

# Endemic Wild Ornamental Plants from Northwestern Yunnan, China

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*Additional index words.* horticultural potential

**Abstract.** Northwestern Yunnan is situated in the southern part of the Hengduan Mountains, which is a complex and varied natural environment. Consequently, this region supports a great diversity of endemic plants. Using field investigation in combination with analysis of relevant literature and available data, this paper presents a regional ethnobotanical study of this area. Results indicated that northwestern Yunnan has an abundance of wild ornamental plants: this study identified 262 endemic species (belonging to 64 genera and 28 families) with potential ornamental value. The distinguishing features of these wild plants, their characteristics and habitats are analyzed; the ornamental potential of most plants stems from their wildflowers, but some species also have ornamental fruits and foliage. Among the endemic genera, *Pedicularis* and *Rhododendron* have particularly high numbers of ornamental wild species, while *Aconitum*, *Gentiana*, *Corydalis*, *Silene*, *Delphinium*, *Cremanthodium*, and *Saussurea* also contain significant numbers of wild ornamental species. It is suggested that cultivation of these species may be beneficial, both commercially and to help conserve endangered endemic plant species.

Northwestern Yunnan, in southwestern China is a diverse region that is internationally recognized as biodiversity hotspot and a center of plant diversity (Davis et al., 1995; Li, 1994; Mittermeier et al., 2004). Bordering the Tibetan Plateau and northern Myanmar, northwestern Yunnan contains a diversity of vegetation zones spanning subtropical to alpine. As a result of these unique habitats and its location, northwestern Yunnan is characterized by exceedingly high levels of species endemism and harbors an exceptionally high number of rare and vulnerable species.

The variety of habitats in northwestern Yunnan stems from unique landscape features: the region is comprised of rugged, parallel mountain ranges (with glaciated peaks exceeding 6,500 m) and deep gorges (down to altitudes of 600 m). The mountain ranges provide dispersal corridors for upland flora from the Tibetan Plateau to the northwest and the Sichuan Highlands to the northeast, while the river valleys are conduits for flora from the Indo-Malayan and east Asian lowlands to the southwest and southeast (Sun, 2002). However, the same mountain ranges and gorges that have allowed adjacent floras to overlap, have also maintained sufficient isolation between valleys to enable significant in situ evolution.

Northwestern Yunnan is part of the *Mountains of Southwest China Biodiversity Hotspot*, which includes the Hengduan, Gaoligong, and Nu Shan mountains of western Yunnan, and

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have played an important role in world horticulture and have been introduced to Western countries where they have been widely cultivated. Some of the best known examples include *Rhododendron*, *Primula*, *Gentiana*, *Pedicularis*, and *Saussurea*, which are all important genera in northwestern Yunnan (Chen et al., 1989; Feng, 1983; Guan et al., 1998; Hu, 1990; Shi and Jin, 1999; Yang, 1956;). Many of these ornamental species are endemic to small areas of northwestern Yunnan (e.g., *Rhododendron russatum*), therefore, their cultivation not only provides for potential sources of income generation, but also offers a potential form of conservation management: these plants can be used directly for their ornamental plant value or as genetic resources for plant breeding programs. The aims of current paper are to describe the unique flora of northwestern Yunnan and provide detailed information of those resources, in terms of their potential horticultural value as ornamental species.

## General Study Area

Northwestern Yunnan (lat. 25°30'–29°15'N and long. 98°05'–101°15'E) is on the Yunnan-Guizhou Plateau in southwestern China (Fig. 1). To the west the region merges into the Himalayan mountain ranges, to the north onto the Tibetan Plateau, while the south borders the temperate and subtropical lowlands of central and southern Yunnan. This mountainous region forms the upper reaches of three major river systems, the Nu Jiang (Salween River), the Lancang (Mekong), and the Jinsha Jiang (the upper reach of the Yangtze River). A wide range of vegetation types exists including, grassland, cushion-like alpine grasslands, evergreen broadleaf forest, mixed forest, alpine mosaic, deciduous broadleaf forest and

extends up to the southeastern edge of the Tibetan Plateau (Mittermeier et al., 2004). Within the Hengduan Mountains more than 7,000 vascular plant species (incorporating 1,467 genera and 985 families) have been recorded. Among these, 5,079 species are endemic to China, 2,988 to the Hengduan Mountains, and 910 are only found in northwestern Yunnan (with 13 genera containing 10 or more endemic species) (Chinese Academy of Science, 1993, 1994; Fang, 1993; Li and Li, 1993; Wu and Ding, 1998).

Given the rich diversity, it is not surprising that montane plants of northwestern Yunnan



Fig. 1. The study area, northwestern Yunnan of China.

Table 1. The families and genera in order of numbers of endemic wild flower species.

Family	No. of species	Genera	No. of species
Ranunculaceae	39	<i>Pedicularis</i>	34
Scrophulariaceae	34	<i>Rhododendron</i>	31
Ericaceae	32	<i>Aconitum</i>	23
Compositae	18	<i>Gentiana</i>	16
Gentianaceae	16	<i>Corydalis</i>	16
Rosaceae	14	<i>Silene</i>	13
Caryophyllaceae	13	<i>Delphinium</i>	12
Fumariaceae	13	<i>Cremanthodium</i>	8
Primulaceae	11	<i>Saussurea</i>	8

temperate conifer forest (Wu and Zhu, 1987; Yang, 1990).

The elevations of lower hill areas and valley plains along the Jinsha, Lancang and Nujiang, range between about 700 and 1,100 m. However, the taller mountains, such as Yulong, Haba and Meili snow mountains exceed heights of 5,000 m. The average temperature in this region is 10 to 15 °C, the highest and lowest temperatures in the ranges of 30 to 37 °C and -4 to -12 °C, respectively. The annual average rainfall is between 1,185 and 1,439 mm (Yang, 1990).

**Site selection.** Northwestern Yunnan covers 16 counties of Diqing, Lijiang, Nujiang, and Dali Prefectures, lat. 25°30'–29°15'N, and long. 98°05'–101°15'E. Its total area is 68,908 km<sup>2</sup> (17.5% of Yunnan Province).

Sites were selected according to the physiogeographical regionalization parameters outlined by Yang (1990) which are comprehensive contributions about physiogeographical regionalization of Yunnan. We used six areas: Yunlong, Lanping alpine-medium hillside area (15,000 km<sup>2</sup>), Nu Jiang alpine mountains and gorge area (10,000 km<sup>2</sup>), Dali and Lijiang basin and alpine-medium coteau area (26,000 km<sup>2</sup>), Jinsha Jiang river valley area (15,000 km<sup>2</sup>), Zhongdian and Deqin alpine mountains and plateau area (16,000 km<sup>2</sup>), and part of the Baoshan and Fengqing medium mountain and basin area. In terms of political boundaries, the study sites covered the northern part of the Dali Bai Autonomous Prefecture, most of the Lijiang Naxi Autonomous Prefecture, the Nujiang Lisu Autonomous Prefecture and Diqing Zang Autonomous Prefecture. 16 counties are included in the study area: Yunlong, Dali, Eryuan, Jianchuan, Heqing, Binchuan, Lijiang, Ninglang, Yongsheng, Zhongdian, Deqin, Weixi, Lanping, Lushui, Fugong, and Gongshan (Fig. 1).

## Methods

An initial check list was made of the presence and distribution of plants in the study areas, based on the following plant surveys: *List of seed plants in Yunan* (Kunming Institute of Botany, 1984), *Vegetation of Yunnan* (Wu and Zhu, 1987), *Vascular Plants in Hengduan Mountains* (Chinese Academy of Science, 1993, 1994), *Flora of Yunnan* (Wu and Chen, 1986, 2000; Wu et al., 1997), and *Flora of China* (Chen and Hu, 1989; Hu, 1990; Shi and Jin, 1999; Yang, 1956). Herbarium records from the Kunming Institute of Botany were used to validate field samples. The compiled database included the following information: species, genus and family names, plant attributes includ-

ing distribution patterns, life form, vegetation types, flower colors, flowering season and ornamental value. Using this database, we identified those endemic species that had ornamental value. Evaluation and reinvestigation of this list of endemic plants from northwestern Yunnan was based on literature, herbarium records, the database and field work.

**Definition of ornamental plants.** Different botanist have different definitions of ornamental plants. In this study, we consider wild ornamental plants to be those which occur naturally in the field and have highly ornamental features such as ornamental flowers, fruit, or foliage.

