



Plants

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Chapter 1

Plants

Deng Hongping, Fang Zhendong, and Rebecca Pradhan

Summary

We carried out a rapid biological (RAP) survey in Kangding, Danba and Yajiang counties of Ganzi Prefecture. After collection and identification of specimens from all three areas we recorded a total of 1,477 vascular plant species from 517 genera and 133 families. Of these, 92 plant species belonging to 31 genera and 18 families were ferns, 36 plant species belonging to 12 genera and 5 families were gymnosperms, 1,349 plant species belonging to 474 genera and 110 families were angiosperms. Among the three areas, we recorded the greatest richness in Kangding (1227 spp.) followed by Yajiang (1013 spp.). The fewest species were recorded from Danba (875 spp.) where much of the vegetation was found to be degraded or destroyed as a result of either natural or human causes. Among species recorded were 22 species of rare and threatened plants which belong to 21 genera. Plant diversity in the RAP survey sites is relatively high when comparing the numbers of species recorded over a relatively short period of time during this survey with species richness recorded from other nearby areas.

Results

As a result of our RAP field survey, collection of specimens, and subsequent identification, we recorded a total of 1477 species of vascular plants from 517 genera and 133 families. Among these, 92 species belong to 31 genera in 18 families of Pteridophyta (ferns). Of the 1385 species of seed plants recorded, 36 species belonging to 12 genera in 5 families were Gymnosperms which accounted for 4.4% of the total number of families; while 1349 species of 474 genera in 110 families were Angiosperms, accounting for 95.6% of the total number of families (Table 1.1). In China overall, seed plants account for 34.1% of total families, 15.2% of total genera and 5.1% of total plant species (Li Xiwen, 1996; Table 1.2). For Sichuan Province, seed plants make up 60.2% of total families, 32.0% of total genera and 16.2% of total plant species (Li Xiwen, 1996; Table 1.2).

Table 1.1. Composition of seed plants in the China RAP survey area.

Taxon	No. of families	% of families	No. of genera	% of genera	No. of species	% of species
Gymnospermae	5	4.4	12	2.5	36	2.6
Angiospermae	110	95.6	474	97.5	1349	97.4
Total	115	100.0	486	100.0	1385	100.0

Table 1.2. Comparison of plant taxa in RAP Areas with Sichuan Province and China.

Area	RAP			China			Sichuan		
	Families	Genera	Species	Families	Genera	Species	Families	Genera	Species
Gymnospermae	5	12	36	10	36	195	9	28	100
Angiospermae	110	474	1349	327	3164	27073	182	1474	8453
Total	115	486	1385	337	3200	27268	191	1520	8553

Note: Sichuan province in this paper included Chongqing city before 1997.

The 691 species recorded from all three RAP sites belong to 92 families and 331 genera, including 38 species of 33 genera in 16 families of Pteridophyta, 10 species of six genera in two families of Gymnosperm, and 643 species of 302 genera in 74 families of Angiosperm.

Among the three areas, we recorded the greatest richness in Kangding with 1227 species of 491 genera in 133 families (76 species, 31 genera, 18 families of Pteridophyta; 29 species, 12 genera, 5 families of Gymnosperm; 1122 species, 448 genera, 110 families of Angiosperm). From Yajiang, we recorded 1013 species of 374 genera belonging to 94 families (50 species, 23 genera, 16 families of Pteridophyta; 20 species, 7 genera, 3 families of Gymnosperm; 934 species, 44 genera, 75 families of Angiosperm). The fewest species were recorded from Danba with 875 species belonging to 377 genera of 109 families (44 species, 24 genera, 17 families of Pteridophyta; 18 species, 8 genera, 3 families of Gymnosperm; 813 species, 345 genera, 89 families of Angiosperm).

Kangding, due to its lower altitude which leads to a warm and moist climate, along with a diverse terrain, is the most species-abundant of the three sites. In Yajiang, although the altitude is higher than the other areas, plants are well protected and species are more abundant than in Danba, where most of the vegetation was found to be degraded or destroyed as a result of either natural or human causes.

