

Snowdrop (*Galanthus nivalis* L.) and its phenotypic diversity in Slovenia

Fenotipska raznolikost malega zvončka (*Galanthus nivalis* L.) v Sloveniji

Jože BAVCON

University Botanic Garden Ljubljana, Department of Biology, Biotechnical Faculty,
Ižanska cesta 15, 1000 Ljubljana, Slovenia; E-mail: Joze.Bavcon@guest.arnes.si

Dedication

The first sky-blue green and its white blossom, emerging still in winter, a bunch of snowdrops is my humble gift to Prof. Dr. Nada Gogala, mentor of my doctoral dissertation, for her seventieth birthday.

Abstract. In Slovenia *Galanthus nivalis* L. is a widely distributed species, being also the sole representative of the genus. Expansive local populations of snowdrops grow on the margins of forests, in forests and non-manured meadows. Based on the observation of its phenotypic diversity over a number of years, both in the wild and after the transfer of specimens to the Botanic Garden in Ljubljana, the morphotypes were divided into groups with respect to the following: shape of flower, size of plant as a whole, shape of outer and inner perianth segments, number of outer and inner perianth segments, green markings of outer perianth segments, pattern of inner perianth segments, shape and colour of the ovary, bracts, extra bracts, green basal leaves (number, width, colour). The Botanic Garden collection currently contains over 1000 specimens of *G. nivalis*, among which all aforementioned groups are represented.

Key words: *Galanthus nivalis*, Snowdrop, intra species diversity, Slovenia, differences, groups.

Izvleček. Mali navadni zvonček (*Galanthus nivalis* L.) je v Sloveniji splošno razširjena vrsta. Velike lokalne populacije rastlin rastejo na gozdnih robovih, v gozdovih in negnojnih travnikih. Večletna opazovanja fenotipske raznolikosti malega zvončka tako v naravi kot na primerkih prinešenih iz narave v botanični vrt v Ljubljani so pokazala, da lahko različice malega zvončka razvrščamo v skupine glede na: obliko, velikost in število cvetov, velikost celotne rastline, obliko zunanjih in notranjih perigonovih listov, število zunanjih in notranjih perigonovih listov, obarvanost zunanjih perigonovih listov, vzorec notranjih perigonovih listov, oblika in barva plodne glavice, ovršne liste, dodatne ovršne liste, stebelne liste. Zbirka rastlin botaničnega vrta v Ljubljani obsega preko 1000 primerkov rastlin malega zvončka, ki predstavljajo navedene skupine različkov.

Ključne besede: *Galanthus nivalis*, mali navadni zvonček, znotraj vrstna raznolikost, razlike po skupinah.

Introduction

The plant was described under this name already by Linné in his work *Species plantarum* in 1753. He states its habitat as *ad radices Alpinum Veronnae, Tridenti, Viennae* (according to DAVIS 1999). In 1772 Scopoli refers to the species in his *Flora carniolica*, describing its habitat as *ad radices montium*. Nowadays, the natural distribution area of the species is believed to extend from the Pyrenees in the

west to western Ukraine in the east. Its northernmost natural habit should not extend beyond Paris. Its area should not reach as far as Asia Minor in the south but should be restricted to the European part of Turkey (DAVIS 1999). Diversity of the species within the said area follows from numerous old names given to different varieties that various authors described as independent species which would later prove to merely reflect diversity within the species, as stated by DAVIS (1999) for instance, *G. montana* Schur, *G. nivalis* var. *minus* Ten, *G. imperati* and others. All of these statements point to the diversity within the species, which may explain an ever present tendency to find a new species within the known one. Two new species were in fact defined on the basis of these varieties, namely, *G. nivalis* subsp. *reginae-olgae* and *G. nivalis* subsp. *cilicus*. The description of the former *G. reginae-olgae* is linked to Peloponessus. It is characterized by blossoming in autumn when its leaves are often absent whereas in spring the leaves are markedly green-blue with a characteristic central stripe. Those blossoming in spring were given a subspecies status, namely, *G. reginae-olgae* Hort. subsp. *vernalis* Kamari; they grow also in Montenegro. The other species derived from the subspecies is *G. cilicus* Baker from southern Turkey. 19 species are currently described within the *Galanthus* genus (DAVIS 1999). Among these no less than 500 cultivars are described only for *G. nivalis* 80 cultivars (BISHOP 2001).

