SOME CYTOLOGICAL OBSERVATIONS IN THE GENUS CAMPANULA. II

(a preliminary survey)

BY

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(Communicated by Prof. J. LANJOUW at the meeting of February 23, 1963)

INTRODUCTION

After DE CANDOLLE's monograph (1830) of the genus *Campanula* only few extensive taxonomic treatments on the genus were published, among wich the most important are that of BOISSIER, in the Flora Orientalis, III (1875), that of CLIFFORD CROOK (1951), and that of A. FEDOROV (1957) in the Flora U.S.S.R. XXIV. The species are classified by these authors in different ways, based on morphological characters only. A more natural classification of the species within the genus, however, has to be based on morphological and cytological characters, as well as on crossing and cultivation experiments.

In a previous paper (GADELLA, 1962), a survey of the number of chromosomes of 31 species was given and differences with results of investigations by other authors were discussed. In continuation of these studies some new counts will be given, as well as a preliminary survey of crossing experiments carried out up to the present.

These investigations will be continued. Moreover, biometric investigations are in progress, in order to ascertain if there is a correlation between the degree of polyploidy and the diameter of the pollengrains, the number of stomata/mm^2 and the size of the stomata.

MATERIAL AND METHODS

Fixation and staining techniques are described in a previous paper (GADELLA, 1962). Herbarium vouchers of all specimens are deposited at the Utrecht Herbarium.

The crossing technique was as follows:

Flowers were emasculated 4 days before anthesis, no pollen having been shed. Access of insects was prevented by bags envelopping the flowers. At the time of anthesis the desired pollen was placed on the stigma, contamination by pollen of unknown origin being prevented. In order to ascertain whether self-fertilisation is possible or not, flowers

of several species were covered with bags before anthesis. The seeds were collected 6–7 weeks after pollination.

Results

I. Chromosome numbers.

Table 1 gives a survey of the number of chromosomes of 42 species, with indication of the origin and the collection number of the material.

TABLE 1

The chromosome numbers of the investigated species

Species	Coll. no.	2n	Origin
Campanula alpina Jacq.	C 328	34	Czecho-Slovakia: Vysoké-Tatry
C. alliariaefolia Willd.	C 241	34	U.S.S.R. (Armenia), collected in nature
	C 240	34	Germany (E): Greifswald *)
	C 272	34	Italy: Pallanza *)
	C 359	34	Scotland: St. Andrews *)
C. aucheri DC.	C 134	34	Germany (W): Frankfurt a. Main *)
	C 344	34	Sweden: Göteborg *)
	C 223	34	Switzerland: Champex *)
	C 304	34	Switzerland: Lausanne *)
C. barbata L.	C 284	34	Austria: Hohe Tauern
	C 236	34	Austria: Schneeberg, 2070 m
C. bononiensis L.	C 397	34	Bulgaria: collected in nature
	C 403	34	Hungary: collected in nature
	C 500	34	Hungary: collected in nature
	C 276	34	Romania: Raion Cluj.
C. carpatica Jacq.	C 603	34	Czecho-Slovakia: Lipovce
	C 559	34	Poland: Zakopane, Krupowki
	C 461	34	Austria: Graz *)
	C 463	34	Austria: Graz *)
	C 552	34	England: Liverpool *)
	C 191	34	Germany (W): Essen *)
	C 262	34	the Netherlands: coll. de Graaff *)
	C 300	34	Switzerland: Lausanne *)
C. cervicaria L.	C 400	34	Bulgary: collected in nature
C. cochleariifolia Lam.	C 282	34	Austria: Kärnten
	C 503–A	37	France: Mont Cenis 1900 m (Savoie)
	C 503–B	37	idem
	C 503–C	34	idem
	C 503–D	34	idem
	C 503–E	37	idem
	C 503–F	35	idem
	C 526	34	Austria: Frohnleiten *)
	C 464	34	Austria: Graz *)
	C 505	34	Canada: Vancouver *)

