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RHODODENDRONS OF THE NUJIANG (SALWEEN) VALLEY OF YUNNAN PROVINCE, PEOPLE'S REPUBLIC OF CHINA

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ABSTRACT. A series of expeditions to the Nujiang (Salween) Valley in 1978, '79, and '80 collected a total of 450 numbers, comprising 89 species of *Rhododendron* (Ericaceae), and made extensive observations on the genus. The taxonomic diversity, altitudinal and horizontal distribution, ecological zonation and floristic affinities of the *Rhododendron* flora are described and discussed. A total of four new species of *Rhododendron* were discovered by the expeditions, and two of these, *R. lateriflorum* R. C. Fang & A. L. Zhang and *R. hirsutipetiolatum* R. C. Fang & A. L. Zhang, are described in an addendum to the paper.

In 1978, '79 and '80 the Kunming Institute of Botany conducted three successive *Rhododendron* collecting expeditions in the Nujiang (Salween) Valley of Nujiang Prefecture, Yunnan Province (Fig. 1). These expeditions included in their itineraries the high altitude areas along both banks of the Nujiang River in Lushui, Bijiang, Fugong and Gongshan Counties. Other collecting stations were near the Pianma Commune on the western slope of the Gaoligong Shan (Gaoligong Mountains) in Lushui County, in the Dulong Valley in Gongshan County, and along the Nujiang Valley towards the Songtashan (Songta Snow Mountain). This last-mentioned mountain massif forms the border between Yunnan Province and Xizang Autonomous Region (Tibet; the administrative designation of Region in this case is equivalent to Province).

More than 450 numbers of *Rhododendron* (comprising nearly 2,000 herbarium specimens) were collected and processed. The expeditions extended from the beginning of April to the end of June in each of the three years. Several very high altitude regions were not explored and collected thoroughly because of logistic problems, and for this reason some *Rhododendron* taxa may have been inadvertently missed. The following communication is based on the data collected on the expeditions.

GEOGRAPHY, PHYSICAL ENVIRONMENT AND VEGETATION DISTRIBUTION

The Nujiang (Salween) Valley is located in the northwestern part of Yunnan Province between 25°32′N and 28°22′N and 98°09′E and 99°03′E. The Biluo-Xueshan Mountain Ridge is the eastern boundary between the Nujiang Valley and Lanping, Yunlong, Weixi and Deqin Counties, also in northwestern Yunnan Province. The Nujiang Valley region is bounded to the south by Baoshan County, to the north by Xizang Autonomous Region, and to the west by Burma. The Nujiang (Salween) River runs through the valley from north to south for more than 300km. Precipitous altitudinal relief prevails with high mountains and deep valleys and only some small areas around Luku, Fugong and Bingzhongluo are

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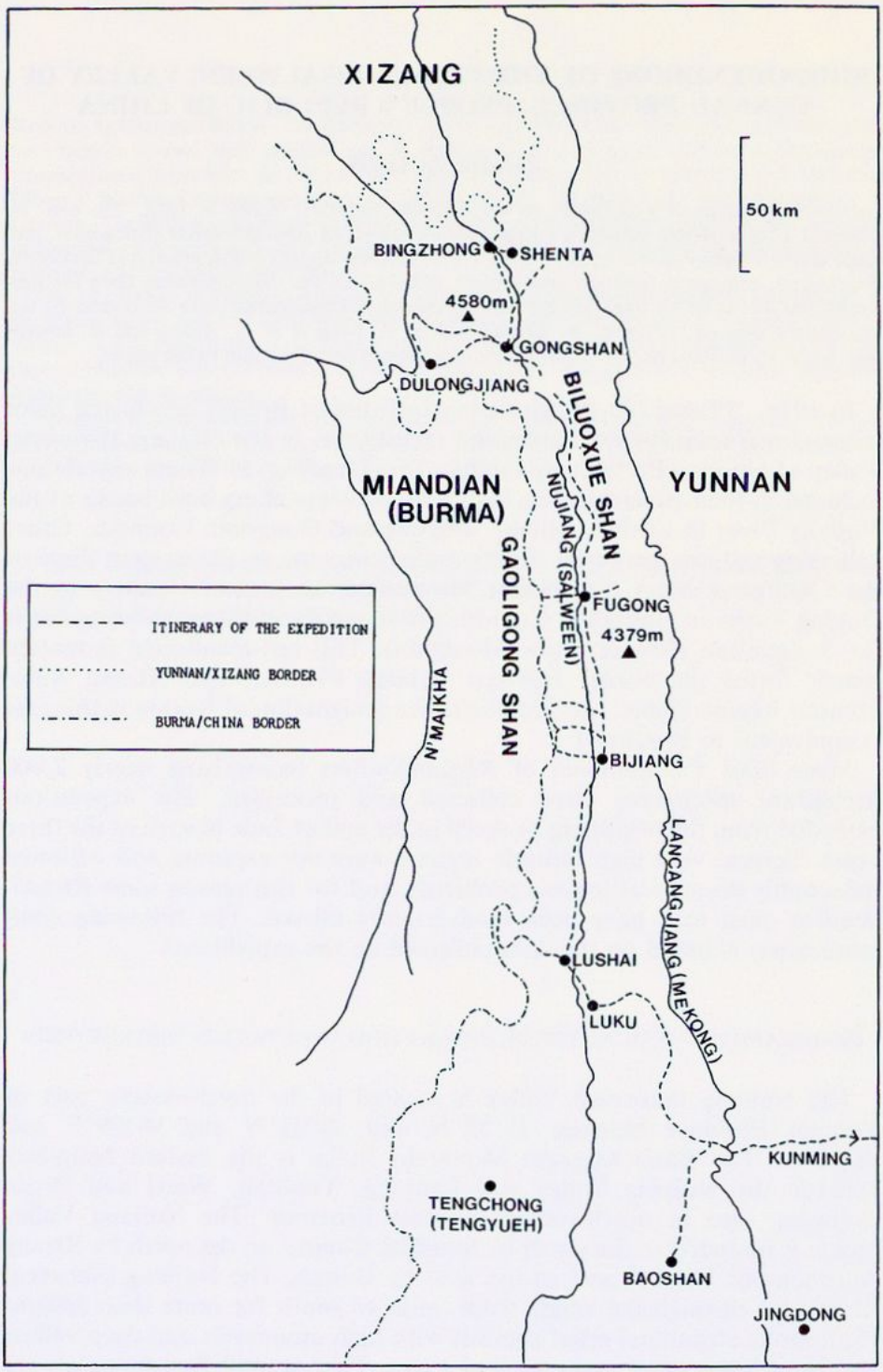

FIG. 1. The Nujiang (Salween) Valley showing itinerary of the 1978–80 expeditions.

TABLE 1: Meteorological data for the Nujiang Valley.
The records are for the administrative centres, all below 2000m alt. Conditions are more extreme in the remote mountainous areas, and rainfall, for instance, will be much greater.

	Altitude (m)	Av. annual temp. (°C)	Av. July temp. (°C)	Av. Jan. temp. (°C)	Absolute max. temp. (°C)	Absolute min temp. (°C)	Av. annual rainfall (mm)	Av. annual % of rel. humid.
Lushui County	1792.0	15.0	19.3	9.2	31.8	0.6	1158.0	70
Bijiang County	1927.8	13.8	19.4	7.6	33.2	−0.9	1182.6	77
Fugong County	1194.8	17.0	23.8	9.5	36.9	−2.8	1349.5	80
Gongshan County	1591.3	14.8	21.4	7.7	34.2	−2.2	1595.8	77
Bingzhongluo Commune	1650.0	14.6	—	—	29.7	−1.0	994.8	—

relatively level. The general elevation of the major mountains is between 3,900 and 4,000m, and the most precipitous and steep mountain range overtopping the Nujiang Valley is the Gaoligong Shan. The depth of the valley is from 2,500 to 3,000m and it is the second deepest gorge in the world.

