Regular article

Analysis of plant resources and diversity in Shennongjia Area of Hubei Province, China

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Abstract

Shennongjia Area is located in northwest of Hubei Province with Shennongding, the highest peak (3105.4 m above sea level) in central China. The unique geographical location and complex terrain of this region make it rich in plant resources. After field investigation, literature review, and specimen identification, the 7th Shenyang Pharmaceutical University Chinese Medicine Resources Scientific Expedition Team studied the plant resources and diversity of Shennongjia Area. 454 species of vascular plants belonging to 106 families and 275 genera were collected from July to August in 2013. The dominant families are *Lamiaceae*, *Ranunculaceae*, *Rosaceae*, and *Asteraceae*, with 20, 21, 37 and 48 species respectively. At the genus level, Rubus is the dominant one with 11 species. 3 species of national first-class protective plants, 13 species of "Huan yang yao" and 36 species of "Qi yao" were collected. In all, our research has updated the plant recources and diversity in Shennongjia Area. Furthermore, by putting forward practical and meaningful suggestions on strengthening the protection and utilization of plant resources in Shennongjia Area, our research will help to protect the diverse ecosystem there.

Keywords: plant resources; diversity; medicinal use; Shennongjia Area

1 Introduction

Shennongjia Area is located in the northwest of the Hubei Province and is home to the highest peak, Shennongding (3105.4 m above sea level), in central China. Its geographical coordinates lie between 106°59'-110°58' east longitude and 31°15'-31°57' north latitude with a total area of 12837.42 km^2 [1,2]. As the transition area from the eastern plain hills to the western Plateau Mountains, this region experiences a shift from subtropical climate to warm temperate climate [3]. With the increase of elevation, the vertical distribution of vegetation in Shennongjia Area shows obvious transition from evergreen broadleaved forest, evergreen deciduous broadleaf mixed forest, deciduous broadleaf forest and coniferous mixed forest to subalpine evergreen coniferous forest [4]. Therefore, Shennongjia Area is recognized as one of the three centers with the highest biodiversity in China and it is also an ideal place to study elevational pattern of animal and plant diversity. There are 3550 vascular plant species

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belonging to 222 families and 184 genera in this area [3]. The purpose of this study is to explore the plant recources and diversity and update natural medicinal plants in Shennongjia Area.

In 2013, the 7th Scientific Expedition Team of Chinese Medicine Resources of Shenyang Pharmaceutical University conducted an extensive study to update the plant species in Shennongjia Area, through field investigation, specimen collection, literature retrieval and specimen checking. The resources and biodiversity were investigated in detail to understand the types, distribution and utilization of plant resources in Shennongjia Area. The findings of this study provide a scientific basis for the rational construction and sustainable utilization of precious plant resources in this area.

2 Research method

In July of 2013, the 7th Scientific Expedition Team of Chinese Medicine Resources of Shenyang Pharmaceutical University conducted a comprehensive investigation on the plant resources in Shennongjia Area. The team investigated representative areas according to the region's topography, landform, altitude and plant type. Samples were collected, and photographs were taken along the way. Detailed information was recorded, including the collection location, time, main morphological characteristics of plants and other information. The latitude and longitude of collected plants were recorded using a GPS logger. The vascular plant species were identified by searching "Flora of China" and "Flora of Hubei". Subsequently, the diversity of plant resources in Shennongjia Area were analyzed and evaluated to provide valuable insights into the development, utilization and protection of plant recources in Shennongjia Area.

3 Results

3.1 Analysis of vascular plant species in Shennongjia Area

According to the results of the investigation, a total of 454 vascular plant species were collected in Shennongjia Area. These species belong to 106 families and 275 genera, including 31 species of pteridophytes in 23 genera, 13 families; 2 species of bryophytes in 2 genera, 2 families; 7 species of gymnosperms in 6 genera, 4 families; 414 species of angiosperms in 244 genera, 87 families (specifically, 362 species of dicotyledons in 208 genera, 71 families; 52 species of monocotyledons in 36 genera, 16 families). Among them, angiosperms have the largest number in families (82.1%), genera (88.7%), and species (91.2%). Dicotyledons are the predominant group within the angiosperms. In contrast, the species numbers of pteridophytes, bryophytes and gymnosperms are relatively low, as shown in Table 1. All information of the collected plants is shown in Table 2.

Table 1 Vascular plant species in Shennongjia Area

Plant type	No.families	Ratio/%	No.genera	Ratio/%	No.species	Ratio/%
Pteridophytes	13	12.26	23	8.36	31	6.83
Bryophytes	2	1.89	2	0.73	2	0.44
Gymnosperms	4	3.77	6	2.18	7	1.54
Angiosperms	87	82.08	244	88.73	414	91.19
Dicotyledons	71	81.61	208	85.25	362	87.44
Monocotyledons	16	18.39	36	14.75	52	12.56
Total	106	100.00	275	100.00	454	100.00

Table 2 Statistics of vascular plant resources in Shennongjia Area

No.	Families	Genera	Species
1	Asphodelaceae	Hemerocallis	*Hemerocallis fulva* (L.) L.
2	Smilacaceae	Smilax	*Smilax stans* Maxim.
3	Smilacaceae	Smilax	*Smilax japonica* (Kunth) P. Li & C. X. Fu
4	Smilacaceae	Smilax	*Smilax scobinicaulis* C. H. Wright
5	Liliaceae	Lilium	*Lilium leucanthum* (Baker) Baker
6	Liliaceae	Clintonia	*Clintonia udensis* Trantv. et Mey.
7	Liliaceae	Gagea	*Gagea serotina* (L.) Ker Gawl.
8	Liliaceae	Tricyrtis	*Tricyrtis macropoda* Miq.
9	Cupressaceae	Juniperus	*Juniperus procumbens* (Endlicher) Siebold ex Miquel
10	Cupressaceae	Juniperus	*Juniperus pingii* var. *wilsonii* (Rehder) Silba
11	Cupressaceae	Metasequoia	*Metasequoia glyptostroboides* Hu & W. C. Cheng
12	Primulaceae	Lysimachia	*Lysimachia christinae* Hance
13	Primulaceae	Lysimachia	*Lysimachia congestiflora* Hemsl.
14	Primulaceae	Androsace	*Androsace henryi* Oliv.
15	Primulaceae	Lysimachia	*Lysimachia stenosepala* Hemsl.
16	Grossulariaceae	Ribes	*Ribes tenue* Jancz.
17	Grossulariaceae	Ribes	*Ribes alpestre* Wall. ex Decne.
18	Grossulariaceae	Ribes	*Ribes franchetii* Janczewski
19	Grossulariaceae	Ribes	*Ribes glaciale* Wall.
20	Plantaginaceae	Plantago	*Plantago depressa* Willd.
21	Plantaginaceae	Plantago	*Plantago major* L.
22	Plantaginaceae	Plantago	*Plantago asiatica* L.
23	Plantaginaceae	Plantago	*Plantago asiatica* subsp. *erosa* (Wall.) Z.Y.Li
24	Plantaginaceae	Veronica	*Veronica henryi* Yamazaki
25	Plantaginaceae	Veronica	*Veronica laxa* Benth.
26	Lamiaceae	Phlomis	*Phlomis umbrosa* var. *emarginata*
27	Lamiaceae	Galeopsis	*Galeopsis bifida* Boenn.
28	Lamiaceae	Clinopodium	*Clinopodium chinense* (Benth.) O. Ktze.
29	Lamiaceae	Scutellaria	*Scutellaria baicalensis* Georgi
30	Lamiaceae	Glechoma	*Glechoma biondiana* (Diels) C. Y. Wu et C. Chen
31	Lamiaceae	Salvia	*Salvia hupehensis* Stib.
32	Lamiaceae	Stachys	*Stachys geobombycis* C. Y. Wu
33	Lamiaceae	Prunella	*Prunella vulgaris* L.
34	Lamiaceae	Clinopodium	*Clinopodium gracile* (Benth.) Matsum.
35	Lamiaceae	Salvia	*Salvia scapiformis* Hance