Resource Plants

According to the Standard of Study of Plant Resource by Liu Shengxiang, the most commonly used resource plants are medicinal, ornamental, aromatic, fibrous plants and nectarial plants. Such resource plants were found to be abundant in Kangding, Danba, and Yajiang. Our survey results include records of about 500 medicinal plant species, 923 ornamental plant species, 196 aromatic plant species, 443 fibrous plant species, and 451 nectarial plant species (see Appendix 1).

We recorded about 500 medicinal plant species during the RAP survey, including species used as important medicines such as *Drynaria*, *Lepisorus*, *Pyrrosia*, *Taxus chinensis*, *Cephalotaxus fortunei*, *Ephedraceae*, *Rheum*, *Aconitum*, *Schisandra*, *Berberis*, *Rhodiola*, *Sorbus*, *Astragalus*, *Acanthopanax*, *Aralia*, *Adenophora*, *Codonopsis*, *Polygala*, *Celastrus*, *Angelica sinensis*, *Bupleurum*, *Notopterygium*, *Elaeagnus*, *Orobanchae*, *Dipsacus*, *Inula*, *Saussurea*, *Dioscorea*, *Smilacina*, *Polygonatum*, *Fritillaria*, *Gastrodia*, and *Gymnadenia*, among others (see Appendix 1).

There are about 932 wildflower and ornamental plant species in Kangding, Yajiang, and Danba, most of which are important for economic and aesthetic values. The three most famous mountain wildflowers are extensively distributed. The characteristics of wildflowers vary from season to season as well as with changes of altitude. Wildflowers have specialized characteristics in different areas, and many of these areas face prospects of exploitation in the near future, however many wildflower resources are currently under-exploited. Examples of some wildflower genera include *Syringa*, *Amygdalus*, *Rhododendron*, *Berberis*, *Acer*, *Malus*, *Sorbus*, *Aconitum*, *Thalictrum*, *Paeonia*, *Cynoglossum*, *Gentiana*, *Primula*, *Meconopsis*, *Clematis*, *Actinidia*, *Schisandra* and all Orchidaceae plants (see Appendix 1).

Aromatic plants combine the characteristics of medicinal plants

and spices. In addition to a number of medical compositions taken from aromatic plants, aromatic plants provide extracts used in medicine, food and make-up. Natural spices are not easily substituted by synthetic spices as there are many unknown micro-compositions which contribute to the aroma of any particular spice, an attractive subject for further research. We recorded about 196 aromatic plant species in Kangding, Yajiang and Danba. Some typical aromatic plants in the area include: *Pinus*, *Cupressus*, *Lindera*, *Erysimum*, *Elsholtzia*, *Mentha*, *Heracleum*, *Ligusticum*, *Syringa*, *Evodia*, *Zanthoxylum*, *Asarum* and *Allium* (see Appendix 1).

Plant fiber, which is very important in paper-making, among other uses is abundant in fibrous plants. We recorded about 443 fiber plant species in Kangding, Yajiang and Danba, some from the following genera: *Anemone*, *Clematis*, *Linum*, *Ulmus*, *Celtis*, *Zelkova*, *Broussonetia*, *Ficus*, *Morus*, *Malva*, *Girardinia*, *Laportea*, *Urtica*, *Juglans*, *Campylotropis*, *Caragana*, *Lespedeza*, *Daphne*, *Wikstroemia*, *Celastrus*, *Tilia*, *Viburnum*, *Lonicera*, *Helianthus*, *Fargesia*, *Elymus*, and *Calamagrostis*, among others (see Appendix 1).

Plant nectar is the primary food resource for bees, and required for the production of honey. We recorded about 451 nectarial plant species in Kangding, Yajiang and Danba. For example: *Rhododendron*, *Trifolium*, *Vicia*, *Helianthus*, *Tilia*, *Elsholtzia*, *Cimicifuga*, *Gentiana*, *Fritillaria*, *Arabis*, *Capsella*, *Cardamine*, *Draba*, *Erysimum*, *Rorippa*, *Primula*, *Nepeta*, *Salvia*, *Codonopsis*, *Morina*, *Valeriana*, *Bupleurum*, *Heracleum*, and *Ligusticum*, among others (see Appendix 1).