## Results and Discussion

**Wild ornamental plants endemic to northwestern Yunnan.** In total, northwestern Yunnan contains 2,206 species, (belonging to 324 genera and 38 families), of which 910 species (41%) are endemic (Li et al., 2003). There are a total of nine endemic families with more than eight endemic species. A considerable number of these endemic species were found to be wild flowers: we identified 262 species, belonging to 64 genera and 28 families endemic to northwestern Yunnan. Among the endemic genera, *Pedicularis* and *Rhododendron* are particularly rich in endemic wild ornamental species (Table 1).

**Analysis of life-form.** The inventory shows that most of the endemic wild flowers are herbaceous which probably is the result of the harsh geographical environment in the study area (Table 2). Alpine plants are highly adapted to growth in particularly harsh conditions, since they have evolved special characteristics in response to a particular combination of cool climate and mountainous terrain. The cool climate in the study area, particularly in winter, results in generally low temperatures, frequent frosts and strong winds. Snow persists at the highest altitudes, for 1 to 3 months in the subalpine zone and 3 to 4 months in the alpine zone. These factors have major effects on plant growth. Low temperatures, frosts and snow restrict plant growth for most of the year, particularly at high altitudes. Northwestern Yunnan alpine and mountain areas are characterised by a sequence of vegetation communities with distinct altitudinal zones. Vegetation communities are groups of plants living together with similar preferences and tolerances for particular environmental conditions. These communities can be described by differences in species, height and growth form, and structure. The most obvious change in communities is the transition, at the altitude

known as the treeline, to a treeless vegetation. Above the treeline is the true alpine zone where the vegetation is primarily dwarfed shrubs and ground hugging herbs, with no trees.

The growth habit also helps in surviving freezing temperatures: cushion and rosette herbs may be 10 °C higher than the surrounding air.

**Analysis of ornamental features.** Ornamental plants can be divided into three main types: those with ornamental flowers, ornamental fruits, or ornamental foliage. However, many wild plants have several ornamental parts, therefore, these divisions serve to distinguish different groups on their primary ornamental features.

The results show that of the endemic ornamental plants in northwestern Yunnan, 235 species have ornamental flowers, and most of them belong to the families *Ericaceae*, *Compositae*, *Liliaceae*, *Orchidaceae*, *Ranunculaceae*, *Rosaceae*, and *Gentianaceae*. Flower colors vary from red and purple to white and yellow. The red-flowered plants include some species of the genus *Pedicularis*, such as *P. habachanensis*, *P. praeruptorum*; the genus *Rhododendron*, such as *R. cyanocarpum*, *R. fastigiatum*, *R. codonanthum*; and the genus *Androsace*, such as *A. alchemilloides*. Most of the purple-flowered plants belong to the genera *Gentiana*, *Primula*, *Aconitum*, *Delphinium*, and *Corydalis* (exemplified by species such as *G. bella*, *P. annulata*, *A. acutiscutum*, *D. brevisepalum*, and *C. petrophila*). White-flowered species include *Sorbus harrowiana*, *Spiraea calcicola*, *Anemone multilobulata*, prominent yellow-green flowers include *Rhododendron dendricola*, *R. rhombifolium*, *Pedicularis lecomtei*, and *P. tomentosa*.

Table 3 shows the approximate flowering times of 262 wild ornamental plants endemic to northwestern Yunnan. Flowering times are affected by a variety of factors, including, habitat, elevation and species type. Generally at higher elevations plants will bloom later and possibly for longer periods of time. The number of species blooming in early spring and midsummer is greater than those blooming in fall or mid-winter. Most *Pedicularis* spp., *Rhododendron* spp., *Primula* spp. and *Gentiana* spp. bloom in early spring and midsummer, whereas, *Cremanthodium* spp. and *Delphinium* spp. bloom in fall and winter.

There are only 17 endemic wild species with ornamental fruits in northwestern Yunnan. These plants have fruits with a vivid color or unique shape; most of the species belong to *Aceraceae*, *Rosaceae*, *Aquifoliaceae* and *Actinidiaceae*. Plants from the *Aceraceae* have light purple or purplish green, winged fruits, each consisting of a pair of samaras which

Table 2. Analysis of the life-form of endemic wild ornamental plants in northwestern Yunnan.

Life form	Endemic wild ornamental plants	
	(species)	Percentage
Herb	184	70.2
Shrub	66	25.2
Tree	12	4.6

Table 3. Inventory of wild ornamental plants endemic to northwestern Yunnan; Fl = flower, Fr = fruit, Fo = foliage.