*) cultivated material

Species	Coll. no.	2n	Origin
	C 355	34	Germany (W): Oldenburg *)
	C 569	34	Switzerland: Geneva *)
	C 570	34	Switzerland: Geneva *)
C. collina Bieb.	C 167	68	Germany (W): Bonn *)
	C 369	68	Sweden: Uppsala *)
	C 383	68	U.S.S.R.: Moskwa *)
C. erinus L.	C 57	28	Portugal: collected in nature
	C 494	28	Portugal: collected in nature
	C 554	28	Portugal: collected in nature
	C 599	28	Portugal: collected in nature
C. expansa Friv.	C 345	40	Sweden: Göteborg *)
C. garganica Ten.	C 183	34	Germany (W): Hamburg *)
	C 209	34	Germany (W): Göttingen *)
	C 61	34	the Netherlands: Baarn *)
	C 360	34	Scotland: St. Andrews *)
	C 483	34	Scotland: Edinburgh *)
C. glomerata L.	C 474	30	Austria: Wienerwald
	C 398	30	Bulgaria: collected in nature
	C 665	30	Czecho-Slovakia: Belanske Tatry
	C 604	30	Czecho-Slovakia: Lomnicke sedlo (Vysoké Tatry)
	C 608	30	Czecho-Slovakia: Zdiar (Vysoké Tatry)
	C 589	30	Czecho-Slovakia: collected in nature
	C 652	30	Czecho-Slovakia: near Praha
	C 434	30	Denmark: Agerup Roskilde
	C 447	30	Denmark: Logstor Fylland
	C 621	30	Denmark: collected in nature
	C 624	30	Denmark: collected in nature
	C 638	30	France: Collines de Balbronn (Obernai)
	C 520	30	France: Côte d'Or, Essarois
	C 530	30	Hungary: Gyogynöveny Kurato Interet
	C 614	30	Poland: E. Carpathians
	C 583	30	Romania: Cazanele Dunarii (raion Orsava)
	C 98	30	Romania: collected in nature
	C 126	30	Sweden: Scania, Härslöv
	C 519	30	Switzerland: Berner Jura
	C 631	30	U.S.S.R.: near Pskov
	C 612	30	Yugoslavia: collected in nature
	C 528	30	Austria: Frohnleiten *)
	C 402	30	Czecho-Slovakia: Praha *)
	C 486	30	Germany (E): Jena *)
	C 161	30	Germany (W): Münster *)
	C 33	30	Italy: Siena *)

*) cultivated material

Species	Coll. no.	2n	Origin
C. grossekii Heuff.	C 248	34	Germany (W): Marburg *)
C. kemulariae Fom.	C 324	34	Austria: Linz *)
	C 303	34	Switzerland: Lausanne *)
	C 302	34	Switzerland: Lausanne *)
C. lactiflora Bieb.	C 156	36	Germany: Berlin *)
	C 572	36	Switzerland: Geneva *)
C. lanata Friv.	C 174	34	Austria: Graz *)
	C 176	34	Austria: Graz *)
C. latifolia L.	C 48	34	U.S.S.R.: near Moskwa
	C 317	34	Sweden: without precise locality.
	C 290	34	Germany (E): Jena *)
	C 339	34	Switzerland: Geneva *)
C. loeflingii Brot.	C 556	18	Portugal: collected in nature
	C 597	18	Portugal: collected in nature
	C 296	20	England: Kew Gardens, London *)
C. medium L.	C 157	34	Germany: Berlin *)
C. oblongifolia (C. Koch) Charad.	C 246	90	U.S.S.R.: Armenia, coll. in nature
C. ochroleuca Kem. Nath.	C 200	34	Germany (E): Dresden *)
	C 289	34	Germany (E): Jena *)
	C 385	34	U.S.S.R.: Moskwa *)
C. patula L.	C 316	20	Sweden: collected in nature
C. persicifolia L.	C 281	16	Austria: Carnic Alps
	C 466	16	Sweden: Småland Bagghemmet
	C 314	16	Sweden: collected in nature
	C 114	16	U.S.S.R.: Otradnoje, N. of Leningrad
	C 326	16	Austria: Linz *)
	C 327	16	Austria: Linz *)
	C 144	16	England: Chelsea Phys. Gard.*)
	C 182	16	Monaco, Bot. Gard.*)
	C 154	16	the Netherlands: Amsterdam *)
	C 155	16	the Netherlands: Leiden *)
	C 313	16	Sweden: Stockholm *)
	C 301	16	Switzerland: Lausanne *)
C. portenschlagiana Roem. et Sch.	C 401	34	Italy: collected in nature
C. poscharskyana Degen.	C 459	34	England: Chelsea Phys. Gard. *)
	C 361	34	Scotland: St. Andrews *)
	C 587	34	Switzerland: Lausanne *)
	C 588	34	Switzerland: Lausanne *)
C. primulaefolia Brot.	C 54	36	Portugal: collected in nature