The climate is controlled mainly by the southwestern monsoons. The area is wet throughout the entire year due to the influence of the warm moist air-currents from the Indian Ocean. The amount of rainfall decreases from Gongshan County northwards because of the rain-shadow effect of the high mountains and the winding river course. The climate becomes even drier in the northern portion of Songtashan, the boundary between Yunnan Province and the Xizang Autonomous Region. A very wide range of climatic conditions exists because of extreme variation of topography and altitude. There are dry, hot, tropical valleys, semi-wet and warm-wet temperate conditions, frigid wet subalpine zones, and alpine environments. Climatic data recorded from the major localities visited during the expeditions are presented in Table 1.

The types and distributions of soil and vegetation in the Gaoligong Shan and Biluo-Xueshan in the Nujiang Valley region are basically similar. However, the soil layer of the Gaoligong Shan is thinner, and this fact significantly affects the development and growth of vegetation, especially in the alpine and subalpine coniferous forests. The vertical distribution of the vegetation and soil in the Gaoligong Shan and Biluo-Xueshan is much more obvious and complex than that of other regions of Yunnan Province.

The soil on the banks of rivers and valleys where the elevation is below 1,400m is usually lateritic, and the vegetation which it supports may be tall tropical grassland, tropical rainforest, or subtropical rainforest. The rainforest vegetation, however, is often sparse and scattered as these lands are most often exploited for farmland; but in some valleys near Fugong, *Hodgsonia macrocarpa* (Blume) Cogniaux and *Cyathea* spp. may still be found.

The soil between 1,400 and 1,800(−2,500)m elevation is usually lateritic red loam, and *Pinus yunnanensis* Franchet predominates.

Between altitudes of 1,800 and 2,600(−2,800)m the soil is yellowish brown earth, and the primary vegetation is a broad-leaved evergreen forest. The major tree species of this broad-leaved evergreen forest are: *Litho-*

carpus hypoglaucus (Hu) Huang ex Hsu & Jen, *L. elegans* (Blume) Saepadmo, *Cyclobalanopsis oxyodon* (Miquel) Oersted, *C. gambleana* (A. Camus) Hsu & Jen, *Machilus shweliensis* W. W. Smith, *M. longipedicellata* Lecomte, *Magnolia campbellii* Hooker f. & Thomson, *M. rostrata* W. W. Smith, *Manglietia insignis* Blume, *Schima argentea* Pritzel, *Symingtonia populnea* (R. Brown) van Steenis and *Juglans regia* L. *Taiwania flousiana* Gaussen occurs widely scattered throughout this broad-leaved evergreen forest, but it does not grow on the northern, western and eastern slopes of the Gaoligong Shan.

Pinus armandii Franchet frequently occurs throughout the broad-leaved evergreen forests, and *Tsuga dumosa* (D. Don) Eichler forests often appear between the altitudes of 2,400 and 3,000m. The soil between the elevations of (2,600–)2,800 and 3,100(–3,300)m is brown earth and the dominant species is *Tsuga dumosa*. *Picea likiangensis* (Franchet) Pritzel is frequently found at the upper limits of the *Tsuga dumosa* forest. The understory of the *Tsuga dumosa* forest is composed of broad-leaved deciduous genera, such as *Acer, Sorbus* and *Betula*.

At elevations of 3,100(–3,300)–4,000m, where the soil is a dark brown earth, the dominant tree species are taxa of *Abies*. The *Abies* forests are well developed on the Biluo-Xueshan, but *Sinoarundinaria* is very rare and seldom encountered. In contrast, the *Abies* forests of the Gaoligong Shan are poorly developed and *Sinoarundinaria* occurs abundantly throughout the forest.

Alpine species of *Rhododendron* occur at elevations of 3,600(–4,000)–4,200m where the substrate is dark brown earth. The alpine taxa of *Rhododendron* are widely distributed throughout the higher altitudes, and the number of species of *Rhododendron* increases significantly above the upper limits of the *Tsuga dumosa* forests.

THE RHODODENDRON FLORA

Taxonomic diversity

The Nujiang Valley is a remarkable centre of taxonomic diversity in the genus *Rhododendron*. Following Sleumer's classification (*Bot. Jahrb. Syst.* 74: 511–553, 1949) six subgenera, eight sections, 26 subsections, 93 species, eight subspecies and nine varieties occur there (see Table 2). The number of taxa above the level of species represents more than half of those indigenous to Yunnan Province, and the number of species constitutes 40% of the total for Yunnan Province, 20% of that for the the People's Republic of China, and 10% of the world's total. Of the 89 species in the valley, 33 belong to subgen. *Rhododendron**, 50 to subgen. *Hymenanthes* and six to four other subgenera as indicated below. Subsect. *Neriiflora* of subgen. *Hymenanthes* is very well developed, being represented by 14 species, four subspecies and seven varieties. However, the subsection is in a state of rapid differentiation and diversification, and future exploration could possibly yield additional taxa, even some new to science. The supposedly primitive groups are well

* Authorities for all taxa of *Rhododendron* collected in the Nujiang Valley are given in Table 3 (p. 152).

TABLE 2. To show the taxa of *Rhododendron* occurring in the Nujiang Valley in relation to wider distribution patterns (following the classification of Sleumer, *Bot. Jahrb. Syst.* 74: 511–553, 1949).

	World-wide	People's Republic of China	Yunnan Province	Nujiang Valley
Subgenera	8	8	6	6
Sections	17	12	10	8
Subsections	52	41	35	26
Species	850	447	223	93

represented and include six of the 10 species of subgen. *Hymenanthes* subsect. *Falconera*, three of the 11 species of subgen. *Hymenanthes* subsect. *Grandia*, and eight of the 36 species of subgen. *Rhododendron* subsect. *Maddenia*. Subgenera *Pseudoazalea* (=sect. *Rhododendron* subsect. *Trichoclada*), *Tsutsutsi, Azaleastrum* and *Pseudorhodorastrum* (=sect. *Rhododendron* subsects *Scabrifolia* and *Virgata*) are represented in the valley by only one or two species each (a total of six species) but their presence is of phytogeographic and taxonomic interest.

Four new species were collected by the expeditions: *R. gratum* T. L. Ming (subgen. *Hymenanthes* sect. *Hymenanthes* subsect. *Falconera*), *R. gongshanense* T. L. Ming (subgen. *Hymenanthes* sect. *Hymenanthes* subsect. *Irrorata*), *R. hirsutipetiolatum* R. C. Fang & A. L. Zhang, *sp. nov.* (subgen. *Rhododendron* sect. *Rhododendron* subsect. *Heliolepida*), and *R. lateriflorum* R. C. Fang & A. L. Zhang, *sp. nov.* (subgen. *Rhododendron* sect. *Rhododendron* subsect. *Cinnabarina*); of these *R. gratum* has been published in *Acta Botanica Yunnanica* 3(1): 113–119 (1981), *R. gongshanense* is in press, and *R. hirsutipetiolatum* and *R. lateriflorum* are described in an addendum to this paper (p. 160).

Altitudinal zonation

Altitudinal zonation of vegetation in the Nujiang Valley is very clear: Fig. 2, synthesized from the data of numerous collecting sites, illustrates the pattern for *Rhododendron* species and the communities to which they belong. The species given in the figure are the common or dominant species occurring in the zones—they occur as forest understory plants, along forest-margins, along sides of ravines, and on shrub-covered slopes.

