

**Genus: *Acampe* Lindl.**

The name *Acampe* originates from Greek *akampes* (rigid), which refers to its overall character pertaining to all aerial parts of the plant. This name recalls *Thalia Maravara*, or the ‘rigid air flower’, the name mentioned by van Rheede in the first published description of an Asian orchid by a European, in 1703 (van Rheede 1693–1703). Rumphius, who lived in Maluka, described orchids much earlier but his book was published after 1703 (Beckman 2002).

*Acampe* is a robust, monopodial epiphyte with coriaceous leaves and rigid flowers on a short raceme (Fig. 7.1). Tight clustering of the flowers and a tendency to cup are dominant traits transmitted to its hybrids. It is not popular among orchid growers as a breeding parent. It is distributed in India, Sri Lanka, southern China and Southeast Asia. There are about ten species in *Acampe*, several with numerous names. Three *Acampe* species are used medicinally.

***Acampe carinata* (Griff.) Panigrahi**

Indian Name: *Kano Kato*.

Thai name: *Phaya mue lung*

Description: A robust, monopodial epiphyte with coriaceous leaves, 8.5–20 by 0.6–2 cm sheathing

at the base. Inflorescence is branching, bearing 5–12 small, yellowish flowers with transverse brown bars, 6 mm across. The lip is white, with fine purple spots (Vaddhanaphuti 2001). It flowers in December in peninsular India (Santapau and Kapadia 1966) and in November to December in Thailand (Vaddhanaphuti 2005). *Acampe carinata* occurs throughout Thailand, and is also found in Myanmar, Sikkim, Mumbai, the Western Ghats and Sri Lanka.

Herbal Usage: The entire plant is used in rural Thailand as a tonic to strengthen the body (Chuakul 2002). Root paste is applied externally on scorpion and snake bites in the eastern peninsular Indian state of Orissa. Here, leaf paste is consumed with a clove of garlic daily for 7 days to obtain relief from chest or epigastric pain (Dash et al. 2008). At Uttarakhand in Western Himalaya, *A. carinata* is used to treat rheumatism, sciatica and nerve pain (Jalal et al. 2008)

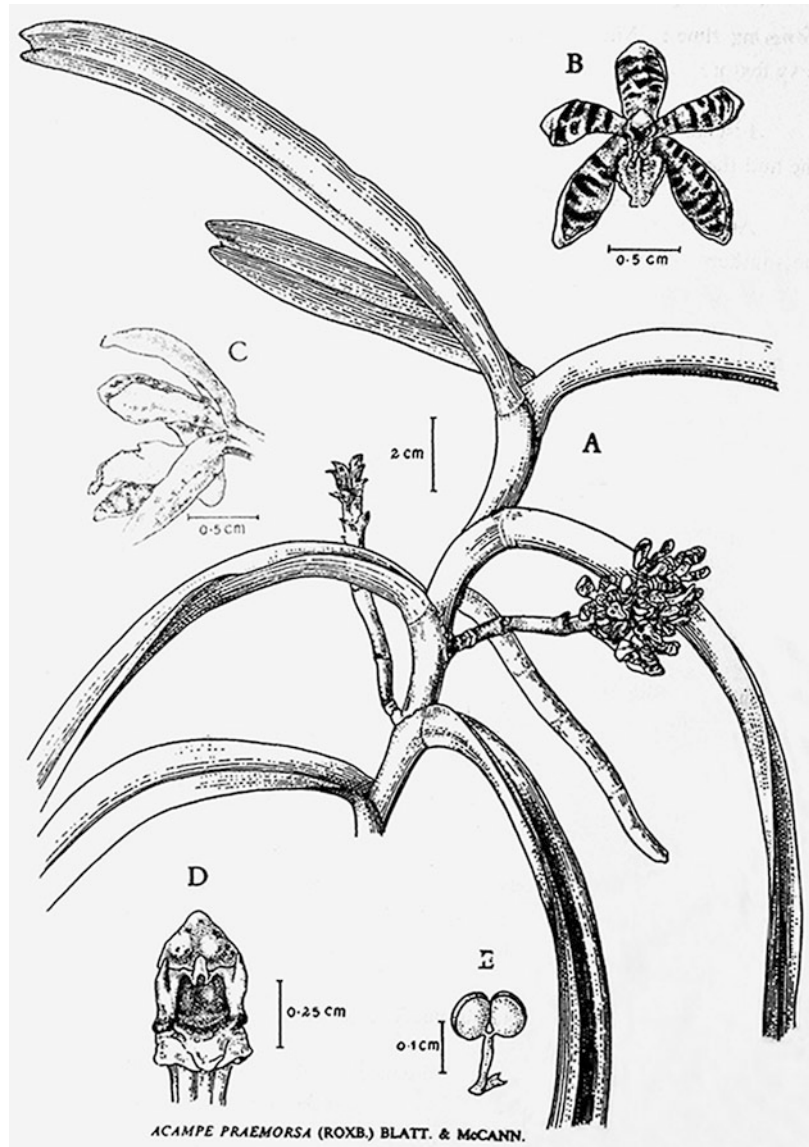
*Acampe multiflora* (Lindl.) Lindl. (see *Acampe rigida* Hunt)

*Acampe papillosa* Lindl. [see *Acampe praemorsa* (Roxb.) Blatt. & McCain]

***Acampe praemorsa* (Roxb.) Blatt. & McCain**

syn. *Acampe papillosa* Lindl., *Acampe wightiana* (Lindl. ex Wight) Lindl.

**Fig. 7.1** *Acampe praemorsa* (Roxb.) Blatt & McCain. Reproduced with permission from *Introductions to Orchids* by Abraham and Vatsala, Parlode, Thiruvananthapuram: Tropical Botanic Garden and Research Centre (TBGRI), 1981



Indian names: *Marabale* in the Canarese dialect, *Maravasha*, *Khanbher*, *Nakul*, *Rasna* (Marathi), *Taliyamaravada* (Malayanam), *Rasna* (Nakuli), *Kano-kato* (Orissa), *Gandhata* (Sanskrit, Malayanam)

Nepali names: *Parajivi* (name is not specific and is widely applied to epiphytic orchids)

Chinese name: *Duanxucui Lan* (short crispy orchid)

Myanmar name: *Mee ma long pan*

Thai name: *Chang saraphi noi*

Description: *A. praemorsa* is a large, robust, monopodial epiphyte with a stout stem, up to 30 cm by 1–1.5 cm in diameter. Leaves are distichous, thick, coriaceous, channeled, 10–30 by 2–3 cm, which appear to be bitten off at the tip (*praemose*). The plant produces several short inflorescences simultaneously, each 3–4 cm long, bearing a crowded cluster of 8–12 long-lasting, fragrant flowers that are yellow, spotted, or barred with crimson. The lip is white, caruncled, and sparsely speckled with magenta to dark brown (Fig. 7.2).



**Fig. 7.2** *Acampe praemorsa* (Roxb.) Blatt. & McCain  
[Photo: Bhaktar B. Raskoti]

Different Indian authors have indicated diverse flowering periods. It was reported to flower in April to August in Bombay (Santapau and Kapadia 1966), December to January in Karnataka and Kerala, also in western peninsular India (Rao and Sridhar 2007), May in Nilgiris (Joseph 1982), March to June in southern India (Abraham and Vatsala 1981), June to October in peninsular India (Misra 2007) and September to November in Sri Lanka (Jayaweera 1981). Flowering season is November to January in Thailand (Vaddhanaphuti 2005) and December to January in China (Chen and Wood 2009a).

*A. praemorsa* is the commonest orchid in peninsular India, distributed from Bengal to both the Eastern Ghats (Tamil Nadu and Andhra Pradesh) and the Western Ghats (Kerala and Karnataka). It grows at sea level to 500 m (Abraham and Vatsala 1981). It is also found in Nepal, Bhutan, Sikkim, Assam, Myanmar, Thailand, China (in Yunnan and Hainan), Vietnam, Laos and Sri Lanka on tree trunks in low-lying forests up to an altitude of 700 m. It is often referred to as *A. papillosa* in northern India because the northern variety was thought to be a separate species, although Indian herbalists believed that medicinally there was no difference between northern and southern plants. In the Bombay state of India, *A. praemorsa* occurs in abundance, in epiphytic masses on *Mangifera indica*,

*Syzygium* spp. and *Terminalia* spp. (Santapau and Kapadia 1966). In Sri Lanka, *A. praemorsa* is epiphytic on roadside rain trees (*Albizia saman* syn. *Samanea*) at low elevations (Jayaweera 1981). This is an interesting phenomenon because *A. saman* is not a native Sri Lankan tree: it was introduced from Madagascar.

**Herbal Usage:** *Rasna*, a decoction of the roots of *A. praemorsa*, is a bitter tonic that is considered to be a specific remedy for rheumatism in India (van Rheede 1693; Caius 1936; Trivedi et al. 1980; Rao 2004; Rao and Sridhar 2007). Its usage also extends to the treatment of sciatica, neuralgia, syphilis and uterine disorders in the country. It is sold as *rasna* (Duggal 1971; Rao 2004), or as a substitute for *Vanda tessellata*. However, it has been reported to be therapeutically inert. It is a substitute for sarsaparilla (Caius 1936; Trivedi et al. 1980).

The primitive Dongria Kandha tribe that resides in the Niyamgiri Hills of southeastern Orissa consume a tablespoon of a paste prepared from the roots of *A. praemorsa* and *Asparagus racemosus* (not an orchid) on an empty stomach, twice daily for 15 days, when they suffer from arthritis (Dash et al. 2008). To the south, in Andhra Pradesh on the Eastern Ghats, the Koya tribe uses the pulverised plant, mixed with egg white and calcium (sic; presumably referring to the lime that is included in *serai*), to produce a paste for application on fractured limbs to promote healing (Akarsh 2004). In Nepal, the powdered root of *A. praemorsa* (syn. *A. papillosa*) is used to treat rheumatism or to produce a cooling effect (Subedi et al. 2013).

**Phytochemistry:** *A. praemorsa* contains flavidin and the phenanthropyran named praemorsin (Anuradha and Prakash 1994a, b).

### ***Acampe rigida* Hunt**

syn. *Acampe multiflora* (Lindl.) Lindl.

Chinese names: *Duohuacui Lan* (many-flowered, rigid or crisp orchid), *Jiawandailan* (fake 10,000-generation or *Vanda* orchid), *Taiwanhouchun Lan* (Taiwan thick-lipped orchid), *Changyejiawandai Lan* (long-leaved,



**Fig. 7.3** *Acampe rigida* Hunt [Photo: Bhaktar B Raskoti]

fake *Vanda* orchid), banana orchid (in Hong Kong); in Taiwan, *Jiao Lan* (fake 10,000-generation or *Vanda* orchid), *pa chio lan*

Chinese medicinal name: *Heishanzhe*

Thai names: *Chaang sarapee*, *Ueang sarapi*, *Ueang jed poi*

**Description:** The stem is short, stout, usually unbranched and entirely covered by leaf bases. Leaves are distichous, 15–40 by 3.5–4 cm, fleshy and leathery. Inflorescence is branched, carrying a crowded cluster of fragrant, orange-yellow flowers marked with crimson bars. Flowers do not open widely (Fig. 7.3). It flowers in August on the Chinese mainland (Chen et al. 1999), in Hong Kong, August to September (Wu et al. 2001), in Taiwan, August to October (Lin 1977), in Thailand, October to January (Vaddhanaphuti 1997) or November to February (Nanakorn and Watthana 2008), in India, June to August (Misra 2007), and in Sri Lanka, September and October (Jayaweera 1981).

This is a common tropical epiphyte widely distributed from East Africa across tropical Asia, generally in lowland forest. In China, it is found in Guangxi, Yunnan and Hainan, on trees or shady cliffs, at the edge of forests and on trees or rocks in Hong Kong and Lantau Island. It is predominantly saxicolous in Taiwan, proliferating into huge clumps (Wu et al. 2002).

**Herbal Usage:** The Chinese herb *Heishanzhe* (*A. rigida*) is obtained from Guangdong, Guangxi and Yunnan (Wu 1994). Chinese medicinal texts state that its roots and leaves relax muscles and joints, promote blood circulation and relieve pain. *Heishanzhe* is used to treat traumatic injuries and fractures. Leaves are harvested in summer or autumn, and either used fresh or dried and cut into sections for storage. A decoction is prepared with 6–15 g of *Heishanzhe* and consumed. The taste is acrid but “neutral in nature” (Wu 1994; *Zhonghua Bencao*, 2000; Ou et al. 2003). In Laos, leaves were used in making mats (Vidal 1963). In Thailand, the entire plant is used as a tonic to strengthen the body (Chuakul 2002).

**Phytochemistry:** 4-hydroxybenzoic acid, 4-hydroxybenzaldehyde and 4-methoxymethyl phenol were isolated from *Acampe rigida* (Cakova 2013).

*Acampe wightiana* (Lindl. ex Wight) Lindl. [see *Acampe praemorsa* (Roxb.) Blatt. & McCain]

### Overview

*Kano-kato* refers to both *A. carinata* and *A. praemorsa* in Orissa, but their usages are different. Root paste of *A. carinata* is used to treat scorpion or snake bites, and a leaf paste is used for pain in the chest or abdomen. A primitive tribe in Orissa uses the root of *A. praemorsa* to treat arthritis (Dash et al. 2008). Elsewhere in India, the principal usage of *A. praemorsa* is to treat rheumatism (van Rheede 1693; Caius 1936; Trivedi et al. 1980; Rao 2004; Rao and Sridhar 2007).

Aqueous extracts of *A. praemorsa* and *A. ochracea* showed inhibitory activity against antibiotic-susceptible, penicillin-resistant and kanamycin-resistant strains of *Escherichia coli* (Chowdhury et al. 2013). However, skin, ear or other infections that might be caused by *E. coli* are not being treated with preparations containing *A. praemorsa*. Medicinal usage of *A. ochracea* has not been reported.

*Cyanobacteria* are ubiquitous on the aerial but not on the substrate roots of *A. praemorsa* (syn. *A. papillosa*); on the other hand, *Cyanobacteria* are present in the substrate roots of *Dendrobium moschatum* (Tsavkelova

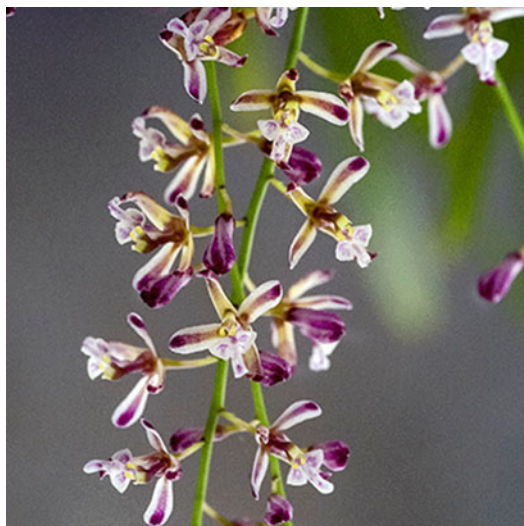
et al. 2003). They are phototrophic organisms that produce auxins, and they are capable of stimulating root growth in other plants (Tsavakelova et al. 2005). *Cyanobacteria* are commonly present in freshwater lakes and reservoirs. Under suitable conditions, they can dominate the phytoplankton and cause nuisance blooms. There are anecdotal reports of allergic skin or gastrointestinal reactions to cyanobacteria. Other effects are headache, fever, myalgia, vertigo, blistering of the mouth and pneumonia. Some species of *Cyanobacteria* produce poisons, neurotoxins and saxitoxins that damage the nervous system (van Apeldoorn et al. 2007; Araoz et al. 2009), and also hepatotoxins, which damage the liver (Zurawell et al. 2005). Human fatality has been reported from ingesting cyanobacteria growing in a golf-course pond (Stewart et al. 2006). However, apart from possible skin allergy, it is unlikely that contact with orchid *Cyanobacteria* will cause any serious problem.

Flavadinin and praemorsin are present in *Acampe praemorsa*; 4-hydroxybenzoic acid, 4-hydroxybenzaldehyde and 4-methoxymethyl phenol are present in *Acampe rigida*. Their medicinal roles, if any, have not been demonstrated. *Acampe* species are not under threat.

## Genus: *Acriopsis* Reinw. ex Bl.

*Acriopsis* is a genus of small, sympodial epiphytes with short, thick rhizomes, ovoid pseudobulbs bearing 2–4 lanceolate, glabrous leaves. Inflorescence is terminal, loosely many-flowered but only a few flowers open at any one time. Flowers are insignificant but they have the unusual characteristic of fused lateral sepals, whereas the column and the lip are joined to form a long slim tube. The name is derived from Greek *acris* (locust) and *opsis* (resembling).

There are nine species in the genus distributed from Sikkim and Assam in India across South-east Asia to the Solomon Islands and Queensland, Australia. They are common in low-land forests and on roadside trees throughout Southeast Asia.



**Fig. 7.4** *Acriopsis liliifolia* (J. König) Seidenf. [Photo: E.S. Teoh]

### *Acriopsis liliifolia* (J. König) Seidenf.

syn. *Acriopsis javanica* Reinw. ex. Blume

Malay Names: *Anggerek darat* (river bank orchid), *Sakat Ubat Kepialu* (medicinal epiphyte for severe fever), *Pemolek*

**Description:** Pseudobulbs are clustered, ovoid, 2.5–5 cm long, up to 1 cm in diameter, with 2–3 narrow, thin leaves, up to 20 by 1.2 cm near the top. Inflorescence is arching, branched, up to 40 cm long with many well-spaced flowers which face in different directions. The small pink flowers resemble insects in flight with outstretched wings. This appearance is brought about because the flower is tetramorous, the perianth consisting of two very narrow petals that stretch out horizontally and an erect dorsal sepal and two narrow lateral sepals that are fused along their length and arranged vertically, thus resembling the body of an insect. The white lip lies anterior to the petals and sepals (Fig. 7.4). Peak blooming season is March to May but it can flower throughout the year. Ants often build gardens around its pseudobulbs. It is thought that lipids on the seed coats of the orchid attract ants that assist in their dispersal. Such plants are

called myrmecochores (Benzing and Clements 1991). *Acriopsis liliifolia* is a small, common, lowland, epiphytic orchid that is widely distributed from Sikkim, Myanmar (in Tenasserim) and Thailand, through Malaysia, Indonesia, the Philippines and New Guinea to the northern tip of Queensland and the Solomon Islands (Seidenfaden and Wood 1992).

**Herbal Usage:** A decoction of the leaves and roots was used as an antipyretic in Malaya (Ridley 1907; Burkill 1935). Alvins, who collected the information around Malacca between 1884 and 1888, reported that the decoction was taken for any prolonged or severe fever which the Malays called *kepialu* (Burkill 1935). A similar usage was subsequently reported from India (Duggal 1971). In Malacca, *A. javanica* was used to treat headaches, whereas in Indonesia, juice from the pseudobulbs was dropped into the ear to cure earache or tinnitus, and pulverised pseudobulb was plastered on the head or abdomen to treat fever and hypertension (van den Brink 1937). Roots are used for treating rheumatism in the Western Ghats in India (Rao 2004).

### Overview

Employment of *A. liliifolia* to treat fever by Malays and Indonesians during the nineteenth and the first half of the twentieth century most probably originated from a similar usage in India. Dropping juice of heated orchid pseudobulbs into the ears to treat earache was similarly a common practice from India to Malaya and Indonesia.

*A. liliifolia* lacks horticultural value and is not endangered. There is no chemical or pharmacological information on *Acriopsis*. It would be interesting to investigate whether this common orchid possesses any antimicrobial activity against microbes (viruses, bacteria or plasmodium).

---

## Genus: *Aerides* Lour.

Chinese name: *Zhijia Lan*

*Aerides* is a genus of attractive, monopodial, epiphytic orchids with elongated, pendulous

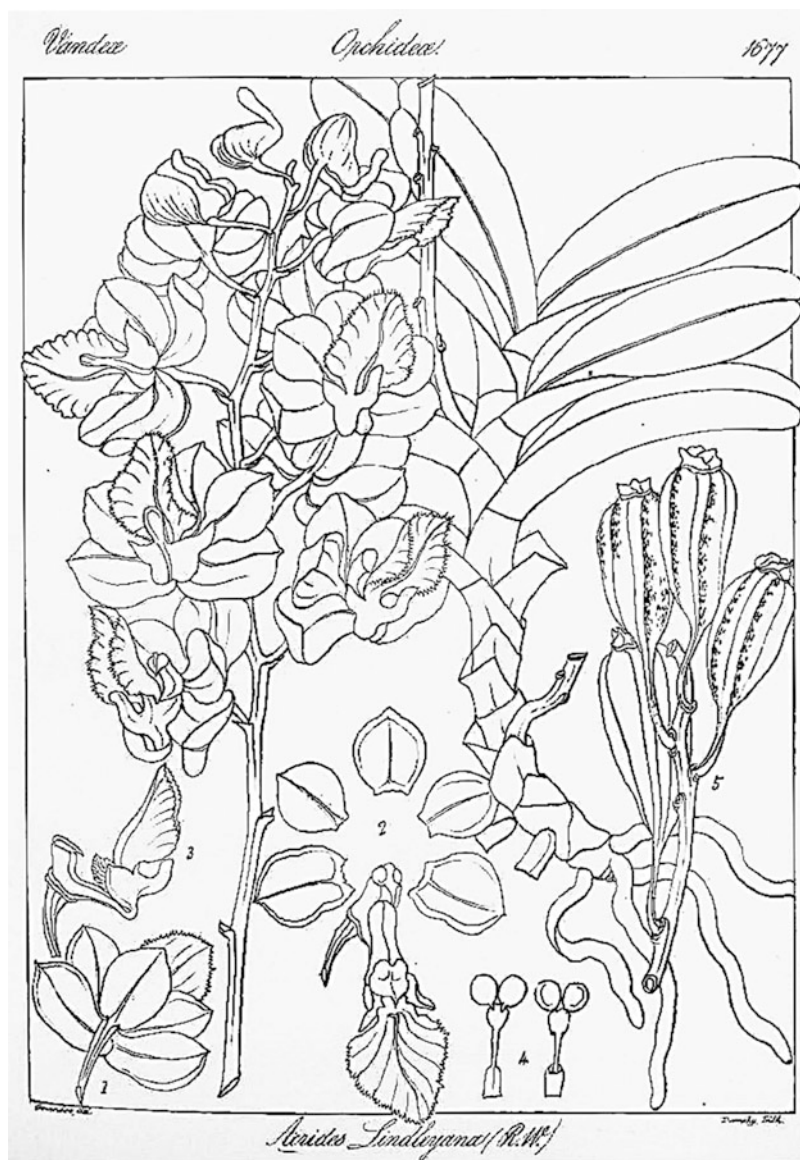
stems that produce many offshoots near the base, thus forming large clumps when well established. Leaves are tough, duplicate and arranged in two rows. Old leaves turn reddish-brown at the base where they sheath the stems. Inflorescence is lateral, arching or pendulous, and many-flowered. Flowers are medium-sized with widespread petals and sepals, a lip with three lobes, and a prominent, hooked spur. There are some 20 species distributed from Sri Lanka and India eastwards through the Asian tropics.