In England where the genus *G. nivalis* is not present naturally at all but has been naturalized (BOURNE 1999) a large number of varieties have been found in gardens alone and from these many new cultivars have appeared (BRICKELL 1996, BISHOP 2001, MCARDLE 2002). Our hypothesis proceeds from the idea that in our very abundant and large local populations is possible to find some intraspecific differences. Growing in Slovenia is in fact just one species, however, the before-mentioned genotype indicate the probability of diversity within the species. Furthermore, taking into account the fact that such a small superficies (20 256 km²) as that of Slovenia is divided between four phytogeographic regions, Alpine, Dinaric, sub-Pannonic and submediterranean, in addition to two transitional regions, pre-Alpine and pre-Dinaric, with *G. nivalis* growing naturally in each of them (JOGAN & al. 2001, MARTINČIĆ & al. 2007), the probability of diversity is therefore even higher.

Material and Methods

The material had been collected for several years. As soon as a larger number of small snowdrops begin to emerge during the late winter, we start with a systematic monitoring of their growing sites. Initially, this work was limited to the environs of Ljubljana but was later extended towards Dolenjska and northern Primorska and taken from there to all other parts of Slovenia. The work is organized in such a way that we first visit and scrutinize the areas with most abundant local populations and select the most anomalous specimens in whatever way differing from the rest. The work is preferably done during sunny weather when the blossoms are fully opened; such weather often alternates with cloudy spells, however, the field work is nonetheless carried on, though at a slower pace. Each specimen is first photographed in its growing site, then dug out and photographed once again so to properly take note of all special features. All specimens from the same growing site are placed into the same bag to which some water is added, if necessary, and taken to the Botanic Garden. Here, each single plant is described and planted into a mixture of compost and leaf mould in the pot. Each pot is provided with the number corresponding to the description number; added thereto are the year of collection and the location from which the plant was collected. The pots are placed on garden beds. We used to sink the pots into the beds, but in time this meant too much extra work, so now the pots are merely put on beds covered with foil to prevent the growth of weeds. The plants are watered to remain green as long as possible. If a plant forms seeds, these, too, are collected. During the rest of the year the pots are watered only during very dry spells, otherwise, they are left to rest. At the end of the next winter when the plants blossom again, each pot is examined to see what part of the original description is still the same. Stability is checked every year. The present collection is comprised of over 1000 units.

Results and Discussion

The intraspecific genotypic diversity within the species such as observed in the local populations of snowdrops differs from one part of Slovenia to another. In the publication *Mala Flora Slovenije* (Small Flora of Slovenia) (MARTINČIČ & al. 2007) the relevant description reads as follows: “Perennial plant with a stem bearing a single flower. Two basal leaves integrated into a cylindrical dry-skin sheaf. Drooping flower with a supporting spathe consisting of two merged leaves. Capsule fleshy.” While all of this is true, very interesting digressions from such a description can be stated in various areas. In some of them diversity is more and elsewhere less pronounced.

In some areas variations occur primarily in the shape of the flower, the length and shape of the outer perianth segments. In other parts these variations are accompanied by green shades on the outer perianth segments whose number is subject to variation. Found on three locations were also specimens with only outer and inner equal perianth segments but their shape was not uniformly correct either. The variation might be dependent of genetic structure, different environment, age of plants and according that to the largeness of bulbs and combination of the mentioned factors.

The differences could, on the whole, be divided into the following groups: Flower shape, size and number, shape of outer perianth segments and shape of inner perianth segments, number of outer and inner perianth segments, green markings of outer perianth segments, pattern of inner perianth segments (shape, color), shape and colour of ovary, bracts (shape and size), extra bracts and leaves (number, width, colour).

