temperate areal type. According to the life form of the plants, the vast majority of the plants are trees, the second are woody plants, and only a few are vines.

3.4 Analysis of the genera's geographic components

It is very significant to clarify the nature and characteristics of the flora by analyzing areal types of the genera. Three hundred and seventy nine genera spermatophytes are

Table 2 Floristic composition of the evergreen broad-leaved forest community in Mt. Jiulianshan

taxon	family	genera	species	trees	herbs	lianas
fern	16 (10.0)	19	30	0	29	1
gymnosperm	6 (3.8)	8	9	9	0	0
monocotyledon	21 (13.1)	77	116	10	101	5
dicotyledon	117(73.1)	294	522	317	153	52
total	160(100.0)	396	677	336	283	58

Notes: Data in the brackets are the percentage of the families, genera and species of the plants in the study area (unit: %).

divided into 14 areal types and 19 modified forms. Among those, the tropical & subtropical areal types predominate in the flora and a few temperate areal types exist in the flora. The main areal types of the seed plant genera of the evergreen broad-leaved forest communities in Mt. Jiulianshan are shown in Table 4.

1) In the above communities, 35 genera are attributed to the cosmopolitan areal type. The majority of the species are in the herbaceous layer under the communities and the

minority species are weeds in the field, i.e., *Agrostis*, *Poa*, *Erigeron* and etc. Furthermore, some aquatic plants also exist in the communities, i.e., *Phragmites* and other genera, but there are only four genera of woody plants in the communities, such as *Hypericum*, *Rubus*, *Sophora* and *Rhamnus*.

2) There are 75 genera belonging to the pantropic areal type, which is the biggest areal distribution type in the study area. Most species of this kind of areal type are the

Table 3 Dominant seed plant families in the evergreen forest communities in Mt. Jiulianshan

family	genera	species	proportion to species number of China flora/%	geographic distribution of family
Poaceae	35	51	3.8	cosmopolitan
Compositae	27	32	1.5	cosmopolitan & main in temp
Rosaceae	11	31	3.6	cosmopolitan
Fagaceae	6	25	10.9	cosmopolitan
Papilionaceae	12	22	2.1	tropical & subtropical
Lauraceae	5	17	4.5	tropical & subtropical
Aquifoliaceae	1	17	9.1	tropical & subtropical
Moraceae	4	15	7.2	tropical & subtropical
Cyperaceae	6	15	3.2	cosmopolitan
Ternstroemiaceae	5	14	9.3	pantropic
Rubiaceae	9	14	2.1	tropical-subtropical
Ericaceae	4	14	1.8	cosmopolitan
Myrsinaceae	4	12	8.0	pantropic
Euphorbiaceae	6	10	8.0	cosmopolitan
Magnoliaceae	4	10	6.1	east Asia & North America
Theaceae	3	8	1.9	tropical & subtropical

Table 4 Areal type of seed plant genera in evergreen broad-leaved forest community of Mt. Jiulianshan

areal type	no. of genera	%	genera of China	%	Jiulianshan Mountain	China
1. cosmopolitan	35	9.2	104	33.7	tropic geographical components	205 genera in Mt. Jiulianshan, and occupied 54.1%
2. pantropic	75	19.8	362	20.7		
3. trop. Asia & trop. Amer. disjunction	16	4.2	62	25.8		
4. old world tropic	24	6.3	177	13.6		
5. trop. Asia to trop. Australasia	20	5.3	148	13.5	temperate geographical components	131 genera in Mt. Jiulianshan, and occupied 34.6%
6. trop. Asia to trop. Africa	18	4.7	164	11.0		
7. trop. Asia (Indo-Malaysia)	52	13.7	611	8.5		
8. north temperate	56	14.3	297	18.9		
9. E. Asia & N. Amer. disjunction	24	6.3	124	19.4		
10. old world temperate	14	3.7	164	8.5		
11. temp. Asia	2	0.5	55	3.6		
12. Mediterranean, W. Asia to C. Asia	4	1.1	171	2.3		
13. E. Asia	31	8.2	299	10.4		
east Himalaya-Japan	(19)	5.0	73	26.0		
13-1. Sino-Himalaya (SH)	(6)	1.6	141	4.3		
13-2. Sino-Japan (SJ)	(6)	1.6	85	7.1		
14. endemic to China	8	2.1	257	3.1		
total	379	100	3116			

