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Morphological variation of specimens and populations of *Galanthus nivalis* L. in western regions of Ukraine

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Abstract: The article shows the nature of variability of 15 morphological features of *Galanthus nivalis* L. populations from different regions of western Ukraine. The analysis of interpopulational variation of *G. nivalis* is given. Correlation structure of morphological parameters of *G. nivalis* is shown.

Keywords: intra- and interpopulational variation, correlation connections, *Galanthus nivalis* L., Transcarpathia

Introduction

In the system of complex ecological and biological study of plant species that need protection (KRICSFALUSY & KOMENDAR 1990) the important issues are focused on intra- and interpopulational variation. Study of different types of variability has important theoretical and practical significance, for example, to clarify the problems of systematic character. Such research on the example of *Galanthus nivalis* L. is conducted by us for the first time. Some of the results have been published some years ago (BUDNIKOV 1992; BUDNIKOV & KRICSFALUSY 1994).

Material and Methods

The object of study were natural populations of *G. nivalis*. Observations and collection of material was held in various geographical points of Western Ukraine:

Transcarpathian Lowland

I. The envirous of Vorochevo village, Perechin district, Transchrpathia (130 m).

Ukrainian Carpathians

II. Foothill belt, the envirous of Shayan village, Khust district, Transchrpathia (260 m).

III. Lower mountain belt, Antalovetska Poljana Mountain, Vyhorlat-Hutynskyj Range, Transchrpathia (810 m).

IV. Upper mountain belt, Menchul-Kvasivskyj Mountain, Chornogora Range, Transchrpathia (1320 m).

Roztochchya

V. The envirous of Janove village, Javoriv district, Lviv region (300 m).

Prykarpattya

VI. Lower mountain belt, the envirous of Jablunytsa village, Nadvirna district, Ivano-Frankivsk region (820 m).

To study biomorphological features as well as intra- and interpopulational variation, 25 generative individuals were taken from each population following the randomization principle and were studied with 15-th morphological characteristics: 1) assimilating leaves length (cm); 2) assimilating leaves width (cm); 3) outer perigonium segments length (см); 4) outer perigonium segments width (cm); 5) inner perigonium segments length (cm); 6) inner perigonium segments width (cm); 7) flower stalk height (cm); 8) pedicel height (cm); 9) spathe length (cm); 10) spot width (cm); 11) anther length (cm); 12) ovary length (cm); 13) ovary width (cm); 14) bulb length (cm); 15) bulb width (cm).

The obtained numerical data were processed by variation statistic methods (LAKIN 1990). The average square deviation (S^2), variance (Sx^2), average standard deviation ($\pm S_{\bar{x}}$), coefficient of variation (V,%), average error (Sx), have been determined for every arithmetical mean ($\bar{X}$). Reliability of the biometric parameters has been estimated through the Student criterion (t). To determine the measurements accuracy the P exponent (%) has been calculated. Relationship between parameters was determined by calculating the coefficients of correlation (r). The numerical value of r was estimated using criteria of accuracy Sz and t. Comparison of arithmetical mean and determining essentiality of difference between them have been estimated through the Student criterion.

Results

Results of the *G. nivalis* intra- and interpopulational variation study are presented in Tab. 1-6 and in Fig. 1. Follow the nature of intra- and interpopulational variation of morphological characteristics of the studied populations of *G. nivalis*.

In population I the most variable features are the length of the assimilating leaves (V = 22.66%) and flower stalk height (V = 28.63%). The rest of the features, apart from the bulb length (V = 8.25%), are characterized by the medium level of variation (V = 10.28-18.56%).