Even in 2004 when the work had been going on for three years we still presumed that certain digressions from the usual form were stable, the others partly stable and the rest unstable (Bavcon & Marinček 2004). Further observations, however, showed that the categories as determined needed some correction. While true that some genotype are more stable than the others, our up-to date field work shows that no matter how unusual, any abnormality can also be stable. The sole condition is to find its stable abnormality the real mutant. As demonstrated on the basis of a large number of single varieties now cultivated in the Garden for a number of years, also those that were initially presumed unstable and put down to the environmental factors can likewise be stable. The original anticipation that the order in the number of elements in single circles of the floral formula ($P_{2+2} A_{2+2} \overline{G_2}$ to $P_{7+7} A_{7+7} \overline{G_7}$), which are in fact always repeated in the same number (Bavcon 2003), had to be later revised by placing these, too, into the group of those just partly stable. However, we could confirm that some »forms« such as Siamese and bifloral can be stable as well. This conclusion has been drawn with respect to the long-year observation both in and outside the Garden. It should be taken into account that the snowdrop bulbs divide themselves according to the so called Fibonacci sequence, and when finding the same genotype within a single clump it is possible to talk of phenotypic stability which could also be genotypic because in such a case the question is of the cloning of the genotype. The seedlings are at least a stem's length away from the original clump, though usually more so since the seeds are carried off by ants.

From the material collected up to date more than fifty forms have been described and many of these can be a basis for a new cultivars, which will not be dealt with in this paper as this would mean going into further detail and including photos of each described abnormality to facilitate subsequent comparison.

Division into groups:

Flower shape, size and number can vary in that the flower can be small, big, wide, symmetrical. Long and big flower are usual with giant plants, described by Ransom 1948 (after Bourne 1999) typically growing in a deep brown soil and are to be found in various parts of Slovenia. They are more frequent on the Sava terraces or along the alluvia of the rivers Idrija and Mura, as well in places over Dolenjska, Primorska and Notranjska. Small flower are most frequent on the Moor. Markedly

big and wide flower are present above Predmeja and in Goriška (Cesta). Symmetrical flower appear in spots in northern Primorska. Plants with two flower in one scape are rare (Most na Soči, Črni vrh, Podsreda) the same plants with two scape in each with one flower (Sava terraces, Goriška -Malovše). Some forms with two three flowers grown together in one scape (siamese) is found in different location (Sava terraces, near Mura river, Slovenian Istra and Goriška).

Shape of outer perianth segments: Wide, shorter with a finely rounded base; wide and long; narrow, lanceolate and long; pointed as canine teeth; cleaved perianth segments; upturned segments; atrophied: very diminished, one or two diminished.

Wide, shorter sepals with a finely rounded base are more often found in the Primorska. Likewise characteristic of this area are also wide long sepals. Narrow lanceolate and long sepals are present in places also in the other parts of Slovenia, while being highly characteristic of Hrastovlje. Those pointed or pointed as canine teeth are most common in Dolenjska. Cleaved perianth segments, namely, one or more smaller separate and jagged segments, respectively, are typical of the Sava terraces ahead of Ljubljana and of the Moor. Upturned segments appear in spots towards Goriška (Lijak, Vrtoče – Renče), however, it is necessary to distinguish those that turn up only at the end of the blossoming season, which is very common primarily in Primorska, from those turned up already during the optimal phase of blossoming. They are very frequent also towards Notranjska (Planina, Cerknica). Atrophied sepals can be found in spots on one single growing site in Primorska (Malovše) and on the Moor.

Shape of Inner perianth segments: Long, narrow, short, equally long as the outer perianth segments. The most interesting form of this group is doubtlessly the already described form *Poculiformis* group where the inner perianth segments are of the same length as the outer ones and where the inner segments are devoid of the green pattern. According to literature (BISHOP 2001), this shape is typical above all of Central Europe (Czech Republic). Our specimens collected in Prekmurje, on the Moor and at Most na Soči are nonetheless different from those mentioned before. The flower are wider and the perianth segment narrower. Coming closest to the described form are our specimens from Prekmurje.

