

HERBARIUM SURVEY OF GENUS *GENTIANA* L.

Raluca-Elena ENESCU^{1*}, Emilia VECHIU¹, I. CÂNTAR²

¹"Marin Drăcea" National Institute for Research and Development in Forestry, Braşov, Romania

raluk.enescu@yahoo.com

²"Marin Drăcea" National Institute for Research and Development in Forestry, Timisoara, Romania

Abstract. The paper present the morphological and ecological description of species belonging to the genus *Gentiana* L. found in "Al. Beldie" Herbarium from "Marin Drăcea" National Institute for Research and Development in Forestry (INCDS) from Bucharest. The majority of gentian species was harvested because are the source of important pharmacologically active properties and was used as ornamental plants. A total of 206 records belonging to genus *Gentiana* was found in the Herbarium. A database was created with information about species, year of collect, the collect site, the botanist who made the identification and the conservation status of the plant. The oldest preserved specimen dates back to the 1919s. A brief description of the inventoried species was made. Certain species of this genus have therapeutic properties. Regarding the place of harvesting, the species of this genus have been harvested mainly from the Bucegi Mountains (Romania) and harvested by Al. Beldie.

Keywords: *Gentiana*, herbarium, Bucegi Mountains

INTRODUCTION

At the "Marin Drăcea" National Institute for Research and Development in Forestry from Bucharest there exist a huge collection of plants called "Alexandru Beldie" Herbarium which containing more than 60,000 plates. The plants from the collection are kept in their original folders and are arranged in 600 drawers (VASILE ET AL., 2017). The herbarium has been inscribed in INDEX HERBARIUM and includes a huge number of plants coming from private donations and from foreign collections.

MATERIALS AND METHODS

The survey was conducted on the 206 plates from the herbarium mentioned above, belonging to the *Gentiana* genus. They were grouped by species, after the harvest year, by the place where they were harvested and by the specialist who harvested them. In table 1 is shown a small part from the database.

Table 1.

Part of database from *Gentiana* genus, "Alexandru Beldie" Herbarium

Drawer no.	Plate no.	Herbarium/ Botanic collection/ Institution	Species	Harvest date	Harvest place	Collected/ Determined by:	Conservation degree (1..4)
86	2	Flora Romaniae Exsiccata a Herbario Universitatis Napocensis Edita	<i>Gentiana bulgarica</i> Velen	1966.10.16.	Transilvania: Braşov county	I. Morariu	2

86	10	Herbarul Școalei Politehnice București/ Laboratorul Botanic	<i>Gentiana asclepiadea</i> L.	1931.08.04.	Bucegi: Zănoaga	C.C Georgescu	1
86	49	Herbarul Politehnice București, Facultatea de Silvicultură/ Laboratorul de botanică	<i>Gentiana ciliata</i> L.	1952.10.01.	Bucegi: Brănele Zănoagei	Al. Beldie	2
86	78	Herbarul Politehnice București, Facultatea de Silvicultură/ Laboratorul de botanică	<i>Gentiana cruciata</i> L.	1946.07.01.	Bucegi: Poiana Căprioarei	Al. Beldie	2
86	73	Herbarium Al. Beldie, București	<i>Gentiana kochiana</i> Perr. Et Song	1938.06.01.	Bucegi: Jepii, Brăul Jepilor	Al. Beldie	2
86	88	Herbarium Al. Beldie, București	<i>Gentiana lutea</i> L.	1937.06.01.	Bucegi: Valea Coștilei	Al. Beldie	3
86	93	Herbarul Institutului de Cercetări Silvice/ Ministerul Agriculturii și Silviculturii	<i>Gentiana nivalis</i> L.	1955.09.09.	Bucegi: Valea Mălăiești	Al. Beldie	2
87	202	Herbarul Școalei Politehnice București/ Laboratorul Botanic	<i>Gentiana utriculosa</i> L.	1919.08.28.	Bucegi: Caraiman, Brăul Mare	M. Haret	1
87	187	Herbarium Al. Beldie, București	<i>Gentiana verna</i> L.	1935.08.01.	Bucegi: Jepii Mici Brăul Mare al Jepilor alt 1800 m exp. Est	Al. Beldie	2