(to be continued)

Continued table 2

No.	Families	Genera	Species
36	Lamiaceae	Phlomoides	*Phlomoides umbrosa* (Turcz.) Kamelin & Makhm.
37	Lamiaceae	Isodon	*Isodon excisoides* (Sun ex C. H. Hu) H. Hara
38	Lamiaceae	Rubiteucris	*Rubiteucris palmata* (Benth. ex Hook. f.) Kudo
39	Lamiaceae	Origanum	*Origanum vulgare* L.
40	Lamiaceae	Salvia	*Salvia cynica* Dunn
41	Lamiaceae	Elsholtzia	*Elsholtzia ciliata* (Thunb.) Hyland.
42	Lamiaceae	Teucrium	*Teucrium ornatum* Hemsl.
43	Lamiaceae	Clinopodium	*Clinopodium megalanthum* (Diels) C. Y. Wu et Hsuan ex H. W. Li
44	Lamiaceae	Clerodendrum	*Clerodendrum bungei* Steud.
45	Lamiaceae	Callicarpa	*Callicarpa bodinieri* Levl.
46	Euphorbiaceae	Euphorbia	*Euphorbia pekinensis* Rupr.
47	Euphorbiaceae	Euphorbia	*Euphorbia hylonoma* Hand.-Mazz.
48	Juncaceae	Juncus	*Juncus setchuensis* Buchen. ex Diels
49	Juncaceae	Luzula	*Luzula plumosa* E. Mey.
50	Fabaceae	Vicia	*Vicia cracca* L.
51	Fabaceae	Hylodesmum	*Hylodesmum leptopus* (A. Gray ex Bentham) H. Ohashi & R. R. Mill
52	Fabaceae	Trifolium	*Trifolium pratense* L.
53	Fabaceae	Pueraria	*Pueraria phaseoloides* (Roxb.) Benth.
54	Fabaceae	Lespedeza	*Lespedeza thunbergii* subsp. *formosa* (Vogel) H. Ohashi
55	Fabaceae	Dalbergia	*Dalbergia mimosoides* Franch.
56	Fabaceae	Kummerowia	*Kummerowia striata* (Thunb.) Schindl.
57	Fabaceae	Hylodesmum	*Hylodesmum podocarpum* subsp. *szechuenense* (Craib) H. Ohashi & R. R. Mill
58	Fabaceae	Hylodesmum	*Hylodesmum oldhamii* (Oliver) H. Ohashi & R. R. Mill
59	Fabaceae	Hylodesmum	*Hylodesmum podocarpum* (Candolle) H. Ohashi & R. R. Mill
60	Fabaceae	Melilotus	*Melilotus officinalis* (L.) Pall.
61	Fabaceae	Amphicarpaea	*Amphicarpaea edgeworthii* Benth.
62	Fabaceae	Pycnospora	*Pycnospora lutescens* (Poir.) Schindl.
63	Fabaceae	Medicago	*Medicago sativa* L.
64	Fabaceae	Vicia	*Vicia chinensis* Franch.
65	Ericaceae	Rhododendron	*Rhododendron simsii* Planch.
66	Ericaceae	Rhododendron	*Rhododendron farrerae* Tate ex Sweet
67	Ericaceae	Rhododendron	*Rhododendron concinnum* Hemsley
68	Ericaceae	Rhododendron	*Rhododendron oreodoxa* var. *fargesii* (Franch.) Chamb. ex Cullen et Chamb.
69	Ericaceae	Rhododendron	*Rhododendron maculiferum* Franch.

(to be continued)

Continued table 2

No.	Families	Genera	Species
70	Ericaceae	Pyrola	*Pyrola calliantha* H. Andr.
71	Pteridaceae	Pteris	*Pteris cretica* L.
72	Pteridaceae	Haplopteris	*Haplopteris flexuosa* (Fée) E. H. Crane
73	Pteridaceae	Adiantum	*Adiantum flabellulatum* L.
74	Pteridaceae	Adiantum	*Adiantum capillus-veneris* L.
75	Pteridaceae	Cryptogramma	*Cryptogramma raddeana* Fomin
76	Balsaminaceae	Impatiens	*Impatiens apalophylla* Hook. f.
77	Balsaminaceae	Impatiens	*Impatiens bellula* Hook. f.
78	Balsaminaceae	Impatiens	*Impatiens macrovexilla* Y. L. Chen
79	Balsaminaceae	Impatiens	*Impatiens siculifer* Hook. f.
80	Balsaminaceae	Impatiens	*Impatiens pterosepala* Hook. f.
81	Balsaminaceae	Impatiens	*Impatiens apsotis* Hook. f.
82	Pittosporaceae	Pittosporum	*Pittosporum podocarpum* var. *angustatum* Gowda
83	Poaceae	Oplismenus	*Oplismenus undulatifolius* (Arduino) Beauv.
84	Poaceae	Leptochloa	*Leptochloa chinensis* (L.) Nees
85	Taxaceae	Torreya	*Torreya fargesii* Franch.
86	Taxaceae	Taxus	*Taxus wallichiana* var. *chinensis* (Pilger) Florin
87	Elaeagnaceae	Elaeagnus	*Elaeagnus lanceolata* Warb.
88	Cucurbitaceae	Gynostemma	*Gynostemma pentaphyllum* (Thunb.) Makino
89	Cucurbitaceae	Thladiantha	*Thladiantha dentata* Cogn.
90	Saxifragaceae	Astilbe	*Astilbe grandis* Stapf ex Wils.
91	Saxifragaceae	Chrysosplenium	*Chrysosplenium pilosum* Maxim.
92	Saxifragaceae	Chrysosplenium	*Chrysosplenium delavayi* Franch.
93	Saxifragaceae	Chrysosplenium	*Chrysosplenium macrophyllum* Oliv.
94	Saxifragaceae	Astilbe	*Astilbe chinensis* (Maxim.) Franch. et Savat.
95	Saxifragaceae	Rodgersia	*Rodgersia podophylla* A. Gray
96	Saxifragaceae	Rodgersia	*Rodgersia aesculifolia* Batalin
97	Saxifragaceae	Tiarella	*Tiarella polyphylla* D. Don
98	Betulaceae	Betula	*Betula utilis* D. Don
99	Betulaceae	Corylus	*Corylus yunnanensis* (Franchet) A. Camus
100	Betulaceae	Corylus	*Corylus ferox* var. *thibetica* (Batal.) Franch.
101	Buxaceae	Buxus	*Buxus sinica* var. *parvifolia* M. Cheng
102	Buxaceae	Pachysandra	*Pachysandra terminalis* Siebold & Zucc.
103	Apocynaceae	Cynanchum	*Cynanchum auriculatum* Royle ex Wight

(to be continued)

