

***Campanula* (Campanulaceae) in Nature and in Pots®**

Gert Jensen, Rune Harboe Nielsen, and Arne Skytt Andersen

PKM Nurseries, Odense N, DK 5270 and Royal Veterinary and Agricultural University, Copenhagen, DK 1871

The Genus *Campanula* L. comprises some 320 species mainly found in the Mediterranean region, the mountains of Central and Eastern Europe, and a few species scattered in other areas of the world. A few of these beautiful plants have been cultivated as garden and rockery plants for a long time. During the late 1980s some Danish growers adapted *C. carpatica* and *C. poscharskyana* among others to pot culture in a combination production schedule in and out of greenhouses. Some selection and breeding took place yielding better and more flowers; also the cultivation practices were improved to give better postproduction shelf life. These species still comprise a large part of the about 10 million *Campanula* plants produced in Denmark each year.

It has been the goal of our company to constantly improve and find new products; thus a program for collecting and breeding of new cultivars of *Campanula* has been established.

This program aims to utilize the enormous variation found in nature within as well as among the separate species. This variation is a result of natural selection due to differences in microclimate, soil, and other edaphic features of the growing place. And the differences within a species can result in visible as well as intrinsic features such as longevity of flowers, variations in growth potential, vegetative propagation potential, and demands for special treatment, e.g., for floral induction. The visible differences may be related to flower size, leaf arrangement, and characteristics. Sometimes there is such large variations that one wonders if the plants belong to the same species.

These variations seldom appear in collections in botanical gardens; therefore it is imperative for a serious breeder to get out in nature and observe and if possible collect seeds and plants from different locations to be included in the breeding program of a given species.

The breeding program has resulted in several new cultivars of *C. cochlearifolia*, *C. × haylodensis*, and *C. portenschlagiana*.

INTRODUCTION

The many species of *Campanula* are found mainly in the Mediterranean region, Carpatia to Caucasus, the Alps, and Himalaya Mountains (Fig. 1). There are several species that are endemic to other mainly northern hemisphere locations. *Campanula* plants are often growing in remote and difficult-to-access locations, e.g., on steep mountain outcroppings or in deep gorges and ravines where even goats and other mountain herbivores cannot devour them. The soils are poor; cracks in the rock are preferred habitats for many species. Propagation is mainly by seed distribution.

The Latin name means "little bell," and many of the plants belonging to the genus have true bell shaped flowers while others have more flat corollas. The common names of these popular garden and rockery plants are various forms including the term "bell": bluebell, harebell, bellflower, carpathian bells, etc. Some species have



Figure 1. Major areas of endemic *Campanula* species.

been widely cultivated through centuries, and songs and poems often mention the bellflower. One species (*rapunculus*) is a vegetable of some renown in the Orient. Leaves are used as salad, and the roots are eaten as radishes.

Plants are usually perennial, rosette-forming herbs; some species are annual or biennial. Alternate leaves have different shapes, often obovate to cordate with rosette leaves larger and more cordate than stem leaves. Roots are often long taproots sometimes with fleshy starch rich parts. All parts of the plants contain milky white latex. Most species are hardy to very low temperatures especially when kept on the dry side.

Flowers are sympetalous (have even given name to the type of flower: “campanulate”), drooping or upright in racemes or singular. Color is blue to violet, but white forms are found in most species, seldom a yellow variant occurs. The flowers are five lobed and contain five stamens and a five- or three-parted stigma. Seeds are abundant, small, ovoid and enclosed in a three- or five-valved capsule that dehisces either basally or along the seams.

In cultivation, cutting propagation is common for the perennial species while seed propagation mainly is used for the annual and biennial species; however a large number of certain perennial species, e.g., *carpatica*, are propagated by seeds.

In the following a few of the wild species with potential for use as potted plants or as breeding material will be described (more details can be found in the general references: Bailey, 1935; Lewis and Lynch, 1998; and Crook, 1951). The latter section contains information on the domestication of some of these and the successful breeding and improving the plants mainly for pot culture.

SELECTED WILD SPECIES WITH POTENTIALS FOR USE IN POT CULTURE AND BREEDING

From the Alps.

Campanula medium Linn. English name: Canterbury bells, Scandinavian name: Marieklokke. Hardy biennial up to 1-m high with floral spikes (racemes). Large flowers (5–6 cm long) upright, true bell shape. Blue to violet; white forms exist. Used in perennial garden borders, can be sown in the late summer and planted in the garden for early flowering next spring. Double forms and an almost daffodil

form ("calycanthema" called cup-and-saucer) are available. Natural habitat: Calciferous, dry soils on mountainsides in Italy and Switzerland. Sun-loving.