There are no species of *Rhododendron* in the tropical high grass-thicket vegetation that occurs below 1,400m. Above, within the *Pinus yunnanensis* forests the soil is very poor and the climate dry; accordingly, only a few drought-resistant species of *Rhododendron* are present here.

Within the broad-leaved evergreen forest there is a well-developed fertile wet soil and high atmospheric humidity but the tree-cover is too dense for rhododendrons to be abundant and only a few species occur. The commonest species here are *R. stenaulum*, which forms a tree, and *R. leptothrinum*, which becomes a large shrub or small tree. Populations of *Rhododendron* are much more common and species diversity is far greater at the margins of these forests and in secondary woody vegetation.

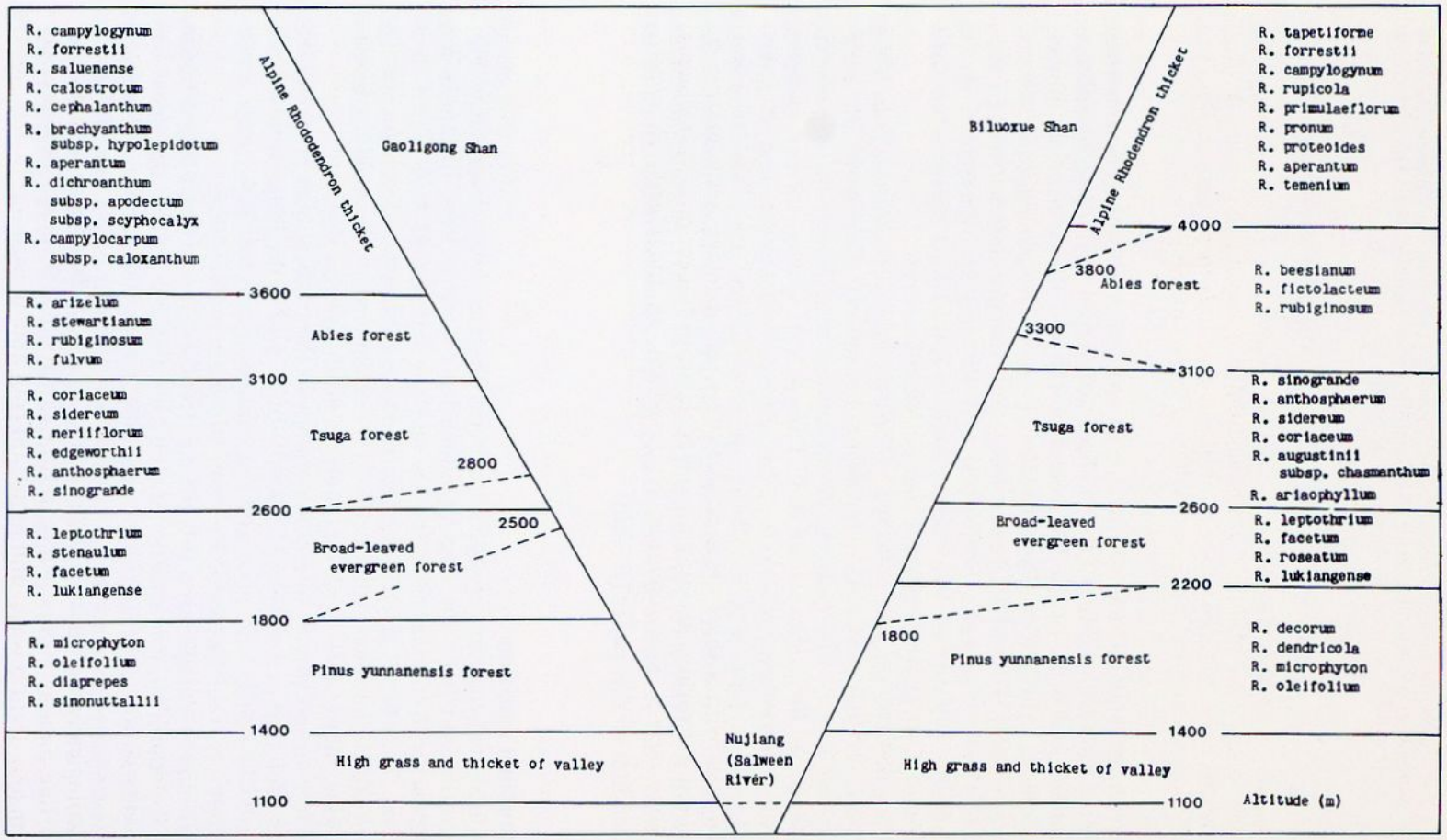

FIG. 2. Vertical distribution of vegetation and the commonest rhododendrons in the Nujiang Valley. The solid horizontal lines indicate the normal altitudinal limits of the vegetation zones, the broken lines variations occurring in some localities. The figures refer to altitude in metres.

In the *Tsuga dumosa* forest zone the species of *Rhododendron* present are relatively diverse. In addition to the species listed in Fig. 2 for this zone, other common *Rhododendron* species include *R. sulfureum, R. megeratum, R. zaleucum* and *R. glischrum*. Within this zone, *R. lukiangense*, a tree 7–8m tall, usually occurs at the lowest elevations, while *R. anthosphaerum*, also a 7–8m tree, occurs at the highest altitudes.

Although species diversity is low, *Rhododendron* is abundant in the *Abies* forest zone. Usually a single dominant species of *Rhododendron* forms the shrubby understory of an *Abies-Rhododendron* association. The dominant understory species in the *Abies* forests of the Biluo-Xueshan is *R. beesianum*, while on the boundary area between Yunnan Province and Xizang Autonomous Region *R. fictolacteum* predominates. Both *R. beesianum* and *R. fictolacteum* often form continuous stands that stretch for several kilometres, or even tens of kilometres. In the Gaoligong Shan the *Abies* forests are not well developed, and *Sinoarundinaria* is the dominant understory plant, forming a mixed *Abies-Rhododendron-Sinoarundinaria* vegetation association. The chief understory species of *Rhododendron* in the Gaoligong Shan, although not dominant, are *R. arizelum* and *R. stewartianum*. However, under some circumstances at particular locations in the Gaoligong Shan, *R. fulvum* can be the dominant understory species and produces a dense, low, shrubby forest. In some areas between the lower altitudinal limit of *Abies* and the upper limit of *Tsuga, R. rubiginosum* may form pure stands of plants up to 7–8m tall. As already stated, species diversity of *Rhododendron* is generally low within the understory of the *Abies* forests. However, along the margins of these forests, in open sites within the forests or in valleys, or in felling areas cleared by lumbering, the diversity may be very high. In such locations, *R. heliolepis, R. oreotrephes, R. crinigerum, R. praestans, R. sanguinem, R. chaetomallum* Balfour f. & Forrest (=*R. haematodes* subsp. *chaetomallum* (Balfour f. & Forrest) Chamberlain), *R. selense* and *R. eclecteum* may be found.

Between the altitudes of (3,600–)3,800 and 4,200m numerous species of *Rhododendron* produce an alpine dense shrub/low forest vegetation association which is a special phytogeographic feature of the southwestern alpine areas of the People's Republic of China. Below 3,800m this vegetation formation is composed of one or more species of *Rhododendron* which are more than one metre tall, such as *R. campylocarpum* subsp. *caloxanthum, R. temenium* and *R. dichroanthum*. Between 3,700 and 3,900m the *Rhododendron* shrub association is formed by lower species, not more than 0.6m tall, such as *R. rupicola, R. proteoides* and *R. primulaeflorum*. Above 3,900m only the lowest-growing species, from 10 to 20cm tall, such as *R. forrestii, R. tapetiforme* and *R. pronum* occur.