RESULTS AND DISSCUTION

Genus *Gentiana* is part of the *Gentianales* Order, *Gentianaceae* family. The name derives from the name of the ancient king called Gentius, who believe that this genus has tonic properties (TUTIN 1972; HO AND LIU 1990; YUAN ET AL. 1996). *Gentiana* genus includes around 400 species which are found mainly in the alpine areas of the temperate regions of Asia, Europe, America and prefer neutral and acidic soils rich in humus and well-drained.

These plants are woody or grassy plants with entire leaves, arranged opposite or in vertical (HSIEH ET AL. 2007; PROSSER AND BERTOLLI 2008). Many of the plants of this genus are known for being used in the pharmaceutical industry. *G. lutea* and *G. punctata* in traditional Serbian medicine are used to treat digestive degeneration; in Italy, the roots macerated in alcohol of *G. lutea* are used in treatments of rheumatism (MIRZAEI ET AL., 2017). The most important plant compounds in the genus *Gentiana* are the following: secoiridoid glycosides (gentiopicroside, sweroside), xanthone glycosides, terpenes, xanthenes, secoiridoids, alkaloids and flavone C-glucosides (HUDECOVÁ ET AL., 2012).

The species of this genus found in herbarium are the following: *Gentiana acaulis* L., *G. angustifolia* Vell., *G. asclepiadea* L., *G. bavarica* L., *G. bulgarica* Velen., *G. campestris* L., *G. carpatica* Wettst., *G. carpaticola* Borb., *G. ciliata* L., *G. clusii* E.P.Perrier & Songeon, *G. compacta* Hegetschw., *G. crispata*, *G. cruciata* L., *G. excisa* Froel., *G. frigid* Haenke, *G. fröliche*, *G. gelida* M., *G. germanica* (Willd.) E.F.Warb., *G. involucrata* Roth., *G. Kochiana* Perr. Et Song, *G. lutea* L., *G. nivalis* L., *G. orbicularis* Schur., *G. phlogifolia*, *G. pneumonanthe* L., *G. praecox*, *G. punctata* L., *G. pyramidalis* Nees., *G. rochetii*, *G. starmiana* A. Et J. Kern, *G. tenella* Rottb., *G. tergestina* Beck., *G. uliginosa* Willd., *G. utriculosa* L., *G. verna* L., *G. vesiculosa*.

The most numerous *Gentiana* species found in herbarium are the following: *G. asclepiadea* L. (21 plates), *G. ciliata* L. (10 plates), *G. Kochiana* Perr. et Song. (11 plates) *G. praecox* (25 plates), *G. verna* L. (23 plates) și *Gentiana utriculosa* L. (20 plates).

Gentiana acaulis is a small plant with a short stem, the leaves at the base are oval elliptical trapped in a rosette and stretched on the ground. At the top there is a single large flower in the shape of an elongated blue-eyed cup. It blooms in June-July. Flowers grow on a very short stem of 3-6 cm long. (HO AND LIU 1990; YUAN ET AL. 1996). Leaves on acidic soils. It is a species specific to Central and South-Eastern Europe found in the Alpine, Cévennes and Pyrenees mountain areas. In Romania, it is found on the meadows of the Carpathian mountains and in the foothills of the forest area. Roots are used to treat digestive disorders, stimulation of appetite, tonic preparations, anti-smoking formulations and cosmetics. It is cultivated for ornamental purposes (MÜLLER 1982).

Gentiana asclepiadea (figure 1) is a native species of central and eastern Europe. The flowers are blue-violet, the stem is simple with oval-lanceolate leaves (ZAJAĆ AND PINDEL, 2011). The plant grows to 100 cm with a strong developed rhizome (MOMCILOVIĆ ET AL., 1997). It grows in forests and bushes in the hills and mountains, on wet, rich and well-drained soils. It is a species of ornamental interest, but especially a medicinal plant, used to treat jaundice (Yuan et al. 1996).