Continued table 2

No.	Families	Genera	Species
104	Zingiberaceae	Zingiber	*Zingiber mioga* (Thunb.) Rosc.
105	Polytrichaceae	Polytrichum	*Polytrichum commune* Hedw.
106	Hamamelidaceae	Corylopsis	*Corylopsis sinensis* Hemsl.
107	Hypericaceae	Hypericum	*Hypericum perforatum* L.
108	Hypericaceae	Hypericum	*Hypericum elodeoides* Choisy
109	Hypericaceae	Hypericum	*Hypericum ascyron* L.
110	Chloranthaceae	Chloranthus	*Chloranthus serratus* (Thunb.) Roem. et Schult.
111	Thelypteridaceae	Metathelypteris	*Metathelypteris hattorii* (H. Ito) Ching
112	Violaceae	Viola	*Viola moupinensis* Franch.
113	Violaceae	Viola	*Viola collina* Bess.
114	Crassulaceae	Sedum	*Sedum oligospermum* Maire
115	Crassulaceae	Hylotelephium	*Hylotelephium verticillatum* (L.) H. Ohba
116	Crassulaceae	Sedum	*Sedum filipes* Hemsl.
117	Crassulaceae	Sedum	*Sedum alfredii* Hance
118	Crassulaceae	Rhodiola	*Rhodiola rosea* L.
119	Crassulaceae	Sedum	*Sedum elatinoides* Franch.
120	Crassulaceae	Rhodiola	*Rhodiola yunnanensis* (Franch.) S. H. Fu
121	Crassulaceae	Phedimus	*Phedimus aizoon* (Linnaeus) ‘t Hart
122	Campanulaceae	Adenophora	*Adenophora capillaris* Hemsl.
123	Campanulaceae	Pseudocodon	*Pseudocodon convolvulaceus* subsp. *forrestii* (Diels) D.Y.Hong
124	Campanulaceae	Codonopsis	*Codonopsis pilosula* (Franch.) Nannf.
125	Campanulaceae	Campanula	*Campanula punctata* Lamarck
126	Asteraceae	Saussurea	*Saussurea oligantha* Franch.
127	Asteraceae	Tussilago	*Tussilago farfara* L.
128	Asteraceae	Senecio	*Senecio scandens* Buch.-Ham. ex D. Don
129	Asteraceae	Aster	*Aster ageratoides* Turcz.
130	Asteraceae	Bidens	*Bidens frondosa* L.
131	Asteraceae	Anaphalis	*Anaphalis sinica* Hance
132	Asteraceae	Inula	*Inula hupehensis* (Ling) Ling
133	Asteraceae	Erigeron	*Erigeron annuus* (L.) Pers.
134	Asteraceae	Sinacalia	*Sinacalia tangutica* (Maxim.) B. Nord.
135	Asteraceae	Picris	*Picris hieracioides* L.
136	Asteraceae	Anaphalis	*Anaphalis margaritacea* var. *angustifolia* (Franchet & Savatier) Hayata
137	Asteraceae	Artemisia	*Artemisia indica* Willd.

(to be continued)

Continued table 2

No.	Families	Genera	Species
138	Asteraceae	Crepidiastrum	*Crepidiastrum denticulatum* (Houttuyn) Pak & Kawano
139	Asteraceae	Leontopodium	*Leontopodium japonicum* Miq.
140	Asteraceae	Galinsoga	*Galinsoga parviflora* Cav.
141	Asteraceae	Carpesium	*Carpesium abrotanoides* L.
142	Asteraceae	Sigesbeckia	*Sigesbeckia glabrescens* (Makino) Makino
143	Asteraceae	Inula	*Inula japonica* Thunb.
144	Asteraceae	Saussurea	*Saussurea leclerei* Lévl.
145	Asteraceae	Parasenecio	*Parasenecio hastatus* (L.) H. Koyama
146	Asteraceae	Sinosenecio	*Sinosenecio latouchei* (J. F. Jeffrey) B. Nord.
147	Asteraceae	Ligularia	*Ligularia nelumbifolia* (Bur. et Franch.) Hand.-Mazz.
148	Asteraceae	Parasenecio	*Parasenecio phyllolepis* (Franch.) Y. L. Chen
149	Asteraceae	Parasenecio	*Parasenecio forrestii* W. W. Smith et Samll
150	Asteraceae	Saussurea	*Saussurea chingiana* Hand.-Mazz.
151	Asteraceae	Cirsium	*Cirsium henryi* (Franch.) Diels
152	Asteraceae	Ligularia	*Ligularia sibirica* (L.) Cass.
153	Asteraceae	Youngia	*Youngia atripappa* (Babcock) N. Kilian
154	Asteraceae	Cirsium	*Cirsium fargesii* (Franch.) Diels
155	Asteraceae	Rudbeckia	*Rudbeckia hirta* L.
156	Asteraceae	Cichorium	*Cichorium intybus* L.
157	Asteraceae	Chrysanthemum	*Chrysanthemum lavandulifolium* var. *Aromaticu*
158	Asteraceae	Chrysanthemum	*Chrysanthemum indicum* Linnaeus
159	Asteraceae	Sonchus	*Sonchus oleraceus* L.
160	Asteraceae	Sinosenecio	*Sinosenecio oldhamianus* (Maxim.) B. Nord.
161	Asteraceae	Ligularia	*Ligularia dentata* (A. Gray) Hara
162	Asteraceae	Ligularia	*Ligularia intermedia* Nakai
163	Asteraceae	Saussurea	*Saussurea polycephala* Hand.-Mazz.
164	Asteraceae	Petasites	*Petasites japonicus* (Sieb. et Zucc.) Maxim.
165	Asteraceae	Artemisia	*Artemisia atrovirens* Hand.-Mazz.
166	Asteraceae	Artemisia	*Artemisia lactiflora* Wall. ex DC.
167	Asteraceae	Saussurea	*Saussurea salicifolia* (L.) DC.
168	Asteraceae	Saussurea	*Saussurea cordifolia* Hemsl.
169	Asteraceae	Saussurea	*Saussurea populifolia* Hemsl.
170	Asteraceae	Saussurea	*Saussurea dolichopoda* Diels
171	Asteraceae	Artemisia	*Artemisia vestita* Wall. ex Bess.

(to be continued)

Continued table 2

No.	Families	Genera	Species
172	Asteraceae	Saussurea	*Saussurea veitchiana* Drumm. et Hutch.
173	Asteraceae	Ajania	*Ajania variifolia* (Chang) Tzvel.
174	Selaginellaceae	Selaginella	*Selaginella moellendorffii* Hieron.
175	Fagaceae	Quercus	*Quercus aliena* var. *acutiserrata* Maximowicz ex Wenzig
176	Fagaceae	Quercus	*Quercus serrata* Murray
177	Fagaceae	Quercus	*Quercus semecarpifolia* Smith
178	Gesneriaceae	Oreocharis	*Oreocharis speciosa* (Hemsl.) Mich. Möller & W. H. Chen
179	Orchidaceae	Spiranthes	*Spiranthes sinensis* (Pers.) Ames
180	Orchidaceae	Platanthera	*Platanthera minor* (Miq.) Rchb. F.
181	Orchidaceae	Pholidota	*Pholidota yunnanensis* Rolfe
182	Orchidaceae	Gymnadenia	*Gymnadenia orchidis* Lindl.
183	Orchidaceae	Ischnogyne	*Ischnogyne mandarinorum* (Kraenzlin) Schlechter
184	Orchidaceae	Liparis	*Liparis campylostalix* H. G. Reichenbach
185	Orchidaceae	Platanthera	*Platanthera japonica* (Thunb. ex Marray) Lindl.
186	Orchidaceae	Liparis	*Liparis nervosa* (Thunb. ex A. Murray) Lindl.
187	Orchidaceae	Gastrodia	*Gastrodia elata* Bl.
188	Melanthiaceae	Trillium	*Trillium tschonoskii* Maxim.
189	Melanthiaceae	Veratrum	*Veratrum nigrum* L.
190	Melanthiaceae	Paris	*Paris polyphylla* var. *chinensis* (Franch.) Hara
191	Melanthiaceae	Paris	*Paris polyphylla* Smith
192	Polygonaceae	Persicaria	*Persicaria microcephala* (D. Don) H. Gross
193	Polygonaceae	Polygonum	*Polygonum thunbergii* Sieb. et Zucc.
194	Polygonaceae	Persicaria	*Persicaria hydropiper* (L.) Spach
195	Polygonaceae	Bistorta	*Bistorta pacifica* (V. V. Petrovsky ex Kom.) Kom. ex Kitag.
196	Polygonaceae	Persicaria	*Persicaria nepalensis* (Meisn.) H. Gross
197	Polygonaceae	Persicaria	*Persicaria runcinata* (Buch.-Ham. ex D. Don) H. Gross
198	Polygonaceae	Bistorta	*Bistorta vivipara* (L.) Gray
199	Polygonaceae	Fagopyrum	*Fagopyrum gracilipes* (Hemsl.) Damm. ex Diels
200	Polygonaceae	Persicaria	*Persicaria pinetorum* (Hemsl.) H. Gross
201	Polygonaceae	Rheum	*Rheum officinale* Baill.
202	Polygonaceae	Rumex	*Rumex nepalensis* Spreng.
203	Polygonaceae	Rumex	*Rumex acetosa* L.
204	Orobanchaceae	Pedicularis	*Pedicularis kiangsiensis* Tsoong et Cheng f.
205	Orobanchaceae	Pedicularis	*Pedicularis torta* Maxim.