*) cultivated material

Species	Coll. no.	2n	Origin
C. pulla L.	C 14	34	Austria: Raxalpe
	C 133	34	Germany (W): Frankfurt a. Main *)
C. punctata Lam.	C 226	34	Austria: Vienna *)
	C 137	34	Germany (W): Frankfurt a. Main *)
	C 366	34	Sweden: Uppsala *)
	C 347	34	Sweden: Göteborg *)
C. pyramidalis L.	C 76	34	Yugoslavia: Novi Vinodal
	C 215	34	Austria: Frohnleiten *)
	C 141	34	England: Chelsea Phys. Gard.*)
	C 294	34	England: Kew Bot. Gard.*)
	C 118	34	Poland: Warszawa *)
C. rapunculoides L.	C 456	68	U.S.S.R.: Armenia, coll. in nature
	C 547	102	Austria: Aigen, Ennstal
	C 399	102	Bulgaria: collected in nature
	C 396	102	France: Cevennes Méridionales
	C 335	102	France: Clery, Côte d'Or
	C 378	102	France: Collines de Sigolsheim (Ht.–Rh.)
	C 501	102	France: St. Michel de Maurienne 900 m (Savoie)
	C 197	102	Italy: near Friuli
	C 406	102	the Netherlands: near Oost-Voorne
	C 407	102	the Netherlands: near Oost-Voorne
	C 43	102	the Netherlands: Wrakelberg near Wijlré
	C 318	102	Sweden: collected in nature
	C 565	102	Sweden: collected in nature
	C 109	102	U.S.S.R. (Estonia): Tartu, Toomemägi
	C 243	102	U.S.S.R.: collected in Armenia
	C 394	102	U.S.S.R. (Latvia): coll. in nature
	C 626	102	U.S.S.R. (Latvia): coll. in nature
	C 325	102	Austria: Linz *)
	C 233	102	Austria: Vienna *)
	C 185	102	Belgium: Antwerpen *)
	C 189	102	Belgium: Antwerpen *)
	C 320	102	Belgium: Brussel *)
	C 321	102	Belgium: Brussel *)
	C 255	102	Czecho-Slovakia: Bratislava *)
	C 332	102	Finland: Helsinki *)
	C 162	102	France: Verrieres le Buisson *)
	C 354	102	Italy: Roma *)
	C 181	102	Italy: Torino *)
	C 63	102	the Netherlands: Baarn *)
	C 267	102	the Netherlands: coll. de Graaff *)
	C 212	102	Portugal: Lisboa *)
	C 536	102	Spain: Valencia *)
	C 537	102	Spain: Valencia *)

*) cultivated material

Species	Coll. no.	2n	Origin
C. rapunculus L.	C 490	20	France: Quevilly (Seine Mar.)
C. rotundifolia L. s.l.	C 651	34	Czecho-Slovakia: near Praha
	C 491	34	Germany (W): near Kassel
	C 271	34	Sweden: Granhogen
	C 390	34	U.S.S.R.: near Pskov
	C 480	68	Austria: N. Tirol
	C 237	68	Austria: Raxalpe
	C 476	68	Austria: Raxalpe
	C 414	68	Belgium: Ruine Reinardstein near Robertville
	C 415	68	Belgium: idem
	C 549	68	Canada: East Canada
	C 86	68	Denmark: Egtved (W. Jutland)
	C 577	68	France: Isneauville (S. Mar.)
	C 8	68	France: Col de Lautaret, 2000 m
	C 22	68	France: Termignon, Savoie, 1400 m
	C 685	68	the Netherlands, near Emmen
	C 677	68	the Netherlands: near Mook
	C 422	68	the Netherlands, near Marienberg
	C 425	68	the Netherlands, near Marienberg
	C 427	68	the Netherlands, near Gieten
	C 439	68	the Netherlands, near Otterlo
	C 388	68	U.S.S.R.: near Leningrad
	C 628	68	U.S.S.R.: near Leningrad
	C, 104	68	Scotland: near Edinburgh
	C 523	102	France: St. Léger de Fourches (Côte d'Or)
	C 580	102	France: St. Adrien (S. Mar.)
	C 214	68	Austria: Frohnleiten *)
	C 529	68	Austria: Frohnleiten *)
	C 229	68	Austria: Vienna *)
	C 550	68	France: Paris *)
	C 371	68	France: Strasbourg *)
	C 163	68	France: Verrieres le Buisson *)
	C 29	68	Italy: Siena *)
	C 30	68	Italy: Siena *)
	C 32	68	Italy: Siena *)
	C 452	68	Poland: Lvov *)
	C 119	68	Poland: Warszawa *)
	C 419	68	Romania: Bucuresti *)
	C 420	68	Romania: Bucuresti *)
	C 348	68	Sweden: Göteborg *)
	C 342	68	Switzerland: Geneva *)
	C 571	68	Switzerland: Geneva *)
	C 393	68	U.S.S.R.: Leningrad *)
	C 465	102	England: Leeds *)
C. sibirica L.	C 160	34	Hungary: collected in nature
	C 195	34	Italy: near Friuli