Fig. 3 shows the vertical distribution of *Rhododendron* taxa above the level of specific rank. It demonstrates that most of the Nujiang Valley *Rhododendron* flora occurs between 2,000 and 4,000m, and that the greatest species diversity is well above 2,500m; very few species occur below 2,000m or above 4,000m.

Ecologically the Nujiang Valley species of *Rhododendron* may be divided into five habitat groups which reflect climatic conditions. These are: (1) warm and dry; (2) warm and moist; (3) cool and moist; (4) cold and moist;

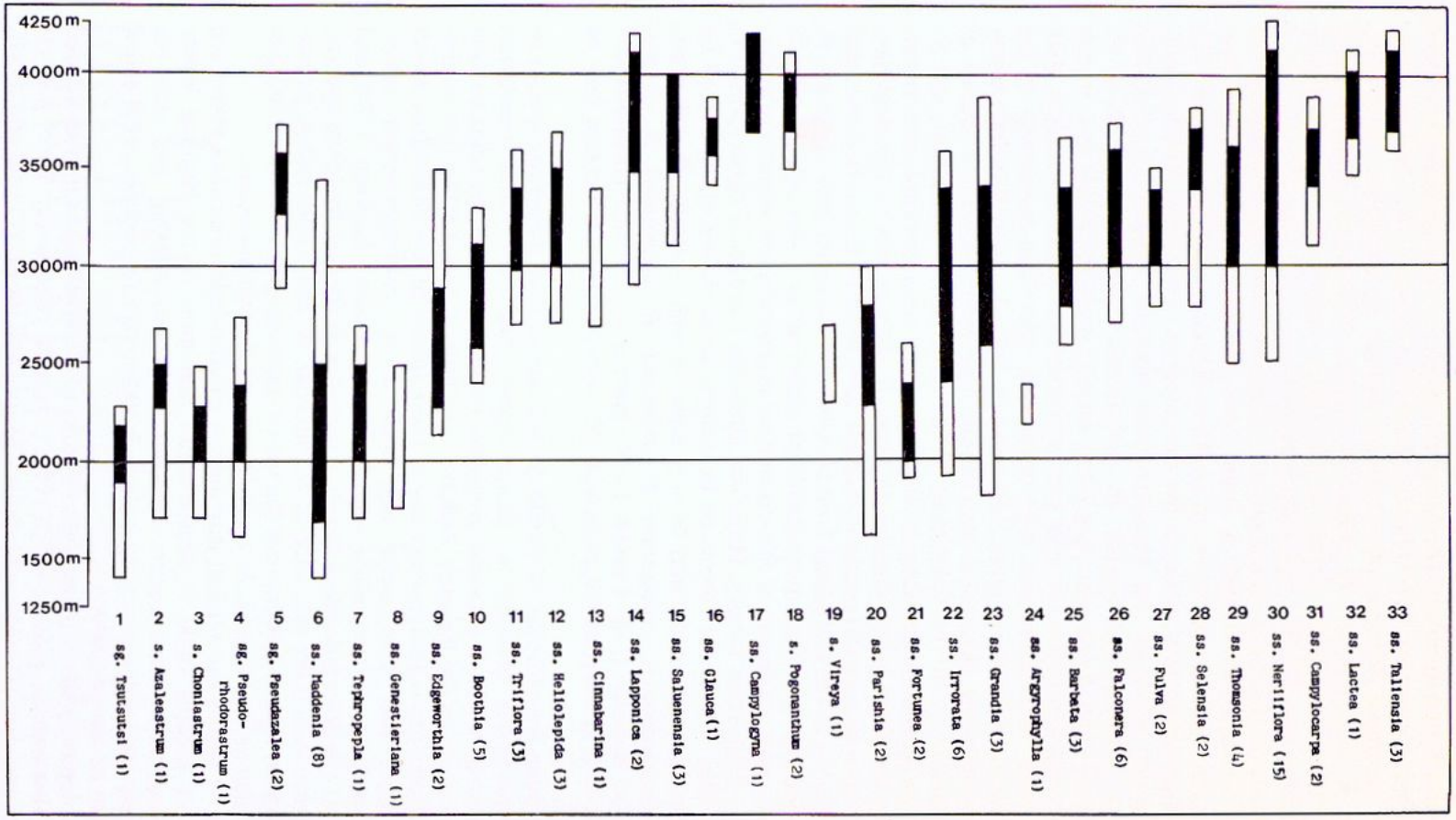

FIG. 3. Altitudinal distribution of *Rhododendron* supraspecific taxa in the Nujiang Valley. The black areas represent abundance and/or diversity. Figures in brackets refer to the number of species. 2–3 subgen. *Azaleastrum*, 6–19 subgen. *Rhododendron*, 20–33 subgen. *Hymenanthes*. sg. = subgenus, s. = section, ss. = subsection.

and (5) frigid and moist. The first habitat-group occurs in the *Pinus* forest zone, the second in the broad-leaved evergreen forest zone (both at elevations below 2,600m) and the third between 2,600 and 3,200m in the *Tsuga* forests and the lower portions of the *Abies* forests. The fourth occurs between 3,300 and 4,000m in the *Abies* forest zone, and the fifth prevails above 4,000m in the alpine *Rhododendron* shrub/low forest vegetation association, and along the upper part of the *Abies* forest. This ecological classification is based on qualitative observations. Obviously, extensive fieldwork and elaborate measurements would be essential to clarify and establish the system on a quantitative basis.

Some taxa of *Rhododendron* are distributed along an altitudinal gradient through several vegetational zones, and may occur in more than one of the five habitat groups. Some species of subgen. *Rhododendron* sect. *Rhododendron* subsect. *Maddenia*, and subgen. *Hymenanthes* subsects *Irrorata, Grandia, Neriiflora* and *Parishia* can be found in three vegetation zones. For example, *R. dendricola* (subsect. *Maddenia*), *R. lukiangense* and *R. tanastylum* (both subsect. *Irrorata*), *R. sinogrande* (subsect. *Grandia*) and *R. facetum* (subsect. *Parishia*) occur in the *Pinus*, broad-leaved evergreen and *Tsuga* forests, while *R. floccigerum* (subsect. *Neriiflora*) is found in the broad-leaved evergreen, *Tsuga* and *Abies* forests. On the other hand, the altitudinal distribution of some taxa is very limited, such as those of subgen. *Rhododendron* sect. *Rhododendron* subsect. *Campylogyna*, and subgen. *Hymenanthes* subsects *Taliensia* and *Lactea*. The ecological conditions in which taxa occur are obviously related to the distributions outside the Nujiang Valley. The warm-dry and warm-moist habitat groups may be found in regions south of the Changjiang (Yangtse River), and even further into Southeast Asia. The alpine frigid-moist group is widely distributed in the western part of the People's Republic of China, and some species (such as *R. lapponicum* subgen. *Rhododendron* sect. *Rhododendron* subsect. *Lapponica*) even occur near the Arctic Circle. Most of the cool-moist and cold-moist taxa are distributed throughout corresponding vegetation zones of alpine and sub-alpine areas in the western part of the People's Republic of China.

Horizontal distribution

Some obvious horizontal distribution differences are worth mentioning (see Table 3). Some species are confined to the Biluo-Xueshan or to the Gaoligong Shan; although these two mountain ranges are very close, isolation is brought about by the deep Nujiang Valley and its river separating them. For example, *R. pronum* and *R. taliense* are common in the southern and northern parts of the Biluo-Xueshan, but after three years of exploration no representatives of this subsection were found on the Gaoligong Shan. Similarly, *R. campylocarpum* subsp. *caloxanthum* and *R. callimorphum* occur on the Gaoligong Shan, but have not yet been found on the Biluoxue Shan.