dominant components of the arboreal layer, such as *Ternstroemia*, *Symlocos*, *Elaeocarpus*, *Celtis*, *Ilex* and etc., which are common in the study communities and most are common in the tree layers or shrub layers of the subtropical evergreen broad-leaved forest. Some herbaceous plants are common under the forest, such as *Chloranthus*, *Begonia*, *Achyranthes*, *Crotalaria*, *Acalypha*, *Hedyotis* and etc. There are two modified forms similar to the pantropic areal type, and these are the tropical Asia, Oceania & South America disjunction type and tropical Asia, Africa & South America disjunction type. In the study communities, *Podocarpus*, *Aphananthe*, *Gahnia*, *Erechtites*, *Passiflora* and etc. belong to the tropical Asia, Oceania & South America disjunction type, and *Laurocerasus*, *Mimosa*, *Lasianthus*, *Coreopsis*, *Bambusa* belong to the tropical Asia, Africa & South America disjunction areal type.

3) There are 16 genera belonging to the tropical Asia and tropical America disjunction areal type in the study area, most of which are woody plants, such as *Phoebe* (2 species) of Lauraceae, *Sloanea* (1 species) of Elaeocarpaceae, *Sapindus* (1 species) of Sapindaceae, *Meliosma* (1 species) of Meliosmaceae, etc., and are common in the tree layer of the communities. Other species such as *Turpinia* (1 species) of Staphyleaceae, *Eurya* (5 species) of Ternstroemiaceae, *Litsea* (2 species) of Lauraceae and etc., are common in the shrub layers of the evergreen broad-leaved forest communities. There are also many genera of herbaceous plants in the communities, i.e., *Pachyrhizus*, *Soliva*, *Zephyranthes*, *Helicteres*, *Cucurbita*, *Manihot* and etc.

4) There are 24 genera belonging to the old world tropics areal type or its modified forms, which mainly include *Pittosporum*, *Momordica*, *Syzygium*, *Mallotus*, *Albizia*, *Cayratia*, *Euodia*, *Brucea*, *Melia*, *Asparagus* and etc. The modified form, which is similar to the old world tropics areal type, is the tropical Asia, Africa, Oceania disjunction areal type, and there are mainly *Fissistigma*, *Aponogeton*, etc. in the communities.

5) There are 20 genera belonging to tropical Asia to tropical Australasia disjunction areal type. The woody plants mainly include *Cinnamomum* (4 species), *Lagerstroemia*, *Daphne*, *Helicia*, *Toona* and etc., and the main grasses are *Anoectochilus* of Orchidaceae, *Cymbidium*, *Microtis*, *Mazus*, *Zingiber*, *Lophatherum*, *Eremochola* and etc. Furthermore, there are also some liana plants belonging to this kind of areal type in the communities, i.e., *Tetrastigma* and etc..

6) There are 18 genera belonging to the tropical Asia to tropical Africa areal type or its modified forms. In the study communities, the woody plants mainly include *Tricalysia* (1 species), *Ixora* (1 species) and etc. Herbaceous plants mainly include *Gynura*, *Sesamum*, *Amorphophallus*, *Clivia*, *Sansevieria*, *Arthraxon*, *Cymbopogon*, *Miscanthus*, *Neyraudia* and etc. The Liana plants include *Trachelospermum* (2 species) of Apocynaceae, *Hedera* of Araliaceae

and etc. One kind of modified form is the tropical Asia to East Africa disjunction areal type, which is similar to the tropical Asia to tropical Africa areal type and mainly includes *Adinandra* and etc.

7) Fifty-two genera are attributed to the tropical Asia (Indo-Malaysia) areal type, which is the third biggest distribution areal type. In the study communities, the woody plants include *Manglietia*, *Michelia*, *Kadsura*, *Lindera*, *Machilus*, *Neolitsea*, *Camellia*, *Anneslea*, *Daphniphyllum*, *Dichroa*, *Distylium*, *Cyclobalanopsis*, *Broussonetia*, *Engelhardtia* and etc. Herbaceous plants include *Duchesnea*, *Aeginetia*, *Sphaerocaryum*, *Ophiorrhiza* and different genera of Orchidaceae such as *Arundina*, *Goodyera*, *Tainia* and etc. Some liana plants also exist in the communities like *Pericampylus*, *Gynostemma*, *Pueraria*, *Sabia*, *Paederia*, *Thysanosperrum* and etc. There are four modified forms similar to the tropical Asia areal type. The first modified form includes some punctuate distributions of Java, Himalaya, southwest and south China, and there are some species of *Schima*, *Bischia* and etc., which are some important trees of the evergreen broad-leaved forests in the study area; the second form is the tropical India to South China areal type, which mainly includes *Sinocalamus*, *Pleione*, etc in the communities; and the third is the Burma and Thailand to Southwest China areal type, which includes *Calocedrus* and *Brandisia* in the communities; the fourth is the Vietnam to South China areal type, and includes, mainly, *Fokienia*, *Tsongiodendron*, *Fordiphyton*, *Lingania* and etc. in the communities.