*) cultivated material

Species	Coll. no.	2n	Origin
	C 275	34	Romania: Borovici
	C 417	34	Romania: Cheile Turzii, reg. Cluj.
	C 171	34	Austria: Graz *)
	C 257	34	Czecho-Slovakia: Bratislava *)
	C 384	34	U.S.S.R.: Moskwa *)
	C 221	34	Switzerland: Champex *)
C. spicata L.	C 479A	51	Switzerland: collected in nature
	C 479B	34	idem
	C 479C	34	idem
	C 479D	34	idem
	C 479E	34	idem
	C 479F	34	idem
C. sprunèriana Hampe	C 358	20	Scotland: St. Andrews *)
C. steveni Bieb.	C 244	32	U.S.S.R.: Armenia, coll. in nature
	C 392	32	U.S.S.R.: Leningrad *)
C. thyrsoides L.	C 93	34	France: Col de Lautaret, 2000 m
C. trachelium L.	C 172	34	Austria: Cetic Alps
	C 283	34	Austria: Noric Alps
	C 224	34	Austria: Raxalpe
	C 288	34	England: near Steyning
	C 375	34	France: Collines de Balbronn, Obernai
	C 253	34	France: near Nantes
	C 372	34	France: between Niederbronn and Bitche 400 m
	C 373	34	France: near Strasbourg
	C 446	34	Italy: between Camogli and S. Rocco
	C 443	34	Italy: between Portofino and S. Fruttuoso
	C 444	34	Italy: between Portofino and S. Fruttuoso
	C 442	34	Italy: near Rapallo
	C 416	34	the Netherlands: Geerendal near Schin op Geul
	C 123	34	Sweden: Scania, Ivetofta
	C 187	34	Belgium: Antwerpen *)
	C 322	34	Belgium: Brussel *)
	C 323	34	Belgium: Brussel *)
	C 206	34	Germany: Göttingen *)
	C 265	34	the Netherlands: coll. de Graaff *)
	C 269	34	idem
	C 279	34	idem
	C 121	34	Poland: Warszawa *)
C. trautvetteri Grossh.	C 91	90	U.S.S.R.: Armenia, coll. in nature
	C 245	90	U.S.S.R.: Erevan *)

*) cultivated material

Species	Coll. no.	2n	Origin
C. verruculosa Hoffmgg. & Link	C 493	20	Portugal: collected in nature
	C 555	20	Portugal: collected in nature
	C 598	20	Portugal: collected in nature
C. waldsteiniana Roem. et Sch.	C 208	34	Germany: Göttingen *)

*) cultivated material

II. Crossing experiments.

a. Interspecific crosses, both intersectional and intrasectional, were made between the species of the section *Medium* (sensu Boissier) and of the section *Rapunculus*.

Table 2 summarizes the results of the crosses, indicating the group to which the species used belong and the seed formation where that was observed.

b. in the *Campanula rotundifolia*-complex.

Cytotypes with the chromosome number 2n = 34, 2n = 68 and 2n = 102 were crossed mutually.

Table 3 shows the results of these crosses, indicating whether seeds were set or not.

c. in the series *Trachelioideae* Boiss.

4 species of this series were crossed mutually. Table 4 shows the results of these crosses, indicating whether seeds were set or not.

d. Selfpollination experiments were carried out in 18 species. Only in 2 species seeds were obtained: *C. expansa* and *C. persicifolia*. In the remaining species no seeds were obtained: *C. bononiensis*, *C. carpatica*, *C. cochleariifolia*, *C. glomerata*, *C. grossekii*, *C. latifolia*, *C. loeflingii*, *C. medium*, *C. poscharskyana*, *C. pulla*, *C. rapunculoides* (2n = 102), *C. rapunculus*, *C. rotundifolia* (2n = 68, 2n = 102), *C. scheuchzeri*, *C. sibirica*, *C. trachelium*.