Campanula pyramidalis Linn. English name: chimney bells, Scandinavian name: Pyramideklokke. Very tall biennial — up to 2 m when flowering. Pyramidal racemes with numerous light blue to white, star-shaped flowers. Especially compact cultivar has been used as a potted plant. Natural habitat: as the former, but mainly occurring in Austria and the Dalmatian region.

Campanula zoysii Wulf. Has no common names. Short-lived perennial, tiny tufted plant, 1–2 cm high. Rare, found in rock crevices at high elevations (2000 m and higher) in the Austrian Alps. The singular flowers are large for such a small plant, upright, cylindrical to drum-shaped bells with a clear azure blue colour.

Campanula pulla Linn. No common names. Perennial herb, 7–14 cm high with glabrous, dentate leaves. Upright small (2 cm) flowers in loose racemes covering the entire plant with their deep blue spray of color. Hybrids called *C. ×pulloides* of this species with *C. carpatica* var. *turbinata* have very striking violet flowers. Grows in Austria at high altitudes (1500 m and higher) on rocky slopes.

From the Mediterranean Region.

Campanula formanekiana Degen & Dorfl. Scandinavian name: Græsk (Macedonsk) klokke English name: Greek bells. Monocarpic (semelparous) species first found in 1931. Tall main raceme (up to 75 cm) supported by spreading basal, prostrate, and lateral racemes. Growing on limestone rocks in northern Greece and Macedonia. It is monocarpic, sometimes taking several years to reach flowering size, but is easily raised from seed. The corolla is fully campanulate, like a small Canterbury bell. Seed propagation.

Campanula rupicola Boiss. & Spruner, no common names. Growing in cracks in limestone rocks on Mt. Parnassus in Greece. Monocarpic rosette plant, the thin prostrate or decumbent flower stems bear a few small, short-petioled leaves and a few (usually not more than three) flowers, which, however, are carried erect and are large for the size of the plant, sometimes as much as 5 cm long and 2 to 3 cm across. It is generally of a blue or violet-blue color.

Campanula oreadum Boiss. & Heldr. No common names. Closely related to *C. rupicola*, but smaller in all parts. Monocarpic as are many other species from this area. All leaves are without any dentations, which serve to distinguish the species from most others of the group. The thin hairy flower stems with only a few small leaves often carry as many as five flowers on fairly long peduncles. Flowers are generally of a rich violet-purple color.

Campanula carpatha Halacsy. Growing in limestone rocks on the Greek Island, Karpathos; biennial with violet-blue, upright flowers. Small, compact plant 10–15 cm.

From Caucasus.

Campanula kemularia Fomin. Growing on cliffs in Transcaucasia at high altitudes (2000 m). A very hardy, almost creeping perennial. The general habit shows that the stems should be erect but they do not seem strong enough to bear the weight of the many flowers, with the result that the greater part of the inflorescence is hidden among the basal leaves. Wide bell shaped blue flowers.

Campanula latifolia Linn. A common, tall (1 to 1.5 m) perennial species growing in woodlands all over Europe. Large, doubly serrated, cordate leaves. Flowers

purple or dark blue, hairy, 6 cm long in loose racemes. Variety *macrantha* from Caucasus is smaller in all parts.

Campanula saxifraga M. Bieb. Danish name: Klippekløkke. Growing in the mountains of eastern Turkey. Many closely related species and subspecies are spread all over Caucasus. Small (<15 cm high) tufted perennial. Upright blue bell-shaped flowers. Small rosettes of basal spatulate leaves, rotund and slightly dentate at the tips, upright stems bearing open cups thrust towards the sun, usually deep blue with a pale or even a white "eye."

Campanula betulifolia (syn. *C. finitima*). The stems, which have a few small ovate and petiolate leaves, are more or less freely branched and carry a loose cluster of erect, fully bell-shaped flowers in groups of three or four. Light pink flowers, no blue variants found. Grows on cliffs, only found in one valley in eastern Turkey. Perennial.

From Himalaya.

Campanula cashmeriana Royle. Growing on cliffs in Kashmir. Many subspecies and close relatives spread all over Himalaya Mountains. Small (<20 cm) perennial, tufted, prostrate plant with large singular flowers, blue inside the bell, dusty white on the outside, keeled, lanceolate leaves. The species is included in the larger section of the genus in which the style is trifid and dehiscence is basal. It forms a woody rootstock that penetrates deeply into rocky crevices and from this are emitted a number of stiff zig-zaggy but often trailing growths bearing a few sessile light green, oblong, slightly dentate leaves about an inch long, covered with grey hairs. These stems are freely branched and carry numerous fairly large bells generally of a pale blue, which are inclined to droop.

Campanula argyrotricha Wall. ex A. DC. Very much like *C. cashmeriana*, but smaller in all parts. The root gives rise to numerous procumbent, hairy, thread-like stems, dichotomously branched, furnished with nearly sessile leaves that are thin, broadly ovate, only very slightly dentate, silvery-green in color and softly hairy. The flowers, on long pedicels and usually solitary, are about one cm long and hairy outside. Other colors than blue occur. Perennial.