Differences in the geographic distribution of some species of *Rhododendron* are also quite apparent when comparing the floristic composition of the southern and northern parts of the Gaoligong Shan and Biluo-Xueshan. *Rhododendron temenium* and *R. eclecteum* occur only in the high mountains above the Nujiang River in the northern part of the two

mountain ranges; *Rhododendron facetum* and *R. microphyton* are present only on the banks of the Nujiang River south of Bijiang—they have not been found north of Bijiang. *Rhododendron fletcheranum, R. fictolacteum* and *R. primulaeflorum* only occur in the northern part of the Biluo-Xueshan, while *R. taliense* is to be found only in the southern part of that mountain. Similar geographic discontinuities can also be detailed for the Gaoligong Shan. *Rhododendron meddianum, R. basilicum* and *R. mallotum* are present in Burma, and in the Nujiang Valley they occur from Lushui towards Tengchong and Jingdong. These species, however, are not known from the middle and northern sections of the Gaoligong Shan.

Floristic relationships

The Nujiang Valley belongs to the Henduan Mountain Region and the Sino-Himalayan forest subkingdom.* It is the core or centre of the Henduan Mountains, and although the area of the region is not vast, the climatic conditions and ecological micro-environments are extremely complex. The flora is very rich, and there are many altitudinal vegetation zones and associations, as well as ecological formations. Because of favourable geographic and climatic conditions *Rhododendron* is well developed in the Nujiang Valley, as demonstrated in this paper, and the genus is a very important floristic element of the Sino-Himalayan forest subkingdom.

The major characteristics of *Rhododendron* in the Nujiang Valley are: high species diversity, abundance of primitive species, distinct altitudinal distribution, and very few endemic species. The last characteristic, however, pertains only to this relatively small area—there are many endemic taxa of *Rhododendron* in the vast region which encompasses the Nujiang (Salween), Lancangjiang (Mekong) and Jingshajiang (Yangtse) River Systems, including the Henduan Mountains, northeastern Burma, and the eastern Himalayan area. Population and species diversity is very pronounced in this very large 'triangle' area, which without any question is the largest modern centre of *Rhododendron* distribution, diversity and differentiation in the world.

Because the area of the Nujiang Valley is limited, only relationships and affinities at specific level between *Rhododendron* taxa of this valley and other areas will be discussed. Fig. 4 illustrates the close relationship between the species of the Nujiang Valley and those of southeastern Xizang Autonomous Region, Burma and the northwestern part of Yunnan Province (mainly Deqin and Weixi Counties). These areas have more than 50 species in common. There is a much weaker relationship with western Yunnan Province (Tengchong), southwestern Yunnan Province (Wuliang Shan), Sichuan Province, the eastern Himalayas of northeastern India, and the southern slopes of the Himalayas, including the southern part of Xizang Autonomous Region, Nepal, Sikkim and Bhutan. Any direct relationships with the southeastern parts of Yunnan, Guangxi and Guizhou Provinces, Vietnam and Thailand are very weak. However, the relationships that do exist are very important in understanding the floristic connections of *Rhododendron*.

* The floristic divisions recognized follow Wu, C. Y. (1979). The Regionalization of Chinese Flora. *Acta Botanica Yunnanica* 1(1): 1–22.

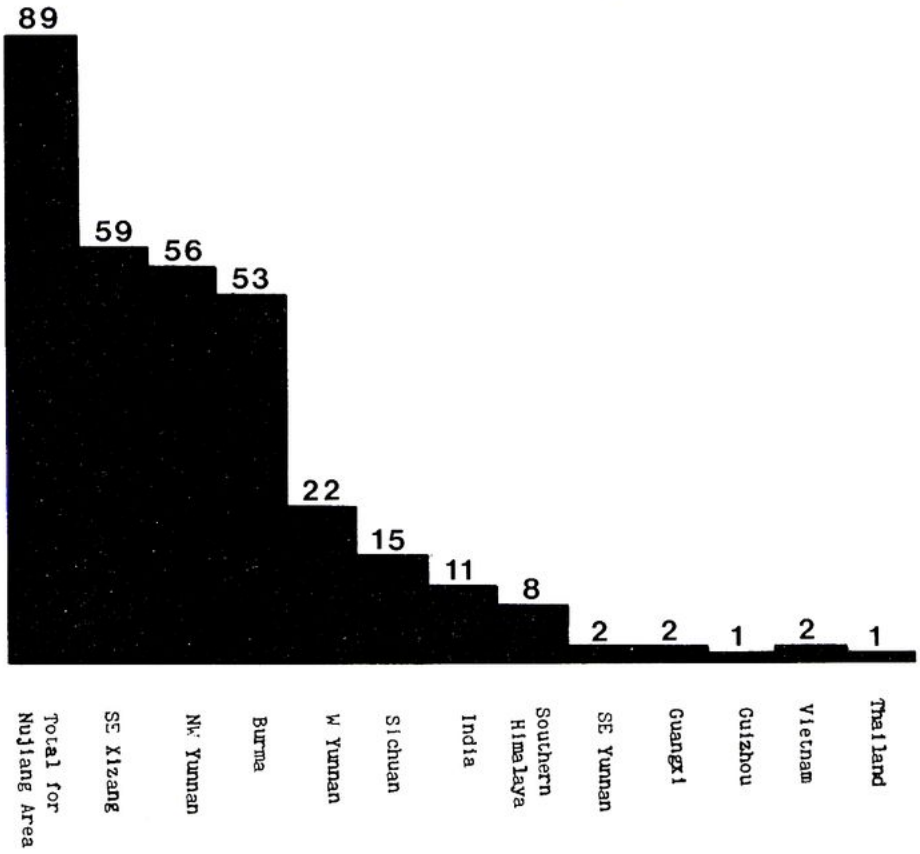

FIG. 4. The co-species of the Nujiang Valley and other areas.

Southern slopes of the Himalayas. The southern slopes of the Himalayas which belong to the Qinghai-Xizang (Chinghai-Tibet) plateau subkingdom and the Nujiang Valley have eight species of *Rhododendron* in common, which are also more widely distributed (Table 3). There are also a few species common to the Nujiang Valley and the southwestern part of Sichuan Province. An important series of closely related pairs of taxa is demonstrated where one species or subspecies occurs in the Nujiang Valley and the other in the eastern and southern Himalayas. These pairs are: *R. crassum* Franchet (= *R. maddenii* subsp. *crassum* (Franchet) Cullen) and *R. maddenii, R. taggianum* and *R. lindleyi, R. seinghjuense* and *R. pendulum, R. oleifolium* Franchet (= *R. virgatum* subsp. *oleifolium* (Franchet) Cullen) and *R. virgatum, R. campylocarpum* subsp. *caloxanthum* and *R. campylocarpum* subsp. *campylocarpum, R. arizelum* and *R. falconeri, R. coriaceum* and *R. hodgsonii,* and *R. sinogrande* and *R. grande.*

Malaysian subkingdom. This subkingdom belongs to the Paleotropic floristic kingdom, and the regions of China which it encompasses are: Taiwan, southern Guangdong Province (including Hainan Island and the islands in the Nanhai Sea), southern Guangxi Province, and the southern, southwestern and southeastern boundary areas of Yunnan Province. These regions are not rich in *Rhododendron* species but there are some affinities

TABLE 3. The distribution of *Rhododendron* in the Nujiang Valley, Yunnan Province and in related areas