(to be continued)

Continued table 2

No.	Families	Genera	Species
206	Orobanchaceae	Pedicularis	*Pedicularis myriophylla* var. *purpurea* Bunge
207	Orobanchaceae	Pedicularis	*Pedicularis rex* C. B. Clarke ex Maxim.
208	Orobanchaceae	Pedicularis	*Pedicularis nanchuanensis* Tsoong
209	Dryopteridaceae	Cyrtomium	*Cyrtomium fortunei* J. Sm.
210	Dryopteridaceae	Cyrtomium	*Cyrtomium lonchitoides* (Christ) Christ
211	Dryopteridaceae	Cyrtomium	*Cyrtomium yamamotoi* Tagawa
212	Dryopteridaceae	Polystichum	*Polystichum dielsii* Christ
213	Dryopteridaceae	Cyrtomium	*Cyrtomium macrophyllum* (Makino) Tagawa
214	Eupteleaceae	Euptelea	*Euptelea pleiosperma* J. D. Hooker & Thomson
215	Onagraceae	Circaea	*Circaea erubescens* Franch. et Sav.
216	Onagraceae	Oenothera	*Oenothera stricta* Ledeb. et Link
217	Onagraceae	Circaea	*Circaea alpina* subsp. *imaicola* (Asch.& Mag.) Kitamura
218	Onagraceae	Circaea	*Circaea mollis* Sieb. et Zucc.
219	Onagraceae	Epilobium	*Epilobium hirsutum* L.
220	Onagraceae	Epilobium	*Epilobium roseum* Schreber
221	Onagraceae	Epilobium	*Epilobium sinense* Lévl.
222	Onagraceae	Circaea	*Circaea cordata* Royle
223	Onagraceae	Chamerion	*Chamerion angustifolium* (Linnaeus) Holub
224	Gentianaceae	Gentianopsis	*Gentianopsis paludosa* var. *ovatodeltoidea* (Burkill) Ma
225	Gentianaceae	Swertia	*Swertia bimaculata* (Sieb. et Zucc.) Hook. f. et Thoms. ex C. B. Clark
226	Aristolochiaceae	Asarum	*Asarum heterotropoides* Fr. Schmidt
227	Aristolochiaceae	Asarum	*Asarum caulescens* Maxim.
228	Aristolochiaceae	Asarum	*Asarum debile* Franch.
229	Coriariaceae	Coriaria	*Coriaria nepalensis* Wall.
230	Geraniaceae	Geranium	*Geranium rosthornii* R. Knuth
231	Ranunculaceae	Thalictrum	*Thalictrum przewalskii* Maxim.
232	Ranunculaceae	Thalictrum	*Thalictrum macrorhynchum* Franch.
233	Ranunculaceae	Aconitum	*Aconitum hemsleyanum* Pritz.
234	Ranunculaceae	Anemone	*Anemone tomentosa* (Maxim.) Pei
235	Ranunculaceae	Aconitum	*Aconitum sinomontanum* Nakai
236	Ranunculaceae	Anemone	*Anemone hupehensis* Lem.
237	Ranunculaceae	Aconitum	*Aconitum sinomontanum* var. *angustius* W.T.Wang
238	Ranunculaceae	Aquilegia	*Aquilegia yabeana* Kitag.
239	Ranunculaceae	Thalictrum	*Thalictrum microgynum* Lecoy. ex Oliv.

(to be continued)

Continued table 2

No.	Families	Genera	Species
240	Ranunculaceae	Clematis	*Clematis florida* Thunb.
241	Ranunculaceae	Clematis	*Clematis pogonandra* Maxim.
242	Ranunculaceae	Aconitum	*Aconitum scaposum* Franch.
243	Ranunculaceae	Asteropyrum	*Asteropyrum peltatum* (Franch.) Drumm. ex Hutch.
244	Ranunculaceae	Clematis	*Clematis montana* Buch.-Ham. ex DC.
245	Ranunculaceae	Aconitum	*Aconitum lioui* W. T. Wang
246	Ranunculaceae	Aquilegia	*Aquilegia viridiflora* Pall.
247	Ranunculaceae	Actaea	*Actaea cimicifuga* L.
248	Ranunculaceae	Thalictrum	*Thalictrum uncinulatum* Franch.
249	Ranunculaceae	Coptis	*Coptis chinensis* Franch.
250	Ranunculaceae	Beesia	*Beesia calthifolia* (Maxim.) Ulbr.
251	Ranunculaceae	Anemone	*Anemone rivularis* Buch.-Ham.
252	Actinidiaceae	Actinidia	*Actinidia melliana* Hand.-Mazz.
253	Magnoliaceae	Yulania	*Yulania multiflora* (M. C. Wang & C. L. Min) D. L. Fu
254	Lardizabalaceae	Decaisnea	*Decaisnea insignis* (Griffith) J. D. Hooker et Thomson
255	Lardizabalaceae	Akebia	*Akebia trifoliata* (Thunb.) Koidz.
256	Oleaceae	Syringa	*Syringa komarowii* subsp. *reflexa* (C. K. Schneider) P. S. Green & M. C. Chang
257	Equisetaceae	Equisetum	*Equisetum hyemale* L.
258	Equisetaceae	Equisetum	*Equisetum arvense* L.
259	Sphagnaceae	Sphagnum	*Sphagnum palustre* L.
260	Ophioglossaceae	Ophioglossum	*Ophioglossum vulgatum* L.
261	Ophioglossaceae	Sceptridium	*Sceptridium ternatu*m (Thunb.) Y. X. Lin
262	Vitaceae	Parthenocissus	*Parthenocissus feddei* (Levl.) C. L. Li
263	Vitaceae	Parthenocissus	*Parthenocissus quinquefolia* (L.) Planch.
264	Vitaceae	Vitis	*Vitis betulifolia* Diels et Gilg
265	Anacardiaceae	Toxicodendron	*Toxicodendron radicans* subsp. *hispidum* (Engl.) Gillis
266	Anacardiaceae	Toxicodendron	*Toxicodendron vernicifluum* (Stokes) F. A. Barkl.
267	Anacardiaceae	Toxicodendron	*Toxicodendron radicans* subsp. *hispidum* (Engl.) Gillis
268	Lythraceae	Lagerstroemia	*Lagerstroemia indica* L.
269	Rubiaceae	Theligonum	*Theligonum macranthum* Franch.
270	Rubiaceae	Galium	*Galium hoffmeisteri* (Klotzsch) Ehrendorfer & Schonbeck-Temesy ex R. R. Mill
271	Rubiaceae	Rubia	*Rubia cordifolia* L.
272	Rubiaceae	Rubia	*Rubia ovatifolia* Z. Y. Zhang
273	Rosaceae	Dasiphora	*Dasiphora glabra* (G. Lodd.) Soják

(to be continued)