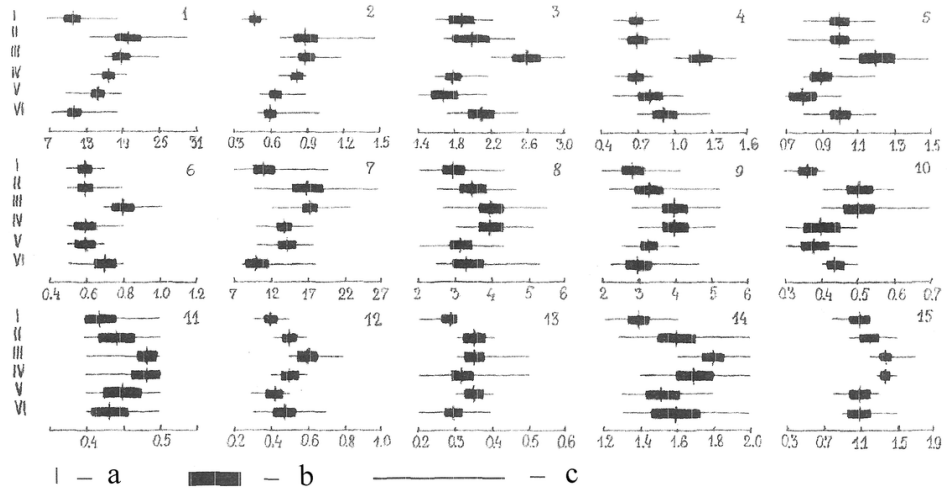

Fig. 1. Intraspecific variation of *Galanthus nivalis* L. morphological features: I-VI – populations; 1-15 – morphological features. Presented graphically are: a – average value, b – standard deviation, c – variation range.

In population II highly variable features are the following: length of the assimilating leaves (*V* = 20.45%), width of the assimilating leaves (*V* = 20.55%), width of the outer perigonium segments (*V* = 22.43%), height of the flower stalk (*V* = 23.06%), height of the pedicel (*V* = 22.38%) and length of the spathe (*V* = 22.92%). The rest of the features have a medium level of variation (11.24-17.64%).

In population III morphological features with high variation level are not noted. Anther length (*V* = 6.80%), bulb length (*V* = 7.43%) and bulb width (*V* = 7.26%) are characterized by low variation. Medium variation indices are observed in the rest of the features (10.84-19.78%).

In population IV two parameters have a high variation level: width of the spot (V = 23.94%) and width of the the ovary (*V* = 22.10%). Six features (1, 2, 3, 11, 14, 15) have low variability (4.58-9.55%), while seven others (4-9, 12) have medium variability (13.00-17.44%).

In population V high variation level is characterized only for the width of outer perigonium segments (*V* = 22.68%). Bulbs length is observed here with low variability (*V* = 8.79%). All other features have a medium level of variation (11.38-19.27%).

In population VI highly variable features are the following: length of the assimilating leaves (*V* = 25.47%), width of the assimilating leaves (*V* = 21.84%), width of the outer perigonium segments (*V* = 22.01%), height of the flower stalk (*V* = 22.26%), height of the pedicel (*V* = 22.20%) and ovary length (*V* = 22.63%). The rest of the features have a medium level of variation (10.66-19.15%). Features with low variation are not noted in this population.

From the analysis of intrapopulational variability implies that most morphological features of *G. nivalis* has a medium level of variation (10-20%), and among the features of high variation this index is not much higher than 20%. Populations I, IV, V have only one or two characteristics with high variability. Populations II, VI show high level of variation in five-six features, moreover four of them are identical. Feature of high variability, which is noted in three populations is the height of the flower stalk (7), in two populations – the length of the assimilating leaves (1), the width of the assimilating leaves (2), the width of the outer perigonium segments (4) and the height of the pedicel (8). Other features of high variability are noted only in any one population. Low level of variation of features is observed in single cases, in populations II and VI such features were not noted at all and only in population IV six characteristics (1, 2, 3, 11, 14, 15) have a low level of variation. Feature of low variability, which is noted in four populations is the length of the bulb (14), in two populations such characteristics are the length of the anther (11) and the width of the bulb (15). Other features of low variability are noted only in any one population.

Index of stability (a ratio of the amount of low and medium variable characteristics to total amount of characteristics) for each population was calculated. For population I it was 86.67%, for population II – 66.67%, for population III – 100.00%, for population VI – 86.67%, for population V – 93.34%, for population VI – 60.00%.

Analysis of occurrence frequency of minimum and maximum average values of the morphological features showed that they are unevenly distributed among populations: the largest number of minimum average values (10) belongs to population I and the largest number of maximum average values (13) belongs to population III.

Interpopulational variation of *G. nivalis* was studied by comparing the average values of the studied features through the Student criterion. The nature of interpopulational (or geographycal) variation of *G. nivalis* is shown in Tab. 7. Results of comparing arithmetical means of morphometric parameters ($X_1 – X_{15}$) of all six populations are presented in Tab. 8. Under each arithmetical mean of one or another parameter the indices of the Student criterion (*t*) and significance level (*p*) are shown. Dash means no reliable difference between the average values of the compared populations under this parameter. Reliability of difference has been estimated in such way: the average values of all parameters of population I was compared with the average values of the according parameters of population II, the average values of parameters of population I – with the average values of parameters of population III etc.