	Altitude (m)	Nujiang Valley: Gaoligong Shan: Lushui Co.	Gaoligong Shan: Bijiang Co.	Gaoligong Shan: Gongshan Co.	Biluoxue Shan: Lushui Co.	Biluoxue Shan: Bijiang Co.	Biluoxue Shan: Gongshan Co.	SE Xizang Reg.	NW Yunnan Prov.	W Yunnan Prov.	SE Yunnan Prov.	Sichuan Prov.	Guizhou Prov.	Guangxi Prov.	S Himalayas	Burma	India	Vietnam	Thailand
Subgen. **Rhododendron**																			
Sect. Rhododendron																			
Subsect. Glauca Sleumer																			
R. brachyanthum Franchet subsp. *hypolepidotum* (Franchet) Cullen	3450–3900		×	×				×	×						×				
R. charitopes Balfour f. & Farrer	3700		×													×			
Subsect. Boothia Sleumer																			
R. chrysodoron [Tagg ex] Hutchinson	2400–2600			×		×		×								×			
R. megeratum Balfour f. & Forrest	2900–3300			×				×	×						×	×	×		
R. micromeres Tagg	2600			×				×	×						×	×	×		
R. monanthum Balfour f. & W. W. Smith	2600–3100		×	×				×								×			
R. sulfureum Franchet	3100–3200		×					×	×										
Subsect. Campylogyna Sleumer																			
R. campylogynum Franchet	3700–4200	×	×	×		×	×	×	×	×					×	×	×		
Subsect. Genestieriana Sleumer																			
R. genestierianum Forrest	2300–3450			×	×			×	×							×			
Subsect. Edgeworthia Sleumer																			
R. edgeworthii Hooker	2150–3100	×	×	×	×	×	×	×	×	×		×			×	×	×		

R. seinghkuense Ward	2600–2950			×			×	×							×		
Subsect. Tephropepla Sleumer																	
R. xanthostephanum Merrill	1700–2600		×	×		×		×	×		×				×	×	
Subsect. Maddenia Sleumer																	
R. ciliipes Hutchinson	2300–2500	×	×			×			×								
R. crassum Franchet	2400–3300	×	×	×	×	×	×	×	×	×					×	×	×
R. dendricola Hutchinson	1400–2700		×	×		×		×	×	×					×	×	
R. fletcherianum Davidian	3400–3500						×	×									
R. megacalyx Balfour f. & Ward	2300–2400	×	×	×				×	×	×					×	×	
R. roseatum Hutchinson	2000–3000		×			×				×							
R. sinonuttallii Balfour f. & Forrest	1700–2300		×	×				×									
R. taggianum Hutchinson	1900			×						×					×		
Subsect. Saluenensia Sleumer																	
R. calostrotum Balfour f. & Ward subsp. *calostrotum*	3100–3900		×	×		×	×	×							×		
R. calostrotum subsp. *riparium* (Ward) Cullen	3700	×						×							×	×	
R. keleticum Balfour f. & Forrest	3150–3880			×				×							×		
R. saluenense Franchet	3450–4000			×			×	×	×						×		
Subsect. Cinnabarina Sleumer																	
R. lateriflorum R. C. Fang & A. L. Zhang (cf. Addendum)	2700–3400			×													
Subsect. Lapponica Sleumer																	
R. rupicola W. W. Smith var. *rupicola*	2900–3850		×	×		×	×	×	×			×			×		
R. rupicola var. *chryseum* (Balfour f. & Ward) Philipson & Philipson	3000–3900			×			×	×	×						×		
R. tapetiforme Balfour f. & Ward	4000–4200		×	×		×	×	×	×						×		
Subsect. Heliolepida Sleumer																	
R. heliolepis Franchet	3300–3700	×	×			×		×	×						×		

TABLE 3. The distribution of *Rhododendron* in the Nujiang Valley, Yunnan Province and in related areas

	Altitude (m)	Nujiang Valley: Gaoligong Shan: Lushui Co.	Gaoligong Shan: Bijiang Co.	Gaoligong Shan: Gongshan Co.	Biluoxue Shan: Lushui Co.	Biluoxue Shan: Bijiang Co.	Biluoxue Shan: Gongshan Co.	SE Xizang Reg.	NW Yunnan Prov.	W Yunnan Prov.	SE Yunnan Prov.	Sichuan Prov.	Guizhou Prov.	Guangxi Prov.	S Himalayas	Burma	India	Vietnam	Thailand
R. hirsutipetiolatum R. C. Fang & A. L. Zhang (cf. Addendum)	3400					×													
R. rubiginosum Franchet	2700–3600		×	×		×	×	×	×			×				×			
Subsect. Triflora Sleumer																			
R. augustinii Hemsley subsp. *chasmanthum* (Diels) Cullen	2800						×	×	×			×							
R. oreotrephes W. W. Smith	3100–3600		×			×		×	×			×				×			
R. zaleucum Balfour f. & W. W. Smith	2800	×							×	×						×			
Sect. Pogonathum G. Don																			
R. cephalanthum Franchet	3500–4100	×	×	×		×	×	×	×						×	×	×		
R. primulaeflorum Bureau & Franchet	3900–4000						×	×	×			×			×				
Sect. Vireya (Blume) Copeland																			
R. vaccinioides Hooker f.	2300–2700			×		×		×						×	×	×	×		
Subgen. **Pseudoazalea** Sleumer																			
R. mekongense Franchet	2900–3750		×	×		×	×	×	×						×	×			
R. trichocladum Franchet	3400	×		×					×							×			
Subgen. **Hymenanthes** (Blume) K. Koch																			
Sect. Hymenanthes																			
Subsect. Barbata Sleumer																			

R. crinigerum Franchet	3000–3650		×	×		×	×	×	×			×
R. glischrum Balfour f. & W. W. Smith	2800–3300		×	×		×		×	×		×	×
R. rude Tagg & Forrest	2600		×									
Subsect. Thomsonia Sleumer												
R. eclecteum Balfour f. & Forrest	3700–3800			×			×	×	×			×
R. hylaeum Balfour f. & Farrer	2500–3600			×				×				×
R. meddianum Forrest var. *meddianum*	3350–3600	×								×		×
R. meddianum var. *atrokermesinum* Tagg	3200		×									×
R. stewartianum Diels	3000–3700		×	×		×		×				×
Subsect. Neriiflora Sleumer												
R. aperantum Balfour f. & Ward	3600–3800		×			×			×			×
R. chaetomallum Balfour f. & Forrest	3200–3700			×			×	×	×	×		×
R. chamaethomsonii (Tagg & Forrest) Cowan & Davidian var. *chamaedoron* (Tagg & Forrest) Chamberlain	3300–3400			×				×	×			
R. citriniflorum Balfour f. & Forrest var. ***citriniflorum***	2500–3000					×		×				
R. citriniflorum var. *horaeum* (Balfour f. & Forrest) Chamberlain	3700			×		×		×	×			
R. dichroanthum Diels subsp. *dichroanthum*	3600–3700					×			×			
R. dichroanthum subsp. *apodectum* (Balfour f. & W. W. Smith) Cowan	3300–3850		×						×			×
R. dichroanthum subsp. *scyphocalyx* (Balfour f. & Forrest) Cowan	2900–3600	×		×								×
R. euchroum Balfour f. & Ward	3200–3300		×			×						×
R. eudoxum Balfour f. & Forrest var. *eudoxum*	3500			×		×		×				

TABLE 3. The distribution of *Rhododendron* in the Nujiang Valley, Yunnan Province and in related areas

