

A STATISTIC OF CAMPANULA SPECIES BASED ON VOUCHERS FROM DIFFERENT HERBARIUM

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ABSTRACT

According to specialty literature, Campanula Genus comprises approximately 400-600 species. A number of 130 species were found within the herbariums studied for this present paper (Al. Beldie Herbarium from Romania, The Royal Botanic Garden Edinburgh's herbarium, WU Herbarium from Wien and Harvard University Herbaria from the U.S.A.). The studied Campanula species are widespread on three continents: Europe, Asia and North America. A lot of species is endemic with seven of them found only in California. The most common species from the studied herbariums were: C. rotundifolia and C. rapunculoides, together with C. sibirica, C. glomerata, C. stevenii, C. spatulata, C. collina and C. bellidifolia. Al. Beldie Herbarium is an important resource as it contains some endemic species such as C. carpatica and C. transsilvanica. In addition, the species were mostly collected from Romania, as well as from other 13 European countries. As such, a detailed analysis of vouchers from different herbariums can bring new information regarding the number of species from a certain Genus, their spreading area or about their nomenclature.

KEY WORDS: *Campanula, herbarium, species, voucher, plants.*

INTRODUCTION

Campanula Genus belongs to the Campanulaceae Family and contains approximately 400-600 species that are spread out in the North hemisphere. The majority of species can be found in the Mediterranean and Balkan regions (Kuss et al., 2007) being spread out in many types of habitats such as meadows, the steppe area, the alpine area, on cliffs or on verges. Only in Turkey, there are 66 endemic species (Erkara et al., 2008). The genus is divided in more sections, each with its particularities (Park et al., 2006; Alçitepe et al., 2010). The species are annual, biennial or perennial, have variable dimensions and alternate, sessile leaves. The flowers resemble a bell and can stand alone or be attached to an inflorescence (Roquet et al., 2008; Bogdanović et al., 2014; Röper et al., 2015).

*Al. Beldie Herbarium (BUCF), owned by Marin Drăcea National Institute for Research and Development in Forestry from Bucharest is included in the list of renowned worldwide herbariums. The herbarium contains numerous vouchers belonging to varied genera such as: 17 *Amaranthus* species (Dincă et al., 2018), 11 *Elymus* species (Pleșca et al., 2019), 7 *Lycopodium* species (Vechiu et al., 2018a), 80 *Trifolium* species (Cântar & Dincă, 2018), 41 *Polygonum* species (Vechiu et al.,*

2018b), 33 *Orobanche* species (Scărlătescu *et al.*, 2017), 21 *Agrostis* species (Cântar & Dincă, 2019), 36 *Bronus* specues (Tudor & Dincă, 2019) and the 58 *Cornus* specues (Vechiu & Dincă, 2019).

WU Herbarium from Wien was created in 1879 and had already 80.000 specimens in 1889. Today, the herbarium contains 1.400.000 specimens covering all worldwide plant groups (<https://herbarium.univie.ac.at/index.htm>).

The Harvard University Herbaria is one of the largest university herbarium collections in the world, and the third largest herbarium in the United States. It includes six collections and more than five million specimens of algae, bryophytes, fungi, and vascular plants, being a centre for botanic and biodiversity studies since the early 1800s (<https://huh.harvard.edu/>).

The Royal Botanic Garden Edinburgh's extensive Herbarium holds approximately 3 million preserved plant specimens, makes up two-thirds of the planet's flora and represents over 300 years of biodiversity (<https://data.rbge.org.uk/search/herbarium/>).

MATERIALS AND METHODS

The general data (number of species, widespread, morphology) were established after studying more specialty articles and websites.

The number of online vouchers from WU Herbarium, Harvard University Herbaria and the Scotland Herbarium were counted in order to create a precise statistic of species belonging to this genus. The plants from Al. Beldie Herbarium were inventories and transformed in a database with information from their labels (Herbarium/Botanic collection; name, harvesting date and place; the person who collected the plant and the voucher's conservation degree).