Campanula sp. New unnamed species, found in the Chinese part of Tibet. Very interesting color combination. The center of the flower is cream colored, while the lobes are deep blue. Creeping perennial.

East Asia.

Campanula chamissonis Fett. Widespread from Siberia to Japan (and Alaska). As with most members of the genus, the color is rather variable, from deep purple to a rather mauve blue with paler margins. Though usually plants do not exceed 8 cm in height, they may reach as much as 15 cm. They are generally single flowered, but in the stronger growing forms may be somewhat branched and carry five or six blooms. Pale blue, some striped flower variants have been described. Perennial.

North America.

Campanula scabrella Engelm. From California to Washington. Growing in dry rocks exposed to full sun. The lower leaves form a rather dense rosette. The stems may be anywhere up to 15 cm high and usually terminate in a single erect flower though they may bear as many as four. The ex-appendiculate calyx has linear-lanceolate segments equal to the calyx tube in length, while the narrowly campanulate violet-purple corolla. Perennial.

Campanula scouleri Hook. Occurs from British Columbia into Alaska. Growing in soft, stony soil in woodlands. Perennial plant (10–30 cm tall) with acute, lanceolate to linear, serrate leaves. Pale blue, outward angled, paniced flowers with exerted styles.

Campanula lasiocarpa Cham. Occurs from northern parts of the Rocky Mountains to Alaska (and also in Japan). It forms neat tufts of smooth ovoid or oblanceolate leaves with noticeably jagged edges tapering to a narrowly winged and ciliate petiole. From each tuft rises a stem some 15 to 18 cm high bearing a few sessile lanceolate leaves each with three or four distinct teeth on each side and terminating in a single, large bell-shaped flower, sub-erect and, in the type, blue.

The Japanese form is larger in all parts. Growing on sandy gravel slopes at high altitudes above 1200 m.

Natural or Old Garden Hybrids.

Campanula 'Lynchmere' Hort. Cross of *C. elatines* Linn. and *C. rotundifolia* Linn. Made in 1948 in England — is one of the latest introductions, has foliage and growth similar to *C. elatines* in its hairy form, but shows the influence of the second parent in the shape and carriage of the flowers a wonderful, deep-blue-flowering perennial plant — but very slow growing.

Campanula 'Kent Belle'. Cross between a European, *C. latifolia* Linn., and a Korean species *C. punctata* Lamm. It produces a number of thin branching stems sometimes as much as 3 ft high terminating in loose clusters of long, narrow, deep-purple buds that develop into pale lavender hanging bells 3 or 4 inches long. Occurred spontaneously in the nursery garden of Elizabeth Strangman, Kent, U.K. A wonderful perennial garden plant — flowering throughout the summer.

Campanula × *haylodgensis* 'Warley White'. Cross between *C. cochlearifolia* Lamm. × *C. carpatica* Jacq. Spontaneous crossing found in an English garden in 1899. The sparse leaves are heart shaped like the parents', but are of a characteristic yellowish-green shade. The flowers are semi- or fully-double, open and almost flat — and pure white. Perennial.

Campanula × *wockeii* 'Puck'. Presumably a cross between *C. pulla* Linn. × *C. waldsteiniana* Roem. & Schult. Unknown origin, but is suspected to be a natural hybrid. Introduced by Alan Bloom. From underground runners, up to 10-cm-long stems emerge bearing lanceolate sessile leaves. It has dangling deep-blue bells on neatly tapered racemes. Perennial.

HISTORY AND PROGRESS OF THE INTRODUCTION OF CAMPANULAS TO MASS POT CULTURE

In the 1950s the production of *C. isophylla* Moretti began in Norway. This is a non-hardy species originating in the Mediterranean region. Its common name is Star of Bethlehem due to the star-shaped corollas; there is a blue and a white form. Like most *Campanula* species it is a long-day plant (Heide, 1965). The growth habit is somewhat trailing, and *C. isophylla* is often used in hanging baskets. Early research on production environment for flowering and growth retardation has been summarized by Moe and Heide (1985). *Campanula isophylla* was introduced in Denmark in 1960 by the founder of the PKM Nurseries, Poul Madsen; production at that time was about 250,000 in Europe. Table 1 gives the following development of the *Campanula* crop in Europe.

Table 1. Production volume of all *Campanula* species and cultivars in Europe from 1960.