Continued table 2

No.	Families	Genera	Species
274	Rosaceae	Geum	*Geum aleppicum* Jacq.
275	Rosaceae	Malus	*Malus hupehensis* (Pamp.) Rehd.
276	Rosaceae	Malus	*Malus kansuensis* var. *calva* (Rehder) T. C. Ku & Spongberg
277	Rosaceae	Rosa	*Rosa kwangtungensis* Yü et Tsai
278	Rosaceae	Spiraea	*Spiraea japonica* L. f.
279	Rosaceae	Rubus	*Rubus columellaris* Tutcher
280	Rosaceae	Cotoneaster	*Cotoneaster horizontalis* Dcne.
281	Rosaceae	Sorbaria	*Sorbaria arborea* Schneid.
282	Rosaceae	Stranvaesia	*Stranvaesia davidiana* Dcne.
283	Rosaceae	Sorbus	*Sorbus caloneura* (Stapf) Rehd.
284	Rosaceae	Prunus	*Prunus salicina* Lindl.
285	Rosaceae	Geum	*Geum japonicum* var. *chinense* F.Bolle
286	Rosaceae	Rubus	*Rubus coreanus* Miq.
287	Rosaceae	Rubus	*Rubus lambertianus* Ser.
288	Rosaceae	Spiraea	*Spiraea fritschiana* Schneid.
289	Rosaceae	Fragaria	*Fragaria orientalis* Lozinsk.
290	Rosaceae	Rosa	*Rosa setipoda* Hemsl. et Wils.
291	Rosaceae	Argentina	*Argentina leuconota* (D. Don) Soják
292	Rosaceae	Rubus	*Rubus lasiostylus* var. *hubeiensis* Yü
293	Rosaceae	Rubus	*Rubus pileatus* Focke
294	Rosaceae	Rubus	*Rubus fockeanus* Kurz.
295	Rosaceae	Rubus	*Rubus amabilis* Focke
296	Rosaceae	Sanguisorba	*Sanguisorba officinalis* L.
297	Rosaceae	Agrimonia	*Agrimonia pilosa* Ldb.
298	Rosaceae	Crataegus	*Crataegus wilsonii* Sarg.
299	Rosaceae	Potentilla	*Potentilla cryptotaeniae* Maxim.
300	Rosaceae	Rubus	*Rubus mesogaeus* Focke
301	Rosaceae	Rubus	*Rubus bambusarum* Focke
302	Rosaceae	Sorbus	*Sorbus hupehensis* Schneid.
303	Rosaceae	Rosa	*Rosa saturata* Baker
304	Rosaceae	Rosa	*Rosa omeiensis* Rolfe
305	Rosaceae	Rubus	*Rubus lasiostylus* Focke
306	Rosaceae	Fragaria	*Fragaria nilgerrensis* Schlecht. ex Gay
307	Rosaceae	Rosa	*Rosa caudata* Baker

(to be continued)

Continued table 2

No.	Families	Genera	Species
308	Rosaceae	Spiraea	*Spiraea veitchii* Hemsl.
309	Rosaceae	Rubus	*Rubus inopertus* (Diels) Focke
310	Helwingiaceae	Helwingia	*Helwingia himalaica* Hook. f. et Thoms. ex C. B. Clarke
311	Caprifoliaceae	Patrinia	*Patrinia monandra* C. B. Clarke
312	Caprifoliaceae	Patrinia	*Patrinia heterophylla* Bunge
313	Caprifoliaceae	Valeriana	*Valeriana officinalis* L.
314	Caprifoliaceae	Lonicera	*Lonicera acuminata* Wall.
315	Caprifoliaceae	Lonicera	*Lonicera chrysantha* Turcz.
316	Caprifoliaceae	Triosteum	*Triosteum himalayanum* Wall.
317	Caprifoliaceae	Lonicera	*Lonicera nervosa* Maxim.
318	Caprifoliaceae	Lonicera	*Lonicera tangutica* Maxim.
319	Thymelaeaceae	Daphne	*Daphne tangutica* var. *wilsonii* (Rehd.) H.F.Zhou ex C.Y.Chang
320	Saururaceae	Houttuynia	*Houttuynia cordata* Thunb.
321	Apiaceae	Bupleurum	*Bupleurum longicaule* var. *franchetii* de Boiss.
322	Apiaceae	Conioselinum	*Conioselinum anthriscoides* (H. Boissieu) Pimenov & Kljuykov
323	Apiaceae	Pimpinella	*Pimpinella acuminata* (Edgew.) C. B. Clarke
324	Apiaceae	Torilis	*Torilis scabra* (Thunb.) DC.
325	Apiaceae	Anthriscus	*Anthriscus sylvestris* (L.) Hoffm.
326	Apiaceae	Pimpinella	*Pimpinella rhomboidea* Diels
327	Apiaceae	Tongoloa	*Tongoloa dunnii* (de Boiss.) Wolff
328	Apiaceae	Sanicula	*Sanicula orthacantha* S. Moore
329	Apiaceae	Bupleurum	*Bupleurum boissieuanum* H. Wolff
330	Apiaceae	Angelica	*Angelica polymorpha* Maxim.
331	Apiaceae	Angelica	*Angelica biserrata* (Shan et Yuan) Yuan et Shan
332	Apiaceae	Heracleum	*Heracleum moellendorffii* var. *paucivittatum* Shan et T.S.Wang
333	Apiaceae	Cryptotaenia	*Cryptotaenia japonica* Hassk.
334	Cyperaceae	Carex	*Carex siderosticta* Hance
335	Theaceae	Stewartia	*Stewartia sinensis* Rehd. et Wils
336	Symplocaceae	Symplocos	*Symplocos tanakana* Nakai
337	Cornaceae	Cornus	*Cornus kousa* subsp. *chinensis* (Osborn) Q. Y. Xiang
338	Cornaceae	Cornus	*Cornus hemsleyi* C. K. Schneider & Wangerin
339	Phytolaccaceae	Phytolacca	*Phytolacca americana* L.
340	Staphyleaceae	Staphylea	*Staphylea holocarpa* Hemsl.

(to be continued)

Continued table 2

No.	Families	Genera	Species
341	Brassicaceae	Arabis	*Arabis sagittata* (Bertol.) DC.
342	Brassicaceae	Cardamine	*Cardamine macrophylla* Willd.
343	Brassicaceae	Cardamine	*Cardamine impatiens* Linnaeus
344	Lycopodiaceae	Huperzia	*Huperzia chinensis* (Christ) Ching
345	Lycopodiaceae	Lycopodium	*Lycopodium annotinum* L.
346	Lycopodiaceae	Lycopodium	*Lycopodium japonicum* Thunb. ex Murray
347	Amaryllidaceae	Allium	*Allium prattii* C. H. Wright ex Hemsl.
348	Amaryllidaceae	Allium	*Allium chrysanthum* Regel
349	Caryophyllaceae	Dianthus	*Dianthus superbus* L.
350	Caryophyllaceae	Silene	*Silene tatarinowii* Regel
351	Caryophyllaceae	Silene	*Silene baccifera* (Linnaeus) Roth
352	Caryophyllaceae	Silene	*Silene hupehensis* C. L. Tang
353	Caryophyllaceae	Moehringia	*Moehringia trinervia* (Linn .) Clairv.
354	Caryophyllaceae	Stellaria	*Stellaria henryi* Williams
355	Caryophyllaceae	Silene	*Silene platyphylla* Franch.
356	Rhamnaceae	Rhamnus	*Rhamnus wilsonii* Schneid.
357	Dioscoreaceae	Dioscorea	*Dioscorea polystachya* Turczaninow
358	Dioscoreaceae	Dioscorea	*Dioscorea nipponica* Makino
359	Polypodiaceae	Lepisorus	*Lepisorus ussuriensis* (Regel et Maack) Ching
360	Polypodiaceae	Lemmaphyllum	*Lemmaphyllum diversum* (Rosenst.) De Vol et C. M. Kuo
361	Polypodiaceae	Pyrrosia	*Pyrrosia lingua* (Thunb.) Farwell
362	Polypodiaceae	Lepisorus	*Lepisorus thunbergianus* (Kaulf.) Ching.
363	Polypodiaceae	Selliguea	*Selliguea conjuncta* (Ching) S. G. Lu
364	Garryaceae	Aucuba	*Aucuba chinensis* Benth.
365	Pinaceae	Abies	*Abies fargesii* Franch.
366	Athyriaceae	Athyrium	*Athyrium costulalisorum* Ching
367	Asparagaceae	Maianthemum	*Maianthemum japonicum* (A. Gray) LaFrankie
368	Asparagaceae	Liriope	*Liriope graminifolia* (L.) Baker
369	Asparagaceae	Maianthemum	*Maianthemum henryi* (Baker) LaFrankie
370	Asparagaceae	Reineckea	*Reineckea carnea* (Andrews) Kunth
371	Asparagaceae	Rohdea	*Rohdea chinensis* (Baker) N.Tanaka
372	Asparagaceae	Liriope	*Liriope muscari* (Decaisne) L. H. Bailey
373	Asparagaceae	Ophiopogon	*Ophiopogon japonicus* (L. f.) Ker-Gawl.