The species were grouped based on the herbariums where they were identified and based on the mentioned sources. In addition, their spreading was also added when it was needed. The spreading area was determined by using literature references and the <http://campanula.e-taxonomy.net/> website.

The name of the species present in the herbarium was verified with the help of the WCSP data base (<https://wesp.science.kew.org>) which offers current data regarding the internationally accepted scientific names and synonyms.

RESULTS AND DISCUSSIONS

Al. Beldie Herbarium contains 476 samples of *Campanula* species, followed by 1.818 samples in Royal Botanical Garden Edinburgh, 2.369 samples in Harvard University Herbaria and 13.121 samples in Herbarium WU. The following table presents *Campanula* species from different herbarium and databases (Table 1).

TABLE 1. *Campanula* species present in different herbarium and databases

No	Species name [synonym]	Spreading area	Wikipedia	Al. Beldie Herbarium (number of vouchers)	WU Herbarium (number of vouchers)	Harvard University Herbaria (number of vouchers)	Royal Botanical Garden Edinburgh (number of vouchers)
1	<i>Campanula acutiloba</i> Vatke.	Turkey, Iran	Yes		5		1
2	<i>Campanula aizoon</i> Boiss.	Greece	Yes		7		5
3	<i>Campanula albanica</i> Wit.	Albania, Greece, Yugoslavia	Yes		4		15
4	<i>Campanula alliarifolia</i> Willd.	Caucasus, Turkey, Great Britain	Yes		478		6
5	<i>Campanula alaskana</i> A.Gray.	North America	Yes				
6	<i>Campanula alpestris</i> All.	Alps	Yes		7		17
7	<i>Campanula alpina</i> Jacq.	Alps, Carpathians, Balkans	Yes	17	67		25
8	<i>Campanula americana</i> L.	North America	Yes		6	161	1
9	<i>Campanula andina</i> Rupr.	E. Caucasus	Yes		12		
10	<i>Campanula andrewsii</i> A.DC.	Greece	Yes		26		3
11	<i>Campanula angustiflora</i> East.	California	Yes			6	
12	<i>Campanula aparinoides</i> Pur.	Asia-Temperate, Finland, Northern America	Yes			399	
13	<i>Campanula armena</i> Stev.	Caucasus, Iran, Turkey	Yes		205		
14	<i>Campanula aristata</i> Wall.	China, Afghanistan	Yes				17
15	<i>Campanula balfourii</i> J. Wag.	Yemen, Socotra	Yes		6		8
16	<i>Campanula barbata</i> L.	Europe	Yes	4	83		77
17	<i>Campanula bayerniana</i> Rupr.	Caucasus, Iran	Yes		182		2
18	<i>Campanula bellidifolia</i> Ad.	Caucasus	Yes		510		8
19	<i>Campanula betulifolia</i> Koch.	Turkey	Yes		5		1
20	<i>Campanula bononiensis</i> L.	Caucasus, Europe, Northern America	Yes	11	119		25
21	<i>Campanula bravensis</i> Chev.	Cape Verde	Yes				
22	<i>Campanula cespitosa</i> Scop.	Alps, Slovenia	Yes	2			
23	<i>Campanula calcarata</i> S & L.	North Caucasus	Yes		18		
24	<i>Campanula californica</i> Hell.	California	Yes			7	
25	<i>Campanula carpatica</i> Jacq.	Europe, Carpathian M., Connecticut, Michigan	Yes	20	18	1	13
26	<i>Campanula caucasica</i> Bieb	North Caucasus, Transcaucasus	Yes		11		
27	<i>Campanula cenisia</i> L.	Austria, Germany, Switzerland, Italy, France	Yes	4	5		46
28	<i>Campanula cervicaria</i> L.,	Europe, Minnesota	Yes	13	50		30
29	<i>Campanula cespitosa</i> Scop.,	Austria, Italy, Yugoslavia	Yes		101		13
30	<i>Campanula ciblesii</i> Prodán	Tibles, Romania	Yes	1			
31	<i>Campanula ciliata</i> Steven	Caucasus	Yes		30		
32	<i>Campanula cochlearifolia</i> Lam.	Pyrenees, Alps, Carpathians	Yes	30	111		7
33	<i>Campanula collina</i> Sims	Caucasus and	Yes		519		4

