

Medicinal Plant Fact Sheet: *Cypripedium*: Lady's slipper orchids

Common Name

slipper orchid, lady's slipper, moccasin flower, camel's foot, squirrel foot, steeple cap, Venus' shoes, whippoorwill shoes, nerve root, American valerian

Scientific Name

Cypripedium spp. (Orchidaceae: Orchid Family)

Description

Cypripedium is a genus of about 50 species of perennial, terrestrial orchids. The herbaceous stems and leaves of the various species grow from a few centimeters to over 1 m in height and die back to a usually short and thick underground rhizome during the winter. Most species have three to several leaves borne along the stem that are ovate, elliptic, or lanceolate, and pleated longitudinally. The smaller species may produce a few leaves at ground level with a single flower on a simple stalk while the larger species often have several leafy stems with scapose, multi-flowered inflorescences borne at the stem ends. The inflorescences are racemose or almost spicate with from one to twelve flowers, with most species bearing 1-3 flowers. The flowers are showy with the color of the petals and sepals often contrasting with that of the inflated, sac-shaped lip—the colors ranging through white, yellow, green, pink, red, brown or purple. Flowers are produced during the warmer months: spring but especially in summer (Brown 1997, Cribb 1997, Doherty 1997, Sheviak 2002). The fruit are linear-ellipsoid capsules that, as is typical with orchids, produce enormous numbers of minute seeds lacking endosperm and needing particular conditions and fungal associates to germinate.

Distribution

Lady's slipper orchids are mainly temperate and found throughout the Northern Hemisphere in North and Central America, Europe and Asia. They occur as far south as the Himalayas in the Old World and Guatemala and Honduras in the Americas. The genus occurs over an extensive latitudinal range extending from north of the Arctic Circle in Alaska to 14° north latitude in Central America. They grow in a variety of soils in coniferous forests, mixed deciduous woodlands, bogs, fens, grasslands, sandy shorelines, glades, seepages on bluffs, or prairies and the tundra of Alaska and Siberia. In the northern parts of their range, plants may occur to sea level but further south they are generally restricted to higher elevations where they inhabit montane woodlands and grasslands. One species has been reported from 4900 m in the Himalayas. Lady's slipper orchids usually grow in light, moderate or deep shade (Brown 1997, Cribb 1997, Doherty 1997). There are 12 recognized species in North America and one or more species are found in every province of Canada and every state of the USA except Nevada, Florida and Hawaii (Sheviak 2002).

Reproduction

Cypripedium flowers are generally self-compatible (Harrod & Knecht 1994) but insects are required to transfer pollen to the stigma. Rather than the discrete, waxy packets of pollen known as pollinia that are found in other orchids, *Cypripedium* pollen masses are granular and often viscid sticky. The lip or labellum of these orchids is inflated into a sac-like structure and this floral morphology is key to their mode of pollination. The labellum has an upper orifice with a smooth margin that affords no purchase and an infolded margin and side lobes that block escape by visiting insects should they fall into the pouch. Insects are generally unable to exit by the route in which they entered. In attempting to escape, insects are guided to climb a particular interior portion of the pouch and then under one of two anthers and out through one of the basal orifices. If they are of the correct size they receive a smudge of granular pollen on the dorsum and may transfer the pollen to the stigma of the same flower or another plant. The flowers are visited by a diverse group of insects in the Hymenoptera (wasps, ants and bees), Diptera (flies), Coleoptera (beetles), Lepidoptera (moths and butterflies) and Thysanoptera (thrips: Nilsson 1979), but the flowers' particular structure means that only insects of certain size and behavior can effect pollination.

The flowers of lady's slipper orchids do not produce nectar. Pollinators appear to be attracted by the color and fragrance of the flowers (Sugiura et al. 2001). The odors of lady's slippers may include acetates (Vance 2007), terpenes (Overton & Manura 1999) or benzenoid compounds (Bergström 1991) and it is thought that they may mimic pheromones of some insects or indicate the presence of food ("food deception"). However, though it has been proposed that the flowers produce pheromone-mimic scents that attract male bees that come to "mate," in some species it is female bees that are attracted. Some Asian species, for instance, are pollinated by bumblebee queens (*Bombus* spp). It has even been hypothesized that the inflated, trap-like labellum mimics the nest site of these queens (Li et al. 2006) or that pollination results as a case of floral mimicry by *Cypripedium* of other flowers that offer rewards (Sugiura et al. 2002).