(to be continued)

Continued table 2

No.	Families	Genera	Species
374	Asparagaceae	Hosta	*Hosta ventricosa* (Salisb.) Stearn
375	Asparagaceae	Polygonatum	*Polygonatum cyrtonema* Hua
376	Asparagaceae	Asparagus	*Asparagus filicinus* D. Don
377	Asparagaceae	Polygonatum	*Polygonatum hookeri* Baker
378	Asparagaceae	Polygonatum	*Polygonatum cirrhifolium* (Wall.) Royle
379	Asparagaceae	Ophiopogon	*Ophiopogon bodinieri* Levl.
380	Araceae	Arisaema	*Arisaema elephas* Buchet
381	Araceae	Arisaema	*Arisaema asperatum* N. E. Brown
382	Araceae	Arisaema	*Arisaema heterophyllum* Blume
383	Araceae	Arisaema	*Arisaema erubescens* (Wall.) Schott
384	Araceae	Arisaema	*Arisaema lobatum* Engl.
385	Aspleniaceae	Asplenium	*Asplenium pekinense* Hance
386	Aspleniaceae	Asplenium	*Asplenium trichomanes* L. Sp.
387	Dennstaedtiaceae	Dennstaedtia	*Dennstaedtia scabra* (Wall.) Moore
388	Celastraceae	Parnassia	*Parnassia delavayi* Franch.
389	Celastraceae	Euonymus	*Euonymus hamiltonianus* Wall.
390	Celastraceae	Celastrus	*Celastrus gemmatus* Loes.
391	Celastraceae	Euonymus	*Euonymus fortunei* (Turcz.) Hand.-Mazz.
392	Celastraceae	Euonymus	*Euonymus phellomanus* Loesener
393	Celastraceae	Euonymus	*Euonymus frigidus* Wall. ex Roxb.
394	Celastraceae	Euonymus	*Euonymus cornutus* Hemsl.
395	Celastraceae	Euonymus	*Euonymus alatus* (Thunb.) Sieb.
396	Blechnaceae	Woodwardia	*Woodwardia unigemmata* (Makino) Nakai
397	Sapindaceae	Acer	*Acer truncatum* Bunge
398	Sapindaceae	Acer	*Acer caudatum* Wall.
399	Sapindaceae	Acer	*Acer palmatum* Thunb.
400	Sapindaceae	Acer	*Acer maximowiczii* Pax
401	Sapindaceae	Acer	*Acer oliverianum* Pax
402	Sapindaceae	Acer	*Acer davidii* Franch.
403	Sapindaceae	Aesculus	*Aesculus chinensis* var. *wilsonii* (Rehder) Turland & N. H. Xia
404	Adoxaceae	Viburnum	*Viburnum henryi* Hemsl.
405	Adoxaceae	Viburnum	*Viburnum betulifolium* Batal.
406	Adoxaceae	Viburnum	*Viburnum erubescens* Wall.

(to be continued)

Continued table 2

No.	Families	Genera	Species
407	Adoxaceae	Sambucus	*Sambucus williamsii* Hance
408	Adoxaceae	Sambucus	*Sambucus adnata* Wall. ex DC.
409	Adoxaceae	Viburnum	*Viburnum opulus* subsp. *calvescens* (Rehder) Sugim.
410	Araliaceae	Eleutherococcus	*Eleutherococcus giraldii* (Harms) Nakai
411	Araliaceae	Aralia	*Aralia fargesii* Franch.
412	Araliaceae	Hedera	*Hedera nepalensis* var. *sinensis* (Tobl.) Rehd.
413	Araliaceae	Eleutherococcus	*Eleutherococcus leucorrhizus* Oliver
414	Araliaceae	Aralia	*Aralia officinalis* Z. Z. Wang
415	Araliaceae	Eleutherococcus	*Eleutherococcus senticosus* (Ruprecht & Maximowicz) Maximowicz
416	Araliaceae	Eleutherococcus	*Eleutherococcus leucorrhizus* var. *setchuenensis* (Harms) C. B. Shang & J. Y. Huang
417	Schisandraceae	Schisandra	*Schisandra incarnata* Stapf
418	Berberidaceae	Dysosma	*Dysosma versipellis* (Hance) M. Cheng ex Ying
419	Berberidaceae	Diphylleia	*Diphylleia sinensis* H. L. Li
420	Berberidaceae	Caulophyllum	*Caulophyllum robustum* Maxim.
421	Berberidaceae	Mahonia	*Mahonia bealei* (Fort.) Carr.
422	Berberidaceae	Berberis	*Berberis veitchii* Schneid.
423	Berberidaceae	Berberis	*Berberis julianae* Schneid.
424	Hydrangeaceae	Hydrangea	*Hydrangea bretschneideri* Dippel
425	Hydrangeaceae	Hydrangea	*Hydrangea strigosa* Rehd.
426	Hydrangeaceae	Hydrangea	*Hydrangea longipes* Franch.
427	Scrophulariaceae	Buddleja	*Buddleja albiflora* Hemsl.
428	Scrophulariaceae	Buddleja	*Buddleja davidii* Fr.
429	Scrophulariaceae	Scrophularia	*Scrophularia moellendorffii* Maxim.
430	Urticaceae	Elatostema	*Elatostema stewardii* Merr.
431	Urticaceae	Boehmeria	*Boehmeria spicata* (Thunb.) Thunb.
432	Urticaceae	Zhengyia	*Zhengyia shennongensis* T. Deng
433	Urticaceae	Urtica	*Urtica laetevirens* Maxim.
434	Urticaceae	Laportea	*Laportea bulbifera* (Sieb. et Zucc.) Wedd.
435	Urticaceae	Elatostema	*Elatostema obtusum* Wedd.
436	Urticaceae	Laportea	*Laportea cuspidata* (Wedd.) Friis
437	Urticaceae	Pilea	*Pilea sinofasciata* C. J. Chen
438	Urticaceae	Pilea	*Pilea notata* C. H. Wright
439	Commelinaceae	Commelina	*Commelina communis* L.

(to be continued)

Continued table 2

No.	Families	Genera	Species
440	Salicaceae	Salix	*Salix heterochroma* Seemen
441	Salicaceae	Populus	*Populus wilsonii* Schneid.
442	Salicaceae	Salix	*Salix mictotricha* Schneid.
443	Ginkgoaceae	Ginkgo	*Ginkgo biloba* L.
444	Papaveraceae	Stylophorum	*Stylophorum lasiocarpum* (Oliv.) Fedde
445	Iridaceae	Iris	*Iris japonica* Thunb.
446	Rutaceae	Skimmia	*Skimmia reevesiana* Fort.
447	Lauraceae	Litsea	*Litsea mollis* Hemsl.
448	Lauraceae	Lindera	*Lindera obtusiloba* Bl.
449	Lauraceae	Litsea	*Litsea ichangensis* Gamble
450	Nartheciaceae	Aletris	*Aletris spicata* (Thunb.) Franch.
451	Boraginaceae	Cynoglossum	*Cynoglossum lanceolatum* Forsk.
452	Osmundaceae	Plenasium	*Plenasium vachellii* (Hook.) C. Presl
453	Osmundaceae	Osmunda	*Osmunda japonica* Thunb.
454	Oxalidaceae	Oxalis	*Oxalis acetosella* L.

3.2 Analysis of plant family and genera composition in Shennongjia Area

The vascular plants collected in Shennongjia Area were classified into 106 plant families. Most of the families contained only a few species. Specifically, 83 plant families consisted of 1-5 species, accounting for 78.3% of the total number of families. Another 15 families contained 6-10 species, accounting for 14.2% of the total number of families. Additionally, 8 families had more than 10 species, comprising 7.6% of the total number of families. These families are *Polygonaceae*, *Apiaceae*, *Asparagaceae*, *Fabaceae*, *Lamiaceae*, *Ranunculaceae*, *Rosaceae* and *Asteraceae*, with 12, 13, 13, 15, 20, 21, 37 and 48 species, respectively. Remarkably, although these 8 families constitute only 7.6% of the total number of families, the species ration is the largest, exceeding 39.4%, as shown in Table 3.