DINĂ & VECHIU: A statistic of *Campanula* species based on vouchers from different Herbarium

		Turkey					
34	<i>Campanula coriacea</i> P.H.Davis	Caucasus, W Asia	Yes		52		1
35	<i>Campanula crassipes</i> Heuff.	Serbia, Romania	Yes	1			9
36	<i>Campanula crispa</i> Lam.	Caucasus, Western Asia	Yes		75		1
37	<i>Campanula divaricata</i> Mich.	United States	Yes			81	
38	<i>Campanula drabifolia</i> Sm.	Greece	Yes		62	1	10
39	<i>Campanula dzaaku</i> Albov	Caucasus	Yes		20		
40	<i>Campanula edulis</i> Forssk	Africa, Arabian Peninsula	Yes		14		43
41	<i>Campanula engurensis</i> Khar.	Caucasus	Yes		12		
42	<i>Campanula erinus</i> L.	Macaronesia, Asia-Temperate, Europe	Yes	2	235		67
43	<i>Campanula exigua</i> Rattan	California	Yes			8	
44	<i>Campanula floridana</i> Wat.	Florida				27	
45	<i>Campanula foliosa</i> Ten.	Italy, Balkan Pen		1	36		5
46	<i>Campanula garganica</i> Ten.	Southern Europe	Yes	1	22	1	5
47	<i>Campanula glomerata</i> L	England, Caucasus, Europe, Northern America	Yes	38	517	19	79
48	<i>Campanula griffinii</i> Morin	California	Yes			1	
49	<i>Campanula grossekii</i> Heuff.	Bulgaria, Romania, Yugoslavia	Yes	5	2		3
50	<i>Campanula hawkinsiana</i>	Albania, Greece	Yes		51	1	7
51	<i>Campanula hercegovina</i> Degen & Fiala	Bosnia Herzegovina	Yes				1
52	<i>Campanula hispanica</i> Willk.	Algeria, Spain	Yes				27
53	<i>Campanula hypopolia</i> Tr.	Caucasus	Yes		36		2
54	<i>Campanula isophylla</i> Moretti	Italy	Yes	1	1	2	6
55	<i>Campanula jacobaea</i> C.Sm.	Cape Verde	Yes				
56	<i>Campanula kladniana</i> Schur.	Carpathians	Yes	18	4		
57	<i>Campanula kolenatiana</i> Mey.	Caucasus	Yes		43		1
58	<i>Campanula lactiflora</i> M.Bieb.,	Caucasus and Turkey	Yes		204	5	5
59	<i>Campanula lanata</i> Friv.,	Serbia, Bulgaria	Yes		1	1	7
60	<i>Campanula lasiocarpa</i> Cham.	North America, Japan, Russian Far East	Yes		1	112	3
61	<i>Campanula latifolia</i> L.,	Europe, W Asia	Yes	4	310		27
62	<i>Campanula lingulata</i> Waldst. & Kit	SW. Carpathians to C. Balkan Pen.	Yes	1	187		17
63	<i>Campanula lusitanica</i> Loeffl.	NW. Spain to N. & S. Portugal	Yes				39
64	<i>Campanula macrorhiza</i> J.Gay	NE. Spain to NW. Italy, Corse	Yes	3	6		12
65	<i>Campanula macrostachya</i> Waldst. & Kit.	SE. Europe to Slovakia and NW. & W. Turkey	Yes	3	9		17
66	<i>Campanula medium</i> L.	Southern Europe	Yes	1	12	4	16
67	<i>Campanula moravica</i> Kov.	EC. & SE. Europe	Yes		86		1
68	<i>Campanula morettiana</i> Rechb.	SE. Alps	Yes	2	12		9

