Acta Botanica Neerlandica **15** (1967) 624–629

THE TAXONOMIC SIGNIFICANCE OF TWO ARTIFICIALLY PRODUCED HYBRIDS IN THE GENUS CAMPANULA

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(*received October 6th, 1965*)

ABSTRACT

Artificial hybridization experiments were carried out between two species-pairs in the genus *Campanula*, viz. between *C. persicifolia* and *C. latiloba*, and between *C. alliariifolia* and *C. ochroleuca*. The hybrid between *C. persicifolia* and *C. latiloba* is completely sterile. For this reason the treatment as separate species of these closely allied taxa is justified. The hybrid between *C. alliariifolia* and *C. ochroleuca*. on the other hand, is completely fertile. Therefore, it is advisable to regard *C, ochroleuca* and *C. alliariifolia* as conspecific, as was previously done by Kem. Nathadze.

INTRODUCTION

In a previous paper (GADELLA, 1964) the results of crossing experiments between species belonging to several groups of the genus *Campanula* have been described. Valuable information on the delimitation of infrageneric natural species groups could be obtained. But hybridization experiments may also support the separation of taxa which are closely allied morphologically, or, on the other hand, may indicate that such taxa could better be treated as conspecific.

An example of the first possibility is presented by *C. persicifolia* and *C. latiloba*, of the latter by *C. alliariifolia* and *C. ochroleuca*. In this paper a description of the produced hybrids will be given, as well as a discussion of their taxonomic significance.

MATERIAL AND METHODS

The plants were grown from seeds, which were obtained from the following sources:

C. alliariifolia Willd., Coll. No. C 36, Botanical Garden of Siena

C. ochroleuca (Kem. Nath.) Kem. Nath., Coll. No. C 289, Botanical Garden of Jena

C. latiloba DC., Coll. No. C 487, Botanical Garden of Oxford

C. persicifolia L., Coll. No. C 542, collected in nature, near Klagenfurt, Austria.

For the methods of emasculation and pollination, see GADELLA, 1964, p. 63. The flowers were emasculated in all cases, despite the

fact that artificial self-pollination did not result in the formation of mature seeds. In previous papers (GADELLA, 1963, 1964) it could be shown that most of the species of the genus *Campanula* are highly allogamous. However, in the summer of 1964 some seeds could be obtained after selfpollination in some strains of *C. rotundifolia*, whereas in most other strains no seed-formation could be demonstrated.

H. BIELAWSKA (1964) considers *C. rotundifolia* to be selffertile to a very limited extend. In the opinion of PODLECH (1965) at least most of the species of the subsection *Heterophylla* are highly allogamous, only in the species *C. baumgartenii* subsp. *baumgartenii* the formation of ripe seeds could be observed when cross pollination failed to occur. According to DAMBOLDT (1965a) most of the species of the *Isophyllae* are selfsterile, with the exception of *C. garganica*. Therefore, DAMBOLDT (1965a, b) is of the opinion that it is not necessary to emasculate the flowers of most species. Bielawska (in litt.) obtained seeds in the species *C. rotundifolia* after selfpollination, after some years of negative results. She is of the opinion that the weather conditions and the season of pollination may be important factors. At any rate, attention should be paid to the possibility of very restricted selffertility, and therefore it seems better, in my opinion, to emasculate the flowers. Voucher specimens of the hybrids and of the parental species have been deposited in the herbarium of the State University of Utrecht.

RESULTS

1. **Campanula persicifolia** L. (♀) X **Campanula latiloba** DC. (♂)

These species belong to the small group of species of the genus *Campanula* which is characterized by the following combination of cytological and morphological characters:
Long chromosomes (4–6 μ), $2n=16$; Basal leaves lanceolate, branches of the stigma equalling the glabrous style, capsule 3-locular, erect, dehiscing near the apex.

The two species are closely allied. The differences between the species as well as the characters of the hybrid are shown in table 1. (all measurements pertain to plants after some years of experimental cultivation under the same conditions).

7 flowers of *C. persicifolia* were emasculated and pollinated with pollengrains of *C. latiloba*. The capsules of 3 flowers contained many seeds after some weeks. 31 seedlings were obtained and grown in pots in the open. The hybrids grew vigorously in their first year, but became yellowish in the spring of their second year. Despite this fact, the plants began to flower in the second half of June. All plants proved to be highly sterile. No seeds were formed, whereas an examination of the young anthers revealed the fact that only a very few shrivelled and abnormal as well as micro-pollengrains had been formed. Only a few pollenmothercells could be observed. Univalents and multivalents and the formation of bridges were found in many cases. The tapetum-cells proved to be very large.