Demonstrated pollinators of the North American *Cypripedium* species vary, but most are Hymenoptera. *Cypripedium acaule* is pollinated by the bumblebee, *Bombus vagans* (Stoutamire 1967), *C. arietinum* by *Dialictus* bees (Brzeskiewicz 2000), and *C. candidum* by *Andrena placida* and other andrenid and halictid bees (Catling and Knerer 1980). *C. fasciculatum* is pollinated by small wasps in the family Diapriidae (Ferguson & Donham 1999). *C. montanum* is visited by andrenid, halictid and colletid bees (Vance 2007). *C. parviflorum* var. *pubescens* is pollinated by males of the small carpenter bee, *Ceratina calcarata* (Stoutamire 1967) and *C. reginae* by the leaf-cutter bees, *Megachile melanophaea* and *M. centuncularis* (Guignard 1886) and a syrphid fly, *Syrphus torvus* (Vogt 1990). Flowers of some Asian species have a mushroom-like scent and it has been suggested that they are pollinated by fungus flies (Bänziger et al. 2005) but this has not been verified in the field, so far as is known.

For reasons that are not completely understood, fruit set can be low among terrestrial orchids, including *Cypripedium* (Gill 1989, Neiland & Wilcock 1998). This has been the source of some concern among conservation biologists. Orchid seeds unlike those of other flowering plants lack a seed coat, differentiated embryo and endosperm. Like other

orchids, *Cypripedium* seeds germinate in association with certain fungi that aid the developing embryo by providing nutrients necessary for development. The seeds are very small, waterproof and can float, suggesting dispersal by water. Wind and even animals have been suggested as other possible modes of dispersal (Vance 2007). At least some lady's slipper orchids regularly reproduce vegetatively by producing offsets—outgrowths of the rhizome that may become separate plants (Cribb 1997). Lady's slippers tend to be long-lived and individual plants have persisted for over 30 years (Harrod 1994).

It has been noted that the rhizomes of some terrestrial orchids, including *Cypripedium*, may not produce above-ground organs (leaves, stems and flowers) every year and can enter an underground mycotrophic state known as “dormancy” (Primack & Stacy 1998, Shefferson et al. 2005). A variety of causes have been proposed in the induction of dormancy—stress of flowering, fruiting, damage from herbivores or mechanical damage to the plant—but there are contradictions in studies (Shefferson & Simms 2007).

Medicinal Uses

The root was formerly much used in North America both by indigenous and immigrant peoples for its sedative and antispasmodic properties and to counter insomnia and nervous tension. *C. parvifolium* was the most important medicinal lady's slipper in North America. Rhizomes were “collected in the fall, or early in the spring, carefully dried and reduced to a powder and administered as a teaspoon of powder, diluted in sugar water, or any other convenient form” (Rafinesque 1828). Although, some whole-root preparations were aqueous, the pungent, unpleasant smelling roots were usually prepared as tinctures as the active principles are not water-soluble. The Cherokees, Iroquois, Menominee, MicMac, Penobscot, and other tribes used *Cypripedium* to treat a variety of disorders (Moerman 1986). Preparations have been taken internally in the treatment of insomnia, anxiety, fever, headache, neuralgia, emotional tension, palpitations, tremors, irritable bowel syndrome, delirium, convulsions due to fever and to ease the pain of menstruation and childbirth (Grieve 1998, Sievers 1930). Herbalists generally consider *Cypripedium* preparations to be antispasmodic, anodyne, diaphoretic, hypnotic, nervine, sedative, stimulant and tonic. In North America species that have been collected for medicinal purposes include *C. acaule*, *C. reginae*, *C. candidum*, and *C. parvifolium* (Cribb 1997, Duke et al. 2002, Moerman 1998).