Discussion

I. Chromosome numbers.

A. 10 species have not been examined previously: *C. aucheri* DC., *C. expansa* Friv., *C. kemulariae* Fom., *C. oblongifolia* (Koch) Char., *C. ochroleuca* Kem. Nath., *C. primulaefolia* Brot., *C. spruneriana* Hampe, *C. steveni* Bieb., *C. trautvetteri* Grossh., *C. verruculosa* Hoffmgg. et Link.

The following will be discussed here further:

TABLE 2

Crosses between some species of the Section *Rapunculus* and the Section *Medium*

No. of cross	Section *Medium*: Capsule with basal pores or valves				Section *Rapunculus*: Capsule with apical pores or valves		Seeds not obtained	Seeds obtained
	Calyx appendiculate		*Calyx exappendiculate*					
	♂	♀	♂	♀	♂	♀		
1		*C. alliariaefolia*	*C. trachelium*					×
2	*C. grossekii*			*C. trachelium*				×
3		*C. grossekii*	*C. trachelium*					×
4	*C. grossekii*			*C. rapunculoides*			×	
5	*C. punctata*			*C. rapunculoides*			×	
6		*C. grossekii*	*C. bononiensis*				×	
7	*C. grossekii*			*C. bononiensis*			×	
8	*C. ochroleuca*	*C. alliariaefolia*						×
9	*C. sibirica*	*C. dichotoma*					×	
10	*C. sibirica*	*C. grossekii*					×	
11	*C. alliariaefolia*	*C. grossekii*					×	
12	*C. lanata*	*C. alliariaefolia*						×
13			*C. colorata*	*C. erinus*				×
14			*C. erinus*	*C. colorata*				×
15			*C. portenschlagiana*	*C. poscharskyana*				×
16			*C. rotundifolia* (2n = 102)	*C. rapunculoides* (2n = 102)			×	
17			*C. rapunculoides* (2n = 68)	*C. rapunculoides* (2n = 102)				×
18			*C. rapunculoides* (2n = 102)	*C. rapunculoides* (2n = 68)				×
19					*C. carpatica*	*C. loeflingii*	×	
20					*C. carpatica*	*C. pyramidalis*		×
21					*C. pyramidalis*	*C. persicifolia*	×	
22			*C. trachelium*			*C. persicifolia*	×	
23			*C. rapunculoides*			*C. persicifolia*	×	
24	*C. punctata*					*C. persicifolia*	×	
25		*C. grossekii*			*C. pyramidalis*		×	

TABLE 3

Crosses between some species of the series *Trachelioideae* Boiss.

	C. latifolia ♀	*C. trachelium* ♀	*C. bononiensis* ♀	*C. rapunculoides* ♀ (2n = 102)
C. latifolia ♂	— (selfed)	—		—
C. trachelium ♂	—	— (selfed)	—	—
C. bononiensis ♂		—	— (selfed)	—
C. rapunculoides ♂ (2n = 102)		+	+	— (selfed)

+ = Seeds obtained — = No seeds obtained

TABLE 4

Crosses between the different cytotypes of the *Campanula rotundifolia*-complex

	2n = 34 ♀	2n = 68 ♀	2n = 102 ♀
2n = 68 ♂	+	— (selfed)	+
2n = 102 ♂	+	+	— (selfed)

+ = seeds obtained — = no seeds obtained

1. **C. expansa** Friv.

This species is related to *C. patula* (2n = 20), but has twice as many chromosomes. This is the first report of the number 2n = 40 for a species of the section *Rapunculus*. Crosses between this species and *C. rapunculus*, *C. patula* and *C. verruculosa* are planned.

2 and 3. **C. oblongifolia** (Koch) Char. and **C. trautvetteri** Grossh.

These species occur in Armenia and they are related to *C. glomerata* (2n = 30). Species with the number 2n = 60 have not been found, but it would be well worth to find out if such species do occur in the Caucasus. For this reason it is highly desirable to determine the chromosome number of *C. subcapitata* M. Pop., *C. symphytifolia* (Alb.) Kolak., *C. panjutini* Kolak. and *C. maleevii* Fed.

4. **C. steveni** Bieb.