Gentiana bavarica is a 5-15 cm high perennial species. The leaves are yellowish-green and are arranged like a rosette. The colour of flowers is dark blue. The flower is 1-2 cm long and it blooms in July-August. It is a native species from European Alps and prefers wet grasslands (RORK 1949).

Gentiana bulgarica - it's a small plant that can reach a height up to 15 cm. Flowers are 1 to 2 cm long, blue-purple, tubular. The leaves are placed in pairs, the bases are rounded and the upper ones are sharper. The stem is often branched, and the branches are approximately the same height as the stem. In Romania, this species blooms in August-September and grows through pastures such as in the Bucegi Mountains, Piatra Craiului (LÖVE AND LÖVE 1975).

Gentiana campestris – is a plant of 3-30 cm high, with erect stems, leaves are opposite and ovate-lanceolate. The color of flowers is bluish-purple, but could be white, pink or lilac, with four petals. The flowering period is very long, from June to October. It is spread in Northern and Central Europe, in Alps, Jura mountains, Italy, France, Spain, Denmark, Finland, Ireland, Norway, Sweden, United Kingdom, Austria, Belgium, Czech Republic, Germany, Netherlands, Poland, Slovakia, Switzerland, Estonia and Russia (RORK 1949).

Gentiana clusii is a species similar to *G. acaulis* and is endemic in Europe. The flower is dark blue, with no green stripes inside, with elliptic to elongated lanceolate leaves. It prefers calcareous soils. It is found in the Alps, the Pyrenees, the Black Forest Mountains and the Carpathians. In Romania, *G. clusii* is a rare species and is included in the red list of rare plants (BARTOK ET AL., 2015).

Gentiana cruciata (figure 1) is a perennial plant of small size, reaching up to 20-40 cm high. It blooms from July to October. Flowers are hermaphrodite, purple-white with four petals pollinated by insects. The fruit is a capsule, and the seeds are dispersed through the wind (TAKHTAJAN 1990). It is spread throughout almost all of Europe and in West Asia. The root is used for the preparation of the gentian bite, having effects in stimulating the appetite, tonic, digestive and antitermic, for the sore throat and hoarseness (KROGULEVICH 1978).



Fig. 1. Preserved plants from ``Al. Beldie`` herbarium - *Gentiana asclepiadea* (left) and *Gentiana cruciata* (right)

Gentiana frigida - is a small plant, 2-8 cm high, with 1-2 cup-shaped flowers at the top. The leaves are arranged in pairs, elongated, rounded to the top, at the base attached to the stem. The petals are white-yellow with streaks and blue dots inside. It blooms in July-August in grassy and rocky places. In Romania it is found in the mountains of Rodnei, Bucegi, Fagaras (BARTOK ET AL., 2015).

Gentiana gelida – plant with ovate to lanceolate, coriaceous and acute leaves, with 4-8 light yellow tubular flowers. It grows at high altitude (2000-3000) in Caucasus, Western Asia, Armenia, Turkey (KROGULEVICH 1978).

Gentiana kochiana – is a 5-10 cm high herbaceous plant with leaves at the base arranged like a rosette. The leaves are oblong to lanceolate with numerous teeth on the margin. The flowers are deep blue. This species grows in alpine and subalpine meadows at 1500 – 2700 m altitude. It blooms from April to June (RORK 1949).

Gentiana lutea (figure 2) - robust plant with stems up to 1 m high. The flowers are large, yellow and they are in frequent bouquets. The leaves are green-bluish, elliptical, wide, placed in pairs. The root is long and thick and is used in the pharmacy because it has tonic and digestive properties. The root contains some of the bitter known compounds and is used as a scientific basis for measuring bitterness. It is widespread in the Carpathian Mountains, on the rugged sunny coasts, on the groves and sometimes in the forest area. Flowering in July-August. It is declared a monument of nature (STOLT 1921).