Follow degree of divergence of populations by morphological parameters. Populations I and II differ in the following features: 1, 2, 6, 7, 8, 9, 10, 12, 13, 14; I and III – in all parameters, I and IV – in 1, 2, 7, 8, 9, 11, 12, 14, 15 parameters; I and V – in 1, 2, 3, 4, 5, 6, 7, 9, 13, 14 parameters; I and VI – in 2, 3, 4, 6, 10, 14 parameters; II and III – in 3, 4, 5, 6, 8, 9, 11, 12, 14, 15 parameters; II and IV – in 1, 2, 3, 6, 7, 8, 9, 10, 11, 15 parameters; II and V – in 1, 2, 3, 4, 5, 7, 10, 12 parameters; II and VI – in 1, 2, 4, 7, 13 parameters; III and IV – in 1, 2, 3, 4, 5, 6,

7, 10, 12, 14 parameters; III and V – in all parameters, except 13 th; III and VI – in all parameters; IV and V – in 1, 2, 4, 5, 6, 8, 9, 11, 12, 14, 15 parameters; IV and VI – in all parameters except 13 th and 14 th and finally V and VI – in 1, 3, 5, 7, 9, 10, 13 parameters.

The degree of distinction between the arithmetical means of parameters in a unit is: between populations I and II – 0.667, I and III – 1.000, I and IV – 0.600, I and V – 0.667, I and VI – 0.400, II and III – 0.667, II and IV – 0.667, II and V – 0.533, II and VI – 0.333, III and IV – 0.667, III and V – 0. 933, III and VI – 1.000, IV and V – 0.733, IV and VI – 0.867, V and VI – 0.467.

Absence of the transgression of the standard deviations of the arithmetical means that is availability of distinction in these values between populations I and II is observed in seven cases (0,467 in this constitutes a unit), between populations I and III – in 15 cases (1.000), between populations I and IV – in 7 cases (0.467), between populations I and V – in 4 cases (0.267), between populations I and VI – in 4 cases (0.267), between populations II and III – in 7 cases (0.467), between populations II and IV – in 4 cases (0.267), between populations II and V – in 5 cases (0.333), between populations II and VI – in 7 cases (0.467), between populations III and IV – in 6 cases (0.400), between populations III and V – in 13 cases (0.867), between populations III and VI – in 13 cases (0.867), between populations IV and V – in 4 cases (0.267), between populations IV and VI – in 9 cases (0.600), between populations V and VI – in 5 cases (0.333).

On the basis of both variants of the analysis three biokhorological groups of populations of *G. nivalis* can be distinguished (Fig. 2). The first of them is isolated population III, which accounts for the largest number of maximal averages of morphological parameters. In this habitat *G. nivalis* var. *major* Red. is singled out. The second, clearly defined group, is formed with populations I, II, V, VI (lokalities of the central part of area). A special place is the population of IV, which grows on the upper limit of distribution of species. However, it has more in common with the populations of south-western macroslopes in which it grows.

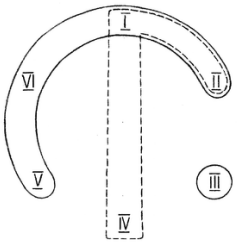

Fig.2. Biokhorological structure of *Galanthus nivalis* L.

To determine the relationships between parameters the correlation coefficients have been calculated. Calculations were made in such way: the first parameter was compared with the 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15 parameters, the second parameter – with the 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15 parameters, the third parameter – with the 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15 parameters etc. Such determination of the correlation coefficients was done in all six populations.

Correlation coefficients of the studied populations of *G. nivalis* are presented in Tab. 9-14. In each cell of the table obtained correlation coefficients (upper number) and their significance level (lower number) are marked. Dash indicates absence of correlation between this pair of parameters. Correlation structure of morphological characteristics of all populations is described by large number of reliable connections (Fig. 3-5). The greatest number of relationships on the first level of reliability ($p < 0.05$) is established in populations II (35) and VI (24) and the lowest number – in population IV (15). Maximum (29 and 33) and minimum (9) number of connections on the second level of reliability ($p < 0.01$) are observed in the same populations. Maximum number of connections (23) on the third level of reliability ($p < 0.001$) is noted also in population VI and minimum number (5) – in population III. In general, maximum number of connections on all three levels (80) is marked in population VI, which probably depends on diminution of specimens because of high density.