8) There are 56 genera belonging to the north temperate areal type, which is the second biggest distribution areal type in the study area. Most species are the typical north temperate zone genera and also the common components of the flora in the evergreen broad-leaved forests or hardwood broad-leaved forests, which include *Acer* of Aceraceae, *Castanea* and *Quercus* of Fagaceae, *Malus* of Rosaceae, *Pinus* of Pinaceae, *Rhododendron* of Ericaceae, *Viburnum* of Caprifoliaceae, *Salix* of Salicaceae and etc. There are also three modified forms in the study area, which are similar to the north temperate areal type. The first modified form is the north temperate & south temperate disjunction distribution areal type. In the communities, there are some woody species of *Myrica*, *Vaccinium*, *Sambucus*, *Lycium* and etc., and also some herbaceous species belonging to different genera such as *Sedum*, *Kochia*, *Angeliaca*, *Rubia*, *Alisma*, *Sagittaria* and etc.; the second form is the arctic mountains areal type and there is only one genera in the communities (i.e., *Schizachyrium*); the third is the Eurasian & South America disjunction distribution areal type and there also is only one genera *Alopecurus*.

9) Twenty-four genera are attributed to the East Asia & North America disjunction distribution areal type in the communities. The study area of Mt. Jiulianshan is the core zone of the East Asia & North America disjunction distribution areal type, and there are some

homologous components according to the North American type, i.e., *Liriodendron*, *Nelumbo*, *Saururus*, *Campsis*, *Gymnocladus* and etc., all of which have the same ancient characteristics with those of North American flora. Other representative genera are *Acorus* of Araceae, *Castanopsis* of Fagaceae, *Cladrastis* of Papilionaceae, *Exbucklandia* of Hamamelidaceae, *Gleditsia* of Caesalpiniaceae and etc. Furthermore, *Zinia* of Compositae is the modified form of this kind of distribution areal type.

10) There are 14 genera belonging to the old world temperate areal type in the communities of the study area, most of which are herbaceous plants, such as *Vaccaria*, *Oenanthe*, *Carpesium*, *Ajuga*, *Leonurus*, *Roegneria* and etc., and only two genera are woody plants (i.e., *Daphne* and *Pyrus*). Three modified forms are similar to the old world temperate areal type. The first form is the Mediterranean areal type, West Asia & East Asia disjunction distribution areal type which includes *Forsythia*, *Ligustrum*, *Nerium* and etc. in the communities; the second form is the Mediterranean & Himalayas disjunction distribution areal type, and only has *Cedrus* in the communities; the third is the Eurasian & South Africa disjunction distribution areal type, and also only one genera is found in the communities (i.e., *Lactuca*).

11) Only two genera are attributed to the temperate Asia areal type in the communities, i.e. *Kalimeris* and *Trigonotis* of Amaryllidaceae.

12) Only four genera (i.e., *Spinacia*, *Punica*, *Coriandrum* and *Olea*) are attributed to the Mediterranean & West Asia to middle Asia areal type, which is very weak in the communities in the study area.

13) There are 31 genera belonging to the East Asia (East Himalayan-Japan) areal type, and most species are mainly in the tree layer and there are eight genera in the communities, i.e., *Ketelleeria*, *Cephalotaxus*, *Corylopsis*, *Platycarya*, *Paulownia*, *Koelreuteria*, *Eriobotrya*, *Dendrobenthamia*. There are also five genera in the shrub layer including *Rhaphiolepis*, *Platyclusus*, *Loropetalum*, *Euscaphis*, *Actinidia*, and four genera are herbaceous plants in the communities, i.e., *Houttuynia*, *Perilla*, *Reineckea*, *Bletilla*. There are two modified forms similar to the East Asia distribution areal type, and the first modified form is the China-Himalayas distribution areal type, and the main genera are *Lysionotus*, *Syneilesis* and etc.; the second form is the China-Japan distribution areal type, and there are 6 genera in the communities, including *Akebia*, *Idesia*, *Hovenia*, *Kummerowia*, *Platycodon*, *Pinellia*. According to the results of the investigation, the flora of the Jiulianshan National Nature Reserve belongs to the China-Japan areal type.