Gentiana nivalis - is a plant with flowers that grow up to 2-10 (15) cm high. The stem is leafy and branched from the base. The flower has 5 intense blue petals. The leaves are small, placed in pairs. It blooms in July-August. It is found on meadows, ridges, boulders and in the rocky places of the Carpathian Mountains (STOLT 1921).

Gentiana orbicularis - a gentian-like plant *G. verna*, however, with small leaves, almost round, the lower ones very cramped one above the other. The flower is of a living blue. Blooms in July-August. It grows in grassy and rocky places, being spread just in the Rodnei, Barsa, Bucegi, Fagarasului mountains (RORK 1949; STOLT 1921).

Gentiana punctata - endemic plant in the Alps and other mountain ranges in Central and South-Eastern Europe. It can reach heights between 20-60 cm, with a straight, cylindrical, unbroken stem, glabrous and hollow on the inside. The flowers are light yellow and brown, hermaphrodite and pollinated by insects. The leaves are large, oval, opposed, sessile, and the petiolate base. It blooms from July to September. Grows on light, sandy and well-drained soils, on cliffs and alpine pastures. From late August to late autumn, rhizomes are harvested with roots. The root of the plant is used to stimulate appetite and fermented is used for the preparation of liqueurs. (SKALINSKA 1951).

Gentiana utriculosa (figure 2)- has a straight stem, 5-15 cm high, branched from the base, with branches pointing upwards and each wearing a flower. Leaves are small, in pairs, and the base is more plentiful. It blooms in June-July, on the meadows in the Carpathian chain (DIDUKH 2009).



Fig. 2. Preserved plants from "Al. Beldie" herbarium - *Gentiana lutea* (left) and *Gentiana utriculosa* (right)

Gentiana verna - is a short plant with intense blue flower. The leaves are elliptical and appear in two or three opposite pairs along the stems. It blooms from the end of spring to August, depending on the altitude. It's a melliferous plant. It is one of the most widespread species from the *Gentiana* type, it is found on the alpine meadows of the central and south-eastern Europe, in the Jura and the Balkans Mountains, on the rocks and in rocky places, being spread throughout the Carpathian Mountains (YUAN 1993).

Harvesting place of the most of species (*G. asclepiadea*, *G. ciliata*, *G. kochiana*, *G. verna*, *G. utriculosa*) is generally represented by high mountain areas: Bucegi Mountains (Caraiman, Piatra Arsă, Jepii Mici, Jepii Mari, Zănoaga, Valea Izvorul Dorului, Vârful cu Dor, Poiana Coștilei, Valea Malaiești, Doamnele, Babele, Valea Gaura, Furnica, Pestera, Valea Rasnoavei), Ceahlău, Cozia Mountains, Apuseni Mountains, Valea Slănicului (Buzău), Piatra Craiului Mountains, Borșa - Știol, Vișeu de Jos, Ciucas Mountains, Rodnei Mountains, Pirinei (figure 3). From the Bucegi Mountains were harvested the most of the species from this genus more than 100 plants (figure 4). Various species of this genus were also harvested from abroad: Switzerland, Austria, Italy, France (Pyrenees Mountains), Spain, Germany, Macedonia, Armenia.