Species	Life form	Color	Fl or Fr time	Habitat
<i>Acer kiukiangense</i> Hu et WC Cheng	Evergreen trees	Fr purplish-green	Fr Sept.	Evergreen broad-leaved forest at 1,700–2,200 m
<i>Acer lanpingensis</i> Feng et Fang	Deciduous trees	Fr light blue	Fr Sept.	Evergreen broad-leaved forest at 2,600–2,700 m
<i>Acer machilifolium</i> Hu et Cheng	Evergreen trees	Fr purplish-green	Fr Jan.–Feb.	Evergreen broad-leaved forest at 1,600–2,400 m
<i>Aconitum acutiusculum</i> Fletcher et Lauener	Perennial herbs	Fl purplish-blue	Fl Aug.	Alpine meadow, alpine gravel desert at 4,000 m
<i>Aconitum bisma</i> (Buch.-Ham.) Rapais	Perennial herbs	Fl light yellow	Fl Aug.–Sept.	Alpine meadow at 3,400–3,800 m
<i>Aconitum bracteolosum</i> WT Wang	Perennial herbs	Fl bluish-purple	Fl July	Alpine meadow at 4,800 m
<i>Aconitum brevipetalum</i> WT Wang	Perennial herbs	Fl blue	Fl Aug.–Oct.	Alpine meadow at 2,800–3,800 m
<i>Aconitum chulanum</i> WT Wang	Perennial herbs	Fl deep blue	Fl Aug.	Alpine meadow at 2,800–3,800 m
<i>Aconitum coriophyllum</i> Hand.-Mazz.	Perennial herbs	Fl greenish-yellow	Fl Oct.	Alpine meadow at 2,600 m
<i>Aconitum crassiflorum</i> Hand.-Mazz.	Perennial herbs	Fl bluish-purple	Fl July–Aug.	Alpine meadow or fir forest at 3,600–4,100 m
<i>Aconitum delavayi</i> Fr	Perennial herbs	Fl bluish-purple	Fl Aug.–Oct.	Alpine meadow at 3,700–3,800 m
<i>Aconitum dolichorhynchum</i> WT Wang	Perennial herbs	Fl bluish-purple	Fl Aug.	Alpine shrubs and meadow at 3,400 m
<i>Aconitum duclouxii</i> H. Lév	Perennial herbs	Fl bluish-purple	Fl Sept.	Alpine meadow or fir forest at 3,600–4,100 m
<i>Aconitum georgei</i> HF Comber	Perennial herbs	Fl bluish-purple	Fl July–Sept.	Alpine shrubs and meadow at 3,700–4,000 m
<i>Aconitum habaense</i> WT Wang	Perennial herbs	Fl bluish-purple	Fl Aug.	Alpine shrubs at about 3,600 m
<i>Aconitum kangshanense</i> WT Wang	Perennial herbs	Fl bluish-purple	Fl Aug.–Sept.	Alpine rhododendron shrubs at 3,400–4,100 m
<i>Aconitum incisofidum</i> W.T. Wang	Perennial herbs	Fl purple	Fl Aug.–Sept.	Alpine shrubs at 3,700–3,900 m
<i>Aconitum pseudostapfianum</i> WT Wang	Perennial herbs	Fl blue	Fl Aug.	Alpine meadow at about 4,150 m
<i>Aconitum ramulosum</i> WT Wang	Perennial herbs	Fl bluish-purple	Fl July–Aug.	Alpine shrubs and meadow at 3,700–4,000 m
<i>Aconitum souliei</i> Finet et Gagnepain	Perennial herbs	Fl yellow	Fl Aug.	Alpine meadow at 3,800–3,900 m
<i>Aconitum stramineiflorum</i> Chang ex WT Wang	Perennial herbs	Fl yellow	Fl Aug.	Alpine meadow at 3,900 m
<i>Aconitum taronense</i> (Hand.-Mazz.) Fletcher et Lauener	Perennial herbs	Fl purple	Fl Aug.–Sept.	Alpine meadow at 2,600–3,600 m
<i>Aconitum tenuicaule</i> WT Wang	Perennial herbs	Fl bluish-purple	Fl Aug.	Alpine meadow, gravel desert at 4,000 m
<i>Aconitum tsaii</i> WT Wang	Perennial herbs	Fl blue	Fl Aug.–Sept.	Subalpine evergreen broad-leaved forest at 2,000–3,600 m
<i>Aconitum weixiense</i> WT Wang	Perennial herbs	Fl blue	Fl Aug.–Sept.	Subalpine evergreen broad-leaved forest at 2,000–3,600 m
<i>Aconitum yangii</i> WT Wang et LQ Li	Perennial herbs	Fl blue	Fl Aug.	Alpine meadow at 3,100 m
<i>Actinidia pilosula</i> (Finet & Gagnepain) Stapf ex Hand.-Mazz.	Woody vines	Fl White, Fr gold-yellow	Fl June, Fr Aug.	Evergreen broad-leaved forest at 2,300–2,400 m
<i>Aeschynanthus angustiolongus</i> WT Wang	Climbing shrubs	Fl red	Fl Sept.	Dry-hot valley shrubs at 1,250–1,500 m
<i>Aeschynanthus lasianthus</i> WT Wang	Climbing shrubs	Fl deep-red	Fl Aug.–Oct.	Dry-hot valley shrubs at 1,600–2,300 m
<i>Amitostigma trifurcatum</i> T. Tang, FW Wang et KY Lang	Herbs	Fl yellow	Fl June	Evergreen broad-leaved forest at 600–700 m
<i>Androsace alchemilloides</i> Fr	Perennial herbs	Fl pink	Fl May–June	Alpine shrubs and meadow at 3,000–4,000 m
<i>Androsace bulleyana</i> Forr.	Biennial or perennial herbs	Fl pink	Fl June–July	Alpine gravel desert at 3,200–3,900 m
<i>Androsace grisea</i> Forrest	Perennial herbs	Fl pink	Fl June–July	Alpine gravel desert at 3,800–4,600 m
<i>Anemone multilobulata</i> WT Wang et LQ Li	Perennial herbs	Fl white	Fl Apr.–May	Alpine meadow at 3,500–3,800 m
<i>Anemone scabriuscula</i> WT Wang	Perennial herbs	Fl white	Fl May–Oct.	Subalpine meadow at about 2,900 m
<i>Aster brevis</i> Hand.-Mazz.	Perennial herbs	Fl purple-red	Fl July–Sept.	Alpine shrubs and meadow at 2,900–3,500 m
<i>Aster bulleyanus</i> Jeffrey	Perennial herbs	Fl purple-red	Fl Mar.–Oct.	Subalpine shrubs and meadow at 1,100–3,500 m
<i>Berberis amoena</i> Dunn.	Shrubs	Fl yellow, Fr red	Fl Nov.–Dec., Fr June–Aug.	Subalpine shrubs and meadow at 2,100–3,000 m
<i>Berberis calcipratorum</i> Ahrendt	Shrubs	Fl dark-yellow, Fr yellow	Fl June, Fr Aug.	Alpine shrubs and meadow at 3,000–4,000 m
<i>Berberis concolor</i> WW Sm.	Shrubs	Fl yellow, Fr purplish-red	Fl May–June, Fr July–Aug.	Alpine shrubs and meadow at 2,900–3,600 m
<i>Berberis forrestii</i> Ahrendt	Shrubs	Fl yellow, Fr bright red	Fl June, Fr Oct.	Alpine shrubs at 2,800–3,600 m
<i>Berberis minutiflora</i> Schneid.	Shrubs	Fl yellow, Fr red	Fl May–June, Fr Sept.–Oct.	Alpine shrubs at 2,500–3,600 m