Lady's slippers are used medicinally in the Old World. In Asia preparations of *Cypripedium* are considered analgesic, diaphoretic, diuretic, detumescent and nervine. The stems, rhizomes, and flowers of various species are used variously in China as sedatives and vascular aids, to stimulate appetite, relieve rheumatic pain and treat edema of the legs, dropsy, dysentery, gastritis, gonorrhoea, headaches, leucorrhoea, fractures and mental disorders (Bensky & Gamble 1993, Cribb 1997).

Chemistry

Chemical analysis has identified phenolics, alkaloids, large amounts of potassium oxalate (Cribb 1997), phenanthrenequinones such as cypripedine (Krohn et al. 2001),

phenanthraquinones such as cypritolbetquinones A and B (Liu et al. 2005) and cypridediquinone A (Ju et al. 2000). *Cypripedium reginae*, like some other species, has coarse glandular hairs on the stems and leaves that have long been known to cause contact dermatitis (MacDougal 1895, Correll 1978). This irritation is caused by quinones (Schmalle & Hausen 1979). Taken internally, overdose of *Cypripedium* preparations can cause hallucinations (Grieve 1998).

Trade

The UNEP-WCMC CITES Trade Database figures for *Cypripedium* exports demonstrate that during the last decade living plants constituted the major trade and that most of these were classed as artificially propagated (CITES Trade Database 2007). A report generated during September 2007 indicates that over three-thousand living plants were exported during 2006, but fewer than 2000 “dried plants” and “roots” were exported during the eleven-year period 1996-2006 (derived from CITES Trade Database 2007). Dried plants and roots could be used for various purposes, but living plants are being used to supply plant collectors. The collection of *Cypripedium* for medicinal purposes has become much less important in their conservation than the harvest of wild plants to supply orchid collectors (CITES 1992, McGough et al. 2006). In fact, the CITES recommendation for monitoring trade in medicinal orchid products in China includes two genera, but not *Cypripedium* (CITES 2000). Likewise, most instances of “poaching” of lady’s slipper orchids in the United States do not appear to be for medicinal purposes (NatureServe 2007). The American Herbal Products Association’s Tonnage Survey of North American Wild-harvested Plants, 2004-2005 (AHPA 2007), does not include figures for *Cypripedium* products.

Legal Protection and Conservation Status

The most recent International Union for the Conservation of Nature’s Red List of Threatened Plants includes 11 Asian *Cypripedium* species that are considered either “critically endangered” or “endangered” (IUCN 2007). The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) currently lists all *Cypripedium* species under CITES Appendix II (CITES 2007). This indicates that the species are not necessarily now threatened with extinction but that may become so unless trade is closely controlled. International trade in specimens of Appendix-II species may be authorized by the granting of an export permit or re-export certificate.

The American species of *Cypripedium* are included in various listings that define their conservation status. Currently, no *Cypripedium* species are considered threatened or endangered under the Endangered Species Act (ESA). Some species are considered Species of Concern by the U. S. Fish and Wildlife Service in various regions. The USDA Forest Service maintains a National Master List of Proposed, Threatened and Endangered species, this includes no *Cypripedium* species (USDAFS 2007). The USDA Forest Service also designates species that are considered sensitive within each of its regions: *Cypripedium arietinum*, *C. candidum*, *C. fasciculatum*, *C. kentuckiense*, *C. montanum*, *C. parviflorum* and subspecies, *C. passerinum*, and *C. reginae* are included on the list in one

or more regions (USDAFS 2004). The state offices of the U.S. Department of the Interior Bureau of Land Management periodically publish lists of BLM sensitive species occurring on public lands whose populations or habitats are rare or in significant decline (Ed Lorentzen, BLM, pers. comm. 2007) various *Cypripedium* species are on some of these lists. Heritage Listings for some states include some *Cypripedium* species. Most of these listings do not confer or proscribe legal protection.