69	<i>Campanula olympica</i> Boiss.	Caucasus, Turkey, Bulgaria, Yugoslavia	Yes		61	1	13
70	<i>Campanula pallida</i> Wall.	China, Afghanistan, Asia-Tropical	Yes				51
71	<i>Campanula parryi</i> A.Gray.	NW U.S.A.	Yes			55	
72	<i>Campanula patula</i> L.	Europe	Yes	43	241	4	113
73	<i>Campanula pendula</i> M.Bieb.	Caucasus, Russia	Yes		110		
74	<i>Campanula persicifolia</i> L.	Europe	Yes	30	208	6	76
75	<i>Campanula petraea</i> L.	Italy, France	Yes	1	3		6
76	<i>Campanula petrophila</i> Rupr.	Caucasus	Yes		134		1
77	<i>Campanula piperi</i> Howell	N America	Yes			10	
78	<i>Campanula phrygia</i> Jaub. & Spach	Western Asia, South-eastern Europe	Yes		74		
79	<i>Campanula portenschlagiana</i> Schult	Croatia	Yes	1	17		7
80	<i>Campanula poscharskyana</i> Degen	Former Yugoslavia	Yes		19		1
81	<i>Campanula praesignis</i> Beck	Austria	Yes		30		1
82	<i>Campanula preclatoria</i> Timb	France, Spain	Yes	1	1		7
83	<i>Campanula prenanthoides</i> Durand	Oregon, California	Yes			46	
84	<i>Campanula primulifolia</i> Brot.	Portugal, Spain	Yes		1		
85	<i>Campanula propinqua</i> Fisch. & C.A.Mey.	Turkey, Iran, Arabian Pen	Yes		87		
86	<i>Campanula punctata</i> Lam.	China, Eastern Asia, Russian Far East, NE U.S.A	Yes		10		5
87	<i>Campanula pyramidalis</i> L.	South Europe	Yes	2	9		9
88	<i>Campanula raddeana</i> Trautv.	Transcaucasus	Yes		53		
89	<i>Campanula radicata</i> B. & C.	Greece	Yes				13
90	<i>Campanula raineri</i> Perp.	Alps	Yes		7	2	4
91	<i>Campanula ramosissima</i> Sm.	SE. Europe	Yes		467	1	21
92	<i>Campanula rapunculoides</i> L.	Europe, Siberia	Yes	35	799	201	48
93	<i>Campanula rapunculus</i> L.	Asia, Africa, Europe	Yes	7	200		71
94	<i>Campanula rhomboidalis</i> L.	France	Yes	1	23		34
95	<i>Campanula robinsiae</i> Small	Florida	Yes			1	
96	<i>Campanula rotundifolia</i> L.	Europe	Yes	13	424	997	156
97	<i>Campanula rupestris</i> Sm.	Greece	Yes		28		16
98	<i>Campanula rupicola</i> Boiss.	Greece	Yes		24		9
99	<i>Campanula sabatia</i> De Not.	NW. Italy	Yes	1	1		5
100	<i>Campanula sarmatica</i> Ker Gawl.	Caucasus	Yes		69		2
101	<i>Campanula saxifraga</i> Bieb	Turkey, Iran	Yes		234		1
102	<i>Campanula scabrella</i> Eng	United States	Yes			10	
103	<i>Campanula scheuchzeri</i> Vill.	Europe	Yes	1	133		56
104	<i>Campanula scouleri</i> Hook.	North America	Yes			57	
105	<i>Campanula scutellata</i> Griseb.	Balkan Pen.	Yes	1	28		2
106	<i>Campanula serrata</i> Kit.	Carpathians	Yes		21		4
107	<i>Campanula sharsmithiae</i> Morin	California	Yes			1	

DINCĂ & VECHIU: A statistic of *Campanula* species based on vouchers from different Herbarium