<i>Carissa yunnanensis</i> Tsiang et PT Li	Evergreen shrubs	Fl white	Fl Apr.	Evergreen broad-leaved forest at 1,200–1,800 m
<i>Cassiope argyrotricha</i> TZ Hsu	Shrubs	Fl white	Fl July–Aug.	Alpine or subalpine scree slopes at 3,000–3,900 m
<i>Cassiope nana</i> TZ Hsu	Dwarf evergreen shrub	Fl milk white	Fl July–Aug.	Alpine or subalpine scree slopes at 3,200–3,900 m
<i>Cassiope palpebrata</i> WW Sm.	Shrubs	Fl milk white	Fl July–Aug.	Alpine or subalpine scree slopes at 3,000–3,900 m
<i>Cassiope ectinata</i> Stapf	Shrubs	Fl milk white	Fl July–Aug.	Alpine or subalpine scree slopes at 3,300–3,900 m
<i>Cephalanthera calcarata</i> SC Chen et KY Lang	Herbs	Fl pink	Fl Sept.	Coniferous and broad-leaved mixed forest at 2,900–3,000 m
<i>Cheiranthus forrestii</i> (WW Sm.) Hand.-Mazz.	Perennial herbs	Fl purplish-red	Fl June–July	Alpine gravel desert at 4,700–5,200 m
<i>Clematis venusta</i> MC Chang	Woody vines	Fl white	Fl May	Coniferous and broad-leaved mixed forest at 2,300–2,700 m
<i>Coelogyne corymbosa</i> Lindl.	Adnascent herbs	Fl yellowish-green	Fl Apr.–May	Evergreen broad-leaved forest at 1,150–1,500 m
<i>Corallodiscus patens</i> (Craib) BL Burt	Perennial herbs	Fl purplish-blue	Fl July–Aug.	Alpine meadow at 3,000–3,300 m
<i>Corydalis bijiangensis</i> CY Wu et H. Chuang	Perennial herbs	Fl yellow	Fl July	Alpine meadow, alpine gravel desert at 4,200–4,600 m
<i>Corydalis calcicola</i> WW Sm	Perennial tufted herbs	Fl yellow	Fl July	Alpine gravel desert at 3,800–4,200 m
<i>Corydalis cheirifolia</i> Fr	Perennial tufted herbs	Fl yellow	Fl July–Nov.	Subalpine meadow at 2,100–2,500 m
<i>Corydalis delavayi</i> Fr	Perennial herbs	Fl blue	Fl July–Nov.	Alpine gravel desert at 3,800–4,200 m
<i>Corydalis hemidicentra</i> Hand.-Mazz.	Perennial herbs	Fl bluish	Fl July–Nov.	Alpine gravel desert at 3,500–4,100 m
<i>Corydalis heterocentra</i> Diels	Perennial herbs	Fl blue	Fl July–Nov.	Scree slopes at 3,900–4,500 m
<i>Corydalis lopinensis</i> Fr	Perennial tufted herbs	Fl yellow	Fl May–June	Subalpine meadow at 1,350–3,900 m
<i>Corydalis mayae</i> Hand.-Mazz.	Perennial herbs	Fl yellow	Fl May–June	Alpine shrubs, meadow at 3,800–4,200 m
<i>Corydalis multisecta</i> CY Wu et H. Chuang	Perennial herbs	Fl pale blue, purple	Fl July	Dry ravine on steep slope under shrubs at 4,100–4,300 m
<i>Corydalis oxypetala</i> Fr	Perennial herbs	Fl yellow	Fl May–July	Limestone shrubs and meadow at 3,500–3,600 m
<i>Corydalis petrophila</i> Fr	Perennial herbs	Fl purple	Fl July–Sept.	Alpine meadow at 3,000–3,400 m
<i>Corydalis atunsiensis</i> WW Sm.	Perennial herbs	Fl pale violet	Fl July	Alpine shrubs, meadow at 3,800–4,200 m
<i>Corylopsis glaucescens</i> Hand.-Mazz.	Shrubs	Fl yellowish-green	Fl Mar.–Apr.	Coniferous and broad-leaved mixed forest at 1,700–3,100 m
<i>Corylopsis trabeculosa</i> He et Cheng	Shrubs	Fl yellowish-green	Fl after Oct.	Coniferous and broad-leaved mixed forest at 1,350–2,000 m
<i>Corylopsis yui</i> Hu et WC Cheng	Shrubs	Fl yellowish-green	Fl Aug.–Oct.	Evergreen broad-leaved forest at 2,700–3,600 m
<i>Corylopsis yunnanensis</i> Diels.	Shrubs	Fl yellowish-green	Fl Mar.–Apr.	Coniferous and broad-leaved mixed forest at 2,400–2,800 m
<i>Cotinus nana</i> WW Sm.	Shrubs, small trees	Fo red	Fo Oct.–Dec.	Dry-hot valley shrubs at 600–1,500 m
<i>Crataegus chungtienensis</i> WW Sm.	Shrubs	Fl white, Fr red	Fl May	Alpine shrubs and meadow at 2,800–3,280 m
<i>Crataegus oresbia</i> WW Sm.	Shrubs	Fl white, Fr red	Fl May	Alpine shrubs at 3,000–3,300 m
<i>Cremanthodium glaucum</i> Hand.-Mazz.	Perennial herbs	Fl yellow	Fl May–Sept.	Alpine rhododendron shrubs at 3,900–4,300 m
<i>Cremanthodium brachychaetum</i> CC Chang	Perennial herbs	Fl yellow	Fl July–Aug.	Alpine shrubs and meadow at 3,100–3,600 m
<i>Cremanthodium calcicola</i> WW Sm.	Perennial herbs	Fl yellow	Fl July–Oct.	Alpine meadow at 2,500–3,300 m
<i>Cremanthodium chungtienense</i> Ling et SW Liu	Perennial herbs	Fl yellow	Fl Aug.–Oct.	Alpine rhododendron shrubs at 3,200–3,300 m
<i>Cremanthodium delavayi</i> Fr et Diels ex H. Léveillé	Perennial herbs	Fl yellow	Fl July–Aug.	Alpine rhododendron shrubs at 3,200–4,000 m
<i>Cremanthodium dissectum</i> Grierson	Perennial herbs	Fl yellow	Fl July–Aug.	Rhododendron shrubs, alpine shrubs, meadow at 2,295–4,800 m
<i>Cremanthodium farreri</i> WW Sm.	Perennial herbs	Fl yellow	Fl July–Sept.	Alpine rhododendron shrubs, gravel desert at 2,950–4,000 m
<i>Cremanthodium pulchrum</i> RD Good	Perennial herbs	Fl purplish-red	Fl Aug.–Oct.	Alpine shrubs and meadow at 3,200–4,600 m
<i>Cypripedium margaritaceum</i> Fr	adnascent herbs	Fl yellowish to white	Fl Mar.–Apr.	Evergreen broad-leaved forest at 1,600–1,700 m
<i>Delphinium brevisepalum</i> WT Wang	Perennial herbs	Fl yellow	Fl Jul.–Aug.	Alpine meadow at 2,900–3,800 m
<i>Delphinium bulleyanum</i> Forrest ex Diels.	Perennial herbs	Fl yellow	Fl Aug.–Sept.	Alpine meadow at 3,100–3,700 m
<i>Delphinium ceratophorum</i> Fr	Perennial herbs	Fl bluish-purplish	Fl Aug.–Sept.	Alpine gravel desert, shrubs at 2,400–3,600 m
<i>Delphinium coleopodium</i> Hand.-Mazz.	Perennial herbs	Fl blue	Fl Sept.–Oct.	Alpine meadow at 3,600–3,900 m