KOLLER (in DARLINGTON and WYLIE, 1955) reports the number 2n = 20 for the forma nana of this species. 10 plants of this species, however, undoubtedly had the number 2n = 32. With regard to the basic number X = 8 this species is tetraploid. As in *Campanula persicifolia* (2n = 16) the cromosomes of *C. steveni* are long.

Some species of the so called "*fragilis*"-complex (MERXMÜLLER and DAMBOLDT, 1962) also have the number 2n = 32. To this group belong the species: *C. fragilis* Cyr., *C. barrelieri* Presl, *C. cavolinii* Ten., *C. isophylla* Morett.

These species, however, belong to the section *Medium* (sensu Boissier), and not, like *C. steveni*, to the section *Rapunculus*. Contrary to the chromosomes of *C. steveni*, the chromosomes of *C. isophylla* f.e. are rather small. (*C. steveni*: 4–5 μ; *C. isophylla*: ca. 2 μ).

In my opinion the chromosome number of the species of the *fragilis*-complex originated in a way totally different from that of *C. steveni*. The chromosome number of the *fragilis*-complex is connected with the number 2n = 34, whereas the number 2n = 32 of *C. steveni* probably originated by doubling of the number 2n = 16. At any rate, the species of the *fragilis*-complex can neither be derived morphologically nor cytologically from any known species with the number 2n = 16.

BÖCHER (1960) suggested that the species of the 17-series might have arisen through alloploid evolution: chromosome doubling of a trisomic diploid: $2 \times (8 + 8 + 1)$. In my opinion, if this hypothesis is right, the species of the 17-series should have larger chromosomes than they actually have. Therefore, Böcher's hypothesis fails to convince me. Preliminary investigations on the relation between the degree of polyploidy and the diameter of the pollengrains so far revealed that the pollen grains of *C. persicifolia* (2n = 16) are not smaller than those of several species of the X = 17 series. Moreover, the epiderm cells of the leaves of *C. persicifolia* are larger than those of several species of the X = 17 series. These facts, together with the objections from the field of cytology are in favour of the theory that it is impossible to derive the species of the X = 17 series from those of the X = 8 series. Consequently, the species of the 17 series with 2n = 34 (together with the species of the *fragilis*-complex, 2n = 32) are considered to be diploid, whereas the species of the X = 8 series with 2n = 16 (*C. persicifolia*) are diploid, and those with 2n = 32 (*C. steveni*) are tetraploid. The relation between the X = 8 and X = 10 series is not clear. Further investigations have to be undertaken to solve this problem.

5. **C. primulaefolia** Brot.

MARCHAL (1920) reports the number 2n = 26 for this species. In my opinion, however, this number refers to *C. peregrina*, a species resembling *C. primulaefolia* in some respects.

B. The following 9 species, listed in table 5, were investigated by other authors, but were not yet discussed in my previous paper:

TABLE 5

A comparison between the present and previous studies of the chromosome numbers of some *Campanula*-species

	New Count	References		
Species	2n	Author	Origin	2n
C. alpina Jacq.	34	SKALINSKA *et al.* (1959)	Poland, High Tatra	34
C. cervicaria L.	34	SUGIURA (1942)	unknown	26
C. collina Bieb.	68	SUGIURA (1942)	unknown	68
C. garganica Ten.	34	MARCHAL (1920)	unknown	34
		SUGIURA (1942)	unknown	68
		MERXMÜLLER and DAMBOLDT (1962)	Italy: Gargano	34
C. lanata Friv.	34	SUGIURA (1942)	unknown	34
C. patula L.	20	RUTLAND (1941)	England	20
		LÖVE and LÖVE (1956)	Iceland	20
C. pulla L.	34	SUGIURA (1942)	unknown	68
		GUTERMANN: (in LÖVE and LÖVE, 1961)	Austria, Germany	34
C. punctata Lam.	34	DE VILMORIN and SIMONET (1927)	unknown	34
		SUGIURA (1942)	unknown	34
C. pyramidalis L.	34	MARCHAL (1920)	unknown	34
		SUGIURA (1942)	unknown	34

The deviating numbers reported by SUGIURA (1942) may be caused by misidentifacation of the plant material used.