The generic name, ‘children of the air’, is derived from Greek *aer* (air) and *eides* (resembling), referring to its epiphytic nature and the way such orchids are cultivated. Joao de Loureiro, a Jesuit missionary who described several important orchid species in his *Flora Cochinchinensis*, coined this name when he saw *Aerides* flowering in wooden hanging baskets in Annam (Fig. 7.5).

### *Aerides crispa* Lindl.

**Description:** *A. crispa* is a large, tough, robust epiphyte. Stem is stout, erect, reaching up to 1.7 m in length, 1–2 cm in diameter, and of a dull purple or brownish-violet, with spreading leaves, 12–20 by 4–6 cm that are widely separated from one another. Leaves are thickly coriaceous, oblong, with two unequal lobes at the apex and sheathing at the base. Young leaves are typically covered with purple spots. Inflorescence is up to 35 cm long, drooping, branching, loosely many-flowered. Flowers are 5 cm across, white, tinged with rose-purple at the tips of the sepals and petals. Lip is large, fringed with a large patch of bright cerise over the mid-lobe. Flowers smell of pineapple. In southern India, it flowers from May to June (Santapau and Kapadia 1966; Abraham and Vatsala 1981), but at Nilgris, April or May to November (Joseph 1982); in Myanmar, June and July, the flowers lasting for 2–3 weeks (Grant 1895; Christensen 1993). *A. crispa* is distributed in Indian Himalaya, the Western Ghats and in Myanmar. It has become rare in the Western Ghats because of overcollection on account of its showy

**Fig. 7.5** *Aerides crisa*.  
From: Wight, R, Icones  
Plantarum Indiae  
Orientalis, vol. 5 (1):  
t. 1677bis (1846). Drawing  
by Govindoo. Courtesy of  
Missouri Botanical  
Gardens, St. Louis, USA



flowers (Santapau and Kapadia 1966). Introduced into cultivation in the west over 200 years ago, *A. crisa* was the most popular species until the discovery of *A. lawrenceae* which has now totally eclipsed the former species as the top horticultural species (Cootes 2001).

**Herbal Usage:** Ear-drops, prepared by boiling the pulverised plant in neem oil, are instilled 2–3 drops at a time into the ear every night to treat earache in the Western Ghats (Rao 2004).

**Phytochemistry:** *A. crisa* contains aeridin, a bactericidal phenanthropyran. (Anuradha and Prakash 1998; Singh and Duggal 2009). Nevertheless, the contribution of aeridin to the management of earache is undetermined.

### ***Aerides falcata* Lindl. & Paxton**

Chinese name: *Zhijia Lan*

Thai names: *Ueang Kulaab Krapao Perd*

**Description:** A showy, monopodial, epiphytic orchid which forms large clumps on trees, with stems that may reach 1.6 m in length. When it blooms, *A. falcata* produces numerous sprays of extremely fragrant, white flowers, about 30 to a spray,. *Falcata* (*falcate* means sickle-shaped) describes the side lobes of the lip that are stretched out, distinguishing this species from that other equally fragrant species, *A. odorata*, whose lip is folded over the column. *A. falcata* is distributed throughout Thailand, Indochina and Myanmar (Tenasserim), but not further south. The cultivated plant blooms well in the lowlands. Flowering season is April to June (Kamemoto and Sagarik 1975; Vaddhanaphuti 2001).

**Herbal Usage:** In Vietnam, it is fed to weak infants as a tonic. Its seeds are sprinkled on boils and other skin disorders to help heal the lesions (Lawler 1984).

### ***Aerides multiflora* Roxb.**

Thai name: *Uang Kulap Malai Daeng*

**Description:** This is a beautiful, robust, epiphytic species of horticultural importance. Stem is 25–30 cm tall; leaves oblong, distichous, deeply channeled, 12–34 by 1.3–3.5 cm. Inflorescence is long, compact and carries up to 50 well-arranged, purplish flowers. Petals and sepals are white, spotted with purple near the base, and flushed with purple at the tip. Lip is purple (Fig. 7.6). Flowering season is March to June in Bhutan (Gurung 2005), April to May in Thailand (Kamemoto and Sagarik 1975; Vaddhanaphuti 1997) and May to July in Nepal (Raskoti 2009). It is widely distributed from the Himalayan foothills through Nepal, Bhutan, Sikkim and Assam to Myanmar and Thailand.

**Herbal Usage:** *A. multiflora* is used to treat wounds in India (Rao 2004). In Nepal, leaf paste is also applied to cuts and wounds (Pant and Raskoti 2013), whereas powdered leaf constitutes a tonic (Subedi et al. 2013). The tubers exhibit an antibacterial effect in vitro (Singh and Duggal 2009). What needs to be demonstrated is that the leaves possess similar antimicrobial effects.



**Fig. 7.6** *Aerides multiflora* Roxb [Photo: Bhaktar B. Raskoti]

### ***Aerides odorata* Lour.**

Common name: Fragrant *Aerides*

Chinese name: *Xianghuazhijia Lan* (fragrant flowered *Zhijia* orchid)

Indonesian names : *Angkre Lilin*, *Lau Bintang* in Kalimantan

Thai name: *Ueang Kulaab Krapao Pid*

Indian name: *Hameri* in Orissa

**Description:** This is a widespread, variable species of *Aerides* which grows into a magnificent clump if it is well anchored in the crotch of a tree, and especially if it receives direct sunlight for half a day and is located near water. The unusual brownish coloration at the stems and leaf bases of *Aerides* distinguishes it from strap leaf *Vanda* when the *Aerides* is not in bloom.

Stems are droopy, stout, up to 1.8 m tall, freely branching. Leaves are thick, leathery, unequally bilobed at the tips, 15–20 by 2.5–4.6 cm. Inflorescences are numerous, appearing simultaneously, racemose, nodding, 15–30 cm long with 20–30 fragrant flowers that open widely, and are white to pink, tipped or spotted with purple. Spur is greenish-yellow (Fig. 7.7). Flowering period in China is May (Chen and Wood 2009a, b, c, d, e, f), in Nepal,



**Fig. 7.7** *Aerides odorata* Lour [Photo: E.S. Teoh]

May to July (Raskoti 2009), in Bhutan, March to June (Gurong 2006) and in Singapore, August to September. Flowers last for 2 weeks and are easily recognised by the funnel-shaped lip which extends into a horn-like spur.

*A. odorata* occurs in southern China, Nepal, India, Myanmar, Thailand, Indochina, Malaysia, Indonesia and the Philippines from sea level to 2000 m. According to Sagarik and Kamemoto (1975), plants in northern Thailand, and presumably those in China, are tetraploid whereas those from the south are diploid. Tetraploid plants have erect, twisted stems with shorter, thicker, sturdier leaves. Floral scape is similarly more erect, but the waxy, fragrant flowers are similar. Flowers are white to mauve or lavender, extremely fragrant and produced in abundance.

**Herbal Usage:** Fallen fruits of *A. odorata* are used to heal wounds in India. Juice extracted from the leaves is used to treat boils in the ear

and nose (Rao 2004). Vietnamese herbalists believe that, if seeds are sprinkled over the lesions, they help to heal boils and other skin disorders (Lawler 1984). Hill tribes in Orissa combine the fresh root of *A. odorata* with root powder from *Saraca asoca*, bark from *Azadirachta indica* and common salt to prepare an oral medicine for painful swollen joints. They also use juice from the leaves to treat tuberculosis (Dash et al. 2008). In Nepal, a poultice prepared from the leaves is applied over cuts and wounds (Pant and Raskoti 2013).

### Overview

Aqueous extract of *A. odorata* exhibits inhibitory activity against antibiotic-sensitive, penicillin-resistant and kanamycin-resistant strains of *Escherichia coli*, common organisms in stools, on skin and in superficial infections. Phytoalexins such as aeridin possess antimicrobial effects. These findings lend support for the principal usage of the various medicinal species of *Aerides*, which is to prevent and treat local infections (wounds, boils, other skin disorders and earache). Nevertheless, effectiveness in treatment of infections would depend on the potency of the associated phytoalexin and how it is delivered.

An oral Indian preparation for treating painful, swollen joints contains four herbal products, one of which is *A. odorata* (Dash et al. 2008). Any of the four herbs might possibly contain a salicylate (the basis of Aspirin<sup>®</sup>). Orchids have been shown to have a salicylic acid-related defence mechanism that helps them to respond to viral invasion (Lu et al. 2012).

There are no data on the phytochemistry on medicinal *Aerides* species, but some data have been published on non-medicinal *A. rosea* Lodd. ex Lindl & Paxton. In addition to gigantol, imbricatin, methoxycelonin and celonin, it contains five minor constituents, namely a phenanthropyran, two phenanthrenes and two dihydrophenanthrene derivatives. The two newly described phenanthrene derivatives are aerosanthrene (5-methoxyphenanthrene-2,3,7-triol) and aerosin (3-methoxy-9,10-dihydro-2,5,7-phenanthrenetriol) (Cakova et al. (2015).

Five species of *Aerides* occur in China, but there is no record of any being used medicinally.

## Genus: *Agrostophyllum* Bl.

Chinese name: *Heye Lan*

*Agrostophyllum* is a genus of epiphytic orchids with clustered, erect stems, with a single thin, flat leaf at each internode. Flowers are small, resupinate, numerous, white or yellow and self-pollinating. There are with 40–50 species distributed from the Seychelles across tropical Asia to the Pacific. There is one species in China, *A. callosum* Rchb. f., but it is not used as medicine (Li et al. 2000).

The generic name comes from Greek, *agrostis* (grass) and *phyllon* (leaf), alluding to the leaves of many species in this genus. *Agrostophyllum* has no horticultural value and is almost unknown in cultivation (Yong 1990).

*Agrostophyllum bicuspidatum* J.J. Smith. [see *Agrostophyllum stipulatum* ssp. *bicuspidatum* (J.J.Sm.) Schuit.]

### *Agrostophyllum stipulatum* ssp. *bicuspidatum* (J.J.Sm.) Schuit.

syn. *Agrostophyllum bicuspidatum* J.J. Smith

Description: Stems are close to one another, 15–40 cm in length, with oblong leaves 4 by 1 cm. Inflorescence is apical, carrying a head of single-flowered spikes. Flowers are 0.6–1 cm across, white or a pale yellow, and they open widely. Petals are very narrow, 3 mm long, the ends curving backwards. Sepals are 3–4 mm long, broad, the upper erect and concave, the lateral ones forming a broad mentum. Lip is sac-shaped at its base (Comber 2001).

*A. stipulatum* ssp. *bicuspidatum* is found in lowland forests at 300 m in Sumatra, Java, Sarawak and Sulawesi, peninsular Malaysia and southern and upper northeastern Thailand.

Medicinal Usage: The Kalabit in Sarawak wear parts of the orchid as talismans to protect against curses (Christensen 2002).

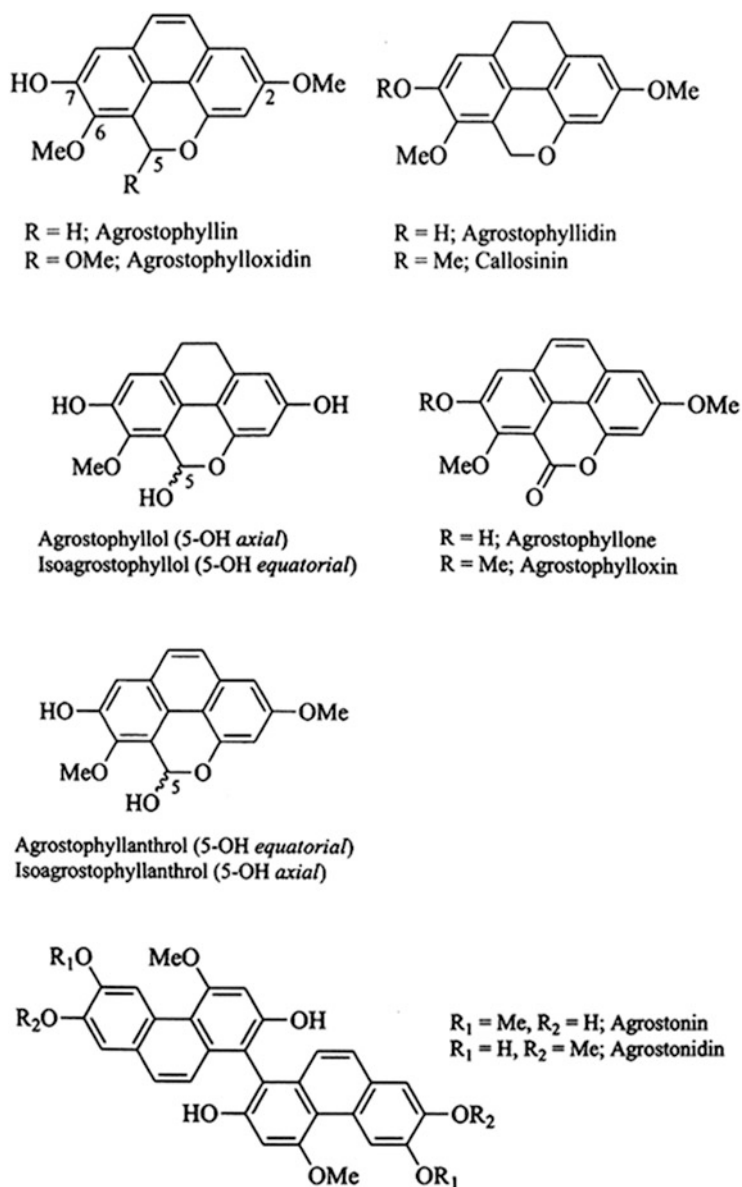
Phytochemistry: No phytochemical investigation has been conducted on *A. stipulatum* ssp. *bicuspidatum* (J.J.Sm.) Schuit., but terpenoids, stilbenoids and derivatives have been isolated from Indian species in the genus: i.e. a naturally occurring phenanthropyran derivative, agrostophyllin from *A. khasiyanum* (Majumder and Sabzabadi 1988); two stilbenoids (agrostophyllol and isoagrostophyllol) and two diasteromeric 9,10-dihydrophenanthropyran derivatives from *A. callosum* Rchb. f. (Majumder et al. 1995, 1996; Majumder et al. 1998; Majumder et al. 1999); and two terpenoids (agrostophyllinol and agrostophylline) from *A. brevipes* Ridley and *A. callosum* Rchb. f. (Majumder et al. 2003).

## Overview

Talismans and charms are very much a part of native medicine. They can be viewed as items of health promotion or preventive medicine; on the other hand, they may also be used to treat illnesses that are considered by native healers to be caused by spirits. This is not the only orchid used in this manner in Southeast Asia (see *Dendrobium crumenatum*). When such treatment did not work, people accepted that the evil spirit taking possession of the patient was too powerful to be put off by the talisman.

Several bio-active compounds (three stilbenoids and several dimeric phenanthrenes) have been isolated from two Indian species, *A. callosum* and *A. khasiyanum* (Majumder et al. 1996; Majumder et al. 1998), but these two orchids are not used medicinally. Nevertheless, with around 100 species in *Agrostophyllum*, several of which are large plants, this genus appears to be a good subject for phytochemical research. From a medicinal perspective, stilbenoids, phenanthrenes, alkaloids and other phytochemicals are important because many have been found to possess antimicrobial, antiprotozoal, antihelminthic, anti-inflammatory, antiplatelet and spasmolytic properties, are cytotoxic against specific human cancer cell lines, or are capable of protecting tissues against toxic damage by chemical compounds (Kovacs et al. 2007). In the *Maxillariinae* species of

**Fig. 7.8** Compounds isolated from *Agrostophyllum*



South American orchids, triterpenoids are the major compounds present in the labellar secretions that constitute the reward for bees attracted to the non-fragrant flowers (Fig. 7.8) (Flach et al. 2004).

### Genus: *Amitostigma* Schltr.

Chinese name: *Wuzhu Lan* (no pillar orchid)

*Amitostigma* are small, montane, terrestrial orchids of the Himalayas, China and Japan with flowers that resemble those of *Habenaria*. There is one species in Thailand and one in Vietnam (Schuiteman and de Vogel 2000). Many species are found on wet mossy rocks or in humus-covered soil in forests and meadows or on hill slopes and cliffs. Plants are small, with spheroid, subterranean tubers and short stems that bear one or two ellipsoid, glabrous leaves, which ensheath

the stem at the base. Flowers are also small, resupinate, trilobed, and borne on a slim, tall, erect inflorescence. Many Chinese species have pink to purple flowers. The exceptional species is *Amitostigma simplex* with its large, yellow flowers (Chen et al. 1999).

The generic name is derived from three Greek words, *a* (not) *mitos* (thread) and *stigma* (stigma).

*Amitostigma chinense* (Rolfe) Schltr. [see *A. gracile* (Blume) Schltr.]

### ***Amitostigma gracile* (Blume) Schltr.**

syn. *Amitostigma chinense* (Rolfe) Schltr.

Chinese names: *Xitingwuzhu Lan* (slim standing no pillar orchid), *Xiewwuzhu Lan* (slim standing no pillar orchid), *Huawuzhu Lan* (no pillar/column orchid)

Chinese medicinal name: *Duyeyizhiqiang*

Description: Tubers are ovoid, globose, bearing a single, oblong-elliptic, membranous leaf, 3.5 by 1.5 cm, which sheathes the slim erect stem at the base. Inflorescence is terminal, lax and carries 5–12 small light pink to purple flowers which resemble *Habenaria*. Mid-lobe of the lip is shaped like a butterfly. Flowering season is June and July (Chen et al. 2009a, b).

Rolfe discovered the species in 1909 at 3800 Steps Pass at 899 m, a small herb growing on moss-laden hill slopes. Subsequently, von Schlechter (1919) reported that it was present in Fujian and Jiangsu. *A. gracile* is distributed from Guangxi northwards in eastern China through Guizhou, Hunan, Jiangxi, northern Fujian, Zhejiang, Anhui, Hubei, Sichuan, Shaanxi, Henan, Jiangsu, Shandong, Hebei and Liaoning to Korea, Japan and Taiwan. It grows on damp, rocky soils in forests, valleys and crevices at 200–3000 m (Chen et al. 2009a, b).

Herbal Usage: Although *A. gracile* and *A. chinense* are regarded by botanists as a single species, in *A Concise Edition of Medicinal Plants in China*, Wu Xiu Ren (1994) described them as two separate species despite their usage being similar. Separate origins or differences in

**Table 7.1** Herbal Usage of *Amitostigma gracile* (*Duyeyizhiqiang*)

1. Indications: Detoxification, relief of swelling and haemostasis Boil whole plants 30–60 g. for consumption. For external application, grind fresh stems and roots.
2. Indication: Venomous snake bite Grind roots and stems and mix with rice water for application
3. Indication: External injuries, haematemesis Prepare decoction with fresh whole plants, 30–90 g, for consumption
4. For dysmenorrhea and metrorrhagia Prepare decoction with 9–15 g of dried herb

vegetative form might have led herbalists to distinguish between the two. The herb is obtained from Zhejiang Province (Wu 1994).

Their alleged properties are that they are cool, antitoxic and with an ability to reduce swellings and arrest bleeding. The whole plant together with its roots is used to treat snake bites, as an antidote for traumatic injury, or to treat dysmenorrhea and menstrual irregularities (Zhonghua Bencao, 2000). Several prescriptions for the use of *A. gracile* (*Duyeyizhiqiang*), and shown in Table 7.1, were originally from the *Zhejiang Commonly Used Folk Herbs* (Zhongyao Da Cidian, 1986).

### ***Amitostigma pinguicula* (Rchb.f. & S.Moore) Schltr.**

Chinese names: *Dahuawuzhu Lan* (big flower no pillar orchid)

Description: *A. pinguicula* is a larger plant, though still small, with ovoid tubers 10–15 mm in diameter. Leaf is single, linear to narrowly elliptic, 1.5–8 by 0.6–1.2 cm. Flower is rose red to purplish-red (Fig. 7.9). It is found on rocky soils in forests, valleys and moist grasslands at 200–400 m in northeast Zhejiang. It flowers from April to May (Chen et al. 2009a, b).

An endemic species, it grows on rocky soils in wet grasslands, forests and valleys at 200–400 m in northeast Zhejiang (Chen et al. 2009a, b).