However, despite the large number of reliable connections that take place in all populations (from 33 to 80) only four pairs of features, between which connection exists on different levels of reliability in all six populations, are noted. Any clear and logical correlation pleiades not be traced on any level, that correlations between features are generally stochastic in nature. In all six populations correlation are observed between the following parameters: 1) length of the assimilating leaves and height of the flower stalk (1 and 7), 2) width of the assimilating leaves and height of the pedicel (2 and 8), 3) length of the outer perigonium segments and length of the inner perigonium segments (3 and 5), 4) height of the pedicel and length of the spathe (8 and 9). Number pairs of features with reliable connections that were established in five populations is 14, in four – 19, in three – 24, in two – 27 and finally 19 pairs of correlative features are noted in which any one population. There are also three pairs of features that have no correlation in either population. This – width of inner perigonium segments and length of bulb (6 and 14), width of spot and ovary width (10 and 13), length of anther and ovary width (11 and 13).

This correlation structure of morphological characteristics of *G. nivalis* (a large number of connections, absence of common correlation pleiades for several populations) demonstrates a high pliability of reaction of populations to environmental conditions of their habitats which cause morphostructure of individuals.

Index of morphological integration of parameters (a ratio of reliable connections to the total number of connections) in the studied populations ranges from 27.5 to 66.7%. The highest index is noted in populations II (62.5) and VI (66.7), in which the largest number of highly variable features is established. The lowest values are established in populations IV (27.5) and V (32.5), which grow in most unfavourable ecological-phytocenotic conditions. Thus, the deterioration of ecological-phytocenotic conditions causes decrease of morphological integration of individuals, and with increasing of variability of morphological characteristics, it increases sharply.

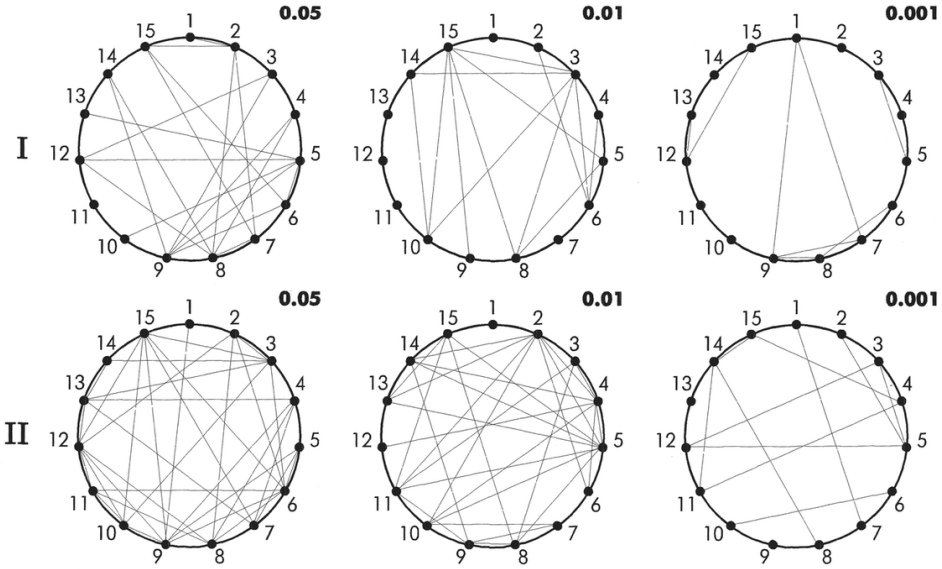

Fig. 3. Structure of correlation connections between morphological parameters of *Galanthus nivalis* L. I-II – populations; 1-15 – morphological features.