Year	Numbers
1960	250,000
1970	500,000
1980	2,000,000
1990	3,000,000
2000	11,000,000
2004	15,000,000

In 1968 production of *C. carpatica* var. *turbinata* 'Förster' began at PKM. Initially it was a seed propagated crop, but soon selections were done for better flower color and more flowers. Seed propagation is still used in some nurseries. The selections were propagated by cuttings from around 1972. *Campanula carpatica* is a fully hardy perennial with large, single, blue or white, upright flowers (Bailey, 1934). Flowering is induced by cold treatments (Zimmer, 1990), which usually is achieved by growing the potted plants outside on field beds throughout the summer and autumn until light frost. In Scandinavia forcing is then done in greenhouses from January until May (Dinesen, et al., 1997; Dinesen and Andersen, 1999).

Campanula portenschlagiana Roem. & Schult. Began to be produced as a field crop in 1978, it is a trailing plant, Scandinavian name Krybe klokke, creeping bell flower with smaller (4 cm) funnel-shaped (infundibuliform) flowers of various shades of blue, but white cultivars are also available. It is cold requiring for induction of flowers, which develop after long-day treatment.

Campanula cochlearifolia Lam 'Elizabeth Oliver' English name: Dwarf Bells, Scandinavian name: Dværg klokke. 'Elizabeth Oliver' appeared in a garden near



Figure 2. Cold treatment for flower induction: 5–7 °C for 3 or 5 weeks compared to no cold treatment.



1 week after treatment



2 weeks after treatment



3 weeks after treatment

Figure 3. Silver thiosulphate treatments to improve longevity of flowers on *Campanula tubulosa* 'Sfakion'.

Nottingham in 1972 and was introduced as a pot crop in 1991. This small campanula is ideal for production indoors in greenhouses almost all year round, preferably in small minipots (6 cm). Several named and patented cultivars have been introduced as a result of breeding and selection at the PKM nurseries. Cultivars with other colors than the powder blue of this hybrid have later on been a result of breeding and selection at PKM.

Campanula ×haylodgensis. Originated as a spontaneous cross in 1885 at Haylodge gardens in England. The blue cultivar *C. cochlearifolia* 'Blue Wonder' was introduced as a minipot crop by PKM in 1995, first as a combination crop with field growing before forcing. White- and single-flowered cultivars as well as cultivars with larger flowers and more upright habit have been bred: 'White Wonder', 'White Fairy', 'Great Blue Wonder', and 'Great White Wonder'.

Campanula tubulosa Lam is one of the latest additions to the assortment at PKM. Seedlings from botanic garden plants of this Greek species has been selected for good performance in the greenhouse, good color, keeping quality, and general shape of the plant. A superior selection has been vegetatively propagated and has recently been named 'Sfakion' in reference to its origin and introduced on the market.

As an example of the domestication procedures we describe a number of experiments with this species (cultivar) that form the basis of the production schedules and various treatments.

First it was necessary to establish the method for producing cuttings to keep the plants in a sufficient vegetative state short-day treatments of 11 to 8 h was tested (Fig. 2). Flower induction is temperature controlled. It is necessary to cool the plants for some time; Figure 3 shows the plants with or without some weeks of 5–7 °C in short day. Three weeks is sufficient. Keepability of the flowering plants is better if they are treated with silver thiosulphate at 0.2%. These and other experiments resulted in the production plan shown in Fig 4.

Colored photos of some of the species and cultivars in this paper are available on the internet: <www.pkm.dk>.

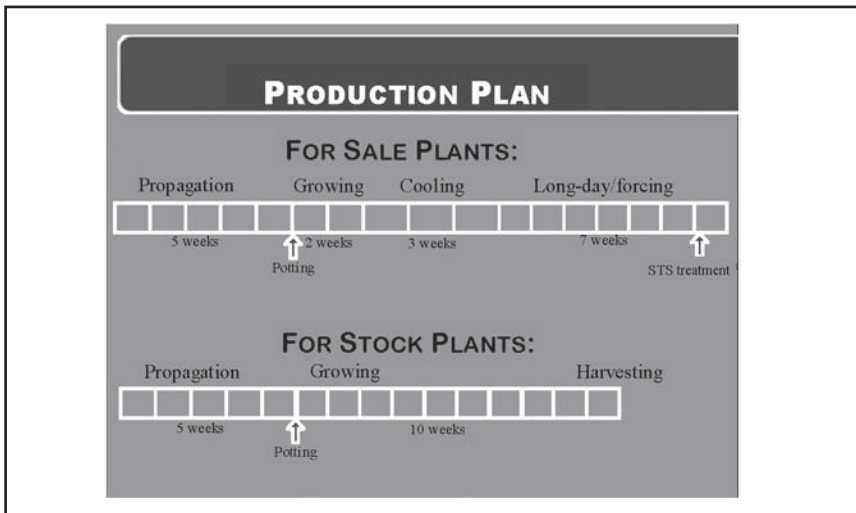


Figure 4. Production program for *Campanula tubulosa* 'Sfakion'.

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