Herbal Usage: The Chinese herbal name, *Duyeyizhiqiang*, also refers to this species of



**Fig. 7.9** *Amitostigma pinguicula* (Rchb.f. & S.Moore) Schltr. [Photo: Courtesy of Plant Photo Bank of China]



**Fig. 7.10** *Amitostigma simplex* Tang & F.T. Wang [Photo: Liu Ming]

*Amitostigma* despite the fact that the flowers of *A. pinguicula* and *A. gracile* are quite different (Zhonghua Bencao, 2000). The entire plant is used in preparing medicine. It is used for detoxification and used to reduce noxious swellings, in the treatment of trauma and snake bites, as an antidote for poisons and to treat haemetemeses. The medicinal plant is cultivated in Fujian, Zhejiang, Hubei and Sichuan (Wu 1994; Zhonghua Bencao, 2000).

### ***Amitostigma simplex* Tang & F.T. Wang**

Chinese name: *Huanghuawuzhu Lan* (yellow flower no pillar orchid)

Description: The yellow-flowered *A. simplex* has the biggest flower with a tri-lobed lip that is 1–1.6 cm in length and 2.5 cm wide. A small plant, its tubers are ovoid, 4–5 mm in diameter (Fig. 7.10). The single leaf is linear to oblong-elliptic, 1.5–4 by 0.3–0.6 cm. It is endemic to China where it occurs on grassy slopes above 2300–4400 m in western Sichuan and Southwestern Yunnan. It flowers in July (Chen et al. 1999, 2009a, b). This plant is on the 2006 IUCN Red List of Threatened Species.

Herbal Usage: Similar to *Amitostigma pinguicula*.

### **Overview**

In describing Item 7057 in his *Concise Edition of Medicinal Plants in China*, Wu Xiu Ren used the scientific name, *Amitostigma pinguicula*. He listed two Chinese names: (1) *Dahuawuzhu Lan* which means ‘big flower no-pillar orchid’ or ‘big flower *Amitostigma*’ the local name for the red to purple *A. pinguicula*; and (2) *Huanghuawuzhu Lan* (yellow flower no pillar orchid) which refers to yellow-flowered *A. simplex*. In fact, the latter species has the largest flower in the genus. The sources of the medicinal herb are stated as: Zhejiang, Fujian, Hebei and Sichuan provinces. *A. pinguicula* is only found in northeast Zhejiang, on rocky soils in forests, moist grasslands and valleys at 200–400 m. *A. simplex* is found in grassy slopes at 2300–4400 m in western Sichuan and northwest Yunnan (Chen et al. 2009a, b). Item 7057 therefore consists of at least two species of *Amitostigma*. Nevertheless, since the medicinal usage of the two or three species of the two rare, endemic mountain orchids is identical, their correct botanical identification is not crucial. In the recent *Zhonghua Bencao* (2000), the medicinal name *Duyeyizhiqing* covers two

species, namely *A. gracile* and *A. pinguicula*, but the *Herbal* makes no mention of *A. simplex*. Since *A. pinguicula* is endemic and present only in a small area in northeast Zhejiang, collection of the herb for medicinal usage is not sustainable. Thus, medicinal *A. pinguicula* is cultivated in Fujian, Zhejiang, Hubei and Sichuan (Wu 1994). Although *A. simplex* has similar medicinal usages, it is not cultivated because its native habitat is the Gaoligongshan Mountains at 2300–4400 m and a similar environment is difficult to replicate, whereas *A. pinguicula* occurs at 200–400 m in a subtropical, coastal province. *Amitostigma* being endemic in continental China, its medicinal usage is only described in the Chinese mainland.

The search for records of pharmacological investigation was unsuccessful.

### Genus: *Anacamptis* Rich.

The genus derives its name from Greek *anakamptein* (to bend back), possibly referring to the shape of the slender spur at the base of the lip or to its reflexed pollinia (Alrich and Higgins 2008). Plants have the habit of *Orchis*, each with two subterranean, globose tubers that resemble testicles (Fig. 7.11). The plant produces a rosette of leaves in autumn which lasts through winter and spring, then senesces with fruit set so that the plant is leafless during the summer heat (Neiland 2001). A dozen species are distributed in montane meadows and grasslands in the northern Iran, the Middle East and southern and central Europe. Tubers of *Anacamptis* are harvested to make *salep*, once thought to be an aphrodisiac and super-nutrient throughout Europe.

#### *Anacamptis coriophora* R.M.Bateman, Pridgeon & M.W. Chase

Common name: Bug orchid

Description: Tubers are paired, globose and sessile. Plants are generally 20–40 (up to 60)

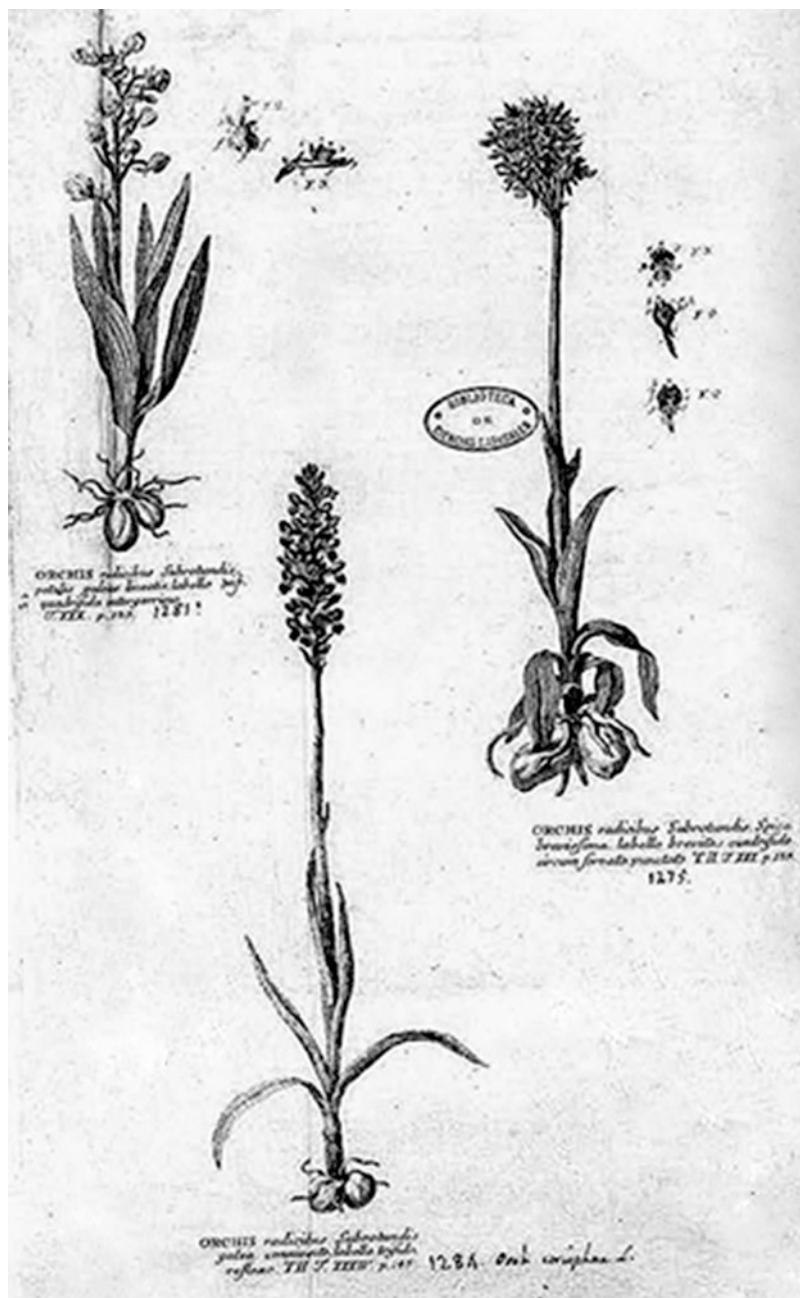
cm tall. Stem is gabrous, sheathed with scale leaves below and bearing a few lanceolate leaves, without spots, 10 cm long, arranged in a rosette. Inflorescence is densely many-flowered (20–40). Bracts are longer than the ovaries, with a green centre bordered in white. Flowers are small, green to deep wine-red. Tepals are joined to form a hood above the column. Lip is shaped like a broad trident which is white and spotted or splashed with red patches centrally, and purple on the distal halves of the lobes. Flowering season is for 2 months in summer, from early May to August, depending on region.

Commonly known as the bug orchid because flowers of many strains possess an unpleasant smell, this is a widespread European species which is distributed from the British Isles across continental Europe to the Middle East and northern Iran. *A. coriophora* occurs in pine forests, dry meadows, dunes and river banks from sea level to 1500 m but it may be found at elevations of up to 2000 m (Neiland 2001).

Phytochemistry: When challenged with *Rhizoctonia repens*, *A. coriophora* produces *p*-hydroxybenzyl alcohol, an aglycone of gastrodin. This compound has been isolated from many terrestrial and mycoheterotrophic orchid species (Stoessl and Arditti 1984). In rats, gastrodin and *p*-hydroxybenzyl alcohol facilitate memory consolidation and retrieval but not its acquisition (Hsieh et al. 1997). By suppressing dopaminergic and serotobergic activities, *p*-hydroxybenzyl alcohol improves learning when rats are evaluated with an avoidance test (Wu et al. 1996). Anti-oxidant-related gene expression on the rat brain induced by exposure to *p*-hydroxybenzyl alcohol may explain the compound's ability to reduce focal ischaemic brain injury in rats (Yu et al. 2005; Kam et al. 2011). This stroke-protective effect which is unique to 4-hydroxybenzyl alcohol is thought to involve the induction of protein disulfide isomerase because it is blocked by bacitracin (Descamps et al. 2009). At doses of up to 200 mg/kg, *p*-hydroxybenzylalcohol was found to be devoid of neurotoxicity (Descamps et al. 2009).

**Fig. 7.11** *Anacamptis coriophora* (L.)

R.M. Bateman, Pridgeon & M.W. Chase. From: Haller, A von, *Historia stirpium indigenarum Helvetiae inchoata* vol. 2: t. 34 (1768). Courtesy of Real Jardin Botanico, Madrid, Spain



*p*-Hydroxybenzyl alcohol may also have a role in skin whitening because it inhibits tyrosinase, the enzyme that catalyses the formation of the skin pigment, melanin (Liu et al. 2007). In co-cultures of melanocytes and keratinocytes (the major component of skin cells), the effect of hydroxybenzyl alcohols (HBAs) was even

more evident. HBAs exhibited low toxicity in vitro (Liu et al. 2008). In the cosmetic industry, tyrosine inhibitors are regularly used in the preparation of skin whiteners.

Herbal usage: Tubers of *A. coriophora* are harvested in Iran for use as *salep* (Ghorbani et al. 2014a, b).

***Anacamptis laxiflora* (Lam.)  
R.M. Bateman, Pridgeon & M.W. Chase**

syn. *Orchis laxiflora* Lam.

Common name: Jersey Orchid

Indian name: *Salep misri* (Bengal), *shala misriri*  
(Madras Presidency in 1933)

Description: Plant is slender, erect, 60 cm tall with a basal rosette of 3–8 narrow leaves, 10–15 by 1–2 cm, and two ovoid tubers that resemble testicles, the current developing tuber being larger than the previous year's. Ten to twelve pink to purple flowers, are loosely arranged on an erect inflorescence that is 6–25 cm tall; hence, *laxiflora*. Lip has a central streak of pure white extending from the base to the apex. It flowers around May (Pridgeon et al. 2001; Wood and Ramsey 2004). Rare cases of triploidy are present in the species (Pridgeon et al. 2001); such plants would be floriferous but sterile.

Plants produce a rosette of leaves in autumn that remain green and functional throughout winter and spring. Leaves become senescent when the plant flowers. Following fruit set, tubers develop and these allow the plant to live through the summer drought. When conditions are favourable, more than one new tuber develops from buds located at the base of the aerial stem. Vegetative reproduction is important in *Anacamptis* because fruit set is low. However, *A. laxiflora* in the Mediterranean is a weed species and it quickly invades abandoned fields (Pridgeon et al. 2001). It is found in fens and marshy, calcareous meadows with slightly acidic to alkaline soils which are permanently wet, predominantly in the Mediterranean–Atlantic region, *A. laxiflora* also occurs in the Middle East, Iran and Afghanistan. Apparently, in Iran and Afghanistan, grazing goats and sheep avoid this orchid (Lawler 1984).

Herbal Usage: In India, the tubers were used as an expectorant, an astringent and as nourishment (Chopra 1933).



**Fig. 7.12** *Anacamptis morio* (L.) R.M. Bateman, Pridgeon & M.W. Chase. [Photo: Henry Oakley]

***Anacamptis morio* ssp. *picta* (Loisel.)  
Jacquet & Scaoat**

Description: Tubers are paired, globular and sessile. Stem is erect and glabrous, 20–40 cm tall. Leaves are basal, lanceolate, unspotted. Inflorescence is laxly 6- to 25-flowered. Dorsal sepal and petals form a helmet whereas lateral sepals, which are green or purple, “wing” above the helmet. Lip is 3-lobed. Lateral lobes are larger than the mid-lobe and they fold backwards. Central lobe is red-purple to pink and carries a central spur which is convex at the apex. The centre of the mid-lobe is white with purple spots. Subspecies *picta* is smaller than the type species and has fewer flowers, which are either purple or white (Fig. 7.12). Flowering season is February to April, or May to June, depending on location.

*A. morio* ssp. *picta* (syn. *A. picta*) occurs in dry grassland that is wet in winter and dry in summer, in meadows and pastures, and in calcareous soil that is either neutral or alkaline. It is a common orchid in the Catabrian Mountains of

Spain (Heiningen 2014) and is distributed across Europe to the Middle East and Iran.

Herbal usage: Tubers are harvested in Iran, at the eastern edge of its distribution, for use as *salep* (Ghorbani et al. 2014b). In Europe, *Anacamptis* species are protected.

***Anacamptis palustris* (Jacq.)  
R.M. Bateman, A.M. Pridgeon,  
M.W. Chase**

Common name: Bog orchid

Description: A slender plant with two globose tubers; stem is erect, 30–60 cm tall. Leaves are 3–5, narrow, lanceolate, unspotted, drawn up, held vertically, and gutted near at the lower portion to ensheath the stem. Bracts are leaf-like and reddish. Inflorescence is erect, 7.5–25 cm, and laxly several-flowered. Flowers are large, pink to purple. Lip has 3 lobes, 16 mm wide. Spur is convex, white with three vertical stripes. *A. palustris* flowers from May to July. It is distributed predominantly in western Europe but is also found in Greece, the Aegen, Turkey and Iran.

Herbal usage: Tubers are harvested in Iran for use as *salep* (Ghorbani et al. 2014b).

***Anacamptis pyramidalis* (L.) A. Rich**

Description: This is a variable species. Tubers are paired, ovoid, 1.2–5.2 (mean 2.2) long and 0.6–4.0 (mean 1.5) cm in diameter. Plants are terrestrial, 20–65 cm tall, stem erect, with 2–14, narrow, lanceolate, basal leaves, the largest being 6.5–23 by 0.6–2.2 cm, that senescence at flowering. Inflorescence is densely many-flowered, with numerous small, lanceolate, subtending bracts, 4–18 mm long. Raceme is initially pyramidal, gradually becoming ovoid as the flowers open. Flowers are pale to bright red or carmine, sometimes pink, rarely white, 1 cm long. Lip is darker than the other floral segments. Lip is flat, trilobed, all lobes of equal size, oblong side lobes well spread out at an



**Fig. 7.13** *Anacamptis pyramidalis* (L.) A. Rich. [Photo: Henry Oakley]

angle of 75° to the vertical (Fig. 7.13). Flowering season is June to July. Butterflies and moths pollinate the flowers. The species is distributed in south and central Europe to Turkey and northern Iran, occurring in sunny meadows or bushy slopes, from lowlands to the foothills, on slightly acidic, neutral or calcareous soil (Hoskovrc 2007; Sevgi et al. 2012).

Herbal usage: Used as *salep* in Iran and Turkey (Ghorbani et al. 2014a). Best grades of *salep* should have a mucin content greater than 40 % and an ash content which is lower than 5 %. *A. pyramidalis* has a mucin content of 44.72 % and an ash content of 1.72 % (Sezik 1967), which places it among the top six most marketable orchids for *salep*.

Tubers are harvested by collectors of *salep* from the Golestan Province of Iran. The main collection areas are the woodlands between Maraveh Tappeh and Golidagh, especially around the village of Aq-Eman in eastern Golestan. Total annual trade in *salep* from Maraveh Tappeh (not restricted to *A. pyramidalis*) in 2013 amounted to 3500 kg of fresh tubers (Ghorbani et al. 2014b).

Phytochemistry: When challenged with *Rhizoctonia repens*, *A. pyramidalis* produces two phytoalexins, orchinol and *p*-hydroxybenzyl alcohol (Veitch and Grayer 2003a, b). Orchinol is bacteriostatic and fungistatic but, being neither bactericidal nor fungicidal, it does not have much pharmaceutical application. *p*-hydroxybenzyl alcohol is neuroprotective and may also have a role as a skin whitener (see *A. coriophora*). Extracts of flowers and above-ground parts of *A. pyramidalis* exhibit anti-oxidant and scavenging capacities in vitro (Stajner et al. 2010).

### Overview

Following the classic *Doctrine of Signatures*, which once determined the role of herbs, the spherical tubers of *A. pyramidalis*, *A. laxiflora*, *A. palustris* and many terrestrial Mediterranean orchids which resembled testicles were reputed to possess aphrodisiacal properties. Powder prepared from dried tubers was used to prepare *salep*, a drink that was alleged to boost one's libido and sexual performance. *Salep* drinking boomed during the heyday of the Ottoman Empire when even sultans took to eating halva made with *salep*, but its reputation dates from a much earlier period, the result of an anecdote spun by Theophrastus (371–287 BC) that on one occasion it caused a man to have 70 consecutive acts of coitus (Wedek 1961). The belief became widespread with the inclusion of orchids as aphrodisiacs in the *Herball of Dioscorides* (Diocorides, 40–90 CE), a text used by Western physicians well into the 19<sup>th</sup> century. The famous Persian physician Avicenna (Ibn Sina, 980–1037) promoted the *Herball of Dioscorides* and his influence on neighbouring India further reinforced the belief. Unnani (Greek) medicine in India holds a similar regard for *salep*. However, native Indian *salep* is generally constituted with pseudobulbs of *Eulophia*.

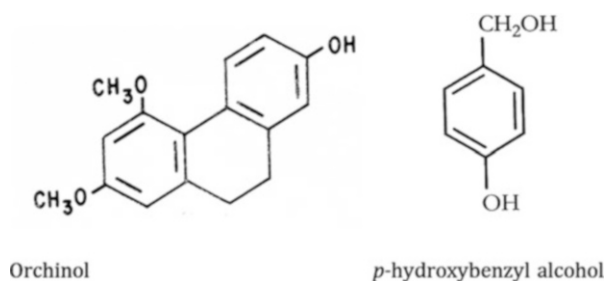
Although also patently untrue, it was once believed that *salep* contained the greatest amount of nourishment in the smallest bulk (Culpeper 1653). A small amount of *salep* in a large volume of warm water converted into a jelly-like substance which was believed to be superior to rice. To protect against famine at sea, it was proposed

that *salep* should constitute part of a ship's provision at all times (Hooper and Akerly 1829; Hooper 1937). *Salep* was seldom used in the United States, “except in the composition of Castillon powders, a nutritive and bland article of diet for invalids” (Griffith 1847). Orchid tubers (not *salep*) are fed to weak children cut off from other supplies (Hedley 1888), and eaten by Australian aborigines during periods of privation (Low 1987). Indian *salep* made with *A. laxiflora* is still advocated as a source of nourishment. *Salep* contains mainly mucilage. Starch, reducing sugar, nitrogen (0.92 %), moisture and ash are present in small amounts (Sezik 1990).

*Salep* imported from Turkey would certainly contain *A. pyramidalis* and *A. laxiflora*. *A. pyramidalis* was shown to synthesise orchinol and *p*-hydroxybenzyl alcohol when incubated with *Rhizoctonia repens* (Stoessl and Arditti 1984). This probably also holds true for *A. laxiflora*, although that has not been purposefully demonstrated. Anti-oxidant enzymes (superoxide dismutase, catalase, peroxidase, etc.) with scavenging activity were demonstrated in the flowers and above-ground parts of *A. pyramidalis* (Stajner et al. 2010). However, their presence does not lend support to the alleged aphrodisiac property of *salep* because they have not been shown to exert such action in humans nor in animals.

At one time, Nepal exported about 5 tons of *A. laxiflora* (syn. *Orchis latifolia*) tubers annually and a considerable quantity would have made its way into India. Several million plants would need to be harvested to obtain this amount of tubers. It is claimed that the orchid is replanted, but experts think that the following year's harvest probably comes from the smaller bulbs which were originally ignored (Lawler 1984) because the plump and fleshy (daughter) tubers that are collected are those that would have produced the following year's crop. Shrivelled (mother) tubers with flowering or senescent plants cannot give rise to another plant. Although wild populations have declined due to drainage of wetlands and modern farming practices (Pettersson 1976), currently, members of the genus are not threatened in Europe (Wood and

**Fig. 7.14** Formulae of Orchinol and *p*-hydroxybenzyl alcohol



Ramsey 2004). Their existence is only precarious in Turkey and Iran (Ghorbani et al. 2014b).

Harriet J. Muir at Kew managed to raise seedlings of *A. laxiflora* through symbiotic germination using mycorrhiza obtained from roots of *Orchis morio* and *Dactylorhiza fuchsia*, and also with *Ceratobrasidium corrigerum* from the Commonwealth Mycological Institute. She used this method to provide seedlings for reintroduction into the field (Fig. 7.14) (Muir 1987).