108	<i>Campanula shetleri</i> Heckard	California	Yes				
109	<i>Campanula sibirica</i> L.	Asia-Temperate, Europe	Yes	22	851	1	47
110	<i>Campanula simulans</i> Carls	Turkey, Greece	Yes				14
111	<i>Campanula sparsa</i> Friv.	Balkan Pen., Hungary	Yes		75		17
113	<i>Campanula spatulata</i> Sm.	Balkan Pen.	Yes		517		22
114	<i>Campanula speciosa</i> Pourr.	NE. Spain, France	Yes	1	1		15
115	<i>Campanula spicata</i> L.	Europe	Yes	1	46		23
116	<i>Campanula stevenii</i> M.Bieb.	Caucasus, Europe	Yes		588		19
117	<i>Campanula suanetica</i> Rupr.	Transcaucasus	Yes		21		
118	<i>Campanula tatrae</i> Borbás	Carpathians	Yes		48		2
119	<i>Campanula thyrsoides</i> L.	France, Alps, Balkan Pen.	Yes	1	46		26
120	<i>Campanula topaliana</i> Beau.	Greece	Yes		30		5
121	<i>Campanula trachelium</i> L.	Europe	Yes	11	319	11	68
122	<i>Campanula transsilvanica</i> Schur	Carpathians, Bulgaria	Yes	1	2		
123	<i>Campanula tridentata</i> Schreb	Turkey, Caucasus	Yes		354		3
124	<i>Campanula tymphaea</i> Hauss	Albania, N Macedonia, N. Greece	Yes		27		6
125	<i>Campanula uniflora</i> L.	N America, Asia	Yes	1	1	118	54
126	<i>Campanula versicolor</i> Andr.	SE. Italy, Balkan Pen.	Yes		73		15
127	<i>Campanula wilkinsiana</i> Greene	California	Yes			3	
128	<i>Campanula witasekiana</i> Vierh.	E. Alps, N. Balkan Pen.	Yes		91		2
129	<i>Campanula zangezura</i> Lipsky	S. Transcaucasus, NW. Iran	Yes		69		
130	<i>Campanula zoysii</i> Wulfen	Austria, Italy, Slovenia	Yes	1	33		

A large number of *Campanula* species are endemic such as in California (which records the largest number of endemic species – 7 inventoried species), Florida, Caucasus, Cape Verde, Czech Republic, Bosnia Herzegovina, Serbia, or Croatia.

As in the case of *Alnus* species (Dincă & Peticilă 2019), the collections of different herbariums presents species name that are actually forms or variations.

Even though it is considered an average collection, Al. Beldie Herbarium contains numerous *Campanula* species (Figure 1), and some specific to our area (such as *C. carpatica*, present with more vouchers than in any other international herbariums or *C. transsilvanica*). The *Campanula* species from BUCF Herbarium are mostly gathered from Romania (363 samples), and completed by other regions or countries (Austria, Bosnia, Bulgaria, Czech Republic, Croatia, Switzerland, France, Germany, Italy, Norway, Moldavia, Sweden, Spain).

The species from WU Herbarium that are very well represented when compared with other collections are the following: *C. alliarifolia*, *C. armena*, *C. bellidifolia*, *C. cespitosa*, *C. cochleariifolia*, *C. collina*, *C. erinus*, *C. glomerata*, *C.*

lactiflora, *C. latifolia*, *C. moravica*, *C. pendula*, *C. perscifolia*, *C. ramosissima*, *C. saxifraga*, *C. sibirica*, and *C. stevenii*.