Fig. 3. Harvesting place from Romania

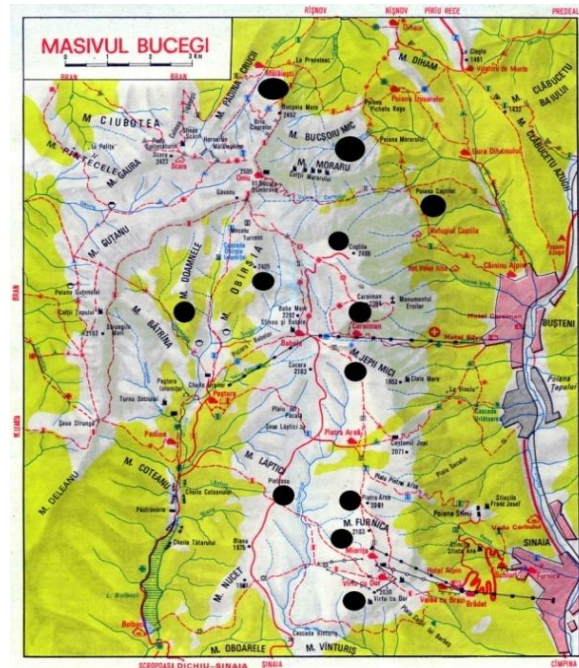


Fig. 4. Harvesting place from Bucegi Mountains

Harvesting year. The plants were harvested between 1810 and 1990. The oldest plants of this genus are *Gentiana cruciata* and *Gentiana lutea* harvested in 1810 in Dâmbovița, respectively in 1939 in the Bucegi Mountains, the Jepilor Valley (figure 5). Most of the plants were harvested between 1940 and 1949, over 50 species, as found in the *Sorbus* genus when at the same time a number of 71 plants were harvested (ENESCU AND CRISAN, 2017). The last plant harvested in 1990 belongs to the species *G. uliginosa*.

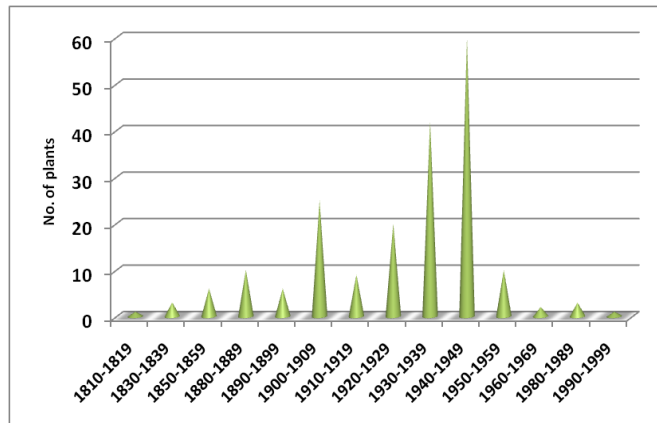


Fig. 5. Harvesting periods of plants from *Gentiana* genus

The experts that collect plants are representatives of Romanian specialists - Al. Beldie, A. Conan, C.C. Georgescu, M. Badea, M. Haret, M. Petcuț, P. Crezoiu, I. Morariu, T. Bunea, E.L. Nyárády, Golescu, dar și străini (Gulyas Antal, J. Neuwirk, L. Vagner, B. Stefanoff, C. Baenitz, Hans Steiniger, L. Walz, Woeff).

CONCLUSIONS

In "Alexandru Beldie" Herbarium which containing more than 60,000 plates, 206 plates belong to the *Gentiana* genus.

From this plates the most numerous *Gentiana* species are the following: *G. asclepiadea* L. (21 plates), *G. ciliata* L. (10 plates), *G. kochiana* Perr. et Song. (11 plates), *G. praecox* (25 plates), *G. verna* L. (23 plates) și *Gentiana utriculosa* L. (20 plates). Harvesting place of the most of species (*G. asclepiadea*, *G. ciliata*, *G. kochiana*, *G. verna*, *G. utriculosa*) is generally represented by high mountain areas and the plants were harvested between 1810 and 1990, most of them being collected by Al. Beldie, A. Conan, C.C. Georgescu, P. Crezoiu, I. Morariu etc.