Genus: *Anaphora* Gagnep.

The species mentioned below is the sole species in this genus which belongs to the subtribe *Liparidinae*. It is now classified as *Dienia* (Alrich and Higgins 2008). In Greek the word *anaphora* means ‘a carrying back’. It refers to the lip which is adnate (united) to half the length of the column (Schultes and Pease 1963).

*Anaphora liparioides* Gagn. [see *Dienia ophrydis* (J. König) Ormerod & Seiden.]

## Genus: *Anoectochilus* Blume

Chinese name: *Jinxian Lan* (gold thread orchid)

Chinese medicinal name: *Jianxianlan* (referring to *Anoectochilus formosanus* and *A. roxburghii*)

A genus of terrestrial orchids, *Anoectochilus* has beautiful, soft, velvety, ovate-lanceolate (oval but terminally pointed) foliage decorated with a network of fine, yellow-orange or “golden” veins. They belong to the Jewel Orchids, so-called because as a group they possess distinctive velvety foliage with attractively coloured

veins and/or multi-coloured blotches. Leaves are arranged in a spiral fashion near the apex of the soft, fleshy, succulent stem.

The generic name, *Anoectochilus*, is derived from Greek, *anoektos* (open) and *cheilos* (lip). There are around 40 species in the genus, distributed from Sri Lanka and India eastward across southern China, the Ryukyu Islands and Southeast Asia to the Pacific islands.

## *Anoectochilus formosanus* Hayata

Chinese names: *Jinxian Lan* (gold thread orchid), similar to its generic name; *Benshanshison* (mountain stone pine), *Jinqianzicao* (golden currency notes baby grass), *Shucan Lian* (tree and grass lotus), *Yaowang* (King of Medicine); *Yaofu* (strong medicine), *Wusen*, Taiwan jewel orchid. In Taiwanese (Hokien dialect): *Kim soa lian* (gold thread lotus), *Kim chi a chha* (gold streaked herb), *Oa ke chahau* (black herb)

Description: *A. formosanus* is a terrestrial herb with creeping stems which produce leaves as they bend upwards towards the light. Leaves are ovate, pointed at the tip, 3–4 cm long and 2–3 cm broad, dark green, greenish-purple on the underside, with white venation. A terminal inflorescence bears few white flowers with an interesting, fimbriate lip terminating in two lobes (Fig. 7.15). *A. formosanus* is found throughout Taiwan in primeval forests or in bamboo stands at 500–1500 m, and in the Ryukyu Islands. It flowers in October and November (Liu and Su 1977).

Herbal Usage: Herbs are obtained from Taiwan and Fujian Province. The entire plant is used in



**Fig. 7.15** *Anoectochilus formosanus* Hayata [Photo: E.S. Teoh]

Chinese medicine for cooling the blood, to smooth the liver, as an antipyretic and for detoxification. It is used to treat tuberculous patients who suffer from haemoptysis, and also to treat diabetes, bronchitis, kidney and bladder infections, cramps in children, snake bites and stomach ache (Liu 1952 quoted by Perry and Metzger 1980; Ou et al. 2003). The entire plant is used for treating pain at the waist and knee, numbness, haemetemesis, nocturnal emission, nephritis, vaginal discharge and convulsions affecting children (Wu 1994; *Zhonghua Bencao* 2000)

**Phytochemistry:** At Peking Union Medical College, He Chun-Nian and his colleagues managed to isolate eight compounds by ethanolic extraction of entire plants of *A. formosanus*. The flavonoid glucoside, quercetin-7-O-beta-D (6''-O-(trans-feruloyl) glucopyranoside, was shown to be a potent anti-oxidant while the remaining compounds possessed weak activity. The remaining seven compounds are: 8-C-*p*-hydroxybenzylquercetin; isorhamnetin-7-O-beta-D-glucopyranoside; isorhamnetin-3-O-beta-D-glucopyranoside; kaempferol-3-O-beta-

**Table 7.2** Chemical compounds isolated from *Anoectochilus roxburghii* and *A. formosanus*

<i>A. roxburghii</i> (He et al. 2006; Cai et al. 2008)
Quercetin-7-o-beta-D-(6''-o-(trans-feruloyl))-glucopyranoside (compound 1)
8-C- <i>p</i> -hydroxybenzylquercetin (compound 2)
Isorhamnetin-7-0-beta-D-glucopyranoside (compound 3)
Isorhamnetin-3-0-beta-D-glycopyranoside (compound 4)
Kaempferol-3-0-beta-D-glucopyranoside (compound 5)
Kaempferol-7-0-beta-D-glucopyranoside (compound 6)
5-hydroxy-3',4',7-trimethoxyflavonol-3-0-beta-D-rutinoside (compound 7)
Isorhamnetin-3-0-beta-D-rutinoside (compound 8)
Beta-D-glucopyranosyl-(3R)-hydroxybutanolide (I),
Stearic acid (II)
Palmitic acid (III), betasitosterol (IV)
Succinic acid (V),
<i>p</i> -hydroxybenzaldehyde VI)
daucosterol (VII)
methyl 4 beta glucopyranosyl-hutanoate (VIII)
<i>p</i> -hydroxy cinnamic acid (IX)
0-hydroxy phenol (X)
<i>A. formosanus</i> (Du et al., 2008)
(3R)-3-(beta-D-glucopyranosyloxy) butanolide (kinsenoside; 1)
(3R)-3-(beta-D-glucopyranosyloxy)-4-hydroxybutanoic acid (2)
2-((beta-D-glucopyranosyloxy)methyl)-5hydroxymethylfuran (3)
Isopropyl-beta-D-glucopyranoside (4)
®-3,4-dihydroxybutanoic acid gamma-lactone (5)
4-(beta-D-glucopyranosyloxy) benzyl alcohol (6)
(6R,9S)-9-(beta-D-glucopyranosyloxy)megastigma-4,7-dien-3-one (7),
(3r)-3-(beta-D-glucopyranosyloxy)-4-hydroxybutanolide (8)

Reference: *Zhongyao Da Cidian* (1986) and *Zhonghua Bencao*, (2000) and *Zhonghua Bencao*, (2000)

D-glucopyranoside; kaempferol-7-O-beta-D-glucopyranoside; 5-hydroxy-3',4',7-trimethoxyflavonol-3-O-beta-D-rutinoside; and isorhamnetin-3-O-beta-D-rutinoside (He et al. 2005). Ten compounds were isolated at the Guangdong Pharmaceutical University by JY Cai and his colleagues (Cai et al. 2008). Scientists at Seiya Pharmaceuticals in Tokyo found that *A. formosanus* grown in the wild and propagated by tissue culture both contained ten compounds including kinsenoside (Table 7.2) (Du et al. 2008). Kinsenoside administered to rats fed a high fat diet significantly reduced their body

and liver weights (Du et al. 2001). The hepatoprotective property of *A. formosanus* is conferred by kinsenoside (Wu et al. 2007).

### ***Anoectochilus koshunensis* Hayata**

Local name: *Gaoxiong Jinxian Lan* (Gaoxiong golden thread orchid or, in Taiwanese spelling, Kao-hsiung jewel orchid).

Other common names: *Hengchunjinxianlian* (Hengchun golden thread lotus); *Jinxian Lan* (golden thread orchid). In Taiwanese (Hokien) dialect: *Ko hiong kim soa lian*; *Heng chhun kim soa lian*

Description: Stems are rigid but soft and succulent, 20 cm long bearing 4–5 ovate, dark green leaves with the typical reticulate pattern, and 5–6 white flowers terminally. Flower is usually non-resupinate, i.e. lip is dorsal. Nearly halfway along its length, the lip splits to produce a pair of divergent blades. Flowering season is from July to October. This jewel orchid is found in broad-leaved forests below 1500 m in the central and southern parts of Taiwan and the Ryukyu Islands (Liu and Su 1977).

Herbal Usage: The whole plant “cools the blood, smoothes the liver”, is antipyretic and removes toxins. It is used to treat haemoptysis resulting from tuberculosis, diabetes, bronchitis, nephritis, cystitis, infant convulsions and snake bites (Ou et al. 2003).

Phytochemistry: Five sterols, including a new one with a non-conventional side chain [26-methylstigmasta-5,22,25, (27)-trien-3 beta-ol], together with a megastigmane glucoside and 2'-deoxyadenosine, was isolated from the whole plant of *A. koshunensis* by Ito et al. (1994). Kinsenoside is also present (Du et al. 2001).

*Anoectochilus regalis* Bl. [see *Anoectochilus roxburghii* (Wall.) Lindl.]

### ***Anoectochilus reinwardtii* Blume**

Description: Plants are up to 20 cm tall with 4–6 round leaves, 5 by 3.5 cm, of a dark velvety green



**Fig. 7.16** *Anoectochilus reinwardtii* Blume [Photo: Peter O'Byrne]

with a reticulation of pink to red veins. Inflorescence is 15 cm tall, pubescent, bearing 2–4 flowers near the apex. Flowers are 2 cm across. Sepals are lanceolate, reddish and hairy on the outside, lighter and smooth on the inside. Petals are white and of the same length as the sepals. Lip is white, extending beyond the sepals, and divides into two claws, each lined with seven teeth on their lateral margins (Fig. 7.16). *A. reinwardtii* is found in Sumatra, Java, Borneo and Maluku at 1400–1700 m (Comber 2001).

Herbal Usage: The Iban and Kelabit tribes of Borneo use the orchid to treat infertility. It is believed to possess magical properties: supposedly infertile woman would conceive if leaves of a single plant are placed under their sleeping mat. From the appearance of the leaves, some people claimed that they could even predict the sex of the child (Christensen 2002)!

### ***Anoectochilus roxburghii* (Wall.) Lindl.**

Synonym: *Anoectochilus regalis* Bl.

Sri Lankan name: *Wanna rajah* (“that which glistens in the woods”). In this instance, *rajah* has the meaning “to shine” rather than “king”—Cooray 1940)

**Fig. 7.17** *Anoectochilus roxburghii*. Adapted from a water-colour painting by A.J. Wendel in Blume C.L., *Collection des Orchidees les plus remarquables de l'archipel Indien et du Japan*, t. 12b, fig. analysis (1858). Courtesy of plantillustrations.org



Taiwanese herbal name: *Yaowang* (King medicine)

Description: Plants are up to 30 cm tall; leaves few, 2.5–4 by 1.7–2.5 cm, of a dark velvety-green or purplish-red with a complex network of golden

veins. Inflorescence is up to 27 cm tall, pubescent, with a few white flowers, 1.8 cm across. Sepals are glandular, pubescent, ovate and acute, with a central vein. Petals are narrow and pointed. Lip is 1.1 cm long, clawed, the margins of the claw carrying 8 filiform lobes on each side (Fig. 7.17).



**Fig. 7.18** *Anoectochilus roxburghii* (Wall.) Lindl., from a herbal kitchen in Xiamen, Fujian Province, China [Photo: E.S. Teoh]

It flowers in December to January and May to September in Sri Lanka (Jayaweera 1981), in October to December in Bhutan (Gurong 2006) and August to December in China (Chen et al. 2009c).

This small, terrestrial, jewel orchid thrives in humus rich soil on sparsely wooded slopes at 600–800 m in continental East Asia, from China to Vietnam, Laos and Myanmar to the Himalayan foothills and Sri Lanka. It also occurs in Japan. *A. roxburghii* grows in humid primary forests in crevices or in rich humus that is constantly dampened by mists and splash, and along steep water courses at 300–1800 m in India (Sathish Kumar and Manilal 1994).

**Herbal Usage:** *A. roxburghii* is not included among the medicinal herbs in the popular Chinese classic *Herbals*. Nevertheless, it is a medicinal herb that enjoys widespread provincial usage in Taiwan and Fujian (Fig. 7.18). Herbalists use it to treat hepatitis, splenic disorders, hypertension, cancer, tuberculosis, impotence, fever,

snake bites and even slow development in children (Lin et al. 2000). In the southern Chinese province of Fujian, *A. roxburghii*, and the cultivated, imported species, *A. formosanus*, are a panacea for numerous ailments that include pleurodynia and other pulmonary conditions, liver disease, hypertension, paediatric malnutrition and snake bites. The Fujian Institute of Traditional Medicine likewise refers to it as “King Medicine” (He et al. 2006).

Stems and leaves of *A. roxburghii* (syn. *A. regalis*) are included in certain medicinal oils in India, but there is no mention of how it is being used (Cooray 1940; Rao 2004). Nevertheless, it has a long history of Indian medicinal usage (Chopra 1930).

**Phytochemistry:** Eighteen compounds have been isolated from *A. roxburghii*. *Zhonghua Bencau* Kinsenoside, a glycoside whose antglycaemic activity has been demonstrated in streptozotoin-induced, diabetic rats is the major constituent of *A. roxburghii* (Zhang et al. 2007a). Numerous compounds were isolated by Cai and his colleagues: beta-D-glucopyranosyl-3R)-hydroxybutanolide, stearic acid, palmitic acid, beta-sitosterol, succinic acid, *p*-hydroxybenzylaldehyde, daucosterol, methyl 4-beta-D-glucopyranosyl-hutanoate, *p*-hydroxycinnamic acid and 0-hydroxy phenol. Ferulic acid, quercetin, daucosterol and cirsilineol in addition to *p*-hydroxybenzylaldehyde were present in the chloroform fraction (Cai et al. 2008). In the same year, two novel sorghumol triterpenoid acyl esters, a new alkaloid (anoecochine) and a known triterpenoid (sorghumol), were isolated from *A. roxburghii* by Han et al. (2008).

## Overview

Four species of *Anoectochilus* are used in herbal medicine. *A. roxburghii* enjoys a wide distribution, but its medicinal usage is mainly limited to southern China where its application for a broad spectrum of conditions has earned it the title of *Yaowang* or “King of Medicines”. In Nepal, plants are used to treat tuberculosis (Pant and Raskoti 2013). *A. roxburghii* is present in some Indian medicinal oils (Cooray 1940; Rao 2004). *A. formosanus* and *A. koshunensis* are endemic to Taiwan and the Ryukyu Islands. The former

species has a high reputation in Taiwan where it enjoys a broader range of medicinal uses than the latter although their applications overlap significantly. *A. formosanus* has been researched extensively in Taiwan (see below). *A. regalis* found in southern India and Sri Lanka is incorporated in local medicinal oils. Both H. N. Ridley and the Dutch botanist A. H. Burkhout, writing in the early years of the twentieth century, observed that Chinese in Malaya cultivated *Anoectochilus* species to use as medicine, but they could not discover the details of its usage (Burkill 1935). *Zhonghua Becao* (2000), the authoritative Chinese *Materia Medica*, stated that the medicinal name *Jinxianian* refers to both *A. roxburghii* and *A. formosanus* whose vegetative forms resemble one another, and their usage is similar. In Indonesia, it was also used to treat tuberculosis (Van Steenis quoted by Perry and Metzger 1980) and this probably held true for Malaya during that period.

The cultivated “*Anoectochilus*” of Ridley and the *Anoectochilus* (sic) of Perry and Metzger (1980) is likely to be *Ludisia discolor* (Ker Gawler) A. Rich which is native to Malaysia and Indonesia, popularly cultivated in the region and still being offered as medicinal plants whereas *A. formosanus* only occurs in Nansei-shoto and Taiwan and the distribution of *A. roxburghii* does not extend south of the major Thai–Indochina land mass. Although *A. reinwardtii* Bl. occurs in Malaysia and Indonesia, it is not commonly cultivated.

A magico-medicinal usage is of anthropological interest: the Kelabit in Sarawak place leaves of *A. reinwardtii* Bl. (*udo anak* in Kelabit) under the sleeping mat to boost the fecundity of a woman who has not conceived (Christensen 2002).

## Commercial Cultivation

*A. formosanus*, the golden-striped lotus, a beautiful, terrestrial, jewel orchid, is used by herbalists who use it to treat disorders of the liver and spleen, cancer, fever, hypertension, tuberculosis, impotence, snake bites and even

slow development in children (Lin et al. 2000). The herb is so popular that it can fetch a price of US\$100 per kg fresh weight (JETRO TTPP 2008). In the southern Chinese province of Fujian, the related and far more widely distributed *A. roxburghii*, the so-called “King of Medicines” (*yaowang*), is a panacea for numerous ailments (He et al. 2006). Fujian supplies *A. formosanus* to the herbal market although the species is not native to mainland China but is a cultivated herb.

Attempts have been made to promote the cultivation of these two orchid species as commercial crops because of the high commercial value of the herbs. Plants are harvested when they reach a height of 10–15 cm. Seedlings can be bought and raised by those who aspire to grow their own herbs, as tea packs, syrup and in dried form (Anonymous 2008).

Such widespread interest in this herb has naturally led to studies to facilitate its propagation through asymbiotic and symbiotic seed germination, synchronous flowering to promote pollination, propagation through the culture of shoot tips and nodal explants and improved methods of cultivation (Wu 1997; Gao and Guo 2001; Tsay 2002; Chou and Chang 2004; Tang and Guo 2004; Shiau et al. 2006). When *A. formosanus* is raised in pot culture, 10 weeks symbiotic co-culture with the addition of F-23 fungus (belonging to the genus *Mycena*, but not identified by species) resulted in gains in shoot height (16.6 %), shoot dry weight (31.3 %), leaf numbers (22.5 %) and, more importantly, increased contents of kinsenosides (by 85.5 %), isorhamnetin-3-O-beta-rutinoside (by 226.1 %) and isorhamnetin-3-O-beta-D-glucopyranoside (by 196.0 %). This suggests that the use of endophytes for other medicinal orchid species should also be investigated (Zhang et al. 2013). In 1997, *Mycena anoectochila* was isolated from mycorrhizal roots of *A. roxburghii* from Xishuanbanna (Guo et al. 1997).

Light intensity affects growth, photosynthetic capability and total flavonoid accumulation of *Anoectochilus* plants. A good cultivation system should employ optimum light intensity; too much light may be almost as bad as too little

(Ma et al. 2010). The possibility of accurately identifying *Anoectochilus* species based on rDNA ITS sequences is also being studied (Gao et al. 2009).

## Pharmacological Studies

Most of the research published or abstracted in English comes from Taiwan and focuses on *A. formosanus*. The study group led by C.C. Lin of Kaoshing Medical College in Taiwan started their research in 1993, and they have been the most active in this field. They have also conducted studies on other medicinal plants. Their findings are summarised and discussed below. Recently, two renowned Chinese medical schools have also published papers on *A. roxburghii* (He et al. 2005; Wu et al. 2007; Cai et al. 2008; Han et al. 2008).

### Anti-inflammatory Effect of *A. formosanus*

Extracts of whole plants of *A. formosanus* administered to rats reduced paw oedema chemically induced by administration of carrageenan. This anti-inflammatory effect was a delayed phenomenon, apparent only after 4 h (Lin et al. 1993). Kinsenoside, the major active compound from *A. formosanus*, inhibited inflammatory reaction in peritoneal macrophages and protected mice from endotoxin shock (Hsiao et al. 2011). Aqueous extract of *A. formosanus* fed to rats suppressed allergic asthma triggered by ovalbumin by modulating cytokine production and T-cell subpopulations (Hsieh et al. 2010).

### Protection Against Liver Damage

Toxic damage to the liver is reflected by sharp increases in two liver enzymes in the blood, SGPT (serum glutamate-pyruvate transaminase), also known as ALT (alanine aminotransferase), and SGOT (serum glutamate-oxaloacetate

transaminase), also known as AST (aspartate aminotransferase). Feeding rats with an aqueous extract of *A. formosanus* (hereafter called AFE) reduces the extent of their liver damage when these animals were exposed to carbon tetrachloride, the dry-cleaning solvent that is extremely toxic to the liver. The steep increase in liver enzymes following exposure to carbon tetrachloride is blunted, and histological evidence of liver damage is less when rats are fed AFE (Lin et al. 1993).

Such hepato-protective effects demonstrable through animal experiments are not uniquely confined to AFE. Lin and his colleagues reported similar anti-inflammatory and hepato-protective effects of an aqueous extracts of *Solanum alatum* (Lin et al. 1995), leaves of *Alstonia scholaris* (Lin et al. 1996) and *Terminalia catappa* (Lin et al. 1997a, 1998), root wood of *Cudrania cochinchinensis* (Lin et al. 1999), burdock (*Arctium lappa*) (Lin et al. 2002b), aqueous extracts of Chinese yam (*Dioscorea alata*), which is commonly used in Chinese medicine (Lee et al. 2002a, b), aqueous root extracts and chloroform leaf extracts of *Limonium sinensis* (Chuang et al. 2003), and various folk (herbal) medicines such as *xiao-chai-hu-tang* (Yen et al. 1991), *thang-kau-tin* (Lin et al. 1992b), *mu-mien* (Lin et al. 1992a), *ban-zhi-lian* (Lin et al. 1997b), *tao-shang-tsao* (Lu et al. 2000), *simo yin*, *guizhi fuling wan*, *xieqing wan*, *sini san* (Lin et al. 2001) and *peh-hue-juwa-chi-cau* (Lin et al. 2002a). Researchers elsewhere have found similar hepato-protective properties in extracts of *Artemisia asiatica* (Ryu et al. 1998), *Trichilia roka* (Germano et al. 2001) and fruit juice of *Aronia melanocarpa* (Valcheva-Kuzmanova et al. 2004). These herbs are not orchids, but three species of the heterotrophic orchid, *Goodyera*, namely *G. schlectendaliana*, *G. matsumurana* and *G. discolor*, also displayed hepato-protective properties (Du et al. 2000) (see *Goodyera*). The cholesterol-lowering agent, simvastatin, reduces liver damage caused by carbon tetrachloride in rats, whereas alcohol aggravated the damage (Okovityi et al. 2007). Finally, there is a long list of other plants which reduce liver damage produced by other hepato-toxins such as

acetoaminophen and beta-D-galactoseamine (Lin et al. 1992b, 1994, 1995, 1997a, b, 1998, 1999, 2002a; Lin, Huang, and Lin 2000; Lee et al. 2002a, b).