TABLE 1

A comparison of the characters of *Campanula persicifolia* and *Campanula latiloba* and their hybrid. The dimensions of all parts of the plants of *C. persicifolia* are much larger under cultivation than of the same plants growing in the wild

Characters	**C. persicifolia**	**Hybrid**	**C. latiloba**
Height of the stem	up to 100 cm	up to 45 cm	up to 60 cm
Diameter of the stem base	up to 4 mm	up to 3 mm	up to 8 mm
Cauline leaves	upper stemleaves much shorter than the basal ones	upper stemleaves scarcely shorter than the basal ones	upper stemleaves scarcely shorter than the basal ones
Margin of the basal leaves	remotely crenulate-dentate	rather densely dentate	rather densely dentate
Length of the pedicel	50 (30–70) mm	30 (20–30) mm	1 (1–2) mm
Length of the petals	35 (34–36) mm	20 mm	22–24 mm
Length of the sepals	16 (15–17) mm	12 (11–12) mm	11 mm
Shape of the corolla	deeply campanulate	rather shallowly campanulate	very shallowly campanulate
Depth of the corolla	25 mm	13 mm	16 mm
Diameter of the corolla	35 mm	20 mm	20–25 mm
Diploid number of chromosomes	16	16	16

2. **Campanula alliariifolia** Willd. (♀) X **Campanula ochroleuca** (Kem. Nath.) Kem. Nath. (♂)

The species *C. alliariifolia* and *C. ochroleuca* belong to the subsection *Cordifoliae* (Fom.) Fed. in the system of FEDOROV (1957). They belong to the large group of species of the genus *Campanula* which is characterized by the following combination of morphological and cytological characters: Short chromosomes, 1,5–3 μ, mostly ca. 2 μ, $2n = 34$; Calyx appendages between the calyx-lobes, style 5–10 × longer than the branches of the stigma, capsule 3-locular, mostly dehiscing basally with 3 valves.

The two species are very closely allied. The differences between the parental species as well as the characters of the hybrid are given in table 2. (all measurements refer to plants after several years of cultivation under the same conditions).

7 flowers of *C. alliariifolia* were emasculated and pollinated with pollengrains of *C. ochroleuca.* All capsules contained mature seeds. 23 seedlings were maintained. The seedlings grew vigorously and did not become yellowish in their first or second year, as was the case with most other artificially produced hybrids in the genus *Campanula.* The plants produced many flowers in the second year and proved to be fully fertile, each capsule containing many mature seeds.

DISCUSSION

The species *C. persicifolia* and *C. latiloba* are allopatric. *C. latiloba* occurs in Asia Minor (Bithynia), whereas *C. persicifolia* inhabits Europe (N., W. and C.) and Siberia. The taxa are capable of limited gene-exchange, as may be concluded from the above-mentioned experiments. BOISSIER (1875) remarks that in Macedonia and Thessalia (where the species is very rare according to CONTANDRIOPOULOS, 1964) some plants of *C. persifolia* have very short peduncles, thus approaching to *C. latiloba* in this respect. It seems desirable, in my opinion, to include these plants in a future crossing-program. For the moment it is justified to treat *C. persicifolia* and *C. latiloba* as separate species.

According to FEDOROV (1957) *C. alliariifolia* occurs in the Balcan Peninsula and in the Caucasus (W. and E. Cis-Caucasia; W.E. and S. Trans-Caucasia), whereas *C. ochroleuca* is endemic in the Cis-Caucasian area. *C. alliariifolia* occurs on rocks in the wood-zone and prefers limestone, *C. ochroleuca* occurs on rocks in the upper wood-zone and the subalpine-zone. The taxa are partially sympatric, but seem to be different in their ecological requirements. From Fedorov's treatment in the Flora U.S.S.R. it could be derived that in 1938 Kemularia Nathadze referred the plants with ochreous flowers to *C. alliariifolia*: *C. alliariifolia* Willd. subsp. *ochroleuca* Kem. Nath. Later, in 1949, the same author raised this taxon to specific rank: *C. ochroleuca* (Kem. Nath.) Kem. Nath. At least under garden conditions the two taxa are fully interfertile; there is no limitation

TABLE 2

A comparison of the characters of the species *Campanula alliariifolia* and *Campanula ochroleuca* and their hybrid

Characters	**C. alliariifolia**	**hybrid**	**C. ochroleuca**
Length of the stem	55 (40–60) cm	50 (45–65) cm	40 (30–45) cm
Apex of the basal leaves	mostly obtuse	mostly acute	mostly acute
Length of the basal leaves	70 (40–110) mm	55 (50–65) mm	50 (40–60) mm
Length of the petiole of the basal leaves	14 (10–17) cm	14 (12–15) cm	9 (8–10) cm
Branches of the main stem	if branched, branches much shorter than the main stem	branches of intermediate length	if branched, branches scarcely shorter than the main stem
Shape of the inflorescence	long, one-sided raceme	long, one-sided raceme	not strictly one-sided, lax raceme
Length of the leaves of the inflorescence	very short, much shorter than the stem leaves	very short	gradually diminishing, not much shorter than the upper stem-leaves
Colour of the corolla	white (yellow when dry)	very light yellowish-white	ochreous
Shape of the corolla	campanulate, more or less inflated	campanulate, not inflated	narrowly tubular
Ratio length calyx: length corolla	1 (:) 4–5	1 (:) 3	1 (:) 3
Ratio length calyx: width calyx	2 (:) 1	2 (:) 1	3–4 (:) 1
Diploid chromosome number	34	34	34

to gene-exchange. For this reason it is justified to consider *C. alliariifolia* and *C. ochroleuca* to be conspecific. The differences in ecological preference and the morphological differences support the treatment of *C. ochroleuca* as a subspecies of *C. alliariifolia*.

ACKNOWLEDGMENT

These investigations have been carried out at the Botanical Museum and Herbarium of the State University of Utrecht (Director: Prof. Dr. J. Lanjouw).

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