C. In a previous paper were discussed (GADELLA, 1962): *C. alliariaefolia*, *C. barbata*, *C. bononiensis*, *C. carpatica*, *C. cochleariifolia*, *C. erinus*, *C. glomerata*, *C. grossekii*, *C. lactiflora*, *C. latifolia*, *C. loeflingii*, *C. medium*, *C. persicifolia*, *C. portenschlagiana*, *C. poscharskyana*, *C. rapunculoides*, *C. rapunculus*, *C. rotundifolia*, *C. sibirica*, *C. spicata*, *C. thyrsoides*, *C. trachelium*, *C. waldsteiniana*.

The following will be discussed here further:

1) **C. cochleariifolia** Lam.

The material of Mont Cenis, France, proved to be not uniform in

cytological respect, the numbers 2n = 34, 35, 37 being found. The meiosis of these plants will be the subject of further investigations.

2) **C. lactiflora** Bieb.

SUGIURA (1942) reports the number 2n = 34 for this species. GADELLA (1962) reports the same number, but this is due to a printer's error. The exact number 2n = 36 was counted in cultivated material originating from Berlin and Geneva.

3) **C. loeflingii** Brot.

Plants collected in nature in Portugal all had the number 2n = 18 (LARSEN, 1954; GADELLA, 1962). This number was counted again, but also the number 2n = 20. *C. loeflingii* is related in some way to *C. patula* (2n = 20), a biennial species. Possibly the chromosome number 2n = 18, which I did not find in any other *Campanula* species was derived from the number 2n = 20.

4, 5, 6) **C. portenschlagiana** Roem. et Sch., **C. poscharskyana** Degen., **C. waldsteiniana** Roem. et Sch.

The chromosome number of these species was confirmed by MERXMÜLLER and DAMBOLDT (1962).

7) **C. rapunculoides** L.

Hitherto only plants with the number 2n = 102 were found.

5 plants of an Armenian population, however, had the number 2n = 68. Possibly this fact throws some light on the origin of the (rare) number 2n = 102. This number may have arisen by a cross of a plant with 2n = 34 (not yet found) and a plant with the number 2n = 68. Notwithstanding the fact that a plant with the number 2n = 34 has not yet been found, it may be possible that such plants occur, possibly in the Caucasus. An alternative possibility is that one of the species of the subsection *Eucodon* (D.C.) Fed. (see FEDOROV, 1957) is involved in the formation of the cytotype with the number 2n = 102.

8) **C.** *spicata* L.

A triploid plant, originating from Switzerland, was met with.

II. Crossing experiments.

1. Table 2: Although some seeds have been formed, it will yet have to be tried whether they will germinate or not. In some interspecific crosses between species with and without calyx-appendages seeds were obtained (Crosses 1–3). With due reserve and as a preliminary conclusion it may be said that the taxonomical significance of the calyx-appendages has possibly been overestimated. It was impossible to obtain seeds in interspecific crosses between plants with basal capsule-pores or -valves (Section *Medium*) and ones with apical capsule-pores or -valves (Section *Rapunculus*). This might indicate that the subdivision of the genus

Campanula into two sections is of more fundamental value for taxonomy.

The crosses between *C. colorata* (2n = 28) and *C. erinus* (2n = 28) and reciprocal yielded some seeds, just like the crosses between the two cytotypes of *C. rapunculoides*.

Only one interspecific cross in the section *Rapunculus* yielded some seeds.

2. Table 3: Some seeds were obtained from the crosses *C. rapunculoides* (2n = 102) ♂ X *C. trachelium* (2n = 34) ♀, and *C. rapunculoides* (2n = 102) ♂ X *C. bononiensis* (2n = 34) ♀. As the parental plants differ in chromosome number, the eventually formed F 1-plants will be investigated cytologically.

3. Table 4: Seeds were obtained in all crosses between the different cytotypes of this complex. The eventually formed F 1-plants will be investigated cytologically.

4. Self-fertilisation experiments.

Most of the species investigated proved to be self-sterile. These data are not in accordance with Hegi's opinion of the flower-biology (Hegi, Flora Mitteleuropas, VI, 1).

SUMMARY

1. The chromosome numbers of 42 species of the genus Campanula were determined.
2. A survey is given of the crossing-experiments carried out up to the present.

ACKNOWLEDGEMENT

These investigations have been carried out in the Botanical Museum and Herbarium of the State University of Utrecht, Lange Nieuwstraat 106, Utrecht, the Netherlands (Director: Prof. Dr. J. LANJOUW).

The author is much indebted to Mr. L. Y. TH. WESTRA for his correction of the English text and to miss J. NIERS for her technical assistance.

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