	Altitude (m)	Nujiang Valley: Gaoligong Shan: Lushui Co.	Gaoligong Shan: Bijiang Co.	Gaoligong Shan: Gongshan Co.	Biluoxue Shan: Lushui Co.	Biluoxue Shan: Bijiang Co.	Biluoxue Shan: Gongshan Co.	SE Xizang Reg.	NW Yunnan Prov.	W Yunnan Prov.	SE Yunnan Prov.	Sichuan Prov.	Guizhou Prov.	Guangxi Prov.	S Himalayas	Burma	India	Vietnam	Thailand
R. eudoxum var. *brunneifolium* (Balfour f. & Forrest) Chamberlain	3600–3800						×	×											
R. eudoxum var. *mesopolium* (Balfour f. & Forrest) Chamberlain	4200					×	×	×	×										
R. floccigerum Franchet	2700–3700			×			×	×	×										
R. forrestii [Balfour f. ex] Diels	3700–4200		×	×			×	×	×							×			
R. mallotum Balfour f. & Ward	3300–3600	×								×						×			
R. neriiflorum Franchet subsp. *neriiflorum*	2700–3000	×	×	×				×	×	×						×			
R. neriiflorum subsp. *phaedropum* (Balfour f. & Farrer) Tagg	2750–2900			×		×													
R. pocophorum [Balfour f. ex] Tagg	3600–3800			×				×											
R. sanguineum Franchet subsp. *sanguineum* var. *sanguineum*	3000–3900			×			×	×	×										
R. sanguineum subsp. *sanguineum* var. *cloiophorum* (Balfour f. & Forrest) Chamberlain	3550–4200						×		×										
R. sanguineum subsp. *sanguineum* var. *haemaleum* (Balfour f. & Forrest) Chamberlain	3600–3650						×	×	×										

R. sanguineum subsp. *didymum* (Balfour f. & Forrest) Cowan	3600–3800			×			×										
R. sperabiloides Tagg & Forrest	2800–3000			×			×										
R. temenium Balfour f. & Forrest var. *temenium*	3650–3900			×			×										
R. temenium var. *gilvum* (Cowan) Chamberlain	3900–4200			×		×	×	×									
Subsect. Selensia Sleumer																	
R. selense Franchet	3500–3800					×	×	×			×						
R. setiferum Balfour f. & Forrest	2800–3800			×		×	×	×									
Subsect. Campylocarpa Sleumer																	
R. campylocarpum Hooker f. subsp. *caloxanthum* (Balfour f. & Farrer) Chamberlain	3100–3850		×	×			×							×			
R. callimorphum Balfour f. & W. W. Smith	3300–3400	×		×				×	×								
Subsect. Fortunea Sleumer																	
R. decorum Franchet	1900					×	×		×			×	×				
R. diaprepes Balfour f. & W. W. Smith	1900–2600	×	×			×				×				×			
Subsect. Irrorata Sleumer																	
R. anthosphaerum Diels	2600–3600	×	×	×	×	×	×	×	×					×			
R. araiophyllum Balfour f. & W. W. Smith	2400–3400	×		×	×	×				×				×			
R. gongshanense T. L. Ming	2100–2500			×													
R. lukiangense Franchet	1900–2900	×	×	×		×	×	×	×			×					
R. tanastylum Balfour f. & Ward	1600–2700	×				×			×	×				×		×	
R. pennivenium Balfour f. & Forrest	2400–2450				×	×				×							
Subsect. Parishia Sleumer																	
R. facetum Balfour f. & Ward	2400–3000	×	×		×	×			×	×				×			
R. kyawi Lace & W. W. Smith	1600–2300			×										×			

TABLE 3. The distribution of *Rhododendron* in the Nujiang Valley, Yunnan Province and in related areas

	Altitude (m)	Nujiang Valley: Gaoligong Shan			Nujiang Valley: Biluoxue Shan			SE Xizang Reg.	NW Yunnan Prov.	W Yunnan Prov.	SE Yunnan Prov.	Sichuan Prov.	Guizhou Prov.	Guangxi Prov.	S Himalayas	Burma	India	Vietnam	Thailand
		Lushui Co.	Bijiang Co.	Gongshan Co.	Lushui Co.	Bijiang Co.	Gongshan Co.												
Subsect. Argyrophylla Sleumer																			
R. coryanum Tagg & Forrest	2200–2400		×	×				×											
Subsect. Lactea Sleumer																			
R. beesianum Diels	3450–4100					×	×	×	×			×							
Subsect. Falconera Sleumer																			
R. arizelum Balfour f. & Forrest	2700–3750		×	×		×	×	×	×							×			
R. basilicum Balfour f. & W. W. Smith	3400–3500	×						×	×	×						×			
R. coriaceum Franchet	2700–3000		×	×		×	×	×	×										
R. fictolacteum Balfour f.	3500–3750						×	×	×			×							
R. gratum T. L. Ming	3200				×														
R. preptum Balfour f. & Forrest	3200				×					×						×			
Subsect. Grandia Sleumer																			
R. praestans Balfour f. & W. W. Smith	3200–3750					×	×	×	×										
R. siderum Balfour f.	2500–3100	×		×	×	×				×						×			
R. sinogrande Balfour f. & W. W. Smith	1800–3000	×	×	×	×	×	×	×	×	×						×			
Subsect. Fulva Sleumer																			
R. fulvum Balfour f. & W. W. Smith	2800–3400			×	×	×	×	×	×							×			
R. uvarifolium Diels	3400–3500						×	×	×			×							

Subsect. Taliensia Sleumer																
R. pronum Tagg & Forrest	3800–3900					×			×							
R. proteoides Balfour f. & W. W. Smith	4200						×	×	×			×				
R. taliense Franchet	3600–3900					×			×							
Subgen. **Tsutsutsi** (Sweet) Pojarkova																
Sect. Tsutsutsi																
R. microphyton Franchet	1300–2300	×	×		×	×			×	×	×	×		×		×
Subgen. **Azaleastrum** [Planchon ex] K. Koch																
Sect. Azaleastrum																
R. leptothrium Balfour f. & Forrest	1700–2700		×	×	×	×		×	×	×		×				
Sect. Choniastrum Franchet																
R. stenaulum Balfour f. & W. W. Smith	1750–2500		×	×											×	
Subgen. **Pseudorhodorastrum** Sleumer																
Sect. Rhabdorhodion Sleumer																
R. oleifolium Franchet	1700–2570		×	×	×	×	×		×							

with the Nujiang Valley. For example, *R. xanthostephanum* Merrill (subgen. *Rhododendron* sect. *Rhododendron* subsect. *Tephropepla*) is widely distributed in the southeastern part of Xizang Autonomous Region, the southern slopes of the Himalayas, northeastern India, northern Burma, and the Nujiang Valley. It is also present on the Laojing Shan on the boundary between Maguan and Malipo Counties of Yunnan Province. *Rhododendron tanastylum* (subgen. *Hymenanthes* sect. *Hymenanthes* subsect. *Irrorata*) and *R. crassum* (= *R. maddenii* subsp. *crassum* (Franchet) Cullen) (subgen. *Rhododendron* sect. *Rhododendron* subsect. *Maddenia*) are also distributed southwards into northern Vietnam. *Rhododendron microphyton* also occurs in the northern mountainous regions of Thailand, and *R. moulmaininense* and *R. stenaulum* (which both belong to subgen. *Azaleastrum*) are distributed from Yunnan Province to Malesia.