14) Eight genera in the communities are attributed to the China special distribution areal type, most of which are ancient and rudimentary components of the flora, such as *Ginkgo* and etc.. Most Chinese special genera belong to Labiatae (including three genera) and Taxodiaceae (including three genera). According to the analysis of the special

genera of the family, not only from the original taxa but also from complex taxa, ancient woody types are the dominant type, so the ancient special genera are much more than the new special genera.

According to the results of statistical analysis, survey data from 78 standard samples indicates that there are 379 genera seed plants in the typical evergreen broad-leaved communities of Mt. Jiulianshan, 205 genera of which belong to the tropical & subtropical distribution areal type; and 131 genera of which belong to the temperate distribution areal type; 35 genera belong to the world-wide distribution areal type and 8 genera belong to the China special distribution areal type. The tropical & subtropical distribution areal type occupies 54.1%. From all of the above, we can get the conclusion that the flora in the Jiulianshan National Nature Reserve is not only affected by the obvious subtropical flora but is also obviously affected by tropical flora, and the number of genera of Tropical & Subtropical distribution areal types is much more than that of the genera of temperate distribution areal types, which could show that the flora in the Jiulianshan National Nature Reserve has the obvious geographical characteristics of the tropics and subtropics.

4 Discussion

Because Mt. Jiulianshan is located in the northern part of the South China flora, the components of the tropical and subtropical flora are abundant, diversified and concentrated. As for family systematic distribution, the ratio of the genera of tropical and subtropical to temperate components was 100:62.8 in 142 genera of 16 families. As for generic distribution in field investigation data, the ratio of genera of the tropical-and-subtropical to temperate was 100:63.9, in which there were 205 genera belonging to the tropical and subtropical areal type, 131 genera belonging to the temperate areal type, 35 genera belonging to the cosmopolitan areal type and 8 genera belonging to the endemic to China areal type.

The flora in the Jinlianshan National Nature Reserve is ancient, residual and original, which is similar to the ancient and original flora in West China and South China. The results of the sample survey indicate that gymnosperm types in Mt. Jiulianshan are extremely abundant, which almost include all of the modern gymnosperms, i.e., Ginkgoaceae, Taxaceae, Podocarpaceae, Cephalotaxaceae, Pinaceae, Taxodiaceae, Cupressaceae and etc, especially including some precious plants, such as *Ginkgo biloba*, *Fokienia hodginsii* and etc. Some components of angiosperm flora in the sampling sites are ancient and original, that is *Liriodendron*, *Magnolia*, *Tsoongiodendron*, *Ranunculus*, *Liquidambar*, *Camellia*, *Adinandra*, *Ternstroemia*, *Itea*, *Begonia* and etc. There are some offspring of angiosperms such as the *Magnolia* and some polycarpous plants which appeared from the Triassic or Jurassic periods

and were preserved in the Mt. Jiulianshan National Nature Reserve.

There are some components in the flora of the Jiulianshan National Nature Reserve which are similar to the affinity components in the flora of East Asia & North America. Further, there are some typical homologous species which are similar to those of the North American flora, i.e., *Saururus chinensis*, *Liriodendron chinense*, *Nelumbo nucifera*, *Gymnocladus chinensis*, *Campsis grandiflora* and etc, which indicates that there are intimate connections in *Phytogeographical affinities* between the flora of Mt. Jiulianshan and North America.

The dominant families of the flora in Mt. Jiulianshan are Fagaceae, Lauraceae, Camelliaceae, Ericaceae, Aquifoliaceae, Euphorbiaceae, Moraceae and etc., most of which are tropical & subtropical families and also are the dominant components of Chinese flora. Moreover, the species of these families take possession of a high proportion in the flora, which are the typical components of Chinese flora and also are the main components of vegetation communities. The results of the geographical composition analysis of the genera indicate that the composition of the evergreen forest community in Mt. Jiulianshan has typical subtropical flora properties and also is influenced by the tropical flora, which approximates to its geographical location. All these could reflect perfectly the combination features, evolution history, modern trends, flora diversity and uniqueness of the components in the flora of Mt. Jiulianshan. This study also indicates that sample data based on community research are valid and convenient for floristic analysis.

All of the above indicate that the flora in the Jiulianshan National Nature Reserve is the conjunction of the pantropic & tropical Asian and north temperate flora. The floras in Jiulianshan are some of the northernmost zones of pantropic flora, and are also some of the southernmost zones of East Asian & North American flora.

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