Conservation determinations of *Cypripedium* vary according to the geographic area considered. Populations at the margins of a species range may be tenuous. Specific populations elsewhere may have been affected detrimentally by various factors. However, considering the entire range may determine a different outlook for the species as a whole. For example, *Cypripedium fasciculatum* is found in eight western states but despite its rather wide occurrence, populations are scattered and can be small. As a result, it is listed as critically imperiled in Utah (state ranking of S1), imperiled in Montana (S2), and vulnerable to extirpation or extinction (S3) in California, Colorado, Idaho, Oregon, Washington, Wyoming (NatureServe 2007). As of 2005, however, because of its large range and number of known populations, NatureServe ranked the Global Status of *C. fasciculatum* at G4: “apparently secure.”

The North American *Cypripedium* Species

The following twelve species are those known from the USA (Sheviak 2002), the NatureServe global conservation rankings are listed last in each entry (NatureServe 2007). For more information on specific USA state and Canadian province conservation rankings and explanations supporting these rankings, see the NatureServe website: <http://www.natureserve.org/> and state and federal databases.

Cypripedium acaule Aiton. Small pink lady’s slipper, pink moccasin flower, stemless lady’s slipper. 10-30 cm tall. Central and eastern Canada, south across the north central and northeastern United States to Minnesota and Georgia. Rounded Global Status: G5 – Secure.

C. arietinum R. Brown. Ram’s head. 12-21 cm tall. Central and eastern Canada south to New York and west through the great lakes region of the north central and northeastern United States to Minnesota. Rounded Global Status: G3 - Vulnerable

C. californicum A. Gray. California lady’s slipper. To 120 cm tall. Northern California and southwestern Oregon. Rounded Global Status: G3 - Vulnerable

C. candidum H.L. Mühlenberg ex Willdenow. White lady’s slipper. 10-25 cm tall. From Manitoba, Ontario, and Saskatchewan through the eastern and central United States. New York west to North Dakota and from Minnesota south to Alabama and Kentucky. Rounded Global Status: G4 - Apparently Secure

C. fasciculatum Kellogg ex S. Watson. Clustered lady’s slipper, brownie lady’s slipper. 5-20 cm tall. Occurs in eight western states from Washington to California, east to

Montana, Colorado, Utah, and Wyoming. Rounded Global Status: G4 - Apparently Secure

C. guttatum Swartz. Spotted lady's slipper. 12-35 cm tall. A circumpolar species, in North America the spotted lady's slipper occurs in Alaska and northern Canada. Rounded Global Status: G5 - Secure

C. kentuckiense C. F. Reed. Ivory lady's slipper, purloined slipper. 40-71 cm tall. Southern USA from Virginia to Texas and Oklahoma in widely separated populations. Rounded Global Status: G3 - Vulnerable

C. montanum Douglas ex Lindley. Mountain lady's slipper. 25-70 cm tall. Southwestern Canada to southeastern Alaska south to California and east to Montana and Wyoming in widely separated populations. Rounded Global Status: G4 - Apparently Secure

C. parvifolium Salisbury. Small yellow lady's slipper. 15-60 cm tall. Three subspecies ranging from the eastern United States and Canada south to Louisiana and Georgia and west to the Rocky Mountains, north to Yukon and Alaska. Rounded Global Status: G5 - Secure

C. passerinum Richardson. Sparrow's egg lady's-slipper. Franklin's lady's slipper. 12-38 cm tall. Boreal and sub-arctic regions of Canada and Alaska, south to northern Montana. Rounded Global Status: G4 - Apparently Secure

C. reginae Walter. Showy lady's slipper, queen lady's slipper. 35-85 cm tall. Northeastern seaboard west to Minnesota, Newfoundland to Saskatchewan, south to Iowa, Arkansas and Alabama in widely scattered colonies. Rounded Global Status: G4 - Apparently Secure

C. yatabeanum Makino. 17-32 cm tall. Alaska (found in both Asia and North America). Rounded Global Status: T4 - Apparently Secure