Nevertheless, work on the hepato-protective effect of AFE continues. More recently, in 2008, Fang and his colleagues demonstrated that surrogate markers of liver damage from carbon tetrachloride, such as plasma glutamate-pyruvate transaminase (GPT) and hepatic levels of hydroxyproline and malondialdehyde, were significantly lower in rats receiving AFE compared with controls. Hydroxyproline is an important component of collagen, and its elevation is an indicator of tissue breakdown. Malondialdehyde is formed by degradation of polyunsaturated fatty acids and its elevation is an indicator of oxidative stress. Therefore, low levels of the liver enzyme GPT, hydroxyproline and malondialdehyde can be seen as evidence of liver protection. Treatment with AFE increased expression of methionine adenosyltransferase 1A essential for liver repair; and decreased the expression of collagen (alpha 1) and transforming growth factor-beta 1, reflecting suppression of inflammation (Fang et al. 2008)

AFE protected rats against fibrous injury induced by intraperitoneal injections of dimethylnitrosamine (DMN). When portions of the liver were subsequently removed, AFE encouraged cell proliferation and liver regeneration in the residual organ accompanied by increase in liver weight. Such liver regeneration did not occur if portions of the liver were removed in normal rats, not damaged by DMN (Shih et al. 2004).

Oral administration of AFE reduced thioacetamide (TAA)-induced liver fibrosis in mice. Animals fed with AFE had significantly reduced plasma alanine aminotransferase (ALT) activity, lowered liver weights, reduced hepatic hydroxyproline, and there was less fibrosis on histological examination of the liver. AFE treatment reduced mRNA expression of collagen (alpha I), lipopolysaccharide binding protein, CD14, TLR4 and TNF receptor 1. The investigators led by Lin Wen-Chuan from the China Medical University in Taichung, Taiwan,

to postulate that the reduced TAA-induced liver fibrosis in mice fed AFE was probably mediated through inhibition of hepatic Kupffer cell activation (Wu et al. 2010).

The hepatoprotective effect is dose-dependent, and one could overdo a good thing. Aqueous extracts of AF at 300–500 mg/kg enhanced recovery from liver injury caused by acetoaminophen in male Wister albino mice. Methanol extracts at 100–300 mg/kg were similarly hepato-protective. However, alcoholic extract at 500 mg/kg resulted in serious injury (Lin et al. 2000). Organic solvent extractions are generally used to obtain pure forms of the active constituents that are more potent. However, it appears that the old approach of decocting a medicinal herb is generally safer for the layman (Lin et al. 2000).

### Antidiabetic and Lipid Lowering Properties

Aqueous extracts of *A. formosanus* (AFE) and *A. roxburghii* both exhibited anti-oxidant and sugar-lowering properties in rats rendered diabetic by treatment with streptozoin. Following forced feeding with AFE (2 g/kg) for 21 days, rats had lower fasting blood glucose, lower serum fructosamine, lower triglycerides and lower total cholesterol levels than rats in the control group (Du et al. 2001; Shih et al. 2003). Kinsenoside is responsible for the antiglycaemic activity of *A. roxburghii* (Zhang et al. 2007a, b). Du's Japanese team found that AFE from cultured *A. formosanus* lowered triglyceride levels in the liver and blood and reduced the deposition of adipose tissue (Du et al. 2003). AFE delayed the oxidation of human LDL (low-density lipoprotein, the harmful cholesterol) by scavenging biological oxidants species like superoxide anion and hydroxyl radicals, and thus shows promise as an agent for preventing atherosclerosis (Shih et al. 2002, 2003). Kinsenoside appears to be the strong anti-oxidant. Flavonoid glycosides and their derivatives present in *A. formosanus* also possessed anti-oxidant activity (Wang et al. 2002).

AFE lowered the plasma triglyceride (Du et al. 2008). Aqueous AFE increased HDL in the blood and vitamin E levels in the liver and kidneys of alloxan-induced diabetic mice (Cui et al. 2013). The protective effect is most likely conferred by kinsenoside (Shiau et al. 2006). This compound also exhibits antihyperglycaemic and antihyperliposis effects in rats (Zhang et al. 2007a; Du et al. 2001). Kinsenoside obtained by extraction and purification of AF reduced body weight, liver size and decreased the liver triglyceride level in rats (Wang et al. 2002).

The effect of daily 450-mg doses of *A. formosanus* (AF) on their serum lipids was tested on a small group of 66 human volunteers who were divided into four groups according to their blood chemistry: 14 had high triglyceride alone; 11 had high cholesterol alone; 5 had both high triglyceride and high cholesterol; and 36 were healthy individuals who served as controls. After 6–12 months, AF significantly decreased the serum levels of cholesterol, LDL cholesterol and very-low-density lipoprotein (VLDL) in all volunteers. These results suggest that some constituents of AF might function like a statin (Du et al. 2007), but the numbers are too small to justify usage of AF to lower blood lipids.

A simple method to demonstrate oxidative stress in vitro is to add hydrogen peroxide to cultured cells. This causes DNA in the cells to disintegrate and the cells to undergo apoptosis (programmed cell death). Using HL-60 cells and the hydrogen peroxide model, Wang and his team at Taipei Medical University showed that oxidative stress damage was prevented in a concentration-dependent manner by AFE (Wang et al. 2005).

## Improved Endurance

Amphetamines (e.g. ‘Speed’ and ‘Ecstasy’) are drugs that improve endurance capacity and exercise performance, but they have dangerous side effects and are banned by sports organisations and responsible governments. Swimming endurance in rats (swimming to exhaustion) was used to demonstrate the psycho-stimulant effect of

such drugs (Estler and Gabrys 1979). When green tea was tested, it enhanced fatty acid usage which was associated with an improved endurance of 8–24 % (Murase et al. 2005). Similar results were observed in mice fed *A. formosanus* extract (Ikeuchi et al. 2005) or a Korean medicinal preparation of *Rubus acoreanus* Miquel (Jung et al. 2007).

## Antitumour Activity

Taiwanese inventors filed a United States patent in 2002 for a product comprising alpha-amyrin trans-*p*-hydroxy cinamate and isorhamnetin obtained by stepwise extraction of *A. formosanus* for the chemoprevention and treatment of human cancer. They showed that the product inhibited the growth of three types of tumour cells in vitro, namely mouse B16 melanoma, MCF-7 human breast cancer and HepG2 human liver cancer (United States Patent 7033617; Yang et al. 2004). Subsequently, the team demonstrated the inhibitory effect of AFE on CT-26 murine (sheep) colon cancer cells which were implanted on the skin of BALB/c mice (Shyur et al. 2004).

Shyur and her team at the Institute of Bio Agricultural Sciences in Taipei prepared a bio-activity-guided ethyl acetate-partitioned fraction of *A. formosanus*. When tested by apoptosis (programmed cell death) induction of cultured MCF-7 human breast cancer cells, it showed an enhanced antitumour activity over aqueous AFE. They also explored the apoptotic signalling pathway of the MCF cells exposed to the ethylacetate extract of *A. formosanus* (Tseng et al. 2006). These antitumour studies are still at an early stage and more testing will have to be performed before human studies are attempted.

## Immunomodulating Activities

Finding that AFE activated phagocytosis and stimulated interferon-gamma production in lymph node cells, Lin and Hsieh (2005) postulated that *A. formosanus* might have a role

in boosting defence against infection. However, animal and clinical studies based on this postulate are not available.

*A. formosanus* produces a polysaccharide known as Type II Arabinogalactan (AGAF). When AGAF was fed to mice treated with an old anticancer agent, 5-fluorouracil, it reduced the leucopaenia resulting from the anticancer treatment (Yang et al. 2013).

## Prevention of Osteopaenia

Bone mass reaches a maximum in humans around the age of 30–32, after which there is an inexorable decline. This contributes to the dramatic rise in the incidence of fractures in old age. In women, an additional drop in universal bone mineral density and loss of collagen from spongy bone in the spine occur at menopause, when the ovaries cease to produce oestrogen and progesterone (Teoh and Teoh 1991). Removal of the ovaries in mammals eliminates the all-important source of oestrogen and progesterone and replicates the effect of menopause. In an experiment conducted on rats whose ovaries were removed, AFE and the potent human oestrogen, 17-beta oestradiol, both prevented bone loss and shrinkage of the pituitary gland. Elevation of circulating alkaline phosphatase, which is present when there is excessive bone loss, was also suppressed by AFE feeding (Shih et al. 2001).

Bone remodelling relies on a balance between the activities of osteoblasts which build up bone and osteoclasts which remove calcium from bone. Excessive osteoclastic activity erodes bone strength. AFE blocks the formation of osteoclasts without suppressing the formation of osteoclast progenitor cells from bone marrow stem cells (Masuda et al. 2008). Kinsenoside is the active compound that suppresses the formation of osteoclasts and bone loss associated with removal of the ovaries (Hsiao et al. 2013).

Oestradiol preserved the vagina and uterus in the experimental animals but *A. formosanus* did not (Shih et al. 2001). In other words, *A. formosanus* behaved like a selective

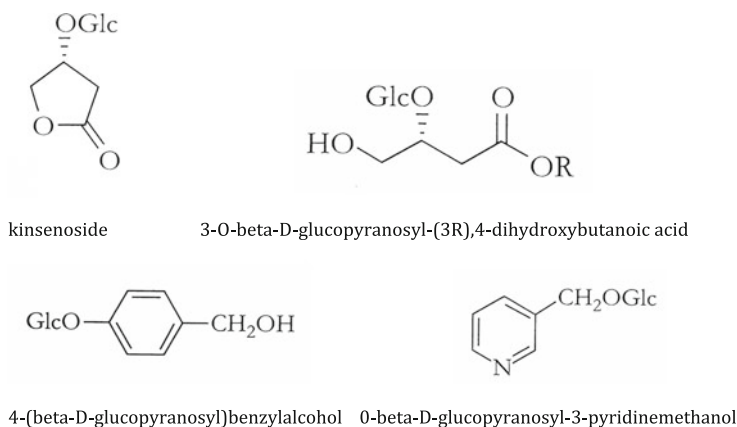
estrogen-receptor modulator (SERM). In their search for an oestrogen-like substance which preserves bone while not increasing the risk of breast or uterine cancer, the pharmaceutical industry came up with SERMs, examples of which are tamoxifen, tibolone and raloxifene. Tamoxifen and raloxifene have been shown to reduce the risk of breast cancer recurrence, while tamoxifen enjoys worldwide usage in the long-term management of oestrogen receptor-positive breast cancer (Johnston and Howell 2002). It might be worthwhile to study the effect of *A. formosanus* on normal and malignant breast tissues.

## Foetal Lung Maturation

Dexamethasone is used to accelerate foetal lung maturation when it becomes necessary to deliver babies prematurely (Crowley 1995; RCOG Guideline No. 7 1996). In 2004, a team of pediatricians from the Taipei Medical University Hospital led by C.M. Chen tested the effects of the “King Medicine” (*A. formosanus*) on foetal lung maturation in rodents and compared its effect with that achieved with dexamethasone. They fed pregnant rats with AFE for 7 days, from Days 12 to 18 and delivered them by caesarean section on Day 19. Another group of rats received an intraperitoneal injection of dexamethasone on Day 18 and were sectioned on Day 19. The control group received intraperitoneal saline. AFE treatment and dexamethasone both increased growth hormone levels in the pregnant rats and saturated phosphatidylcholine (surfactant) levels in the foetal lung tissue. A surfactant is required to allow the lungs of mammalian newborn to expand at birth. Lungs of the newborn rats treated with AFE and dexamethasone showed histological evidence of accelerated lung maturation (Chen et al. 2004).

The normal duration of human pregnancy is 38 weeks from the date of fertilisation, and protection of premature human babies from respiratory distress is achieved 36–48 h after the administration of high doses of dexamethasone. Thus, the exposure of pregnant rats to

**Fig. 7.19** Structure of some compounds present in *Anoectochilus*



AFE in the experiment is inordinately prolonged and cannot be said to be comparable to that of dexamethasone, since the latter acts much more rapidly in the human. It would be logical to prove the efficacy and safety of AFE in veterinary medicine before any test is conducted on humans.

### Effect on Amnesia

A small study on rats by researchers in Taiwan showed that rats fed with extracts of AF had better memory retention of an unpleasant experience when they were treated with scopolamine to induce amnesia. The anti-amnesic effect was boosted by the simultaneous administration of neostigmine, a drug which is known to enhance cholinergic neural transmission (Cheng et al. 2003).

### Comment

Such a wide range of possible beneficial effects of a common herbal remedy with considerable safety ought to be properly investigated by randomised controlled clinical trials on human subjects. To date, the report on the lipid-lowering effect of kinsenoside is the sole published human data (Du et al. 2007), but the study sample is too small for a definitive conclusion to be made. Many modern drugs that show great promise either in the laboratory or with surrogate markers in humans fail to demonstrate real benefits when

they are subjected to randomised clinical trials. Therefore, until large human trials validate the beneficial effects of *A. formosanus*, the extent of the benefits of this orchid, if any, is still subject to speculation.

Considerable overlap in the medicinal effects of *A. formosanus* and *A. roxburghii* is likely because both contain kinsenoside, the principal pharmacologic constituent (Fig. 7.19).

### Genus: *Anthogonium* Lindl.

Chinese name: *Tongban Lan* (barrel petal orchid)

This is a small genus of terrestrial or occasionally saxicolous herbs with a single species in China (Figs. 7.20–7.22). The generic name is derived from Greek, *anthos* (flower) and *gonia* (angle). It probably refers to “the curious angle at which the tubular flower is joined to the pedicellate ovary” (Schultes and Pease 1963).

### *Anthogonium gracile* Wall ex Lindl.

*Anthogonium griffithii* Rehb. f.

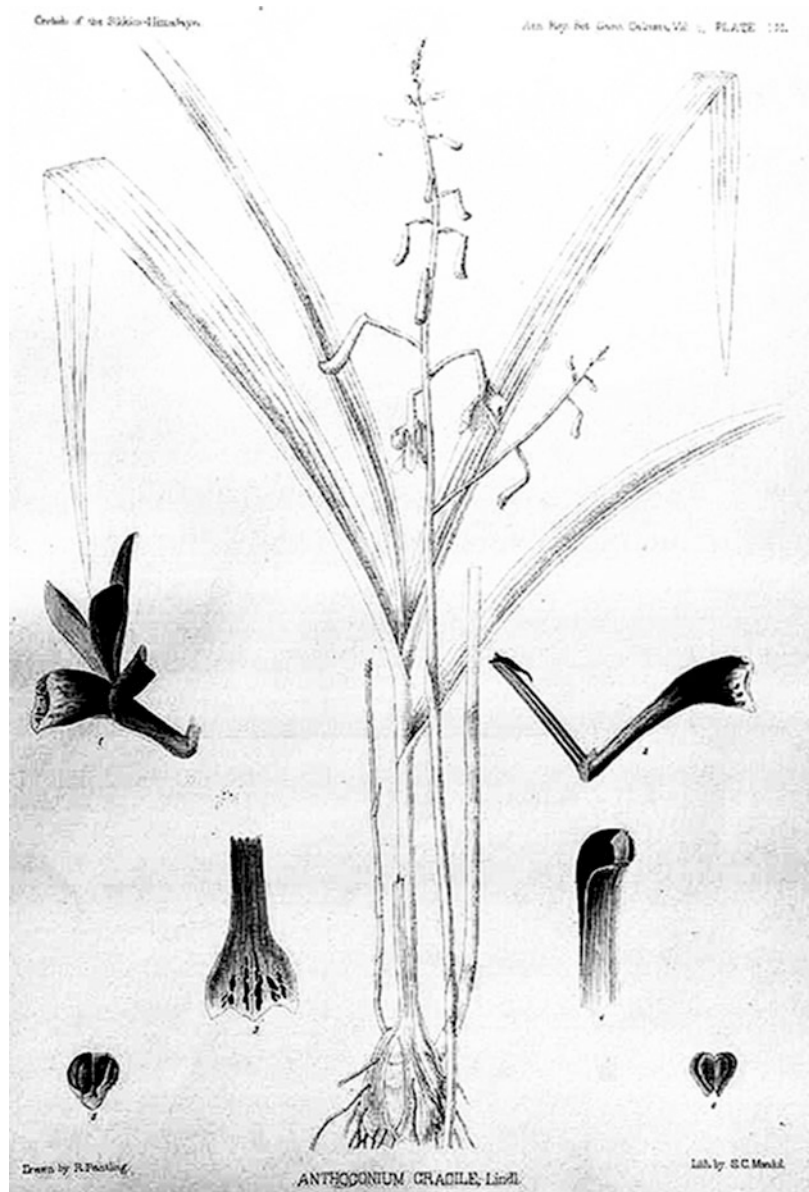
Chinese name: *Tongban Lan* (barrel petal orchid)

Chinese medicinal name: *Honghuaxiaodusuan*

Thai name: *Wan phrao*

Description: *A. gracile* is a small, slender, terrestrial or occasionally saxicolous, sympodial

**Fig. 7.20** *Anthogonium gracile* Wall ex Lindl.  
From: *Annals of the Royal Botanic Gardens, Calcutta*, vol. 8 (3): t.134, (1891) Drawing by R. Pantling. Courtesy of Missouri Botanical gardens, St. Louis, USA



orchid, with subterranean corm-like pseudobulbs the size of a hazel nut or walnut. Stem is slender, 14–40 cm tall. Leaves are 1–3, narrow, petioled, pleated, 15–30 by 0.8–2.5 cm and deciduous (Fig. 7.21). Inflorescence is erect, simple or branched, reaching or exceeding the tip of the leaves, with a few greenish-white or pink, oddly shaped, non-resupinate flowers, loosely arranged and opening in succession (Grant 1895). Lip is purple (Fig. 7.22). It occurs at mid- to high

elevation in deciduous forests and scrub from Sri Lanka and the eastern Himalayas to the southern Chinese provinces of Xizang, Yunnan, Guizhou and Guangxi, at 1200–2300 m, and in the northern parts of Myanmar, Thailand, Laos and Vietnam. It flowers in October in Thailand (Vaddhanaphuti 2005), from July to November in China (Chen and Wood 2009a) and July to September in India (Misra 2007).



**Fig. 7.21** *Anthogonium gracile*, plant [Photo: E.S. Teoh]

**Phytochemistry:** No alkaloid was detected in *Anthogonium gracile* (Luning 1967), but the plant produces Batatasin III. (Veeraju, et al. 1989).

**Herbal Usage:** *Honghuaxiaodusuan* is obtained from Guangxi, Yunnan and Xizang. In Chinese Herbal Medicine, the orchid is used to treat menstrual disorders and to prevent pain (Wu 1994; *Zhonghua Bencao*, 2000).

### Overview

Pharmacological information on *Anthogonium* is lacking. Batatsin II is a phytoalexin with antifungal properties.

## Genus: *Apostasia*, Blume

Chinese name: *Ni Lan*

*Apostasia* is a genus of seven primitive terrestrial orchids with erect stems and narrow, lanceolate leaves and inconspicuous flowers



**Fig. 7.22** *Anthogonium gracile* Wall ex Lindl. [Photo: Bhaktar B. Raskoti]

(Fig. 7.23). Petals and sepals and sometimes even the lip are similar in shape and open widely. It is not resupinate. Flowers carry two anthers which have not evolved into pollinia. However, there is a primitive column which carries two or three stamens (Ridley 1894). If someone was describing a hypothetical ancestor of the modern orchid, this flower would fit their description (Fernier 2006). There are six species in Southeast Asia (Comber 2001), none with horticultural interest (Kocyan 2010).

*Apostasis* is a Greek word which means ‘divorced or desertion’, i.e. the tribe and genus are separated from the usual more advanced orchids in which the anthers are replaced by pollinia.