Rare and Threatened Plants

According to the results of the RAP survey, and referring to the China Plant Red Data Book (Fu and Chin 1992) and List of Wild Plants of State Priority Conservation (Chinese Forestry Bureau, Ministry of Agriculture 1999), we recorded 22 species of rare and threatened plants belonging to 21 genera. Twenty-six orchidaceous plants (excluding *Gastrodia elata*) belong to the second-class rank of protected plants on the List of Wild Plants of State Priority Conservation. Table 1.3 shows the distribution and threat status of the rare and threatened plant species recorded during the RAP survey.

Discussion

From Tables 1.2 and 1.4, we can see that the plant diversity in the RAP survey sites is relatively abundant when comparing the numbers of species recorded over a relatively short period of time with species richness recorded from other nearby areas after more thorough investigation. Because the geographical location and flora of the RAP sites are similar to Haizishan Mt. Nature Reserve, the rate of families, genera and species of plants from Sichuan Province is similar to that of Haizishan Mt. Nature Reserve. Because the area is small and the altitude is high in Baihe Nature Reserve, the plant diversity is lower here than in the RAP survey sites. Other nature reserves such as Labahe, Si'er and Qianfoshan Mt. have more abundant plant diversity than the areas surveyed during the RAP due to larger area, significant difference in altitude, and less sloping terrain.

Table 1.3. Rare, threatened and protected plants recorded during the China RAP survey.

Family	Species	CPRDB	1st	2nd	Distribution		
					D	K	Y
Pinaceae	<i>Abies georgei</i> Orr	V				x	
Cupressaceae	<i>Cupressus chengiana</i> S. Y. Hu	V	x			x	
Taxaceae	<i>Taxus chinensis</i> (Pilger) Rehd.		x		x	x	
Tetracentraceae	<i>Tetracentron sinense</i> Oliv.	R	x			x	
Cercidiphyllaceae	<i>Cercidiphyllum japonicum</i> Sieb. et Zucc.	R	x			x	
Papaveraceae	<i>Meconopsis punicea</i> Maxim.		x				x
Ranunculaceae	<i>Circaea agrestis</i> Maxim.	R			x	x	x
Solanaceae	<i>Anisodus tanguticus</i> (Maxim.) Pascher		x		x	x	x
Guglandaceae	<i>Juglans regia</i> L.	V		x	x	x	x
Salicaceae	<i>Salix magnifica</i> Hemsl.	V				x	
Oleaceae	<i>Syringa pinnatifolia</i> Hemsl.	E				x	
Berberidaceae	<i>Sinopodophyllum emodi</i> Wall.ex Royle Ying.	R		x	x	x	x
Eupteleaceae	<i>Euptelea pleiospermum</i> Hook.f. et Thoms.	R			x	x	
Eucommiaceae	<i>Eucommia ulmoides</i> Oliv.	R		x		x	
Ericaceae	<i>Rhododendron alutaceum</i> Balf. f. W. W. Smith	V					x
Orchidaceae	<i>Gastrodia elata</i> Bl.	V		x	x	x	x
Rosaceae	<i>Malus rockii</i> Rehd.			x			x
	<i>Amygdalus kansuensis</i> (Rehd.) Skeels			x			
	<i>Amygdalus mira</i> (Koehne) Yú et Lu			x			
Elaeagnaceae	<i>Hippophae rhamnoides</i> subsp. <i>sinensis</i> Rousi				x	x	x
Clavicipitaceae	<i>Cordyceps sinensis</i>		x		x		x
Tricholomataceae	<i>Tricholoma matsutake</i>		x		x		x
26 orchidaceous species belonging to 18 genera excluding <i>Gastrodia elata</i> *							

* Other orchidaceous species listed in Appendix 1
 CPRDB = China Plant Red Data Book (Fu and Chin 1992);
 E (Endangered); R (Rare); V (Vulnerable);
 1st = List of Wild Plant of State Priority Conservation (1st group);
 2nd = List of Wild Plant of State Priority Conservation (2nd group -- request for approval pending);
 D (Danba); K (Kangding); Y (Yajiang)

Table 1.4. A comparison of taxa between all RAP sites and other Nature Reserves.