Number of Outer and Inner perianth segments: 2, 3, 4, 5, 6, 7 ($P\ 2+2\ A2+2\ G\bar{2}$ to $P\ 7+7\ A\ 7+7\ G\bar{7}$) up to a flower with only perianth segments ('Flore Pleno'). It is most frequent on the Sava terraces ahead of Ljubljana and also in Prekmurje. These forms can be found elsewhere in Slovenia but they are rare. The P2 specimens can often be seen on the Moor. The differences in the number are very rare in Dolenjska, Goriška and Slovenian Istria. It should be added that the number appearing in the outer circle of the perianth segments, as a rule, repeated in all circles of the floral formula. In spite of it being the same in all circles, such forms, as pointed out before, are not very stable. A perfectly stable form is *G. n. 'Flore Pleno'*, known already since 1703 when it was first drawn although its origin is unknown (BISHOP 2001). In Slovenia, this longtime acknowledged cultivar has been found on two growing sites, both of them in the vicinity of a settlement. The one in Dolenjska lies on the other side of a castle hill with a small brook running in between. The growing location is very rich but as it is unprotected and exposed to plundering, I shall refrain from giving its name. The other location is in the environs of Ljubljana, here again along a small brook. It has by now been most probably completely destroyed because on the occasion of our last year's visit the place was being bulldozed. Both locations may have developed as a result of human intervention, namely, the plant may have been introduced by people, whereafter the species multiplied vegetatively.

Green markings of outer perianth segments the shape of green streaks or merely green blotches in *G. nivalis* forma *pictus* from the environs of Sarajevo was described by MALY already in 1904. Some recent records refer also to Slovenia (PRELEC 1994, MERLJAK 1995, REŠETIČ 1995), which points to a fine monitoring of the environment. These varieties most often appear on the Sava terraces, are

completely absent from Dolenjska, rare in Prekmurje, towards Kočevje they begin to be present from Livold onwards, Goriška and Slovenian Istria are almost without them or they are present only in traces. Very fine specimens can be found high above Predmeja. However, the green coloration of the inner and also outer perianth segments progressing to completely green specimens appears, in spots only, in the very area of Goriška from Vrtoče to Renče, and on the Ljubljana Moor, i.e. just here and there in the environs of Tomišelj. These genotype is during our observation time looking stable.

Pattern of inner perianth segments: Without pattern, hardly perceptible dots, narrow A wide progressing along the entire inner circle. Some of such cultivars is described by different authors (BISHOP 2001). In certain spots the variation of the inner pattern appears everywhere, but in other parts the variability is more pronounced (Goriška, Sava terraces ahead of and behind Ljubljana, Črni vrh, Col, Predmeja). The pattern is dark green, yellow green or yellow. During our observation time is looking stable.

Shape and colour of the ovary: The ovary varies in length, some are long and narrow, others short, almost spherical. It also varies in colour that may be green, sky-blue green to sky-blue-green blue and yellow. In England the yellow varieties are known and described as the Sandersii group (BISHOP 2001). Such specimens were found also in Slovenia but, expectedly, all proved unstable. They preferably emerge along roads where as a result of snow ploughing hips of snow, additionally covered with dead leaves or soil, take longer to melt away, or else they grow beside molehills. We also came across stable varieties with pale sky-blue and long ovary. They appear mostly in Goriška (Malovše) and Dolenjska (Mokronog) in Goriška together with those with a yellow ovary, which might be one of stable form.

Bracts: Grown together, long and cleaved; long and grown together, wrapped, hardly developed. This variability is outstanding on the Sava terraces ahead of Ljubljana, on both sides of the Sava river. Long bracts, looking the same as *G. n. 'Scharlockii'* (BISHOP 2001) without green-tipped outer segments. These genotype is during our observation time looking stable the other less so.

Extra Bracts: White coloured as the perianth segments. Their position is in the middle of the ovary or above it. They can be two, three or more, all normally shaped, upturned in the same way as bracts or turned downwards as perianth segments. The shape and colour is the same as that of perianth segments, they are usually narrower and more pointed. Such extra bracts most often appear on the Moor, towards Medvode and immediately behind Škofja Loka (Zminec), the most beautiful and purest specimen having been found in Goriška (Malovše).

Leaves: Number (two, three, four, five appear in spots), width (narrow, pointed, widely rounded off, alternatively appears everywhere, although those with very narrow leaves are abundant on certain growing sites in Slovenian Istria, already reminding of such species as *G. n. reginae-olgae* subsp. *vernalis* (DAVIS 1999). Colour (mostly sky-blue green, but also green and deep sky-blue green with a marked farina). The most massive presence of the sky- blue green is in Goriška, namely, even greater than in Slovenian Istria (which is near the seaside). However, the Goriška growing sites are more in the open than those in Istria which, with rare exceptions, are all fairly overgrown with forest, quite often also undergrowth, where *Ruscus aculeatus* L. is prevalent. Where undergrowth is almost complete, the snowdrops are in full retreat.