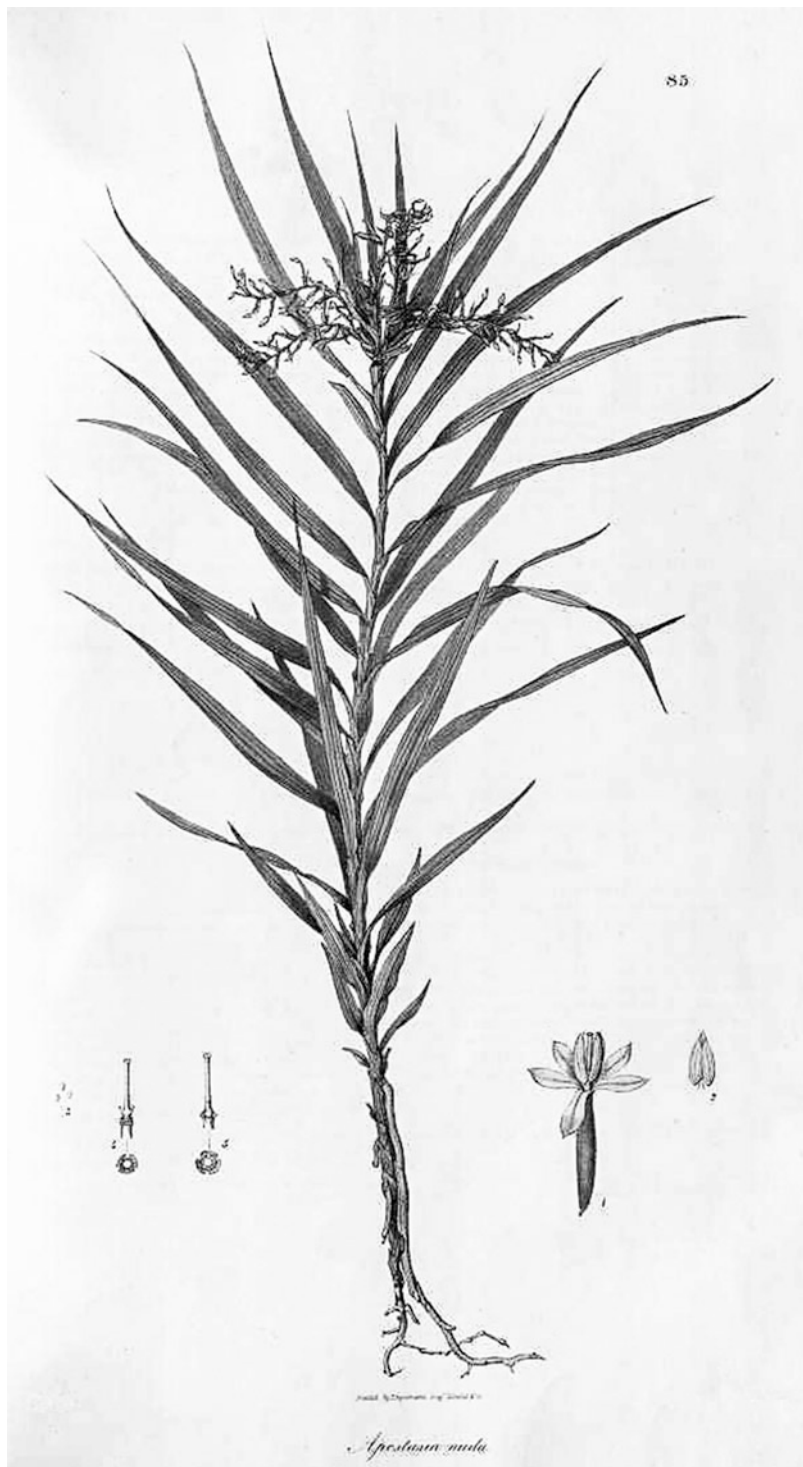
### *Apostasia nuda* R. Br.

Malay names: *Si sarsar bulang*, *Si marsari sari*, *Duhut bane-bane*, *Poko pulumpus bedak*, *Dudulu ingap*, *Kniching pelandok*

**Description:** Plant is grass-like, 20–60 cm tall, with linear-lanceolate, green leaves, 15–30 cm by 0.6–1.2 cm, spirally arranged around the

**Fig. 7.23** *Apostasia nuda*.

Adapted from a water-colour painting by C.M. Curtis in Wallich N: *Plantae Asiatica Rariores*, vol. 1: t. 85 (1830). Courtesy of Missouri Botanical Gardens, St. Louis, USA



stem. Aerial roots arise from lower parts of the stem, 2–3 mm in diameter. Inflorescence is terminal, emerging horizontally and becoming

pendulous as it matures, branching, the base of the branches covered with numerous, narrow, overlapping bracts. Raceme is pendulous.



**Fig. 7.24** *Apostasia nuda* R. Br. [Photo: Tim Yam]

Flowers are 15–20, yellow or white, 5–8 mm across, loosely arranged. Tepals and lip are of nearly equal size (4 by 0.5–1 mm) and appearance, lanceolate, and rolled backwards. Ovary is prominent, 8 mm long, lengthening to 1.2 cm in fruit (Fig. 7.24). It flowers from May to June (Seidenfaden and Wood 1992; Nanakorn and Watthana 2008). *Apostasia nuda* is distributed in Myanmar, southern Thailand, Malaysia and Indonesia in lowland forests at 100–1300 m, in shade. It is fairly common in lowland dipterocarp forests in Malaysia but is not easily recognised as an orchid (de Vogel 1969; Seidenfaden and Wood 1992; Beaman et al. 2001).

**Herbal Usage:** Roots were boiled and made into poultices to treat diarrhoea in Malaysia, and an infusion of the fruit was a local remedy for sore eyes (Burkill 1935). Root was also used to treat dog bite (de Vogel 1969).

### ***Apostasia wallichii* R. Br.**

Chinese name: *Jianyeni Lan*

Thai name: *Tan khamoi*, *Ma thon lak*

Indonesian name: *Djukut mayang kasintu* (grass like tail feather of jungle cockerel)

Malay name: *Hanching fatimah*, *Kenching fatimah*



**Fig. 7.25** *Apostasia wallichii* R. Br. [Photo: Peter O'Byrne]

**Description:** Plants are 40 cm tall bearing a rosette of narrowly lanceolate leaves 30 by 1.2 cm. Inflorescence is 8 cm long, with a few, long, arching branches not densely covered with bracts at their base. Flowers are 5–25, yellow. Petals, sepals and lip are identical in form, not recurved, 5.5 mm long (Fig. 7.25). Ovary is 1.2–1.5 cm long, lengthening to 2.5 cm in fruit (Seidenfaden and Wood 1992). A widespread, variable, lowland, terrestrial species, *A. wallichii* is distributed from Nepal and Assam to Sri Lanka and through Southeast Asia to New Guinea and Australia. It is also found in Sri Lanka, and at 1000 m in Hainan and southwest Yunnan in China. It grows on the forest floor in lowland forests at 250–1200 m in the tropics (de Vogel 1969). Flowering is not seasonal.

**Herbal Usage:** The root is used as a tonic in Thailand (Chuakul 2002). It was used as an antidiabetic agent in Malaya (de Vogel 1969).

### **Overview**

As a primitive genus, it would be interesting to compare its constituents with those of more advanced genera. Unfortunately, phytochemical and pharmacological information on *Apostasia* are lacking.



**Fig. 7.26** *Appendicula cornuta* Blume [Photo: E.S. Teoh]

### Genus: *Appendicula* Blume

*Appendicula* is a genus with 163 species, distributed from India and China throughout Southeast Asia to the Pacific. Plants are epiphytic or saxicolous, rarely terrestrial, small or large, with stems that are erect or pendulous, simple or branched, and enclosed by permanent leaf sheaths. Leaves are arranged in two ranks, regular, flat and usually held obliquely to the stems. Leaves are twisted at the base so that the blades all lie in one plane. Inflorescences are terminal and axillary, generally short with one or a few, small, white or greenish flowers.

#### *Appendicula cornuta* Blume

syn. *Dendrobium bifarium* Lindl.

**Description:** Stems are up to 30 cm in length with short internodes ensheathed by two ranks of oblong leaves that are rounded at the tip, 5 by 1.1 cm. Flower is solitary, single, white or slightly greenish, 1.2 cm across; lip flat, large, without side lobes, white, and marked by several, central, warty

ridges (Fig. 7.26). *A. cornuta* is the commonest species of *Appendicula* and the most widely distributed. It is a fairly common, small lowland orchid in Sikkim, southern China, Myanmar, Thailand, Indochina, Malaysia and Indonesia.

**Phytochemistry:** Alkaloid was detected in *A. cornuta* (Luning 1967; Chen and Gale 2009).

**Usage:** Juice extracted from the stems of *A. cornuta* (syn. *Dendrobium bifarium*) was used in Maluku as a medicine for whitlow (Dragendorff 1898, quoted by Lawler 1984).

### Overview

Being a fairly common and widely distributed lowland species in Southeast Asia, it is not surprising that it was used in Indonesian folk medicine.

### Genus: *Arachnis* Blume

Chinese name: *Zhizhu Lan*

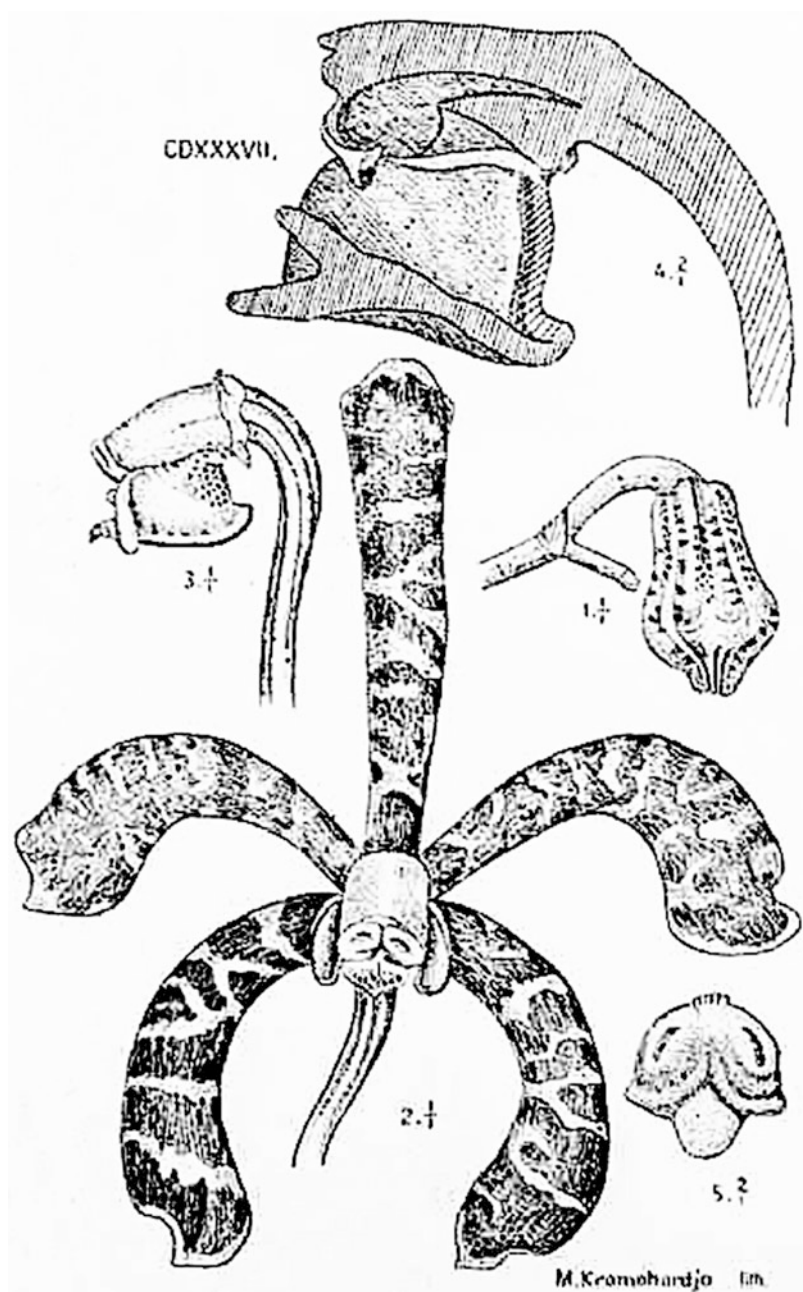
The Greek word *arachne* (spider, scorpion) is well known and the generic name describes the overall shape of the tough, fleshy flower which looks like a scorpion (Fig. 7.27). Members of the genus are commonly known as Scorpion Orchids. Spider Orchid is an alternative name. *Arachnis* is a robust, sun-loving, monopodial, tropical epiphyte that often has its roots scrambling over the ground or over rocks. Leaves are leathery, strap-shaped, ensheathing the stem and arranged in two straight alternating rows. Inflorescence is simple or branched, straight or arching, and carries several well-spaced flowers. *Arachnis* is distributed in Peninsular Thailand, Malaysia, Singapore and Indonesia. Hybrids between *Arachnis* and other monopodial orchids travel well, and they were used to initiate the transcontinental cut flower orchid industry. Intergeneric hybridisation involving *Arachnis* is extensive.

#### *Arachnis flos-aeris* (L.) Rchb. f.

syn. *Arachnis moschifera*

Iban name: *Wi buntak*

**Fig. 7.27** *Arachnis flos-aeries*, from: Smith J.J., Die Orchideen von Java Figureatlas, t. 437 (1905–1914). Drawing by M. Kromohardjo. Courtesy of the Swiss Orchid Foundation



Thai name: *Ueang maeng mum*

Description: *A. flos-aeries* is found frequently on limestone in Perak and Pahang in Peninsular Malaysia, Peninsular Thailand, Sumatra and Borneo. The variety *insignis* has dark maroon petals and sepals. Although this species is not

known to occur in Singapore, C.E. Carr managed to collect its natural hybrid, *A. maingayi*, which was growing on coastal mangrove in Pulau Seletar. *A. maingayi* is a natural hybrid between *A. flos-aeries* and *A. hookeriana* (Holtum 1964).

Plants are large and rambling, over 2 m in length, with leaves 15–20 cm long and 5 cm

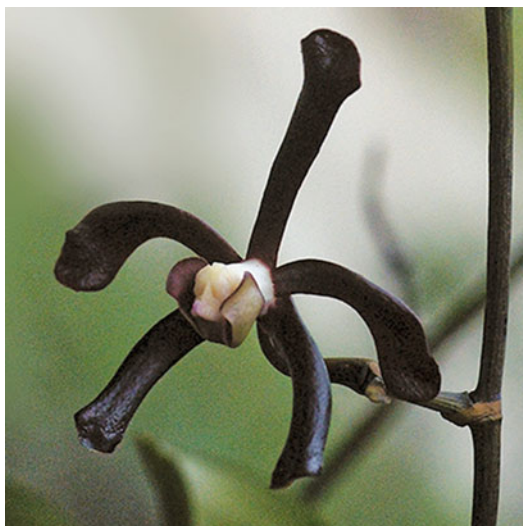


**Fig. 7.28** *Arachnis flos-aeris* (L.) Rchb. f [Photo: E.S. Teoh]

across. Inflorescence is up to 150 cm long, branching, bearing many widely spaced, large flowers 10 cm tall and 8 cm across. Sepals and petals are narrow, pale yellow-green marked with broad, irregular bars of purplish-brown (Fig. 7.28). Their strong musk scent is a lead when tracking down the species in the forest. The species was formerly known as *A. moschifera* because of the scent.

There are two natural varieties in addition to the type. *A. flos-aeris* var. *insignis*, the black scorpion orchid, occurs in Sumatra. Sepals and petals are dark maroon, almost black. Lip is white (Fig. 7.29). When not in bloom, the plant can be recognised by the purple flush on its young leaves (Comber 2001; Teoh 2005). Flowers of *A. flos-aeris* var. *gracilis* are four-fifths the size of the type, and curvature of lateral sepals and petals is more pronounced. Native to the mangrove swamps of Selangor and Negri Sembilan in Peninsular Malaysia, this variety has a strong, unpleasant scent (Teoh 2005). *A. flos-aeris* blooms twice a year, in May and November. In Thailand, flowering season is July (Vaddhanaphuti 2005). The variety *gracilis* blooms only in June.

Herbal Usage: Ibans of Sarawak apply sap from the orchid plant onto the painful site to relieve toothache (Christensen 2002).



**Fig. 7.29** *Arachnis flos-aeris* (L.) Rchb. f. var. *insignis* [Photo: E.S. Teoh]

### Overview

Although *Arachnis* is widespread in Malaysia and Indonesia, it is not widely used as a medicinal genus and pharmacological information on the genus is not available.

---

### Genus: *Arundina* Blume

Chinese name: *Zhuye Lan* (bamboo leaf orchid).

In Taiwanese (Hokien) dialect: *chiao a hoe*

*Arundina* is a grass-like, terrestrial orchid which resembles bamboo in vegetative form, and *Cattleya* in the appearance of its flowers. It is an attractive, sun-loving, free-flowering genus which enjoys a wide distribution from India, Nepal and Sri Lanka across southern China and Southeast Asia to the Ryukyu Islands and Tahiti. Flowers are variable in colour, size and fullness of their form, but experts who are very familiar with *Arundina* have opined that the differences do not constitute sufficient criteria to constitute several species; they all belong to a single variable species (Holtum 1964; Seidenfaden and Wood 1992). Nevertheless, a second dwarf species, *A. graminifolia* var. *revoluta* A.L. Lamb and C.L. Chan, which is native to Indochina and

**Fig. 7.30** *Arundina graminifolia* (D. Don) Hochr. (as *Arundina bambusifolia* Lindl.) adapted from a colour painting in Warner R., Williams B.S., *The Orchid Album* vol. 1884: t. 139 (1884) (painting by J.N. Fitch). Courtesy of Missouri Botanic Gardens, St. Louis, USA



Borneo, was recently described and recorded as a distinct species, *A. caespitosa* Aver.

*Arundina* is a familiar orchid in Southeast Asia. It has the ability to establish itself in secondary scrubland from sea level to moderate elevations and may be unaffected by logging. *Arundo* is Latin for 'reed'. The generic name describes the stems of the orchid (Fig. 7.30).

### ***Arundina graminifolia* (D. Don) Hochr.**

Common name: Bamboo Orchid

Chinese names: *Zhuye Lan* (bamboo leaf orchid); *Changgan Lan* (long stem orchid) *Shiyu Lan*

(jade stone orchid); *Hu Lian* (lake lotus); *Caojiang* (ginger grass); *Dayeliaodiaozhu* (big leaf bamboo); in Taiwan: bird orchid  
 Indonesian name: *Anggerik Bamb*; in Sundanese: *Handjuwang Sapu*  
 Malaysian name: *Phanyar* among the aboriginal Jakuns of Johor  
 Myanmar name: *Wah thitkhw*  
 Thai name: *Ueang Pai*  
 Vietnamese name: *Lan say*

Description: Stems and leaves are reed-like, or rather like diminutive bamboo. Flowers are borne singly or two at a time, successively on a slender erect stem. They are medium-sized to large,



**Fig. 7.31** *Arundina graminifolia* (D. Don Hochr) [Photo: E.S. Teoh]

looking a bit like *Cattleya* (Fig. 7.31). Petals and sepals are white to deep pink. Lip is deep purple with a yellow throat. There is a dwarf species with paler flowers. Jim Comber discovered an *alba* variety in North Sumatra at 1550 m which is also present in Borneo (Comber 2001; Beaman et al. 2001). It flowers throughout the year in Malaysia, Singapore and Indonesia (van Steenis 1958). In Thailand, the flowering season extends from August to March (Vaddhanaphuti 2001), but in the Kachin and Shan states of adjacent Myanmar, the flowering season is reversed, March to July (University of Myanmar Department of Botany, 2004). It flowers from July to December in Hong Kong (Wu et al. 2001). An extremely common orchid in open scrub, lowland forests, and in the foothills throughout southern China and Southeast Asia, this is an elegant orchid for lowland gardens in the tropics. However, lowland plants usually have smaller and less colourful flowers than plants from the highlands.

**Herbal Usage:** In Indian traditional medicine, applications of the scrapings of the bulbous stem are used to heal cracks on the skin. It is thought to have antibacterial properties (Singh and Duggal 2009).

The Hong Kong Chinese Medical Research Institute commented that *A. graminifolia* (syn. *A. chinensis* Blume) which flowers locally from July to December could be collected throughout

the year, and the whole plant or pseudobulb was either used fresh or divided into small pieces and sun-dried. The orchid was used for a variety of apparently unrelated conditions ranging from hepatitis and jaundice to urinary tract infections, oedema, rheumatic pain, trauma and snake bites. To treat a snake bite, the following prescription was recommended: (1) decoction of *Arundina*, 10–15 g in water, to be drunk; (2) additionally, a poultice made from mashed fresh bulbs to be applied to the wound. The herb is bitter, neutral, anti-inflammatory and diuretic (Li 1988).

Dispelling “heat” and toxicity, antirheumatism, anti-inflammation, diuresis, rheumatism with waist and thigh pain, gastric pain, urethritis, leg oedema and food poisoning are reasons for using the herb in Yunnan. In Guangxi, a decoction prepared by boiling 9–15 g of the whole plant of *A. graminifolia* is used for pain relief, the treatment of bruises, oedema, abdominal pain, intestinal parasitic infestation, jaundice, pulmonary tuberculosis, mental illness, rheumatism and bleeding from knife wounds (Zhongyao Da Cidian, 1986).

**Phytochemistry:** *Arundina* tested negative for alkaloids with the Dragendorff reaction (Lüning 1974, Luning 1975). However, it contains numerous stilbenoids, namely arundin and its analogues: arundinin, isoarundinin-I, isoarundinin II; lusianthridin, flavanthrin; flavidin; and batatasin III. Arundinol (a triterpenoid) and *p*-hydroxybenzyldehyde are also present. The first four compounds had not previously been isolated from other orchids (Majumder and Ghosal 1991, 1993, 1994).

Recently, one new benzyldihydrophenanthrene has been isolated from *A. graminifolia*. Named arundinaol, it is 7-hydroxy-1-(*p*-hydroxybenzyl)-2,4-dimethoxy-9,10-dihydrophenanthrene (Liu et al. 2004a, b, 2005a). Five phenanthrene constituents were separately reported by Liu et al. (2005b), namely: orchinol or 7-hydroxy-2,4-dimethoxy-9,10-dihydrophenanthrene; 4,7-dihydroxy-2-methoxy-9,10-dihydrophenanthrene; 2,7-dihydroxy-4-methoxy-9,10-dihydrophenanthrene; 7-hydroxy-2-methoxyphenanthrene-1,4-dione or densiflorol B; and 7-hydroxy-2-methoxy-9,10-dihydrophenanthrene-1,4-dione. The pharmacologic actions of these compounds have not been reported.



et al. 2014), It was one of three orchid species that were among the earliest plants to reappear in Krakatoa after the massive volcanic eruption in 1883 (Goldman 2005).