Area	Rate (%) of China			Rate (%) of Sichuan		
	Families	Genera	Species	Families	Genera	Species
RAP Area	34.1	15.2	5.1	60.2	32.0	16.2
Baihe Reserve	31.5	11.7	4.7	55.5	24.7	14.8
Jiuzhaigou Reserve	39.2	18.9	7.3	69.1	39.7	23.2
Haizishan Reserve	30.0	14.3	5.2	52.9	30.0	16.6
Xuebaoding Reserve	40.7	19.9	9.0	71.7	42.0	28.7
Labaye Reserve	44.8	23.5	8.9	79.1	49.4	28.2
Qianfoshan Reserve	45.4	24.0	9.1	80.1	51.1	29.2

*The data in Table 1.4 are based on published floristic papers.

Table 1.5. Breakdown of number of species per plant family in China RAP sites.

Rank	Gymnospermae	Angiospermae	Total	Rate (%)
Monotypic (1 type)	2	31	33	28.7
Oligotypic (2-9 types)	2	46	48	41.7
Mesotypic (10-19 types)	0	12	12	10.4
Plurotypic (20-49 types)	1	15	16	13.9
Plurimotypic (≥ 50 types)	0	6	6	5.2
Total	5	110	115	100.0

Floristic Characteristic of Families

For convenience of statistical analysis, RAP vegetation records have been divided into five ranks: Monotypic (one type), Oligotypic (2-9 types), Mesotypic (10-19 types), Plurotypic (20-49 types) or Plurimotypic (≥ 50 types), according to the numbers of seed plants in each family (Table 1.5).

Table 1.5 shows that there are 81 families that have fewer than 10 species, accounting for 70.4% of the total number of families, and 34 families with 10 or more species constituting 29.6% of total families. However, the total number of species (1138) included in the 34 families of the Mesotypic, Plurotypic and Plurimotypic ranks account for 82.2% of the total number of species, showing the dominance of a few families, especially Compositae (136 species), Rosaceae (115 species) and Gramineae (65 species).

Table 1.6. The Area-types of plant families recorded during the China RAP survey.

Area-type	Number of families	Percent (%)
1. Cosmopolitan	27	-
2. Pantropic and forma	40	45.5
3. Tropical Asia and Tropical America Disjuncted	1	1.1
4. Old World Tropics and forma	2	2.3
7. Tropical Asia (Indo-Malaysia)	2	2.3
8. North Temperate and forma	31	35.2
9. East Asia and North America Disjuncted	3	3.4
10. Old World Temperate and forma	2	2.3
14. East Asia	6	6.8
15. Endemic to China	1	1.1
Total (excluding Cosmopolitan)	88	100

According to the Area-types of seed plant genus as divided by Wu Zhengyi (1991), 115 families have been divided into 10 area-types (Table 1.6). Among these, the Cosmopolitan Area-types has 27 families, Tropical has 45 families (Area-types 2-4 and 7) accounting for 51.1% of the total (excluding Cosmopolitan); Temperate has 42 families (Area-types 8-10 and 14), accounting for 48.9% of the total. There is only one family endemic to China accounting for 1.1% of the total.

There are 27 families in the study area that are Cosmopolitan Area-types including the dominant families such as Compositae, Rosaceae, Gramineae and Liliaceae. Among these, Compositae is the largest family of the four special dominant families in the world. Also included within the Cosmopolitan Area-type are smaller families such as Convolvulaceae and Chenopodiaceae.