Table 3 Species in different families of vascular plants in Shennongjia Area

No.species within families	No.families	Ratio/%	No.species	Ratio/%
1 species	42	39.62	42	9.25
2-5 species	41	38.68	123	27.09
6-10 species	15	14.15	110	24.23
>10 species	8	7.55	179	39.43

As for genera, the vascular plants were classified into 275 plant genera in total. Among them, 184 genera contained only 1 species, accounting for 66.9% of the total number of genera. Additionally, there was only one genus, *Rubus*, including 11 species, as shown in Table 4.

Table 4 Species in different genera of vascular plant in Shennongjia Area

No.species within genera	No.genera	Ratio/%	No.species	Ratio/%
1 species	184	66.92	184	40.53
2-5 species	86	31.27	232	51.10
6-10 species	4	1.45	27	5.95
>10 species	1	0.36	11	2.42

3.3 Diversity analysis of medicinal plants in Shennongjia Area

Among 454 species vascular plants collected in Shennongjia Area, 68.1% are medicinal plants. They are used to treat a variety of diseases in Traditional Chinese Medicine and Ethnic Medicine. There are 90 families, 220 genera and 309 species of medical plants in Shennongjia Area. The main families are *Asteraceae* (30), *Rosaceae* (21), *Ranunculaceae* (18), *Lamiaceae* (16), *Asparagaceae* (12) and *Fabaceae* (11). The main genus is *Rubus* (6), as shown in Table 5. The plant whose medicinal part was the whole plant accounted for the most, as shown in Table 6.

Table 5 Diversity of major medicinal plant families and genera in Shennongjia Area

Composition	Main families (No. species)	Main genera (No. species)
90 families 220 genera 309 species	*Asteraceae* (30) *Rosaceae* (21) *Ranunculaceae* (18) *Lamiaceae* (16) *Asparagaceae* (12) *Fabaceae* (11)	*Rubus* (6)

Table 6 Diversity of medicinal parts of medicinal plant in Shennongjia Area

Medicinal parts	No. species
Whole plant	143
Undergroud stem	139
Flower	14
Branch and leaf	47
Fruit	23
Seed	9

3.4 Characteristic plants in Shennongjia Area

In our research, we found 3 species of national first-class protected plants in Shennongjia Area, such as *Ginkgo biloba* L., *Taxus wallichiana var. chinensis* (Pilger) Florin and *Metasequoia glyptostroboides* Hu & W. C. Cheng. Shennongjia Area is also famous for four characteristic plants, all of which are named poetically. They are “seven leaves and one flower” *Paris polyphylla* Smith, “a bowl of water by the river” *Diphylleia sinensis* H. L. Li, “a bead on the top of the head” *Trillium tschonoskii* Maxim, and “a pen of King Wen” *Balanophora involucrata* Hook. f. They have unique medicinal properties, and their pictures are shown in Fig. 1.

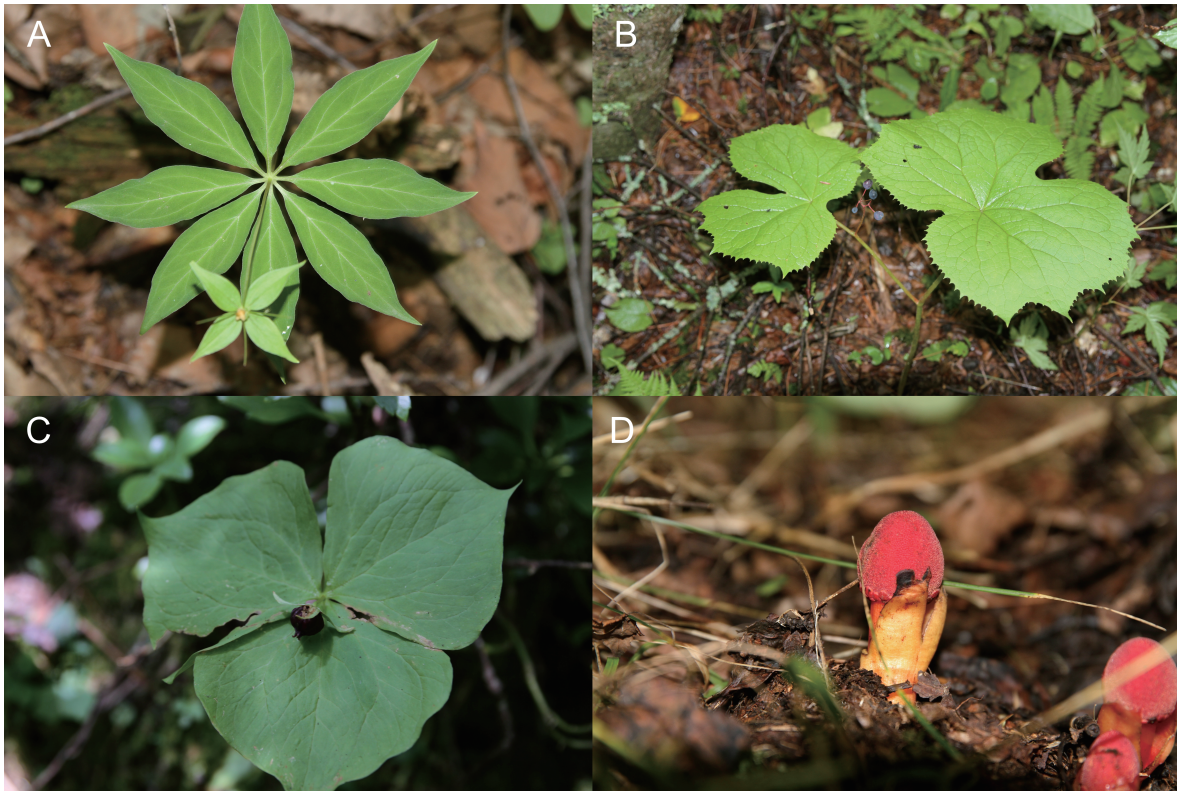

Fig. 1 Four characteristic plants in Shennongjia Area: A: *Paris polyphylla* Smith, Chinese variant name "Qi ye yi zhi hua"; B: *Diphylleia sinensis* H. L. Li, Chinese variant name "Jiang bian yi wan shui"; C: *Trillium tschonoskii* Maxim, Chinese variant name "Tou ding yi ke zhu"; D: *Balanophora involucrata* Hook. f., Chinese variant name "Wen wang yi zhi bi".

There were abundant folk medicinal herbs in Shennongjia Area. Among them, two kinds of folk herbs named "Huan yang yao" and "Qi yao" were most widely used by local people. Huan yang yao is the herb which can be used to restore yang and rescue patient from collapse with strong regenerative capacity [5,6]. Qi yao is the herb with the same function as *Panax notoginseng*, which can be used to treat five exhaustions seven damages [7,8]. In our research, we found 13 kinds of Huan yang yao and 36 kinds of Qi yao. The folk name, scientific name, plant parts used, and medicinal value are shown in Table 7 and Table 8.