Table 3 (continued). Inventory of wild ornamental plants endemic to northwestern Yunnan; Fl = flower, Fr = fruit, Fo = foliage.

Species	Life form	Color	Fl or Fr time	Habitat
<i>Delphinium hamatum</i> Fr	Perennial herbs	Fl bluish-purple	Fl Sept.–Oct.	Alpine meadow at 2,900–3,800 m
<i>Delphinium latirhombicum</i> WT Wang	Perennial herbs	Fl blue	Fl July	Alpine meadow at 2,900 m
<i>Delphinium likiangense</i> Fr	Perennial herbs	Fl blue	Fl Aug.–Sept.	Alpine meadow or gravel desert at 3,400–4,500 m
<i>Delphinium majus</i> (WT Wang) WT Wang	Perennial herbs	Fl bluish-purple	Fl Aug.–Sept.	Dry-hot valley shrubs at 1,600–1,800 m
<i>Delphinium micropetalum</i> Finet et Gagnep.	Perennial herbs	Fl bluish-purple	Fl Aug.–Oct.	Alpine meadow at 3,300–4,200 m
<i>Delphinium pseudohamatum</i> WT Wang	Perennial herbs	Fl blue	Fl Sept.	Alpine meadow at about 3,790 m
<i>Delphinium yangii</i> WT Wang	Perennial herbs	Fl blue	Fl July–Aug.	Alpine shrubs and meadow at 4,200–4,500 m
<i>Delphinium yulungshanicum</i> WT Wang	Perennial herbs	Fl purplish-blue	Fl Sept.–Oct.	Alpine meadow at 3,300–4,200 m
<i>Dolomiaea berardioides</i> (Fr) C. Shih.	Perennial herbs	Fl purple	Fl Sept.	Alpine gravel desert at 4,500–4,800 m
<i>Dolomiaea salvinensis</i> (Hand.-Mazz.) C. Shih.	Perennial herbs	Fl purple	Fl Aug.–Oct.	Subalpine shrubs, Rhododendron shrubs at 2,400–4,100 m
<i>Draba involucrate</i> WW Sm.	Tufty herbs	Fl yellow	Fl May–July	Alpine shrubs, meadow, gravel desert at 4,050–4,100 m
<i>Draba jucunda</i> WW Sm.	Tufty herbs	Fl yellow	Fl June–Aug.	Alpine gravel desert or shrubs and meadow at 4,075–4,375 m
<i>Draba oerodoxa</i> WW Sm.	Tufty herbs	Fl yellow	Fl May–July	Alpine shrubs and meadow at 2,400–4,600 m
<i>Draba piepunensis</i> OE Schulz.	Tufty herbs	Fl yellow	Fl July–Aug.	Alpine meadow at 3,700–4,650 m
<i>Draba senilis</i> OE Schulz.	Perennial herbs	Fl yellow	Fl May–July	Alpine meadow, gravel desert at about 4,000 m
<i>Draba serpens</i> OE Schulz.	Groundling herbs	Fl yellow	Fl June–July	Alpine gravel desert at 4,100–5,500 m
<i>Dysosma aurantiocaulis</i> (Hand.-Mazz.) Hu	Perennial herbs	Fl dark red	Fl May–June	Evergreen broad-leaved forest at 2,800–3,000 m
<i>Eriobotrya tenguuehensis</i> WW Sm.	Evergreen shrubs	Fl milk yellow, Fr red	Fl Apr.–May	Subalpine shrubs at 1,700–2,500 m
<i>Fritillaria crassicaulis</i> S. C. Chen	Perennial herbs	Fl yellowish-green	Fl May	Alpine meadow at 3,000–3,900 m
<i>Gaultheria cardiosepala</i> Hand.-Mazz.	Shrubs	Fr white	Fr Aug.–Oct.	Scree slopes at 2,800–3,600 m
<i>Gentiana alsinoides</i> Fr	Annual herbs	Fl light blue	Fl July–Sept.	Limestone shrubs at 2,700–3,350 m
<i>Gentiana anisostemon</i> C. Marquand.	Annual herbs	Fl blueish-purple	Fl Apr.–May	Alpine meadow, shrubs at 3,600–4,300 m
<i>Gentiana asparagoides</i> TN Ho	Annual herbs	Fl bluish-purple	Fl Aug.	Alpine wetland at 3,500–3,800 m
<i>Gentiana bella</i> Fr	Annual herbs	Fl bluish-purple	Fl June–Aug.	Alpine meadow at 3,000–4,050 m
<i>Gentiana caryophyllaea</i> Harry Sm.	Perennial herbs	Fl deep blue	Fl Aug.–Sept.	Alpine meadow at 4,000–4,300 m
<i>Gentiana chungtienensis</i> C. Marquand	Annual herbs	Fl light blue	Fl May–June	Alpine shrubs and meadow at 3,000–3,700 m
<i>Gentiana dentiformis</i> TN Ho	Annual herbs	Fl yellowish-yellow	Fl Aug.	Deciduous pine forest at 3,700–3,800 m
<i>Gentiana grata</i> Harry Sm.	Perennial herbs	Fl blue	Fl Aug.–Sept.	Alpine swamp at 2,900–4,050 m
<i>Gentiana linooides</i> Fr	Annual herbs	Fl blueish-purple	Fl July–Aug.	Alpine shrubs and meadow at 3,000–4,000 m
<i>Gentiana maeluchanensis</i> Fr	Annual herbs	Fl light blue	Fl Apr.–July	Alpine shrubs at 2,500–3,600 m
<i>Gentiana ninglangensis</i> TN Ho	Annual herbs	Fl light blue	Fl May	Alpine meadow at 2,500–3,000 m
<i>Gentiana pubiflora</i> TN Ho	Annual herbs	Fl yellowish-green	Fl Apr.–May	Alpine shrubs at 2,600–3,300 m
<i>Gentiana qiujiangensis</i> TN Ho	Perennial herbs	Fl bluish-purple	Fl Aug.	Alpine meadow, alpine swamp at about 3,900 m
<i>Gentiana stellulata</i> Harry Sm.	Annual herbs	Fl blue	Fl June–Sept.	Alpine meadow at 3,300–3,950 m
<i>Gentiana subintricata</i> TN Ho	Annual herbs	Fl light purplish-red	Fl July–Aug.	Alpine meadow at 3,400–3,700 m
<i>Gentiana subtilis</i> Harry Sm.	Annual herbs	Fl bluish	Fl Apr.–July	Alpine meadow at 3,650–4,500 m
<i>Hedysarum limitaneum</i> Hand.-Mazz.	Perennial herbs	Fl yellow	Fl July	Evergreen broad-leaved forest at 1,500–3,200 m
<i>Hemerocallis nana</i> WW Sm. et Forr.	Small Perennial herbs	Fl orange yellow	Fl June	Subalpine or alpine shrubs at 2,400–3,400 m
<i>Hernium carnosilabre</i> T. Tang et FT Wang	Herbs	Fl brown	Fl May	Subalpine meadow at about 2,900 m
<i>Hypericum elliptifolium</i> HL Li	Shrubs	Fl light yellow	Fl Aug.–Sept.	Coniferous and broad-leaved mixed forest at 1,800–2,200 m
<i>Impatiens ceratophora</i> Comber	Herbs	Fl white, pink, orange, red	Fl July–Oct.	Subalpine shrubs and meadow at 1,700–2,700 m
<i>Impatiens chilimensis</i> HF Comber	Herbs	Fl white, pink, orange, red	Fl July–Oct.	Subalpine shrubs and meadow at 2,300–3,600 m
<i>Impatiens microcentra</i> Hand.-Mazz.	Herbs	Fl white, pink, orange, red	Fl July–Oct.	Subalpine meadow at 2,200–2,800 m
<i>Impatiens taronensis</i> Hand.-Mazz.	Herbs	Fl white, pink, orange, red	Fl July–Oct.	Subalpine meadow at 2,800–3,100 m
<i>Impatiens tomentella</i> JD Hooker	Herbs	Fl white, pink, orange, red	Fl July–Oct.	Evergreen broad-leaved forest at 1,400–1,800 m
<i>Impatiens xanthina</i> HF Comber	Herbs	Fl white, pink, orange, red	Fl July–Oct.	Evergreen broad-leaved forest at 1,500–2,800 m
<i>Indigofera calcicola</i> Craib	Shrubs	Fl purple-red	Fl Aug.–Oct.	Subalpine shrubs at 2,400–2,600 m
<i>Indigofera densa</i> NE Br.	Shrubs	Fl yellow	Fl June–July	Alpine rhododendron shrubs at 2,400–3,600 m
<i>Indigofera sensitiva</i> Fr	Shrubs	Fl purple-red	Fl Aug.–Sept.	Subalpine shrubs at 2,200–2,600 m
<i>Iris subdichotoma</i> YT Zhao	Perennial herbs	Fl purplish	Fl Aug.–Oct.	Alpine shrubs and meadow at 2,200–3,400 m
<i>Lilium habaense</i> FT Wang et T. Tang	Perennial herbs	Fl yellowish-green	Fl July–Aug.	Alpine shrubs at 3,300 m
<i>Listera bambusetorum</i> Hand.-Mazz.	Adnascent herbs	Fl pink	Fl May–June	Evergreen broad-leaved forest at 800–1,260 m
<i>Lysionotus angustisepalus</i> WT Wang	Adnascent subshrubs	Fl purplish	Fl Sept.	Dry-hot valley shrubs at about 1,200 m
<i>Lysionotus gracilis</i> WW Sm.	Subshrubs	Fl purplish	Fl July–Aug.	Evergreen broad-leaved forest at 2,000–2,250 m
<i>Lysionotus sessilifolius</i> Hand.-Mazz.	Subshrubs	Fl light purple	Fl Aug.–Sept.	Evergreen broad-leaved forest at 1,250–2,800 m
<i>Lysionotus sulphureus</i> Hand.-Mazz.	Subshrubs	Fl yellowish	Fl Sept.	Evergreen broad-leaved forest at 2,300–2,800 m
<i>Meconopsis delavayi</i> (Fr) Fr ex Prain.	Perennial herbs	Fl deep purple	Fl May–July	Alpine meadow at 2,700–4,000 m
<i>Meconopsis Smithiana</i> (Hand.-Mazz.) G.	Perennial herbs	Fl yellow	Fl June–July	Alpine meadow at 3,120–3,400 m
<i>Neillia serratisepala</i> HL Li	Shrubs	Fl white	Fl July–Aug.	Shrubs at 1,700–3,200 m
<i>Nomocharis aperta</i> Wils. ex Fr	Perennial herbs	Fl yellowish	Fl June–July	Alpine shrubs at 2,800–4,000 m
<i>Nomocharis farreri</i> (WE Evans) Harrow	Perennial herbs	Fl pink	Fl July	Alpine shrubs, meadow at 2,800–3,600 m
<i>Nomocharis forrestii</i> Balf.	Perennial herbs	Fl pink	Fl June–July	Coniferous and broad-leaved mixed forest, Rhododendron shrubs, alpine shrubs at 3,000–3,800 m
<i>Nomocharis meleagrina</i> Fr	Perennial herbs	Fl white	Fl June–July	Deciduous broad-leaved forest, fir forest, alpine meadow, shrubs at 2,100–3,900 m
<i>Olea laxiflora</i> HL Li	Evergreen shrubs	Fl white	Fl July–Aug.	Evergreen broad-leaved forest at about 900 m
<i>Omphalogramma elegans</i> Forrest	Perennial herbs	Fl deep bluish-purple	Fl June–July	Alpine shrubs at 3,200–4,700 m
<i>Oreocharis aurantiaca</i> Baill.	Perennial herbs	Fl purple-red	Fl Aug.–Sept.	Subalpine meadow at 1,700–3,000 m
<i>Paphiopedilum armeniacum</i> Chen et Liu	Adnascent herbs	Fl yellow	Fl May–June	The wall of rock at 2,000–2,400 m
<i>Pedicularis atunsiensis</i> Bonati.	Perennial herbs	Fl purple	Fl July–Aug.	Alpine shrubs at 4,200–4,500 m
<i>Pedicularis crenularis</i> HL Li	Perennial herbs	Fl rose-red	Fl Oct.	Alpine fir forest at 2,400–3,000 m
<i>Pedicularis cyclorhyncha</i> HL Li	Perennial herbs	Fl purplish-red	Fl June	Alpine shrubs and meadow at 3,400–4,000 m
<i>Pedicularis dichrocephala</i> Hand.-Mazz.	Perennial herbs	Fl purplish-red	Fl Aug.	Alpine shrubs and meadow at 3,200–3,500 m
<i>Pedicularis fastigiata</i> Fr	Perennial herbs	Fl rose-red	Fl July	Alpine shrubs and meadow at 3,300–4,350 m
<i>Pedicularis filicula</i> Fr ex Maxim.	Perennial herbs	Fl purplish-red	Fl May–July	Alpine shrubs and meadow at 2,800–4,880 m
<i>Pedicularis gracilicaulis</i> HL Li	Perennial herbs	Fl purplish-red	Fl July–Aug.	Alpine shrubs and meadow at 3,000–3,300 m
<i>Pedicularis habachanensis</i> Bonati.	Perennial herbs	Fl red	Fl July	Alpine shrubs and meadow at 4,100–4,270 m
<i>Pedicularis humilis</i> Bonati.	Perennial herbs	Fl rose-red	Fl July	Alpine shrubs and meadow at 3,050–4,000 m
<i>Pedicularis kariensis</i> Bonati	Perennial herbs	Fl deep rose-red	Fl Aug.–Sept.	Alpine meadow at 2,400–4,000 m
<i>Pedicularis lamioides</i> Hand.-Mazz.	Perennial herbs	Fl deep rose-red	Fl Aug.–Sept.	Alpine shrubs and meadow at 3,000–4,100 m
<i>Pedicularis lanpingensis</i> HP Yang	Perennial herbs	Fl purplish-red	Fl June–July	Alpine shrubs and meadow at 3,200–3,500 m
<i>Pedicularis lecomtei</i> Bonati,	Perennial herbs	Fl yellow	Fl June	Alpine meadow at 3,500–4,000 m
<i>Pedicularis macrorhyncha</i> HL Li.	Perennial herbs	Fl purplish-red	Fl July–Sept.	Alpine meadow at 3,400–3,700 m
<i>Pedicularis maxonii</i> Bonati,	Perennial herbs	Fl purple	Fl July	Alpine meadow at 2,500–3,000 m
<i>Pedicularis mayana</i> Hand.-Mazz.	Perennial herbs	Fl purple	Fl May–Aug.	Alpine meadow at 3,700–4,400 m

Table 3 (continued). Inventory of wild ornamental plants endemic to northwestern Yunnan; Fl = flower, Fr = fruit, Fo = foliage.