## References

- Abraham A, Vatsala P (1981) Introduction to Orchids, with illustrations and descriptions of 150 South Indian Orchids. TPGRI, Trivandrum
- Akarsh (2004) Newsletter of ENVIS NODE on Indian Medicinal Plants 1(2): June 2004)
- Alrich P, Higgins W (2008) The Marie Selby Botanical Gardens illustrated dictionary of orchid genera. Comstock Books, Carson City, NV
- Anonymous (Advert) 2008 Window on Taiwan, Puli Township
- Anuradha V, Prakash NS (1994a) Revised structure of flavidin in from *Acampe praemorsa*. *Phytochemistry* 35:273–274
- Anuradha V, Prakash NS (1994b) *Praemorsin*, a new phenanthropyran from *Acampe praemorsa*. *Phytochemistry* 37:909–910
- Anuradha V, Prakash NS (1998) A phenanthropyran from *Aerides crispum*. *Phytochemistry* 48(1):185–186
- Araoz R, Molgo J, Tandeau Marsac NT (2009) Neurotoxic cyanobacterial toxins. *Toxicon* 56:813–28
- Beaman TE, Wood JJ, Beaman RS, Beaman JH (2001) Orchids of Sarawak. Natural History Publications, Kota Kinabalu
- Beckman EM (2002) Rumphius Orchids. Orchid texts from the Ambonese Herbal by Georgius Everhardus Rumphius. Yale University Press, New Haven
- Benzing DH, Clements MA (1991) Dispersal of the Orchid *Dendrobium insigne* by the Ant *Tridomyrmex cordatus* in PNG. *Biotropica* 23(4, Part B):604–607
- Burkill IH (1935) (1966 reprint, 2nd ed., with contributions by Birtwistle W, Foxworthy FW, Scrivenor JB, Watson IG) A dictionary of economic products of the Malay Peninsula, Vol. II. London, Crown Agents for the Colonies. Kuala Lumpur: Ministry of Agriculture & Co-operatives
- Cai JY, Gong LM, Zhang YH et al (2008) Studies on chemical constituents from *Anoectochilus roxburghii*. *Zhong Yao Cai* 31(3):370–372
- Caius JF (1936) The medicinal and poisonous plants of India. *J Bombay Nat History Soc* 38(4):791–799
- Cakova V (2013) Contribution a l'etude phytochimique d'orchidees tropicales: identification des constituants d'*Aerides rosea* et d'*Acampe rigida*. Techniques analytiques et preparatives appliquees a *Vanda coerulea* et *Vanda teres*. Doctoral thesis, Universite de Strasbourg
- Cakova V, Urbain A, Antheaume C et al (2015) Identification of phenanthrene derivatives in *Aerides rosea* (Orchidaceae) using the combined systems of HPLC-ESI-HRMS/MS and HPLC-DAD-S-SPE-UV-NMR. *Phytochem Anal* 26(1):34–39
- Chen CM, Wang LF, Cheng KT, Hsu HH, Gau B, Su B (2004) Effects of *Anoectochilus formosanus* Hayata extract and glucocorticoid on lung maturation in pre-term rats. *Phytomedicine* 11(6):509–515
- Chen SC, Tsi ZH, Luo YB (1999) Native Orchids of China in Colour. Science Press, Beijing
- Chen XQ, Gale SW (2009) *Arundina* Blume. In: Chen XQ, Zj L, Zhu GH et al (eds) *Flora of China—Orchidaceae*. Science Press, Beijing
- Chen XQ, Gale SW, Cribb PJ (2009a) *Amitostigma* Schltr. In: Chen XQ, Zj L, Zhu GH et al (eds) *Flora of China—Orchidaceae*. Science Press, Beijing
- Chen XQ, Gale SW, Cribb PJ (2009b) *Apostasia* Bl. In: Chen XQ, Zj L, Zhu GH et al (eds) *Flora of China—Orchidaceae*. Science Press, Beijing
- Chen XQ, Gale SW, Cribb PJ, Ormerod P (2009c) *Anoectochilus* Blume. In: Chen XQ, Zj L, Zhu GH et al (eds) *Flora of China—Orchidaceae*. Science Press, Beijing, p 79
- Chen XQ, Wood JJ (2009a) *Acampe* Lindley. In: Chen XQ, Zj L, Zhu GH et al (eds) *Flora of China—Orchidaceae*. Science Press, Beijing
- Chen XQ, Wood JJ (2009b) *Aerides* Loureiro. In: Chen XQ, Zj L, Zhu GH et al (eds) *Flora of China—Orchidaceae*. Science Press, Beijing
- Chen XQ, Wood JJ (2009c) *Agrostophyllum* Blume. In: Chen XQ, Zj L, Zhu GH et al (eds) *Flora of China—Orchidaceae*. Science Press, Beijing
- Chen XQ, Wood JJ (2009d) *Anthogonium* Wall ex Lindl. In: Chen XQ, Zj L, Zhu GH et al (eds) *Flora of China—Orchidaceae*. Science Press, Beijing
- Chen XQ, Wood JJ (2009e) *Appendicula* Blume. In: Chen XQ, Zj L, Zhu GH et al (eds) *Flora of China—Orchidaceae*. Science Press, Beijing
- Chen XQ, Wood JJ (2009f) *Arachnis* Bl. In: Chen XQ, Zj L, Zhu GH et al (eds) *Flora of China—Orchidaceae*. Science Press, Beijing
- Cheng HY, Lin WC, Kiang FM, Wu LY, Peng WH (2003) *Anoectochilus formosanus attenuatus* amnesia induced by scopolamine in rats. *J Chin Med* 14 (4):235–245
- Chou LC, Chang DCN (2004) Asymbiotic and symbiotic seed germination of *Anoectochilus formosanus* and *Haemaria discolor* and their F1 hybrids. *Bot Bull Acad Sin* 45:143–151
- Chopra RN (1933) The indigenous drugs of India. The Art Press, Calcutta
- Chowdhury A, Paul P, Nath D, Bhattacharjee MK (2013) Antimicrobial efficacy of orchid extracts as potential inhibitors of antibiotic resistant strains of *Escherichia coli*. *Asian J Pharm Clin Res* 6(3):108–111
- Chuakul W (2002) Ethnomedical uses of Thai Orchidaceous plants. *Mohidol Univ J Pharm Sci* 29 (3-4):41–45
- Chuang SS, Lin CC, Lin J, Yu KH, Hsu YF, Yen MH (2003) The hepatoprotective effects of *Limonium sinense* against carbon tetrachloride and beta-D-galactosamine intoxication in mice. *Phytother Res* 17 (7):784–791
- Christensen E (1993) *Aerides*. *Am Orchid Soc Bull* 62 (6):594–609

- Christensen H (2002) Ethnobotany of the Iban and the Kelabit. Forest Department Sarawak; NEP Con Denmark; and Aarhus: University of Aarhus
- Comber JB (2001) Orchids of Sumatra. Natural History Publications (Borneo) and Singapore Botanic Gardens, Kota Kinabalu
- Cooray DA (1940) Orchids in oriental literature. *Orchids Zelandica* 7:73–80
- Cootes J (2001) Orchids of the Philippines. Marshall Cavendish, Singapore
- Crowley P (1995) Antenatal corticosteroid therapy: a meta-analysis of the randomized trials, 1972–1994. *Am Obstet Gynecol* 173:322–335
- Cui SC, Yu J, Zhang XH et al (2013) Antihyperglycemic and antioxidant activity of water extract from *Anoectochilus roxburghii* in experimental diabetes. *Exp Toxicol Pathol* 65(5):485–488
- Culpeper N (1653) Complete herbal: consisting of a comprehensive description of nearly all herbs with their medicinal properties and directions for compounding the medicines extracted from them
- Dash PK, Sahoo S, Bal S (2008) Ethnobotanical studies on orchids of Niyamgiri Hill Ranges, Orissa, India. *Ethnobot Leaflet* 12:70–78
- Descamps E, Petrault-Lapr ais M, Maurois P et al (2009) Experimental stroke protection induced by 4-hydroxybenzyl alcohol is cancelled by bacitracin. *Nerosci Res* 64(2):137–142
- Du XM, Irino N, Furusho N, Hiyashi J, Shoyama Y (2008) Pharmacologically active compounds in the *Anoectochilus* and *Goodyera* species. *Nat Med (Tokyo)* 62(2):132–148
- Du XM, Sun N, Tamura T, Mohri A, Sugiura M, Yoshizawa T, Irino N, Hayashi J, Shoyama Y (2001) Higher yielding isolation of kinsenoside in *Anoectochilus* and its antihyperliposis effect. *Biol Pharm Bull* 24(1):65–69
- Du XM, Sun NY, Chen Y, Irino N, Shoyama Y (2000) Hepatoprotective aliphatic glycosides from three *Goodyera* species. *Biol Pharm Bull* 23(6):731–734
- Du XM, Sun NY, Hayashi J, Chen Y, Sugiura M, Shoyama Y (2003) Hepatoprotective and antihyperliposis activities of in vitro cultured *Anoectochilus formosanus*. *Phytother Res* 17(1):30–33
- Du XM, Sun NY, Furusho N, Hayashi J, Shoyama Y (2007) Effect of in-vitro cultured *Anoectochilus formosanus* on lipid metabolism in clinical uses. *Am J Chin Med* 35(5):735–741
- Duggal SC (1971) Orchids in human affairs (A review). *Pharm Biol* 11(2):1727–1734
- Estler CJ, Gabrys MC (1979) Swimming capacity of mice after prolonged treatment with psychostimulants, II. Effect of methamphetamine on swimming performance and availability of metabolic substrates. *Psychopharmacology (Berl)* 60(2):173–176
- Fang HL, Wu JB, Lin WL, Ho HY, Lin WC (2008) Further studies on the hepatoprotective effects of *Anoectochilus formosanus*. *Phytother Res* 22(3):291–6)
- Fernier H (2006) Cyrtipediums in China. Part I: A history of Cyrtipedium in China. *Orchids* 75(10):764–771
- Flach A, Dondon RC, Singer RB et al (2004) The chemistry of pollination in selected Brazilian Maxillariinae orchids: floral rewards and fragrances. *J Chem Ecol* 30(5):1045–1056
- Gao C, Zhang FS, Zhang J et al (2009) Identification of *Anoectochilus* based on rDNA ITS sequences alignment and SELDI-TOF-MS. *Int J Biol Sci* 5(7):727–735
- Gao WW, Guo SX (2001) Effects of endophytic fungi hyphae and their metabolites on the growth of *Dendrobium candidum* and *Anoectochilus roxburghii*. *Zhongguo Yi Xue Ke Xue Yuan Xue Bao* 23(6):556–559
- Gao XM, Yang LY, She YQ et al (2013) Phenolic compounds from *Arundina graminifolia* and the anti-Tobacco Mosaic Virus activity. *Bull Kor Chem Soc* 33(7):2447–2449
- Germano MP, D'Angelo V, Sanoogo R, Morabito A, Pergolizzi S, De Pasquaale R (2001) Hepatoprotective activity of *Trichillia roka* on carbon tetrachloride-induced liver damage in rats. *J Pharm Pharmacol* 53(11):1569–1574
- Ghorbani A, Gravendeel B, Zarre S, de Booer H (2014a) Illegal wild collection and international trade in CITES-listed terrestrial orchid tubers in Iran. *Traffic Bull* 26(2):52–58
- Ghorbani A, Gravendeel B, Naghibi F, de Booer H (2014b) Wild orchid tuber collection in Iran: a wake-up call for conservation. *Biodivers Conserv* 23:2749. doi:10.1007/s10531-014-0746-y
- Goldman D (2005) *Arundina*, ecology. In: Pridgeon AC, Cribb PJ, Chase MW, Rasmussen FN (eds.) *Genera Orchidacearum, Vol 4 Epidendroideae (Part One)*. Oxford, University Press
- Grant B (1895) *The Orchids of Burma*. Hanthawaddy Press, Rangoon
- Griffith RE (1847) *Medical Botany of descriptions of the more important plants used in medicine, with their history, properties and mode of administration*. Lea and Blanchard, Philadelphia
- Guo SX, Fan L, Cao WQ et al (1997) *Mycena anoectochila* nov. isolated from mycorrhizal roots of *Anoectochilus roxburghii* from Xishuanbanna. *Mycologia* 89(6):952–954
- Gurong DB (2006) *An illustrated guide to the orchids of Bhutan*. DSB Publications, Thimphu
- Gurong DB (2005) *An illustrated guide to the orchids of Bhutan*. DSB Publications, Thimphu
- Han MH, Yang YW, Jin YP (2008) Novel terpenoid acyl esters and alkaloids from *Anoectochilus roxburghii*. *Phytochem Anal* 19(5):438–443
- He CN, Wang CL, Guo SX, Yang JS, Xiao PG (2005) Study on chemical constituents in herbs of *Anoectochilus roxburghii* II. *Zhongguo Zhong Yao Za Zhi* 30(10):761–763 (in Chinese)
- He CN, Wang CL, Guo SX, Yang JS, Xiao PG (2006) A novel flavonoid glucoside from *Anoectochilus roxburghii* (Wall.) Lindl. *J Integr Plant Biol* 48(3):359–363
- Hedley C (1888) Uses of Queensland plants. *Proc R Soc Queensland* 5:10–13

- Heiningen MV (2014) Overview of the wild orchids that occur in the Cantabrian mountains. <http://natuur-cantabrisch.blogspot.com/>
- Holttum RE (1964) Orchids of Malaya, 3rd edn. Government Printers, Singapore
- Hooper D (1937) Useful drugs of Iran and Iraq. Chicago, Field Museum of Natural History IX (3)
- Hooper R, Akerly S (1829) Lexicon medium or medical dictionary. 4th American edition. Collins and Hannay, New York, p 137
- Hoskovrc L (2007) *Anacamptis pyramidalis* (L.) Rich. – *Rrudhiavek pyramidal/Red pyramidal*. Botany.cz. 15.7.2007
- Hsiao HB, Lin H, Wu JB, Lin WC (2013) Kinsenoside prevents ovariectomy-induced bone loss and suppresses osteoclastogenesis by regulating classical NF- $\kappa$ B pathways. *Osteoporos Int* 24(5):1663–1676
- Hsiao HB, Wu JB, Lin H, Lin WC (2011) Kinsenoside isolated from *Anoetochilus formosanus* suppresses LPS-stimulated inflammatory reactions in macrophages and endotoxin shock in mice. *Shock* 35 (2):184–190
- Hsieh MT, Wu CR, Chen CF (1997) Gastrodin and p-hydroxybenzyl alcohol facilitate memory consolidation and retrieval, but not acquisition, on the passive avoidance task in rats. *J Ethnopharmacol* 56:45–54
- Hsieh CC, Hsiao HB, Lin WC (2010) A standardized aqueous extract of *Anoetochilus formosanus* modulated airway hyperresponsiveness in an OVA-inhaled murine model. *Phytomed (Jena)* 17(8-9):557–562
- Hu QF, Zhou B, Huang JM (2013a) Antiviral phenolic compounds from *Arundina graminifolia*. *J Nat Prod* 76 (2):292–296
- Hu QF, Zhou B, Ye YQ et al (2013b) Cytotoxic deoxybenzoins and diphenylethylenes from *Arundina graminifolia*. *J Nat Prod* 76(10):1854–1859
- Ikeuchi M, Yamaguchi K, Nishimura T, Yazawa K (2005) Effects of *Anoetochilus formosanus* on endurance capacity in mice. *J Nutr Sci Vitaminol (Tokyo)* 51 (1):40–44
- Ito A, Yasumoto K, Kasai R, Yamasaki K (1994) A sterol with an unusual side chain from *Anoetochilus koshunensis*. *Phytochemistry* 36(6):1465–1467
- Jalal JS, Kumar P, Pangtey YPS (2008) Ethnomedicinal Orchids of Uttarakhand. Western Himalayas Ethnobot Leaflets 12:1227–1230
- Jayaweera DMA (1981) A revised handbook of the flora of Ceylon, vol II. A.A. Balkema, Rotterdam
- JETRO TTPP 8/9/2008: *Anoetochilus formosanus*
- Johnston SRD, Howell A (2002) Endocrine treatment of advanced breast cancer: selective estrogen–receptor modulators (SERMS). In: Miller WR, Ingle JN (eds) Endocrine therapy in breast cancer. Marcel Dekker, New York
- Joseph J (1982) Orchids of Nilgiris. Records of the Botanical Survey of India, vol XXII. Botanical Survey of India (Department of Environment), Howrah
- Jung KA, Han D, Kwon EK, Lee CH, Kim YE (2007) Antifatigue effect of *Rubus coreanus* Miquel extract in mice. *J Med Food* 10(4):689–693
- Kam KY, Yu SJ, Jeong N et al (2011) p-Hydroxybenzyl alcohol prevents brain injury and behavioral impairment by activating Nrf2, PDI and neurotrophic factor genes in a rat model of brain ischaemia. *Mol Cell* 31(3):209–215
- Kamemoto H, Sagarik R (1975) Beautiful Thai orchid species. Orchid Society of Thailand, Bangkok
- Kocyan A (2010) Apostasioideae—the least known orchid sub-family. *Malesian Orchid J* 5:125–138
- Kovacs A, Vasas A, Hohmann J (2007) Natural phenanthrenes and their biological activity. *Phytochemistry* 69:1084–1110
- Lawler LJ (1984) Ethnobotany of the orchidaceae. In: Arditti J (ed) Orchid biology reviews & perspectives 3. Cornell University Press, Ithaca
- Lee SC, Tsai CC, Chen JC, Lin CC, Hu ML, Lu S (2002a) The evaluation of reno- and hepato- protective effects of huai-shan-yao (Rhizome Dioscoreae). *Am J Chin Med* 30(4):609–616
- Lee SC, Tsai CC, Chen JC, Lin JG, Lin CC, Hu ML, Lu S (2002b) Effects of “Chinese yam” on hepatonephrotoxicity of acetaminophen in rats. *Acta Pharmacol Sin* 23(6):503–508
- Li H, Guo HJ, Dao ZL (eds) (2000) Flora of Gaoligong Mountains. Science Press, Kunming
- Li NH (ed) (1988) Chinese medicinal herbs of Hong Kong, vol 2. Hong Kong Chinese Medicinal Research Institute, Hong Kong
- Lin CC, Chen SY, Lin JM, Chiu HF (1992a) The pharmacological and pathological studies on Taiwan folk medicine (VIII): the anti-inflammatory and liver protective effects of “mu-mien”. *Am J Chin Med* 20 (2):136–146
- Lin CC, Chen YL, Lin JM, Ujiie T (1997a) Evaluation of the antioxidant and hepatoprotective activity of *Terminalia catappa*. *Am J Chin Med* 25 (2):153–161
- Lin CC, Hsu YF, Lin TC, Hsu FL, Hsu HY (1998) Antioxidant and hepatoprotective activity of punicalagin and punicalin on carbon tetrachloride-induced liver damage in rats. *J Pharm Pharmacol* 50(7):789–794
- Lin CC, Huang PC, Lin JM (2000) Antioxidant and hepatoprotective effects of *Anoetochilus formosanus* and *Gynostemma pentaphyllum*. *Am J Chin Med* 28 (1):87–96
- Lin CC, Lee HY, Chang CH, Yang JJ (1999) The anti-inflammatory and hepatoprotective effects of fractions from *Cudrania cochinchinensis* var. *gerontogea*. *Am J Chin Med* 27(2):227–239
- Lin CC, Lin JM, Chiu HF (1992b) Studies on folk medicine “thang-kau-tin” from Taiwan. (I). The anti-inflammatory and liver-protective effect. *Am J Chin Med* 20(1):37–50
- Lin CC, Lin WC, Yang SR, Shieh DE (1995) Anti-inflammatory and hepatoprotective effects of *Solanum alatum*. *Am J Chin Med* 23(1):65–69
- Lin CC, Ng LT, Yang JJ, Hsu YF (2002a) Anti-inflammatory and hepatoprotective activity of peh-hue-juwa-chi-caio in male rats. *Am J Chin Med* 30(2–3):225–234