Table 7 Huan yang yao in Shennongjia Area

Name of Huan yang	Scientific name	Part used	Medicinal value
Dou ban huan yang	*Sedum filipes* Hemsl.	W	clearing heat-toxin, promoting blood circulation for relieving pain.
Zhu zong huan yang	*Adiantum capillus-veneris* L.	W	clearing heat-toxin, inducing diuresis for detumescence.
Ya que huan yang	*Pholidota yunnanensis* Rolfe	W, P	nourishing yin for moistening lung, removing phlegm and arresting cough.
Tai yang huan yang	*Polygonatum hookeri* Baker	Rh	tonifying deficiency, tranquilization.
Shi sun huan yang	*Thalictrum microgynum* Lecoy. ex Oliv.	W, R	clearing heat and removing dampness, clearing fire and removing toxic substance.
Qing shui huan yang	*Oreocharis speciosa* (Hemsl.) Mich. Möller & W. H. Chen	W	promoting blood circulation and removing blood stasis.
Po wei huan yang	*Aconitum hemsleyanum* Pritz.	Tr	treatment of toufeng and throat paralysis, carbuncle swelling and boils.
Sui gu huan yang	*Aconitum sinomontanum* Nakai	R	promoting blood circulation for removing blood stasis, removing edema and relieving pain.
Ma wei huan yang	*Haplopteris flexuosa* (Fée) E. H. Crane	W	clearing heat, relax muscles and relieve pain.
Liu yue huan yang	*Phedimus aizoon* (Linnaeus) ’t Hart	W, R	promoting blood circulation for removing blood stasis, hemostasis, calming the nerves.
Jin er huan yang	*Beesia calthifolia* (Maxim.) Ulbr.	Rh	dispelling pathogenic wind and clearing heat-toxin.
Ji tui huan yang	*Ischnogyne mandarinorum* (Kraenzlin) Schlechter	W	nourishing yin, clearing heat, nourishing the stomach and promoting fluid production.
Ji mao huan yang	*Asplenium pekinense* Hance	W	removing phlegm and arresting cough, stopping bleeding.

Note: W, whole plant; P, pseudobulb; Rh, rhizome; R, root; Tr, tuberous root.

Table 8 Qi yao in Shennongjia Area

Name of Qi yao	Scientific name	Part used	Medicinal value
Ba jiao qi	*Dysosma versipellis* (Hance) M. Cheng ex Ying	Rh	dissipating phlegm and resolving masses, removing blood stasis and rlieving pain.
Bing pan qi	*Polygonatum cyrtonema* Hua	Rh	benefiting qi and nourishing yin, strengthening spleen, moistening lung.
Cheng gan qi	*Rodgersia aesculifolia* Batalin	Rh	clearing heat-toxin, cooling blood for hemostasis.
Deng tai qi	*Paris polyphylla* Smith	Rh	clearing heat-toxin, detumescence and rlieving pain.
Hong mao qi	*Caulophyllum robustum* Maxim.	R, Rh	promoting blood circulation for removing blood stasis, dispelling pathogenic wind and removing dampness.
Hong suan qi	*Tricyrtis macropoda* Miq.	R	tonifying deficiency, arresting cough.
Da ren xue qi	*Stylophorum lasiocarpum* (Oliv.) Fedde	W	promoting blood flow for regulating menstruation, removing dampness and freeing strangury.
Wu zhuan qi	*Triosteum himalayanum* Wall.	W	inducing diuresis for removing edema, promoting blood flow for regulating menstruation.
Ji xin qi	*Liparis campylostalix* H. G. Reichenbach	W	promoting blood flow for regulating menstruation, rlieving pain and hemostasis.
Jin gang ci	*Smilax scobinicaulis* C. H. Wright	R, Rh	dispelling pathogenic wind and removing dampness, promoting blood circulation for removing obstruction in collaterals.
Jin shan tian qi	*Anthriscus sylvestris* (L.) Hoffm.	R	benefiting qi for strengthening spleen, promoting blood circulation for rlieving pain.
Jing tian san qi	*Phedimus aizoon* (Linnaeus) ‘t Hart	W	promoting blood circulation for removing blood stasis, hemostasis, calming the nerves.
Jiu niu qi	*Euphorbia hylonoma* Hand.-Mazz.	R	relaxing bowels and inducing diuresis, removing blood stasis and resolving static blood.
Kou zi qi	*Pseudocodon convolvulaceus* subsp. forrestii (Diels) D.Y.Hong	Rh	nourishing lung and nourishing yin, relieving rigidity of muscles and activating collaterals, hemostasis.
Lei gong qi	*Clintonia udensis* Trantv. et Mey.	W	dispelling pathogenic wind and toxin, rlieving pain.
Jing mao qi	*Astilbe chinensis* (Maxim.) Franch. et Savat.	Rh	promoting blood circulation for rlieving pain, dispelling pathogenic wind and removing dampness.
Long tou qi	*Polygonatum cirrhifolium* (Wall.) Royle	Rh	invigorating spleen and replenishing qi, promoting fluid production for nourishing stomach.
Mai he qi	*Dianthus superbus* L.	W	inducing diuresis, promoting blood circulation for removing obstruction in collaterals.

(to be continued)

Continued table 8

Name of Qi yao	Scientific name	Part used	Medicinal value
Pian tou qi	*Maianthemum japonicum* (A. Gray) LaFrankie	Rh	promoting blood circulation and detumescence, dispelling pathogenic wind and rlieving pain.
Pian tou qi	*Maianthemum henryi* (Baker) LaFrankie	Rh	treating bruises and rheumatic joint pain.
Qian ceng lou	*Hypericum perforatum* L.	W	soothing the liver and relieving depression, clearing heat and promoting diuresis.
She gu qi	*Arisaema heterophyllum* Blume	Tu	eliminating dampness and phlegm, dispelling pathogenic wind for resolving convulsion.
Wu jin qi	*Asarum caulescens* Maxim.	W	curing stomach pain.
Xiao zhu gen qi	*Reineckea carnea* (Andrews) Kunth	W	moistening lung for arresting cough, dispelling pathogenic wind.
Xie zi qi	*Bistorta vivipara* (L.) Gray	Rh	hemostasis, relieving diarrhea.
Yan san qi	*Hylotelephium verticillatum* (L.) H. Ohba	W	promoting blood circulation for removing blood stasis, removing toxic and edema.
Ma bu qi	*Aconitum sinomontanum* Nakai	R	promoting blood circulation for removing blood stasis, removing edema and relieving pain.
Yang jiao qi	*Aconitum hemsleyanum* Pritz.	Tr	treatment of toufeng and throat paralysis, carbuncle swelling and boils.
Yu er qi	*Trillium tschonoskii* Maxim.	Rh, Fr	relieving pain, hemostasis, removing toxic.
Zhu mao qi	*Adiantum capillus-veneris* L.	W	clearing heat-toxin, inducing diuresis for detumescence.
Zhu gen qi	*Rohdea chinensis* (Baker) N.Tanaka	Rh	nourishing yin and clearing fire, promoting blood circulation for detumescence.
Zhui feng qi	*Geum aleppicum* Jacq.	W	benefiting qi and nourishing blood, nourishing yin, removing edema and relieving pain.
Mang yao cang er qi	*Parnassia delavayi* Franch.	W	clearing lung-heat and arresting cough, inducing diuresis and eliminating dampness.
Du yang qi	*Sceptridium ternatum* (Thunb.) Y. X. Lin	W	clearing heat-toxin, removing phlegm and arresting cough.
Zhu zong qi	*Asplenium trichomanes* L. Sp.	W	clearing heat-toxin, regulating menstruation and hemostasis.
Cun jie qi	*Viola collina* Bess.	W	clearing heat-toxin.

Note: W, whole plant; R, root; Rh, rhizome; Tu, tuber; Tr, tuberous root; Fr, fruit

4 Discussion

Shennongjia Area has the most well-preserved subtropical virgin and mature forest in the mid-latitude area of the earth [9]. There are many kinds of animals and plants in the area. Limited by time and the number of researchers, we only selected some typical sites such as Shen nong ding, Guan men shan, Jin hou ling and Da jiu hu to collect plant samples. Compared to the vast Shennongjia Area, the area we investigated was relatively narrow. The findings of our research provide some additional value for the plant resources in Shennongjia Area.

5 Conclusion

Shennongjia Area, located in the northwest of Hubei Province, is home to the highest peak (3105.4 m above sea level) in central China. We collected 454 species of vascular plants in the area, belonging to 106 families and 275 genera. Among them, the dominant families are *Lamiaceae*, *Ranunculaceae*, *Rosaceae*, and *Asteraceae*, with 20, 21, 37 and 48 species, respectively. Their dominant position in the ecosystem may be related to their superior reproductive structure and strong environmental adaptability. Folk herbs named "Huan yang yao" and "Qi yao" were also collected, with 13 and 36 species, respectively. Further research will be conducted in the future.

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