Species	Life form	Color	Fl or Fr time	Habitat
<i>Pedicularis meteororrhyncha</i> HL Li	Perennial herbs	Fl purplish-red	Fl July–Aug.	Alpine meadow at 3,100–4,150 m
<i>Pedicularis micrantha</i> HL Li	Perennial herbs	Fl rose-red	Fl July	Alpine meadow at 3,100–4,400 m
<i>Pedicularis mussoii</i> Fr	Perennial herbs	Fl red	Fl July–Aug.	Alpine meadow at 3,500–4,000 m
<i>Pedicularis obscura</i> Bonati	Perennial herbs	Fl yellowish-red	Fl June	Alpine meadow at 3,600–4,200 m
<i>Pedicularis oligantha</i> Fr ex Maxim.	Perennial herbs	Fl yellow	Fl July	Alpine meadow at 2,500–3,000 m
<i>Pedicularis orthocoryne</i> HL Li	Perennial herbs	Fl white-yellow	Fl June	Alpine meadow at 4,420–4,480 m
<i>Pedicularis pinetorum</i> Hand.-Mazz.	Perennial herbs	Fl red	Fl Aug.	Subalpine meadow at 2,500–2,800 m
<i>Pedicularis praeruptorum</i> Bonati.	Perennial herbs	Fl red	Fl June–Aug.	Alpine meadow at 3,600–4,400 m
<i>Pedicularis pseudoversicolor</i> Hand.-Mazz.	Perennial herbs	Fl yellow	Fl May–June	Alpine meadow at 3,600–4,400 m
<i>Pedicularis remotiloba</i> Hand.-Mazz.	Perennial herbs	Fl rose-red	Fl Aug.	Alpine meadow at 3,600–4,000 m
<i>Pedicularis salicifolia</i> Bonati.	Perennial herbs	Fl deep rose-red	Fl July–May	Subalpine, alpine meadow at 1,000–3,500 m
<i>Pedicularis sigmoidea</i> Fr ex Maxim.	Perennial herbs	Fl purple-red	Fl Aug.	Alpine meadow at 3,000–3,600 m
<i>Pedicularis tomentosa</i> Li	Perennial herbs	Fl yellow	Fl Aug.–Sept.	Alpine meadow at 2,300–3,000 m
<i>Pedicularis tsaii</i> HL Li	Perennial herbs	Fl purple	Fl Aug.	Alpine meadow at 4,000–4,250 m
<i>Pedicularis umbelliformis</i> HL Li	Perennial herbs	Fl purple-red	Fl June–Aug.	Alpine meadow at 3,440–4,000 m
<i>Pedicularis weixiensis</i> HP Yang	Perennial herbs	Fl purple	Fl June–July	Alpine rhododendron shrubs at 3,600–4,000 m
<i>Pedicularis yui</i> HL Li	Perennial herbs	Fl purple	Fl June	Alpine rhododendron shrubs at 3,600–4,000 m
<i>Pedicularis zhongdianensis</i> HP Yang	Perennial herbs	Fl purplish-red	Fl June–July	Alpine meadow at 3,300–4,300 m
<i>Photinia prionophylla</i> (Fr) CK Schneid	Shrubs	Fl white, Fr red	Fl May, Fr Sept–Nov.	Dry-hot valley shrubs at 1,940–2,700 m
<i>Platanthera likiangensis</i> FT Wang	Adnascant herbs	Fl yellowish	Fl July–Aug.	Evergreen broad-leaved forest at 800–2,800 m
<i>Platanthera sinica</i> T Tang et FT Wang	Herbs	Fl greenish	Fl Aug.–Sept.	Alpine meadow at 3,200 m
<i>Pleione forrestii</i> Schltr.	Herbs	Fl green	Fl July–Aug.	Alpine meadow at 1,950–3,900 m
<i>Potentilla delavayi</i> Fr	Perennial herbs	Fl yellow	Fl July–Sept.	Subalpine shrubs and meadow at 3,000–4,200 m
<i>Primula amulata</i> Balf. et Kingdon-Ward	Perennial herbs	Fl blue-purple	Fl July	The wall of limestone at 4,700 m
<i>Primula bullata</i> Fr	Perennial herbs	Fl deep yellow	Fl May–June	Pine forest at 3,000 m
<i>Primula dryadifolia</i> Fret.	Perennial herbs	Fl light red	Fl June–July	Alpine meadow at 4,000–5,500 m
<i>Primula euosma</i> Craib	Perennial herbs	Fl deep purplish-blue	Fl Apr.–July	Alpine meadow at about 3,000 m
<i>Primula forrestii</i> Balf.	Perennial herbs	Fl deep gold-yellow	Fl Apr.–May	Alpine shrubs at 3,000–3,200 m
<i>Primula runcinata</i> CM Hu	Perennial herbs	Fl blue	Fl July	Alpine shrubs at 3,100–3,200 m
<i>Primula sinolisteri</i> Balf.	Perennial herbs	Fl light red	Fl Feb.–Aug.	Alpine shrubs, coniferous and broad-leaved mixed forest at 2,300–3,000 m
<i>Ranunculus nematolobus</i> Hand.-Mazz.	Perennial herbs	Fl yellow	Fl July–Sept.	Shrubs and meadow at 2,500–2,900 m
<i>Rhodiola nobilis</i> (Fret) SH Fu	Perennial herbs	Fl red, Fo pinks and reds	Fl May–Oct., Fo Aug.–Oct.	Alpine meadow at 2,500–4,200 m
<i>Rhododendron albertsenianum</i> Forrest	Shrubs	Fl red to purple	Fl Apr.–May	Coniferous and broad-leaved mixed forest at 700–2,600 m
<i>Rhododendron araiophyllum</i> Balf. et WW Sm.	Shrubs	Fl white	Fl May–June	Alpine fir forest, alpine rhododendron shrubs at 3,000–4,200 m
<i>Rhododendron basilicum</i> Balf. et WW Sm.	Shrubs	Fl rose	Fl May–July	Alpine rhododendron shrubs at 3,900–4,200 m
<i>Rhododendron charitopes</i> Balf. et Farrer.	Shrubs	Fl rose	Fl Apr.	Coniferous and broad-leaved mixed forest at about 2,600 m
<i>Rhododendron chrysodoron</i> Tagg ex Hutch.	Small shrubs	Fl pink	Fl May–July	Alpine rhododendron shrubs at 3,000–3,400 m
<i>Rhododendron codonantherum</i> Balf. et Forrest	Groundling small shrubs	Fl deep red	Fl May–July	Alpine rhododendron shrubs at 3,400–4,100 m
<i>Rhododendron cyanocarpum</i> (Fr) WW Sm.	Shrubs	Fl deep red	Fl May–July	Alpine rhododendron shrubs at 3,270–4,050 m
<i>Rhododendron dendricola</i> Hutch.	Shrubs	Fl light yellow	Fl May–June	Coniferous and broad-leaved mixed forest at 1,200–2,800 m
<i>Rhododendron dumicola</i> Tagg et Forrest	Shrubs	Fl deep yellow	Fl May	Alpine rhododendron shrubs at 2,600–3,050 m
<i>Rhododendron facetum</i> IB Balfour et Kingdon-Ward	Shrubs	Fl purple	Fl May–June	Alpine rhododendron shrubs, fir forest at 3,500–4,500 m
<i>Rhododendron fastigiatum</i> Fr	Shrubs, small trees	Fl deep red	Fl Apr.–May	Evergreen broad-leaved forest at 1,600–2,700 m
<i>Rhododendron gemmiferum</i> MN Philipson et WR Philipson	Shrubs	Fl yellow or pink	Fl May–July	Alpine rhododendron shrubs, fir forest at 3,500–3,900 m
<i>Rhododendron gongshanense</i> T. L. Ming	Shrubs	Fl reddish	Fl Apr.–June	Alpine rhododendron shrubs, evergreen broad-leaved forest at 1,900–3,600 m
<i>Rhododendron haematodes</i> Fr	Small shrubs	Fl purplish	Fl May–June	Alpine rhododendron shrubs, alpine gravel desert at 3,100–4,000 m
<i>Rhododendron kyanwi</i> Lace et WW Sm.	Shrubs, small trees	Fl white	Fl May–June	Alpine rhododendron shrubs, coniferous and broad-leaved mixed forest at 2,700–4,450 m
<i>Rhododendron lateriflorum</i> RC Fang et AL Chang	Deciduous shrubs	Fl pink or white	Fl Mar.–May	Evergreen broad-leaved forest at 600–2,400 m
<i>Rhododendron leptopseplum</i> Balf. f. et Forrest	Evergreen shrubs	Fl white	Fl May	Coniferous and broad-leaved mixed forest at 2,300–2,700 m
<i>Rhododendron mollicomum</i> Mollis.	Shrubs, small trees	Fl white to pink	Fl Apr.–May	Evergreen broad-leaved forest, coniferous and broad-leaved mixed forest at 2,000–3,400 m
<i>Rhododendron nakotiltum</i> Balf. et Forrest	Shrubs, small trees	Fl white	Fl May–June	Alpine rhododendron shrubs, fir forest at 2,600–4,200 m
<i>Rhododendron polycladum</i> Fr	Shrubs	Fl purplish-red	Fl May–June	Alpine rhododendron shrubs, fir forest at 3,200–4,500 m
<i>Rhododendron prunum</i> Tagg et Forrest	Shrubs	Fl purplish-red	Fl May–June	Evergreen broad-leaved forest at 1,100–2,500 m
<i>Rhododendron rhombifolium</i> RC Fang	Shrubs, small trees	Fl yellowish-green	Fl May–June	Alpine rhododendron shrubs, fir forest at 3,000–4,450 m
<i>Rhododendron rothschildii</i> Davidian	Shrubs	Fl yellow	Fl May–June	Alpine rhododendron shrubs at 3,200–4,400 m
<i>Rhododendron rude</i> Tagg et Forrest	Small shrubs	Fl yellow	Fl May	Alpine rhododendron shrubs at 2,600–2,800 m
<i>Rhododendron russatum</i> Balf. et Forrest	Shrubs	Fl white	Fl May–June	Alpine meadow at 1,500–2,400 m
<i>Rhododendron sperabile</i> IB Balfour et Farrer	Shrubs	Fl red	Fl Mar.–July	Alpine rhododendron shrubs at 2,300–3,800 m
<i>Rhododendron taliense</i> Fr	Shrubs	Fl red	Fl Apr.–May	Coniferous and broad-leaved mixed forest at 1,850–2,100 m
<i>Rhododendron trichocladum</i> Fret	Shrubs	Fl white or pink	Fl June–July	Alpine rhododendron shrubs, fir forest at 3,500–4,500 m
<i>Rhodoleia forrestii</i> Chun ex Exell	Evergreen trees	Fl red	Fl after Oct.	Coniferous and broad-leaved mixed forest at 1,600–2,800 m
<i>Rosa glomerata</i> Rehd. Et Wils.	Shrubs	Fl pink	Fl July–Sept.	Subalpine shrubs at 2,400–2,900 m
<i>Rosa praelucens</i> Bijh.	Shrubs	Fl red	Fl June–July	Subalpine shrubs at 2,700–3,000 m
<i>Rosa taronensis</i> TT Yü et TC Ku	Spined shrubs	Fl yellowish	Fl July–Aug.	Shrubs and meadow at 2,900–3,400 m
<i>Rosa weisiensis</i> Yu et Ku.	Climbing shrubs	Fl white	Fl Apr.–May	Subalpine shrubs at 1,850–2,300 m
<i>Saussurea delavayi</i> Fr	Herbs	Fl purple	Fl July–Sept.	Alpine gravel desert at 3,300–3,660 m
<i>Saussurea grosseserrata</i> Fr	Perennial herbs	Fl yellow	Fl July–Sept.	Alpine gravel desert at 3,200–4,800 m
<i>Saussurea peduncularis</i> Fr	Perennial herbs	Fl purple	Fl May–Sept.	Alpine gravel desert at 4,200–4,500 m
<i>Saussurea porphyroleuca</i> Hand.-Mazz.	Perennial herbs	Fl purple	Fl Aug.–Sept.	Alpine meadow, alpine gravel desert at 3,800–4,800 m
<i>Saussurea pratensis</i> Anthony	Perennial tufted herbs	Fl purplish-red	Fl July–Oct.	Alpine shrubs, alpine gravel desert at 3,500–4,500 m
<i>Saussurea rockii</i> Anthony	Perennial cushion herbs	Fl light purple	Fl Aug.–Sept.	Alpine shrubs, alpine gravel desert at 3,500–4,500 m
<i>Saussurea semiamplexicaulis</i> Lipschitz	Perennial herbs	Fl yellow	Fl July–Sept.	Alpine shrubs and meadow at 3,000–5,200 m
<i>Saussurea uliginosa</i> Hand.-Mazz.	Perennial cushion herbs	Fl purplish-red	Fl July–Aug.	Alpine gravel desert at 4,500–5,200 m
<i>Sedum magniflorum</i> KT Fu	Perennial herbs	Fl yellow	Fl June–Aug.	Alpine shrubs, meadow and gravel desert at 3,300–5,400 m
<i>Sedum wangi</i> SH Fu	Perennial herbs	Fl yellow	Fl May–Aug.	Coniferous and broad-leaved mixed forest at 1,300–2,700 m
<i>Silene atrocastanea</i> Diels.	Perennial herbs	Fl purple	Fl Aug.–Nov.	Alpine shrubs and meadow at 2,900–3,600 m
<i>Silene chodatii</i> Bocq.	Perennial herbs	Fl purple-brown	Fl Aug.–Nov.	Alpine shrubs and meadow at 2,700–3,800 m
<i>Silene delavayi</i> Fr	Perennial herbs	Fl purple-red	Fl June–Nov.	Alpine shrubs and meadow at 2,700–3,000 m
<i>Silene lichingensis</i> KT Fu	Perennial herbs	Fl red	Fl July–Aug.	Alpine shrubs at 2,900–3,300 m