It is worth mentioning that *R. vaccinioides* (subgen. *Rhododendron* sect. *Vireya*) is distributed from the southern and eastern Himalayas to the Henduan Mountains in Yunnan Province, and also into the Shiwan Da Shan of Guangxi Province. The closely allied *R. emarginatum*, although not present in the Nujiang Valley, is distributed in Guizhou and Guangxi Provinces, the southern part of Yunnan Province, and into northern Vietnam. The other species of sect. *Vireya* that occur in Thailand and Vietnam are *R. malayanum* Jack, from Thailand, *R. triumphans* Yersin & Chevalier, and *R. chevalierei* Dop—the last two from southern Vietnam. Section *Vireya* is, of course, best developed in the tropical mountainous areas between Malaysia and Australia where more than 280 species constitute the second largest centre of distribution and diversity of the genus *Rhododendron*.

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ADDENDUM: TWO NEW SPECIES OF RHODODENDRON

FANG RHUI-CHENG*

Rhododendron lateriflorum R. C. Fang & A. L. Zhang (subgen. *Rhododendron* sect. *Rhododendron* subsect. *Cinnabarina*), **sp. nov.** Fig. 5.

Species nova foliis anguste oblongis vel lanceolatis, infructescentiis axillaribus, stylis ad basim pubescentibus, probabiliter *R. keysii* Nuttall affinis sed foliis infra glaucescentibus pubescentibus, squamis aequalibus obtectis, capsulis majoribus differt.

* Kunming Institute of Botany.

FIG. 5. *Rhododendron lateriflorum* R. C. Fang & A. L. Zhang. A, fruiting branch × approx. 0.9; B, capsule × approx. 2; c, enlarged part of lower surface of leaf showing hairs and scales × approx. 1.5.

Frutex sempervirens 5m altus; ramuli juveniles cinereo-brunnei, squamis parvis cito deciduis dense induti. Folia coriacea, anguste oblonga vel lanceolata, 4.5–8 × 0.9–1.9cm, apice acuta manifeste mucronata, basi cuneata, supra dense lepidota, juventute secus costas puberula, infra glaucescentia, dense lepidota et puberula, ad costas densissime puberula, squamis parvis aequalibus spatium 1–2 diametro suo inter se distantibus, nervis lateralibus circiter 13-jugis, supra inconspicuis, infra leviter prominentibus; petioli 0.8–1.4cm longi, squamis parvis obtecti. Flores non visi.

Fructus 2–3 in racemos breves dispositi, pedicellis curvatis 2–3cm longis, dense lepidotis; capsulae breviter cylindricae, 1–1.5cm × 4–5mm, in 5 valvae dehiscentes, squamis parvis dense indutae, stylis, gracilibus persistentibus versus basin dense pubescentibus, calycibus persistentibus lobis triangularibus circiter 1mm longis extra lepidotis.

A new species with narrow oblong or lanceolate leaves, axillary infructescences and basally pubescent styles, which is probably allied to *R. keysii* Nuttall, but from which it differs by the lower surfaces of the leaves being glaucescent and pubescent with uniform-sized scales, and having larger capsules.

Evergreen shrub, 5m tall; juvenile branchlets greyish-brown, densely covered with small early deciduous scales. Leaves coriaceous, narrowly oblong or lanceolate, 4.5–8 × 0.9–1.9cm; apices acute, strongly mucronate; bases cuneate; upper surfaces densely lepidote, both sides of mid-veins puberulent when young; lower surfaces glaucescent, densely lepidote and puberulent, mid-veins very densely pubescent, small lepidote scales 1–2 × their own diameter apart; lateral veins approximately 13 pairs, inconspicuous on upper surfaces, slightly prominent on lower surfaces; petioles 0.8–1.4cm long, covered with small scales. Flowers not seen. Fruit borne 2 to 3 in short racemes; pedicels curved, 2–3cm long, densely lepidote; capsules shortly cylindrical, 1–1.5cm × 4–5mm, dehiscing into 5 valves, densely covered with small scales; styles slender, persistent, densely pubescent towards base; calyces persistent, lobes triangular, approximately 1mm long, lepidote on the outside.

Holotype: People's Republic of China, Yunnan Province, Nujiang Valley, Gongshan, in silvis frondosis, 2,700m, 10 xi 1959, *K. M. Feng* 24128—fruiting (KUN; iso. E).

Paratype: People's Republic of China, Yunnan Province, Nujiang Valley, Gongshan, in fruticetis declivitatis apricae, 3,400m, 30 v 1960, *Yunnan Bor.-Occident. Exped.* 10029 (KUN).

Rhododendron hirsutipetiolatum R. C. Fang & A. L. Zhang (subgen. *Rhododendron* sect. *Rhododendron* subsect. *Heliolepida*), **sp. nov.** Fig. 6.

Habitu *R. heliolepidis* Franchet similis, sed costa et nervis lateralibus supra prominentibus, foliis subtus squamis parvis munitis, petiolis hispidis, stylis glabris differt.

Frutex sempervirens 5m altus; ramuli juveniles brunnei, lepidoti, vetustiores cinerei. Folia oblongo-elliptica, perchartacea, 6–8 × 2.5–3.2cm, apice breviter acuminata, basi cuneata vel anguste obtusa, juventute supra squamis cito deciduis dense obtecta, secus costam puberula, infra dense lepidota, squamis parvis fulvis margine membranaceis dispositis inter se spatium diametro suo minus distantibus vel fere contiguis, costa utrinque leviter prominenti, nervis lateralibus circiter 9-jugis, supra leviter conspicuis, subtus inconspicuis; petioli 0.8–1.2cm longi, dense lepidoti, hispidi et puberuli. Inflorescentiae terminales, e floribus 2–4 in corymbos umbelliformes dispositis compositae; pedicelli crassi, 0.8–1.6cm longi, dense lepidoti. Calyx vix evolutus patelliformis interdum margine undulatus, extra lepidotus. Corolla late infundibuliformis, lilacina, 2.5–3.5cm longa, extra dense lepidota, ad medium 5-lobata, lobis late ovatis, intra maculatis. Stamina 10, inaequalia, corolla breviora, filamentis

FIG. 6. *Rhododendron hirsutipetiolatum* R. C. Fang & A. L. Zhang. A, flowering branch × approx. 0.8; B, part of lower surface of leaf, natural size.

basim versus minute puberulis vel glabris. Ovarium 5-loculare, dense lepidotum, stylo glabro staminibus paulo longiore corollam aequilongo. Capsula non visa.

Evergreen shrub 5m tall; juvenile branchlets brownish, lepidote, becoming greyish with age. Leaves oblong-elliptic, thickened-papery, 6–8 × 2.5–3.2cm; apices shortly acuminate; bases cuneate or narrowly obtuse; leaf upper surfaces densely covered with early deciduous scales when young, mid-veins puberulent on both leaf surfaces; lower surfaces of leaves densely lepidote with small fulvous membranous-margined scales that are spaced one diameter apart or nearly contiguous; mid-veins of both leaf surfaces slightly prominent; lateral veins approximately 9-paired,

slightly conspicuous on the upper leaf surfaces, inconspicuous on lower; petioles 0.8–1.2cm long, densely lepidote, hispid and puberulent. Inflorescences terminal, of 2–4 flowers arranged in umbelliform corymbs; pedicels thick, 0.8–1.6cm long, densely lepidote. Calyces scarcely developed, patelliform, occasionally with undulated margins, lepidote on the outside. Corollas widely infundibuliform, lilac, 2.5–3.5cm long, densely lepidote externally, 5-lobate from the middle; lobes wide ovate, maculate on the inside. Stamens 10, unequal, shorter than corolla; filaments minutely puberulent or glabrous towards the base. Ovaries 5-locular, densely lepidote; styles glabrous, a little longer than the stamens and of the same length as corollas. Capsules not seen.

Holotype: People's Republic of China, Yunnan Province, Nujiang Valley, Bijiang, in abietis, alt. 3,400m, 29 iv 1980, *C. H. Yang* 80-0025 (KUN; iso. E).