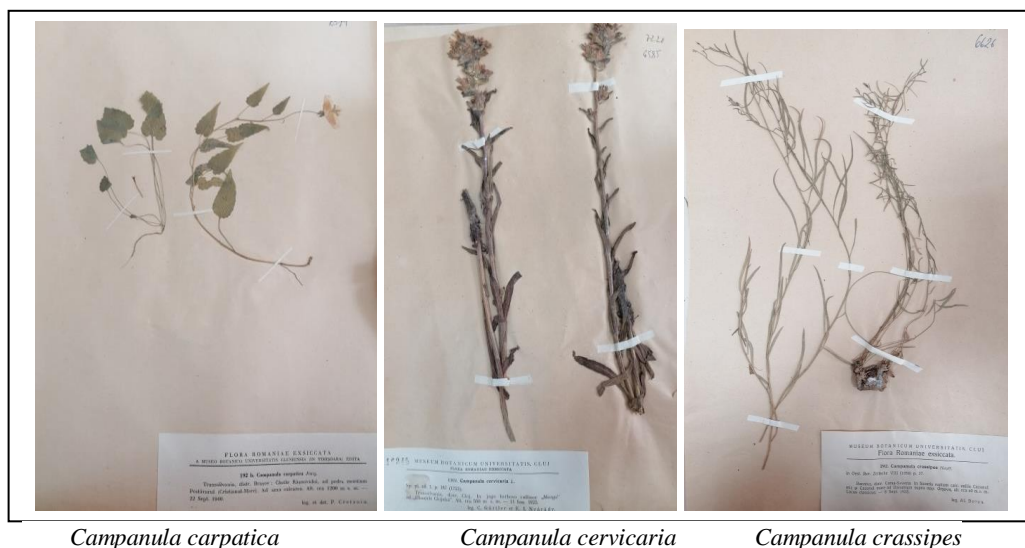


FIGURE 1. Samples of preserved biological material from BUCF Herbarium

The Harvard University Herbarium has numerous vouchers from species that are specific to North America, such as: *C. americana*, *C. divaricata*, *C. floridana*, *C. lasiocarpa*, *C. parryi*, *C. scouleri*, and *C. uniflora*.

In comparison with the other analysed herbarium, the Edinburgh Herbarium has numerous samples of *C. barbata*, *C. cenisia*, *C. edulis*, *C. hispanica*, *C. lusitanica*, *C. medium*, *C. pallida*, and *C. rhomboidalis*.

The largest number of vouchers were identified for *C. rotundifolia* (1590), *C. rapunculoides* (1083) and *C. sibirica* (921), followed by *C. glomerata* (653), *C. stevenii* (603), *C. spatulata* (539), *C. collina* (523) and *C. bellidifolia* (518) (Figure 2). In comparison with the species described by Wikipedia (<https://en.wikipedia.org/wiki/Campanula>), we have identified only two new *Campanula* species present in the analysed herbarium. On the other hand, Wikipedia mentions four *Campanula* species that were not represented in any of the four analysed herbariums.

The *Campanula* species present in the four analysed herbariums are especially spread out in Europe and Asia and less in North America (Figure 3). From a geographic point of view, the majority of areas were located in the Caucasus, Balkans, and the United States, with lower percentages in the Carpathians, Alps or in Turkey (Figure 4).

DINCĂ & VECHIU: A statistic of Campanula species based on vouchers from different Herbarium