BIBLIOGRAPHY

- BARTOK A., HURDU B., SZATMARI P. 2015. Distribution of endangered *Gentiana Clusii* E. M. Perrier & Sonceon in the Romanian Carpathians – A critical overview. *Contribuții Botanice*, no 50, p. 15-32.
- DIDUKH YAP (ED). 2009. Red Data Book of Ukraine. Vegetable Kingdom. Globalconsulting, Kyiv.
- ENESCU, R.E., CRISAN, V.E, 2017. Plante conservate în herbar: genul *Sorbus*. *Revista de Silvicultura și cinegetica*, no. 41. In press.
- HO T-N, LIU S-W.1990.The infrageneric classification of *Gentiana* (Gentianaceae). *Bull British museum (Natural History)*. Botany 20:169–192.
- HSIEH TY, HSU TC, KONO Y, KU SM, PENG CI. 2007. *Gentiana bambuseti* (Gentianaceae), a new species from Taiwan. *Bot Stud* 48:349–355.
- HUDECOVÁ A., HAŠPLOVÁ K., MIADOKOVÁ E. ET AL. 2012. *Gentiana asclepiadea* protects human cells against oxidation DNA lesions, *Cell Biochemistry and function*, 30(2), 101-107.
- KROGULEVICH R.1978.Karyological analysis of the species of the flora of eastern Sayana. In:Malyshev LI, Peshkova GA (eds) *Flora of the Prebaikal*. Nauka, Sibirskoe Otdelenie, Novosibirsk, pp 19–48.
- LÖVE A, LÖVE D 1975.The Spanish gentians. *Anales del instituto botanico A.J. Cavanilles* 32:221–232
- MIRZAEI F.,HOSSEINI A., JOUYBARI H., DAVOODI A., AZADBAKHT M. 2017. Medicinal, biological and phytochemical properties of *Gentiana* species, Volume 7, Issue 4, p. 400-408.
- MOMCILOVIĆ I., GRUBISIĆ D., NESKOVIĆ M. 1997. Micropropagation of four *Gentiana* species (*G. lutea*, *G. cruciata*, *G. purpurea* and *G. acaulis*). *Plant Cell, Tissue and Organ Culture* 49: 141-144.
- MÜLLER G.1982. Contribution à la cytotaxonomie de la section *Cyclostigma* Griseb. du genre *Gentiana*. *Feddes Repertorium* 93:625–722.
- PROSSER F, BERTOLLI A. 2008. A new species of *Gentiana* sect. *Calathianae* (Gentianaceae) from the Brenta Group, European Alps, Italy. *Willdenowia* 38:423–431.
- RORK C.L. 1949. Cytological studies in the Gentianaceae. *Amer J Bot* 36:687–70.
- SKALINSKA M.1951.Cytological studies in *Gentiana*-species from the Tatra and Pieniny Mts. *Bulletin de la Academie Polonaise des Sciences, Serie des Sciences Biologiques* 1:119–137.

STOLT K.A.H. 1921. Zur embriology der gentianaceen und menyanthaceen. Svenska Vetenskaps Academiens Handlingar 61:3–55.

TAKHTAJAN A.L (ED). 1990. Chromosome numbers of flowering plants of flora USSR. Aceraceae Menyanthaceae. Nauka, Leningrad, pp 426–429.

TUTIN T.G.1972. Gentianaceae. In: Tutin T.G., Haywood V.H., Burges N.A., Moore D.M., Valentine D.H., Walters S.M., Webb D.A. (eds) Flora Europea, vol 3. Cambridge Univ Press, Cambridge, pp 59–63.

VASILE D., DINCĂ L., INDREICA A., VOICULESCU I. 2017. Herbarul Alexandru Beldie - o colecție de plante și o importantă bază de date pentru specialiști. Revista de Silvicultură și Cinegetică, nr.39, pag. 114-119.

ZAJAC, A., PINDEL A., 2011. Review of the Willow Gentian, *Gentiana asclepiadea* L. Biodiversity 12(3), 181-185.

YUAN Y-M, KÜPFER PH, DOYLE JJ. 1996. Infrageneric phylogeny of the genus *Gentiana* (Gentianaceae) inferred from nucleotide sequences of the internal transcribed spacers (ITS) of nuclear ribosomal DNA. Am J Bot 83:641–652.