The hypothesis according to which in the presence of such abundant populations of *G. nivalis* as stated in Slovenia some genotype should be found proved correct and has exceeded our expectations with respect to the differences as anticipated. However, not all of the possibilities and variability have been explored, which is confirmed by finding ever new specialities every year.

Conclusions

The intraspecific diversity within the species such as observed in the populations of snowdrops differs from one part of Slovenia to another. The differences could, on the whole, be divided into the following groups: Flower shape, size and number of plant, shape of outer perianth segments and shape of inner perianth segments, number of outer and inner perianth segments, green markings of outer perianth segments, pattern of inner perianth segments (shape, color), shape and colour of ovary, bracts (shape and size), extra bracts, leaves (number, width, colour). Some varieties are more stable than the others, our up-to date field work shows that no matter how unusual, any abnormality can also be stable. The sole condition is to find its stable abnormality, namely, the real mutant. As demonstrated on the basis of a large number of single genotype now cultivated in the Garden for a number of years, also those that were initially presumed unstable and put down to the environmental factors can likewise be stable.

Acknowledgements

My gratitude for discovering unusual snowdrops in the initial phase goes to Mrs. Meta Berce, doctor of stomatology, Irena Šiško, economist (Flore Pleno growing site), Anita Vidic Grah, geologist, my colleagues Alenka Marinček, professor of biology, Miloš Bartol, biologist (Flore Pleno growing site), Elvica Velikonja teacher of mathematics. I most particularly thank my own family (David, Sara, Eva, Lea and my wife Jožica) who have been keeping me company through numerous field work weekends, looking for anything unusual.

Literature

- BAVCON J. 2003: Domači posebneži med navadnimi zvončki. *Vrtnar*, 12 (1): 14–17.
- BAVCON J. & A. MARINČEK 2004: *Galanthus nivalis* in Slovenia and observed anomalies. V: Abstracts : botanic gardens: a world of resources and heritage for humankind.
- BISHOP M., A. DAVIS, J. GRIMSHAW 2001: Snowdrops, A Monograph of Cultivated *Galanthus*. The Griffin Press, UK, 361 pp.
- BOURNE V. 1999: Gifts from Crimea. *The Garden* 124 (1): 26–27.
- BRICKELL C. 1996: A-Z Encyclopedia of Garden Plants. Dorling Kindersley, London, New York, Stuttgart, Moscow, pp. 383–384, 500.
- DAVIS A. P. 1999 (Reprint 2000): The Genus *Galanthus*. A Botanical Magazine Monograph. The Royal Botanic Gardens, Kew & Timber Press, 297pp.
- JOGAN N., T. BAČIČ, B. FRAJMAN, I. LESKOVAR, D. NAGLIČ, A. PODOBNIK, B. ROZMAN, S. STRGULC KRAJŠEK & B. TRČAK 2001: Gradivo za Atlas flore Slovenije. Center za kartografijo favne in flore, Miklavž na Dravskem Polju pp.
- MARTINČIČ A., T. WRABER, N. JOGAN, A. PODOBNIK, B. TURK, B. VREŠ, V. RAVNIK, B. FRAJMAN, S. STRGULC KRAJŠEK, B. TRČAK, T. BAČIČ, M. FISHER, K. ELER., B. SURINA 2007: Mala flora Slovenije. Ključ za določanje praprotnic in semenk. Tehniška založba Slovenije, Ljubljana, 967 pp.
- MCARDLE C. 2002: The legacy of Lambrook Manor. *The Garden* 127 (1): 18–23.
- MALY K. 1904: Beiträge zu Kenntnis der Flora Bosniens und Herzegowina 54: 302
- MERLJAK L. 1995: Presenečenje v spomladanskem šopku. *Proteus* 57/9–10: 402.
- PRELC M. 1994: Nenavaden zvonček. *Proteus* 56 (9): 347.
- SCOPOLI J. A. 1772: Flora carniolica, Ed. 2.
- REŠETIČ M. 1995: Nenavadna trobentica in zvonček. *Proteus* 57/9–10: 402.