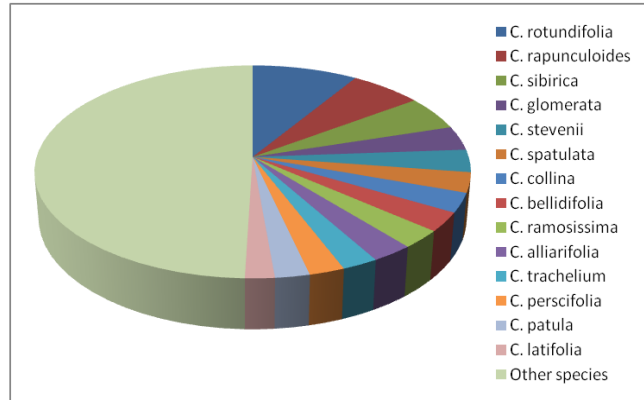


FIGURE. 2. *Campanula* species present in the four herbariums

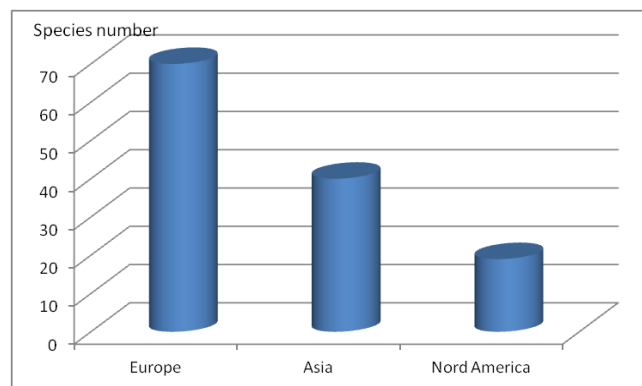


FIGURE. 3. Spread of analysed *Campanula* species on continents

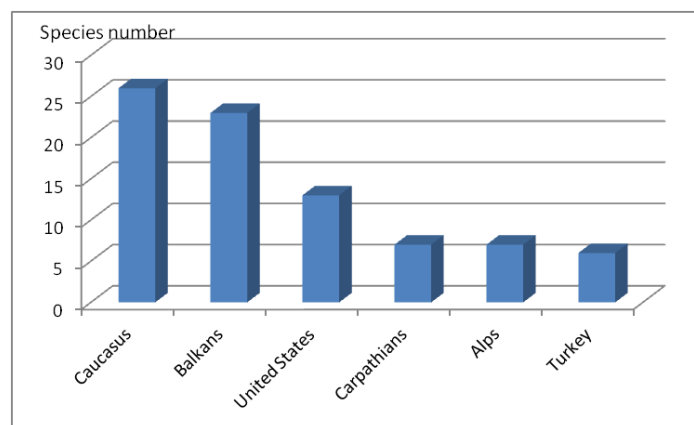


FIGURE. 4. Spread of analysed *Campanula* species on geographic areas

CONCLUSIONS

The present article has synthesized the *Campanula* species based on a number of reference herbariums. These resources are valuable in identifying a part of the total number of species present in this Genus. The spreading area of these species is large and includes endemic species for some regions (7 endemic species in California). The majority of plants were found in Europe, followed by Asia and North America.

A total number of 130 species were inventoried from 4 herbariums in reference with the 400-600 *Campanula* species mentioned by certain authors.

The following species were identified within all the studied herbariums: *C. garganica* Ten., *C. medium* L., *C. patula* L., *C. persicifolia* L., *C. rapunculoides* L., *C. rotundifolia* L., *C. sibirica* L., *C. trachelium* L. and *C. uniflora* L.

Al. Beldie Herbarium is important because it contains endemic species such as *C. carpatica*, and *C. transsilvanica*. The species were mainly gathered from Romania as well as from other 13 European countries.

WU Herbarium contains the largest number of *Campanula* species, with the following ones as best represented: *C. alliarifolia*, *C. armena*, *C. bellidifolia*, *C. cespitosa*, *C. cochleariifolia*, *C. collina*, *C. erinus*, *C. glomerata*, *C. lactiflora*, *C. latifolia*, *C. moravica*, *C. pendula*, *C. persicifolia*, *C. ramosissima*, *C. saxifraga*, *C. sibirica*, and *C. stevenii*.

The Harvard University Herbarium contains numerous samples of *Campanula* species that are specific to North America: *C. Americana*, *C. divaricata*, *C. floridana*, *C. lasiocarpa*, *C. parryi*, *C. scouleri*, and *C. uniflora*.

While the Edinburgh Herbarium is represented by *C. barbata*, *C. cenisia*, *C. edulis*, *C. hispanica*, *C. lusitanica*, *C. medium*, *C. pallida*, and *C. rhomboidalis*.

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DINCĂ & VECHIU: A statistic of *Campanula* species based on vouchers from different Herbarium

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