- Lin CC, Shieh DE, Yen MH (1997b) Hepatoprotective effect of fractions of Ban-zhi-lian on experimental liver injuries in rats. *J Ethnopharmacol* 56(3):193–200
- Lin JM, Lin CC, Chiu HF, Yang JJ, Lee SG (1993) Evaluation of the anti-inflammatory and liver-protective effects of *Anoectochilus formosanus*, *Ganoderma lucidum* and *Gynostemma pentaphyllum* in rats. *Am J Chin Med* 21(1):59–69
- Lin KJ, Chen JC, Tsauer W, Lin CC, Lin JG, Tsai CC (2001) Prophylactic effect of four prescriptions of traditional Chinese medicine on alpha-naphthylisothiocyanate and carbon tetrachloride induced toxicity in rats. *Acta Pharmacol Sin* 22(12):1159–1167
- Lin SC, Lin CC, Lin YH, Shyuu SJ (1994) Hepatoprotective effects of Taiwan folk medicine: *Wedelia chinensis* on three hepatotoxin-induced hepatotoxicity. *Am J Chin Med* 22(2):155–168
- Lin SC, Lin CH, Lin CC, Lin YH, Chen CF, Chen IC, Wang LY (2002b) Hepatoprotective effects of *Arctium lappa* Linne on liver injuries induced by chronic ethanol consumption and potentiated by carbon tetrachloride. *J Biomed Sci* 9(5):401–409
- Lin SC, Lin CC, Lin YH, Supriyatna S, Pan SL (1996) The protective effect of *Alstonia scholaris* R. Br On hepatotoxin-induced acute liver damage. *Am J Chin Med* 24(2):153–164
- Lin TP (1977) Native orchids of Taiwan, Vol. 2, pp. 166–7, colour photo 98
- Lin WC, Hsieh CC (2005) Commercial application of *Anoectochilus formosanus*: immunomodulating activities. *Int J Appl Sci Eng* 3(3):175–178
- Liu M, Lv H, Ding Y (2012) Antitumoral bibenzyl derivatives from tuber of *Arundina graminifolia*. *Zhongguo Zhong Yao Zhi* 37(1):66–70
- Liu MF, Ding Y, Zhang DM (2005a) Phenanthrene constituents from rhizome of *Arundina graminifolia*. *Zhongguo Zhong Yao Zazhi* 30(5):353–356
- Liu MF, Han Y, Xing DM et al (2004a) A new stilbenoid from *Arundina graminifolia*. *J Asian Nat Prod Res* 6(3):229–232
- Liu MF, Han Y, Xing DM et al (2004b) Chemical constituents from the rhizome of *Arundina graminifolia*. *Zhongguo Zhong Yao Zazhi* 29(2):147–149
- Liu MF, Han Y, Xing DM, Wang W, Xu LZ, Du LJ, Ding Y (2005b) One new benzyldihydrophenanthrene from *Arundina graminifolia*. *J Asian Nat Prod Res* 7(5):767–770
- Liu SH, Pan IH, Im C (2007) Inhibitory effect of p-hydroxybenzyl alcohol on tyrosinase activity and melanogenesis. *Biol Pharm Bull* 30(6):1135–1139
- Liu SH, Chu IM, Pan IH (2008) Effects of hydroxybenzyl alcohols on melanogenesis in melanocyte-keratinocyte co-culture and monolayer culture of melanocytes. *J Enzyme Inhib Med Chem* 23(4):526–534
- Liu TS, Su HJ (1977) Flora of Taiwan. Taiwan National University, Taipei
- Low T (1987) Australian wild foods. Ground orchids—Salute to Saloop. *Aust Nat Hist* 22(5):202–203
- Lu KL, Chang YS, Ho LK et al (2000) The evaluation of the therapeutic effect of tao- tsang -tsao on alpha-naphthylisothiocyanate and carbon tetrachloride-induced acute liver damage in rats. *Am J Chin Med* 28(3-4):361–370
- Lu HC, Hsieh MH, Chen CE et al (2012) A high-throughput virus-induced gene-silencing vector for screening transcription factors in virus-induced plant defense response in orchid. *Mol Plant Microbe Interact* 25(6):738–746
- Luning B (1967) Studies on Orchidaceae alkaloids. IV. Screening of species for alkaloids 2. *Phytochemistry* 6:857–861
- Lüning B (1974) Alkaloids of the Orchidaceae. In: Withner CL (ed) The orchids: scientific studies. John Wiley & Sons, New York
- Luning B (1975) Hunting orchids for chemistry. In: Senghas SK (ed) Proceedings, 8th World Orchid Conference, Frankfurt, 538–9
- Ma ZQ, Li SS, Zhang MJ et al (2010) Light Intensity affects growth, photosynthetic capability, and total flavonoid accumulation of *Anoectochilus* plants. *Hortsci* 45(6):863–867
- Majumder PL, Banerjee S, Maiti DC, Sen S (1995) Stilbenoids from the orchids *Agrostophyllum callosum* and *Coelogyne flaccida*. *Phytochemistry* 39:649–653
- Majumder PL, Banerjee S, Sen S (1996) Three stilbenoids from the orchid *Agrostophyllum callosum*. *Phytochemistry* 42:847–852
- Majumder PL, Banderjee S, Lahari S et al (1998) Dimeric phenanthrenes from two *Agrostophyllum* species. *Phytochemistry* 47:855–860
- Majumder PL, Ghosal S (1991) Arundinol, a new triterpene from the orchid *Arundina babbusifolia*. *J Indian Chem Soc* 68:88–91
- Majumder PL, Ghosal S (1993) Two stilbenoids from the orchid *Arundina bambusifolia*. *Phytochemistry* 32:439–444
- Majumder PL, Ghosal S (1994) Two stilbenoids from the orchid *Arundina bambusifolia*. *Phytochemistry* 35(1):205–208
- Majumder PL, Majumder S, Sen S (2003) Triperoenoids from the orchids *Agrostophyllum brevipes* and *Agrostophyllum callosum*. *Phytochemistry* 62:591
- Majumder PL, Sabzabadi E (1988) Agrostophyllin, a naturally occurring phenanthropyran derivative from *Agrostophyllum khasianum*. *Phytochemistry* 27(6):1899–1901
- Majumder PL, Sen S, Banerjee S (1999) Agrostophyllol and isoagrostophyllol, two novel dimeric 9,10-dihydrophenanthropyran derivatives from the orchid *Agrostophyllum callosum*. *Tetrahedron* 55(21):13
- Masuda K, Ikeuchi M, Koyama T, Yamaguchi K, Woo JT, Nishimura T, Yazawa K (2008) Suppressive effects of *Anoectochilus formosanus* extract on osteoclast function in vitro and bone resorption in vivo. *J Bone Miner Metab* 26(2):123–129
- Misra S (2007) Orchids of India A Glimpse. Bishen Singh Mahendra Pal Singh, Delhi
- Muir HJ (1987) Symbiotic micro propagation of *Orchis laxiflora*. *Orchid Rev* 95:27–29

- Murase T, Haramizu S, Shimotoyadome A, Nagasawa A, Tokimitsu I (2005) Green tea extract improves endurance capacity and increases muscle lipid oxidation in mice. *Am J Physiol Regul Integr Comp Physiol* 288 (3):R708–R715
- Nanakorn W, Watthana S (2008) Queen Sirikit Botanic Garden (Thai Native Orchids 1 and 2). Wanida Press, Chiang Mai
- Neiland MRM (2001) *Anacamptis*, ecology. In: Pridgeon AM, Cribb PJ, Chase MW (eds.) *Genera Orchidacearum Vol. 2 Orchidoideae (Part 1)*. Oxford, Oxford University Press
- Okovityi SV, Arkad'eva AV, Bezborodkina NN, Sakuta GA, Iaroslavtsev MI, Shulenin SN, Kudriavtsev BN (2007) New protective effect of simvastatin in rats with experimental steatohepatitis. *Eksp Klin Farmakol* 70(3):43–5 (in Russian) (English Abstract in PubMed)
- Ou JC, Hsieh WC, Lin IH, Chang YS, Chen IS (eds) (2003) The catalogue of medicinal plant resources in Taiwan. Department of Health, Executive Yuan, Taipei
- Pant B, Raskoti BB (2013) Medicinal orchids of Nepal. Kathmandu, Himalayan Map House (P) Ltd
- Perry LM, Metzger J (1980) Medicinal plants of East and Southeast Asia: attributed properties and uses. MIT Press, Cambridge, MA
- Pettersson B (1976) Orchids and men in European landscapes. In: Senghas K (ed) *Proceedings of 8th World Orchid Conference*. Deutsch Orchideen Gesellschaft, Heidelberg, pp 80–83
- Pridgeon AM, Cribb PJ, Chase MW, Rasmussen FN (eds) (2001) *Genera Orchidacearum, Vol. 2. Orchidoideae (Part 1)*. Oxford University Press, Oxford, pp 251–255
- Rao AN (2004) Medicinal orchid wealth of Arunachal Pradesh. *Newslett ENVIS NODE Indian Med Plant* 1 (2):1–7
- Rao TA, Sridhar S (2007) Wild Orchids in Karnataka. A pictorial compendium. Institute of Natural Resources Conservation, Education, Research and Training (INCERT), Bangalore
- Raskoti BB (2009) The Orchids of Nepal. Bhakta Bahadur Raskoti and Rita Ale, Kathmandu
- RCOG Guideline No. 7 (1996) Antenatal corticosteroids to prevent respiratory distress syndrome
- Recart W, Ackerman JD, Falcon W, Hernandez P (2014) Here and there and everywhere: the invasion experience differs among islands for the bamboo orchid. [www.ibparticipation.org/pdf/wilnelia\\_Phase3\\_Poster.pdf](http://www.ibparticipation.org/pdf/wilnelia_Phase3_Poster.pdf)
- Ridley H (1894) The Orchidaceae and Apostasiaceae of the Malay Peninsula. *J Linn Soc* 32:335–338
- Ridley H (1907) Materials for a flora of the Malay Peninsula, vol 1. Methodist Publishing House, Singapore
- Ryu BK, Ahn BO, Oh TY, Kim SH, Kim WB, Lee EB (1998) Studies on protective effect of DA-9601, *Artemisia asiatica* extract, on acetaminophen and CCl<sub>4</sub>-induced liver damage in rats. *Arch Pharm Res* 21 (5):508–513
- Santapau H, Kapadia Z (1966) The orchids of Bombay. Government of India Press, Calcutta
- Sathish Kumar C, Manilal KS (1994) A catalogue of Indian orchids. Bishen Singh Mahendra Pal Singh, Mehra Dun
- von Schlechter R (1919) *Orchidologiae Sino-Japonicae Prodrum Eine Kritische Besprechung der Orchideen Ost-Asiens*. Berlin, Verlag Des Repertoriuns, pp. 92–93, 99. 50, 125–135
- Schuiteman A, de Vogel EF (2000) *Cac Ci Ho Lan (Orchidaceae) Cua Thai Lan, Lao, Campuchia Va Viet Nam. Orchid Genera of Thailand Laos, Cambodia and Vietnam*. (Vietnamese-English edition). Leiden, National Herbarium Nederland
- Schultes RE, Pease AS (1963) Generic names of Orchids. Their origin and meaning. Academic, New York & London
- Seidenfaden G, Wood JJ (1992) The orchids of peninsular Malaysia and Singapore. Olsen & Olsen, Fredensborg
- Sevgi E, Attandag E, Kara O et al (2012) Studies in the morphology, anatomy and ecology of *Anacamptis pyramidalis* (L.) L. C. M. Richard (Orchidaceae) in Turkey. *AGRIS Records, FAO*
- Sezik E (1967) *Türkiye'nin Salepgilleri Ticari Salep Cestitleri ve Ozellike Mugla Salebi Uzerinde Arastirmalar*. Doctoral Thesis. Istanbul Universitesi Eczacihk Fakultesinde (In Turkish. Summary in English)
- Sezik E (1990) *Türkiye'nin orkideleri*. Bilim ve Teknik 269:5–8 (quoted by Ericisli, Esitken, 2002)
- Shiau YJ, Hsia CN, Tsay HS (2006) In vitro study, conservation and utilization of medicinal plant *Anoetochilus formosanus* in Taiwan. *ISHS Acta Horticulturae* 764: XXVII International Horticultural Congress—IH 2006: International Symposium on Plant Biotechnology: From Bench to Commercialization
- Shih CC, Wu YW, Lin WC (2001) Ameliorative effects of *Anoetochilus formosanus* extract on osteopaenia in ovariectomised rats. *J Ethnopharmacol* 77 (2-3):233–238
- Shih CC, Wu YW, Lin WC (2002) Antihyperglycaemia and anti-oxidant properties of *Anoetochilus formosanus* in diabetic rats. *Clin Exp Pharmacol Physiol* 29(8):684–688
- Shih CC, Wu YW, Lin WC (2003) Scavenging of reactive oxygen species and inhibition of the oxidation of low density lipoprotein by aqueous extraction of *Anoetochilus formosanus*. *Am J Chin Med* 31 (1):25–36
- Shih CC, Wu YW, Hsieh CC, Lin WC (2004) Effect of *Anoetochilus formosanus* on fibrosis and regeneration of the liver in rats. *Clin Exp Pharmacol Physiol* 31 (9):620–625
- Shyur LF, Chen CH, Lo CP, Wang SY, Kang PL, Sun SJ, Chang CA, Tzeng CM, Yang NS (2004) Induction of apoptosis in MCF-7 human breast cancer cells by phytochemicals from *Anoetochilus formosanus*. *J Biomed Sci* 11(6):928–939
- Singh A, Duggal S (2009) Medicinal orchids: an overview. *Ethnobot Leaflets* 13:351–363
- Stajner D, Popovic B, Kapo A et al (2010) Antioxidant and Scavenging Capacity of *Anacamptis*

- pyramidalis—Pyrimidal Orchid from Vojvodina. *Phytother Res* 24(5):759–763
- Stoessel LJ, Arditti J (1984) Orchid Phytoalexins. In: Arditti J (ed) *Orchid biology reviews and perspective*, vol III. Comstock Publishing Associates, Cornell University Press, Ithaca
- van Steenis CCGJ (1958) Magic plants of the Dayak. *Sarawak Museum J* 11:432–436
- Stewart I, Webb PM, Schluter PJ, Shaw GR (2006) Recreational and occupational field exposure to freshwater cyanobacteria—a review of anecdotal and case reports, epidemiological studies and the challenges for epidemiologic assessment. *Environ Health* 5:6
- Subedi A, Kunwar B, Choi Y et al (2013) Collection and trade of wild-harvested orchids in Nepal. *J Ethnobiol Ethnomed* 9:64–73
- Tang MJ, Guo SX (2004) Effect of endophytic fungi on the culture and four enzyme activities of *Anoectochilus formosanus*. *Zhongguo Zhong Yao Za Zhi* 29(6):517–520
- Teoh ES (2005) *Orchids of Asia*, 3rd edn. Marshall Cavendish, Singapore
- Teoh ES, Teoh K (1991) Over 45 feeling fabulous. Menopause and the hormone replacement controversy. Times Editions, Singapore
- Trivedi VP, Dixit RS, Lal VK (1980) Orchids in the drug markets of Bareilly, Kanpur and nearby districts. *Nagarjun (Calcutta)* 23(8):157–163
- Tsavakelova A, Cherdynitseva TA, Netrusov AI (2005) Auxin production by bacteria associated with orchids. *Mikrobiologiya* 74(1):55–62
- Tsavakelova EA, Lobakova ES, Kolomeitseva GL et al (2003) Localization of associative cyanobacteria on the roots of epiphytic orchids. *Mikrobiologiya* 72 (1):99–104
- Tsay HS (2002) Tissue culture of *Anoectochilus formosanus*. In: *Proceedings of the 16th World Orchid Conference*, Kuala Lumpur, p. 438
- Tseng CC, Shang HF, Wang LF, Su B, Hsu CC, Kao HY, Cheng KT (2006) Antitumor and immunostimulating effects of *Anoectochilus formosanus* Hayata. *Phytomedicine* 13(5):355–370
- United States Patent 7033617 filed by Shyur LF, Yang NS, Kang PL, Sun SJ, Wang SY (2002). Use of *Anoectochilus formosanus* plant extracts and their derived fractions as herbal medicines or nutraceutical supplements for chemoprevention or treatment of human malignancies. University of Yangon Department of Botany (undated, possibly 2004): Myanmar Native Orchids
- Vaddhanaphuti N (1997) A field guide to the wild orchids of Thailand. Silkworm Books, Chiang Mai
- Vaddhanaphuti N (2001) A field guide to the wild orchids of Thailand, 3rd edn. Silkworm Books, Chiang Mai
- Vaddhanaphuti N (2005) A field guide to the wild orchids of Thailand, Fourth and expanded edn. Silkworm Books, Chiang Mai
- Valcheva-Kuzmanova S, Borisova P, Galunska B, Krasnalaaiev I, Belcheva A (2004) Hepatoprotective effect of the natural fruit juice from *Aronia melanocarpa* on carbon tetrachloride-induced acute liver damage in rats. *Exp Toxicol Pathol* 56 (3):195–201
- van Apeldoorn ME, van Egmond HP, Speijers GJ, Bakker GJ (2007) Toxins of cyanobacteria. *Mol Nutr Food Res* 51(1):7–60
- van den Brink RCB (1937) Synopsis of the vernacular names and the economic use of the indigenous orchids of Java. *Blumea Suppl* 1:38–51
- van Rheede HA (1693) *Hortus Indicus Malabaricus*, vol 12. Dutch East India Company, Kerala
- Veitch NC, Grayer B (2003a) Phytochemistry of *Anacamptis*. In: Pridgeon AM, Cribb PJ, Chase MW, Rasmussen FN (eds) *Genera Orchidacearum*, vol 3, Orchidoideae (Part Two) Vanilloideae. Oxford University Press, Oxford
- Veitch NC, Grayer B (2003b) Phytochemistry of *Anoectochilus*. In: AM Pridgeon, PJ Cribb, MW Chase, FN Rasmussen (eds) *Genera Orchidacearum*, Vol. 3. Orchidoideae (Part Two) Vanilloideae. Oxford, University Press
- Veeraju P, Rao P, Rao NSJ et al (1989) Bibenzyls and phenanthrenoids of some species of Orchidaceae. *Phytochemistry* 28:3031–3034
- Vidal J (1963) *Les plantes utiles Du Laos*. Cryptograms—Gymnospermes—Monocotyledones. Museum National d'Histoire Naturelle, Paris
- de Vogel EF (1969) Monograph of the tribe Apostasiaeae (Orchidaceae). *Blumea* 17:313–350
- Wang LF, Lin CM, Shih CM, Chen HJ, Su B, Tseng CC, Gau BB, Cheng KT (2005) Prevention of cellular oxidative damage by an aqueous extract of *Anoectochilus formosanus*. *Ann NY Acad Sci* 1042:379–386
- Wang SY, Kuo YH, Chang HN, Pl K, Tsay HS, Lin KF, Yang NS, Shyur LF (2002) Profiling and characterization antioxidant activities in *Anoectochilus formosanus* Hayata. *J Agric Food Chem* 50 (7):1859–1865
- Wedek H (1961) *Dictionary of Aphrodisiacs*. Philosophical Library, New York, p 216
- Wood J, Ramsey M (2004) Plate 482. *Anacamptis laxiflora* Orchidaceae. *Curtis's Botanical Magazine* 21(1):26–33
- Wu CR, Hsieh MT, Liao J (1996) p-Hydroxybenzyl alcohol attenuates learning deficits in the inhibitory avoidance task: involvement of serotonergic and dopaminergic systems. *Clin J Physiol* 39:265–273
- Wu TL, Hu QM, Xia NH, Lai PCC, Yip KL (2001) Check list of Hong Kong plants 2001. Agriculture, Fisheries and Conservation Department Bulletin 1, Hong Kong
- Wu JB, Lin WL, Hsieh CC, Ho HY, Tsay HS, Lin WC (2007) The hepatoprotective activity of kinsenoside from *Anoectochilus formosanus*. *Phytother Res* 21 (1):58–61
- Wu JB, Chuang HR, Yang LC, Lin WC (2010) A standardized extract of *Anoectochilus formosanus* ameliorated thioacetamide-induced liver fibrosis in

- mice. The role of Kupffer cells. *Biosci Biotechnol Biochem* 74(4):781–787
- Wu K (1997) Quick propagation and immediate test on *Anoectochilus formosanus*. *Zhong Yao Cai* 20 (12):595–597 (in Chinese)
- Wu TL, Hu QM, Xia NH, Lai PCC, Yip KL (2002) Check list of Hong Kong plants 2001. Hongkong, Agriculture, Fisheries and Conservation Department Bulletin 1 (Revised)
- Wu XR (1994) A concise edition of medicinal plants in China. Guangdong Higher Education Publication House, Guangdong (in Chinese)
- Yang LC, Lu TJ, Lin WC (2013) A Type II Arabinogaactan from *Anoectochilus formosanus* for G-CSF production in macrophages and leukopenia improvement in CT-28 bearing Mice treated with 5-Fluorouracil. *Evid Based Complement Alternat Med*
- Yang NSD, Shyur LF, Chen CH, Wang SY, Tzeng CM (2004) Medicinal herb extract and a single-compound drug confer similar complex pharmacogenomic activities in mcf-7 cells. *J Biomed Sci* 11(3):418–422
- Yen MH, Lin CC, Chuang CH, Liu SY (1991) Evaluation of root quality of *Bupleurum* species by TLC scanner and the liver protective effects of xiao-chai-hu-tang” prepared using three different *Bupleurum* species. *J Ethnopharmacol* 34(2-3):155–165
- Yong HS (1990) Orchid portraits. Tropical Press Sdn Bhd, Kuala Lumpur
- Yu SJ, Kim JR, Lee CK et al (2005) *Gastrodia elata* Blume and an active component, p-hydroxybenzyl alcohol reduce focal ischaemic brain injury through antioxidant related gene expression. *Biol Pharm Bull* 28:1016–1020
- Zhang FS, Lu YL, Zhao Y, Guo SX (2013) Promoting role of an endophyte on the growth and contents of kinsenosides and flavonoids of *Anoectochilus formosanus* Hayata, a rare and threatened orchidaceous plant. *J Zhejiang Univ Sc B* 14(9):785–792
- Zhang Y, Cai J, Ruan H et al (2007a) Antiglycemic activity of kinsenoside, a high yielding constituent of *Anoectochilus roxburghii* in streptozoin diabetic rats. *J Ethnopharmacol* 114(2):141–145
- Zhang YH, Cai JY, Pi HF, Wu JZ (2007b) Antihyperglycaemic activity of kinsenoside, a high yielding constituent from *Anoectochilus roxburghii* in streptozoin treated rats. *J Ethnopharmacol* 114 (2):141–145
- Zhongyao Da Cidian* (1986 reprint of 1997): compiled by the Jiangsu College of New Medicine in 1977
- Zhonghua Bencao* vol. 8 (2000) edited by Hu XM, Zhang WK, Zhu QZ, et al. Shanghai, Shanghai Scientific and Technical Press, 1999
- Zurawell RW, Chen H, Burke JM, Prepas EE (2005) Hepatotoxic cyanobacteria: a review of the biological importance of microcystins in freshwater environments. *J Toxicol Environ Health B Crit Rev* 8(1):1–37

Medicinal Orchids of Asia

Teoh, E.S.

2016, XVIII, 752 p. 443 illus., 162 illus. in color.,

Hardcover

ISBN: 978-3-319-24272-9