Sustainable Use and Conservation

With their often large, colorful, and long-lasting flowers held conspicuously above the foliage, many consider lady's slippers to be the most beautiful of terrestrial orchids. Lady's slipper orchids have been collected and grown by plant enthusiasts for centuries and are avidly sought by collectors. Though lady's slipper orchids have been used medicinally by people of Asia and North America for centuries, it appears that the collection of roots for these purposes has become much less important in their conservation than the harvest of wild plants to supply orchid collectors. In North America and Europe, collection of *Cypripedium* plants for medicinal uses is discouraged. During 1988, a request was made by the American Herbal Products Association that its members cease using wild-harvested *Cypripedium*. The intense harvesting of living terrestrial orchids demonstrates that collection to supply enthusiasts is a serious threat (Case et al.

1998, Stolzenburg 1993). China with its rich assemblage of striking *Cypripedium* and its access to world markets via the internet is exporting large numbers of wild-collected orchids (CITES 2000, Holden 2006, McGough et al. 2006, Perner 2006, Holger Perner, pers. comm. 2007).

Whether for horticultural or medicinal uses, the harvest of the rhizomes (“roots”) generally destroys the entire plant. Lady’s slippers are not considered to be particularly fast growing and need several years to grow to reproductive (flowering) size. Unregulated collection of plants leads to reduction or elimination of populations, as it has, for instance, in Britain where only a single plant of *Cypripedium calceolus* survived in the wild (Cribb 1997) before restoration attempts began. As in many orchid species, research into germination and *in vitro* propagation has been an important aid to conservation. There has been excellent recent success in laboratory germination (Steele 1996) with methods improving constantly and it is now relatively easy to produce large numbers of plants from seed. Laboratory-produced plants are being sold to orchid fanciers—a method that is to be encouraged because it reduces or eliminates the market for wild-collected plants. Education of collectors to harvest in a sustainable manner is always important in the case of wild-collected material and on-site training programs have been undertaken in countries where *Cypripedium* are still harvested from the wild (IUCN 2000, McGough et al. 2006).

Potential threats to populations of American species of *Cypripedium* include various forms of habitat destruction and disturbance such as urbanization, competition from exotics, alteration of forest habitat through fire suppression, mining, grazing of livestock, trampling by recreationists, road building, soil erosion, timber harvest and the attendant alteration of the light regimes, high-intensity wildfire and other disturbance (Brzeskiewicz 2000, Vance 2007). Harvest of lady’s slipper orchids by collectors is noted as an important cause of decline in many areas (Farrell & Fitzgerald 1990, NatureServe 2007). White-tailed deer readily consume the foliage of at least some *Cypripedium* orchids, and local populations may require a deer-resistant fence for protection where these animals are abundant (Judziewicz 2001). Continuing research on *Cypripedium* is needed to properly assess the current status of species in the wild and will be necessary everywhere they occur (Cribb 1997, Cribb & Sandison 1998).

[BOX]Sustainable Actions

- Wild-harvesters: Though it is generally agreed that collection of wild material should follow certain procedures that allow sustainable harvest (Medicinal Plant Specialist Group 2007), the consensus among experts is that wild *Cypripedium* roots should no longer be harvested for any reason.
- Growers: Although great progress has been made recently in germinating seed of *Cypripedium*, it takes several years for plants to become reproductive and generate much root mass. This slow rate of growth and specialized cultivation means that commercial production of medicinal material may not be viable when compared to herbal substitutes.

- Practitioners and Consumers: *Cypripedium* should not be harvested for medicinal uses. Instead choose substitutes such as *Valerian*, *Scutellaria* and *Lavendula* (Bown 1995, Grieve 1998).
- Suppliers and manufacturers: Refrain from purchasing *Cypripedium* or formulations that contain the roots. Insist that formulations do not contain lady's slipper root, particularly imports from Asia where the plants are more commonly used and ethics regarding terrestrial orchid harvesting are not well publicized.

Disclaimer

The information contained in this article is not intended nor implied to be a substitute for professional medical advice relative to your specific medical condition or question. All medical and other healthcare information that is given here should be carefully reviewed by the individual reader and their qualified healthcare professional.

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