Out of 45 tropical families, 40 are pantropic in distribution with only one family (Iridaceae) belonging to the Tropical Asia and Tropical America Disjuncted distribution. Two families belong to Old World Tropics and forma distribution and two

families belong to Tropical Asia (Indo-Malaysia) distribution. Two families, Phytolaccaceae and Aristilochiaceae, belong to Tropical Asia, Africa and Middle South America distribution. The large families among the Pantropic area-type are Orchidaceae, Fabaceae, Euphorbiaceae and Araliaceae. The family Fabaceae has great diversity and occupies a considerable amount of habitat, especially open and secondary habitat. The family Orchidaceae derives antiquatedly, and is also distributed in India and Malaya and Tropical America as its two distribution centers. The families of Aristilochiaceae, Acanthaceae, and Buxaceae (among others) are of a more modern distribution center, while Anacardiaceae spread down the Yangze River, and especially over the Crossing Mountain, its evolutionary pivotal area.

There are 31 families in the study area of the North Temperate Area-type, accounting for 72.1% of the total number of temperate families and including Umbelliferae, Ericaceae, and Cabiaceae, among others. Eucommiaceae is the only family endemic to China and one which has a very ancient origin.

From these results it can be concluded that the vegetation of the RAP survey area has a transitional character that corresponds to the geographical position and the types of vegetation of the subtropics. Similarly, Monotypic and Oligotypic family types that account for 70.4% of the total number of families recorded from the RAP area, along with Disjuncted Area-types, have ancient floristic origins.

Floristic Characteristic of Genus

Table 1.7. Breakdown of number of species per plant genus in China RAP sites.

Genus Rank	Gymnosperm	Angiosperm	Genus No.	Rate (%)	Species No.	Species /Total (%)
Monotypic (1 type)	5	226	231	47.5	231	16.7
Oligotypic (2-4 types)	4	159	176	36.2	445	32.1
Mesotypic (5-9 types)	3	48	51	10.5	331	23.9
Plurimotypic (10 or more types)	0	28	28	5.8	378	27.3
Total	12	474	486	100	1385	100

According to the numbers of species in each genus, the 486 genera of plants recorded during the RAP survey have been divided into four ranks: Monotypic (one type), Oligotypic (2-4 types), Mesotypic (5-9 types) and Plurimotypic (10 or more types). The ranks of the genera and the species are included in Table 1.7. The results show that Monotypic and Oligotypic genera with 407 species account for 83.7% of the total. Especially *Tribulus*, *Tetracentron*, *Hippuris* and so on have shown their ancient origin. In addition, Mesotypic and Plurimotypic types with 79 genera accounted for 16.3% of the total number. At the same time,

species included in Mesotypic and Plurimotypic genera constitute 51.2% of the total number of species. Monotypic and Oligotypic genera ranks have only 676 species, accounting for less than 50% of the total number, while the numbers of the genera of these types account for 83.7% of the total. This shows that the dominant genera are significant, especially woody genera such as *Rhododendron*, *Rubus*, *Lonicera*, *Cotoneaster*, *Salix*, *Rosa* etc. and herb genera including *Saussurea*, *Saxifraga*, *Gentiana*, *Primula*, *Artemisia*, and *Thalictrum*.

Table 1.8. The Area-types of plant genera from the China RAP survey.

Area-types	Number	Percent (%)
1. Cosmopolitan	48	---
2. Pantropic and forma	51	11.6
3. Tropical Asia and Tropical America Disjuncted	5	1.1
4. Old World Tropics and forma	10	2.3
5. Tropical Asia to Tropical Australasia	6	1.4
6. Tropical Asia to Tropical Africa	6	1.4
7. Tropical Asia (Indo-Malaysia)	6	1.4
8. North Temperate and forma	160	36.5
9. East Asia and North America Disjuncted	29	6.6
10. Old World Temperate and forma	56	12.8
11. Temperate Asia	14	3.2
12. Mediterranean, West Asia to Central Asia	7	1.6
13. Central Asia	5	1.1
14. East Asia	66	15.1
15. Endemic to China	11	2.5
Total (excluding Cosmopolitan)	438	100