Table 3 (continued). Inventory of wild ornamental plants endemic to northwestern Yunnan; Fl = flower, Fr = fruit, Fo = foliage.

Species	Life form	Color	Fl or Fr time	Habitat
<i>Silene lineariloba</i> CY Wu	Perennial herbs	Fl purple	Fl Aug.–Oct.	Alpine shrubs at 2,700–2,900 m
<i>Silene longipes</i> (Post) D.	Perennial herbs	Fl purple	Fl after Aug.	Subalpine meadow, alpine shrubs at 3,300–4,000 m
<i>Silene melanantha</i> Fret	Perennial herbs	F deep purple	Fl July–Sept.	Alpine shrubs and meadow at 3,200–4,150 m
<i>Silene otodonta</i> Fr	Perennial herbs	Fl light red	Fl after Sept.	Subalpine meadow at 2,100–2,500 m
<i>Silene phoenicodonta</i> Fr	Perennial herbs	Fl deep purple	Fl after July	Subalpine meadow at about 1,800 m
<i>Silene pubicalycina</i> (Fenzl) Maire	Perennial herbs	Fl reddish	Fl after July	Alpine shrubs at about 3,200 m
<i>Silene rosiflora</i> Kingdon-Ward	Perennial herbs	Fl reddish	Fl May–July	Alpine shrubs, alpine gravel desert at 1,900–2,600 m
<i>Silene scopulorum</i> Fr	Perennial herbs	Fl dark purple	Fl July–Aug.	Alpine meadow, alpine gravel desert at about 4,000 m
<i>Silene yunnanensis</i> Fret	Perennial herbs	Fl deep purple	Fl June–Sept.	Alpine shrubs, alpine gravel desert at 2,400–3,900 m
<i>Smithorchis calceoliformis</i> (WW Sm.) T. Tang et FT Wang	Herbs	Fl white	Fl Dec.	Evergreen broad-leaved forest at 1,000–2,100 m
<i>Solms-Laubachia pulcherrima</i> Muschler	Perennial shrublike herbs	Fl bluish, Fr purplish-red	Fl Apr.–June, Fr July–Aug.	Alpine gravel desert at 3,400–4,300 m
<i>Sorbus harrowiana</i> (IB Balfour et WW Sm.) Rehder	Trees	Fl white	Fl May–June	Evergreen broad-leaved forest at 2,100–3,500 m
<i>Sorbus kiukiangensis</i> TT Yu	Shrubs or trees	Fl white, Fr red	Fl May–June	Evergreen broad-leaved forest at 1,700–3,000 m
<i>Sorbus poterifolia</i> Hand.-Mazz.	Small shrubs	Fl pinkish-white, Fr white	Fl May–June, Fr Sept.–Oct.	Shrubs at 3,000–4,000 m
<i>Spiraea calcicola</i> WW Sm.	Shrubs	Fl white	Fl May–June	Subalpine shrubs and meadow at 2,700–2,800 m
<i>Spiraea compsophylla</i> Hand.-Mazz.	Shrubs	Fl white	Fl July–Sept.	Shrubs and meadow at 1,450–2,450 m

Table 4. The relationships between endemic wild ornamental plants and their habitat.