There are 48 genera in the study area which are Cosmopolitan area-types, as shown in Table 1.8. Among these, *Astragalus* was found to be distributed in all global sub-tropic and temperate areas except Australasia. *Ranunculus* is distributed on every continent while *Clematis* is also found all over the world. The Pantropic Area-types include 51 genera such as *Pratia*, *Andropogon*, *Indigofera*, *Siegesbeckia*, and *Pennisetum*. Some of these species have very ancient origins, such as *Eupatorium*, *Smilax*, *Bothriochloa*, and *Imperata*. The Tropical Asia and Tropical America Disjuncted Area-type has five genera: *Cosmos*, *Zea*, *Zanthoxylum*, *Meliosma* and *Sageretia*. There are 10 genera in Old World Tropics such as *Capillipedium*. There are six genera in the Tropical Asia and Tropical Australasia Area-type, such as *Mazus*, *Balanophora*, *Rhamne* and *Peristylus*. The total number of the genera in the Tropical Asia to Tropical Africa Area-type is 12, including *Dichrocephala*, *Arthraxon*, *Themeda*, and *Gerbera*, among others. In Trop. Asia, there are six genera which include *Typhonium*, *Goodyera*, and *Lindera*.

There are 160 genera in the North Temperate Area-type, such as *Gentianopsis*, *Swertia*, *Anaphalis*, and *Leontopodium*. There are 29 genera in East Asia and North America Disjuncted, such as *Cacalia*, *Aletris*, and *Smilacina*. There are 56 genera in the Old World Temperate area-types. Genera in this area-type are *Serratula*, *Ligularia*, *Carduus*, and *Ajuga*, among others. The number of genera in the Temperate Asia Area-type is 14. Genera belonging to this area-type include *Ajania*, *Myriactis*, *Ptilagrostis*, *Campylotropis*.

Mediterranean, W. Asia to C. Asia include seven genera such as *Pterocarpus*, *Eremurus*, *Pistacia* and others. There are five genera in the Central Asia Area-type including *Dilophia*, *Notholirion*, and *Megacarpaea*, while the East Asia Area-type has 66 genera including *Hemiphragma*, *Cremanthodium*, *Parasenecio*, and *Heteropappus*. There are 11 genera that are endemic to China. These include *Syncalathium*, *Xanthopappus*, *Fargesia*, and *Souliea*.

Compared to other adjacent nature reserves, plant diversity of the RAP sites was less abundant than some natural reserves such as Labahe, Ersi, and Qianfushan as a result of geographical position, environmental conditions, total area surveyed, elevation, and vertical zonality of vegetation, among other factors. However, if we just consider the plant diversity of Haizi Natural Reserve with respect to species number, it is similar to the RAP areas.

Floral and geographical compositions were complex in the RAP survey areas. According to the standard proposed by Li Xiwen (1996), there are 10 areal-types of families in the RAP areas, representing two-thirds of the 15 areal-types of families of plants known from China. However, the RAP areas represent all areal-types with reference to genera, according to the standard of Wu Zhengyi (1991). Meanwhile, a great variety of types and discontinuous areal-types strongly suggest the complexity of floral composition in these areas.

Floral characteristics of variable zone and pantropic were shown obviously on the level of family and genus of seed plant in the RAP areas. Furthermore, the flora show features of transition resulting from the fact that the RAP survey crossed three different areas.

Dominant taxa are prominent with respect to both family and genus. Families which contain more than 10 species account for 29.6% of the total number of families. However, the species in these families account for 82.2% of total species. There are 48 rare families which constitute 41.7% of overall families. On the level of genus, unique and rare species of genera are prominent. Moderately abundant and abundant genera account for 16.3% of overall genera, whose species account for 51.2% of overall species.

Floral compositions have age-old origins. Meanwhile, unique and rare species of families account for 70.4% of overall families; and unique and rare species of genera account for 83.7% of overall genera. These findings all demonstrate high diversity in the area. Primordial taxa formed before tertiary such as *Tribulu*, *Tetracentron*, *Hippuris* etc. were found in the RAP areas. In addition, the abundance of discontinuous types of flora shows their age-old origin. Thus, we believe the findings of this RAP survey accurately reflect the true nature and comprehensiveness of floral diversity in this area.

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