Habitat	Endemic wild ornamental plants (species)	Percentage
Alpine shrub	73	27.8
Alpine meadow	70	26.6
<i>Rhododendron</i> scrub	29	11.0
Evergreen broad-leaved forest	28	10.6
Alpine gravel desert	27	10.3
Subalpine or alpine meadow	20	7.6
Conifer and broad-leaved mixed forest	17	6.6
Dry-hot valley scrub	5	1.9



Fig. 2. *Primula bulleyana* Forr. Taken in Yulong snow Mountains, meadows, altitude 2,700 m, in Lijian, northwestern Yunnan.

separate when ripe and are dispersed by the wind, whereas *Actinidia pilosula* has golden yellow fruits and the fruit of *Berberis* spp. are often red in fall.

In terms of plants which have spectacular ornamental foliage, the inventory indicates that there are 15 species endemic to northwestern Yunnan. These species are dominated by several of the same families that also produce ornamental fruit, namely, Aceraceae, Rosaceae, and Anacardiaceae.

*The habitats of the endemic wild flowers.* The predominant habitats in the study sites are evergreen broad-leaved forest, subalpine or alpine meadow, alpine gravel desert, conifer

and broad-leaved mixed forest, alpine scrub, *Rhododendron* scrub, and dry-hot valley scrub. The research shows that the endemic wild flowers are richest in the vegetation types of alpine scrub and alpine meadow, followed by alpine *Rhododendron* scrub, which means that endemic wild flowers are most abundant at elevations between 2,500 and 4,500 m (Table 4).

Subalpine meadow, alpine scrub and alpine gravel desert are special habitats for northwestern Yunnan. The Hengduan mountains are the consequence of the upheaval of the Qinghai-Xizang Plateau after the collision between the Indian plate and Eurasian plate (Wu, 1988),

thus the vegetation types mentioned above were formed through rapid species differentiation. Alpine gravel desert is the high, cold desert plateau zone vegetation type, for which the typical ecological conditions are very low temperatures, a very short or nonexistent growing season, severe drought, high wind, and barren, rocky soil (Chang, 1981). In this harsh environment, plants formed adaptive physiological and ecological characteristics, developing into cushion plant communities. Most of these cushion plants, small in size and peculiar in shape, grow in rock cracks, and their flowers are very bright and showy, thus they have excellent potential as rock gardens plants. For example, the genera *Primula*, *Rhododendron*, *Meconopsis*, *Gentiana*, and *Lilium* are all found in alpine gravel desert, with *Primula* and *Meconopsis* especially abundant in this habitat. In addition to these genera, many other alpine flowers, such as *Aconitum* spp., *Delphinium* spp., *Corydalis* spp., *Draba* spp., *Solms-laubachia* spp., *Sedum* spp., *Rhodiola* spp., *Silene* spp., and *Saussurea* spp. are also widely distributed in alpine gravel desert.

Subtropical evergreen broad-leaved forest only occurs at elevations of 2,300 to 3,000 m in northwestern Yunnan. This subtropical evergreen vegetation is the result of an unusual local environment, so it is not surprising that it has created a niche for many endemic wild ornamental plants. For example, subtropical conditions are present at 2,700 m in the Gaoli-gong mountains and the Dulong river valley due to the influence of the Indian warm-wet airstream.

*Several rare ornamental taxa with peculiar habitats.* Interspersed with the forests are a number of wet meadows occurring on very gentle slopes where there is ground water seepage. Although species of *Primula* grow in variety of habitats, they often occur in great abundance and diversity in these moist meadows. One phenomenon in *Primula* (Fig. 2) is that two or more morphologically very similar species, but with totally different flower colors, often grow together. For example, *P. forrestii* with deep gold-yellow flowers, *P. uncinata* with blue flowers and *P. sinolisteri* with light red flowers often grow intermixed.

Another interesting habitat are the barren gravelly areas that occur in the saddles between peaks at elevations of 3,900 m to 4,600 m. These gravelly areas were formed by glacial deposits during past colder climates. These

barren areas are exposed, windswept habitats, which suppresses the development of woody vegetation and limits the kinds of plants that can grow. Consequently, all plants in these areas are with stemless aboveground: the stems are either below ground, or the vegetative parts arise directly from subterranean bulbs, corms or rhizomes. In these exposed gravel habitats, the only parts of the plants visible above the ground are the leaves and flowers. Among the more common and conspicuous herbaceous plants that have evolved in these environments are *Saussurea* and *Solms-Laubachia pulcherrima* (Figs. 3 and 4). *Saussurea* species have interconnected underground stems with short branches that bear leaves and inflorescences

at the soil surface. What appears to be a small colony of several individual plants is actually a single plant with a turf of leaves at the end of each branch and inflorescences clustered in the center of the leaves. Similarly, *Solms-Laubachia pulcherrima* have the main stem and branches totally below ground level and only the leaves, flowers and fruits appear above the soil surface.

In contrast to the compact and low habit of other species in exposed environments, members of the genus *Meconopsis* (a member of the poppy family, Papaveraceae) often send their flowering stems well above the associated vegetation in defiance of the wind. This genus is characteristic of high elevation areas in north-

western Yunnan and its habit in these exposed sites is rather amazing, since the flowers of *Meconopsis* appear to be extremely delicate. One important species, *Meconopsis delavayi* (Fig. 5), is grown for its beautiful flowers. The small, cup-shaped, pendant, lavender-blue flowers are borne singly on long, thin stems, in late spring and early summer, however, the heights of stems differ considerably among the varieties, ranging from 0.3 to 2 m.

Another example of a genus characteristic of northwestern Yunnan is *Gentiana* (Fig. 6). This genus tends to be particularly abundant in alpine meadows at altitudes of 4,500 m to 4,700 m. Of special interest to botanists in northwestern Yunnan are Gentianas that are annual or biennial herbs as their flowers are very colorful, ranging from dark red, purple, light yellow, green, white, and even to bright-blue which is especially uncommon. Therefore, this genus is considered to have great potential for the future development of ornamental wildflower species.

### Conclusions

As an initial regional ethnobotanical study of this area, it is clear that northwestern Yunnan is rich in endemic ornamental species. During the course of this study, we identified 262 taxa, belonging to 64 genera and 28 families, endemic to this region with potential ornamental value. This high number of endemic species reflects the diverse environment and taxonomic significance of northwestern Yunnan. Encouraging the use of natural ornamental plants in these regions can make considerable contributions to the economy and the culture of these rural regions. Therefore, the taxonomic investigation of these plants and the use of them by gardeners should be encouraged. These wild ornamental plants in northwest Yunnan not only are the ancestors for existing cultivated plants, but also are the rare basis for the cultivation of various new breeds in the future, as well as they are very important genetic resources, which could be used for introducing and conserving plants from the field. We hope that this work will help the researchers and people who are interested in wild ornamental plants.

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Fig. 3. *Saussurea delavayi* Fr. Taken in Daxueshan (big snow mountains, altitude 4,100 m), Zhongdian, Yunnan.



Fig. 4. *Solms-Laubachia pulcherrima* Muschler. Taken in Daxueshan (big snow mountains, altitude 4,100 m), in Zhongdian, Yunnan.



Fig. 5. *Meconopsis delavayi* (Fr) Fr ex Prain. Taken in Yulong snow Mountains, alpine grasslands at alt. 3,800 m, in Lijian, northwestern Yunnan.

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Fig. 6. *Gentiana chungtienensis* C. Marquand. Taken in alpine meadows, altitude 3,200 m, Xiaozhongdian, Yunnan.