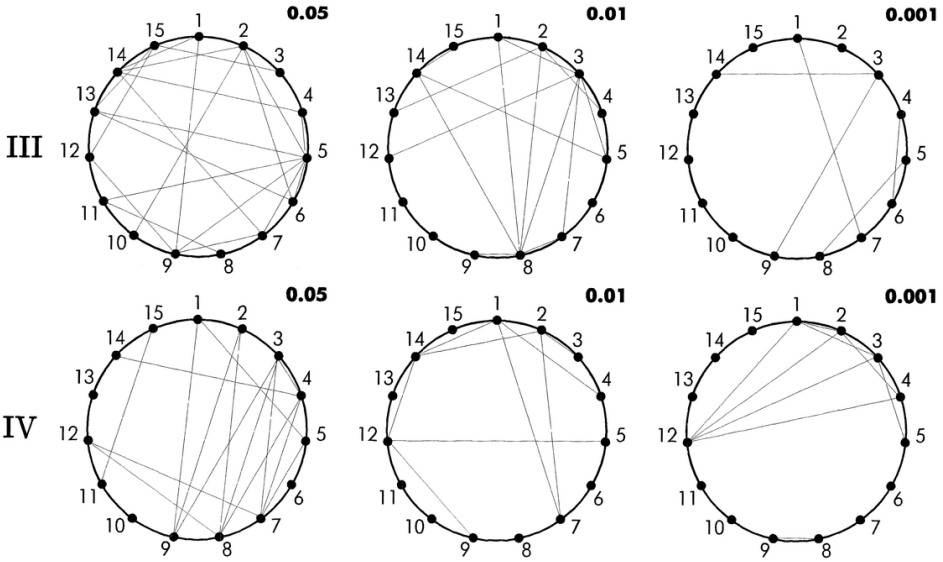

Fig. 4. Structure of correlation connections between morphological parameters of *Galanthus nivalis* L. III-IV – populations; 1-15 – morphological features.

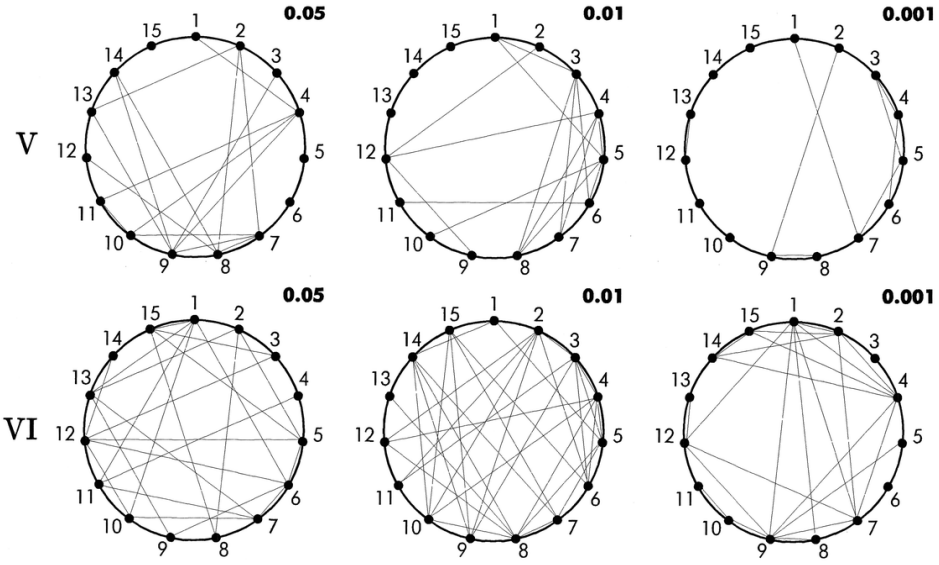

Fig. 5. Structure of correlation connections between morphological parameters of *Galanthus nivalis* L. V-VI – populations; 1-15 – morphological features.

Conclusions

G. nivalis is characterized by medium level of variation of most morphological parameters. Within the studied region three biokhorological groups of populations are distinguished which significantly differ from each other on morphological characteristics. The first includes population with the maximum number of the largest average values of morphological parameters, in which *G. nivalis* var. *major* Red. is singled out; the second includes the populations of the central part of area; the third group includes a population which grows on the upper limit of distribution.

Correlation structure of morphological parameters of populations is described by large number of reliable connections. However any clear and logical correlation pleiades not be traced on any level of reliability, that relationships between features are generally stochastic in nature. With the deteriorating of ecological-phytocenotic conditions the morphological integration of individuals decreases, and with increasing of variability of morphological characteristics, it increases sharply. This shows the high pliability of reaction of individuals and populations to various ecological-phytocenotic conditions of their habitats.

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Tab. 1. Morphometric parameters of *Galanthus nivalis* L. (population I – Vorochevo)

№	Parameters	$\overline{X}$	$S_{\bar{x}}$	*V*, %	*t*	*P*, %
1.	Assimilating leaves lengh (cm)	11.33	2.56	22.68	22.07	4.53
2.	Assimilating leaves width (cm)	0.53	0.08	14.99	13.35	3.00
3.	Outer perigonium segments lengh (cm)	1.92	0.25	12.93	38.67	2.59
4.	Outer perigonium segments width (cm)	0.72	0.11	15.07	33.18	3.91
5.	Inner perigonium segments lengh (cm)	0.97	0.13	13.45	37.17	2.69
6.	Inner perigonium segments width (cm)	0.57	0.07	11.86	42.17	2.37
7.	Flower stalk height (cm)	11.22	3.21	28.63	17.47	5.73
8.	Pedicel height (cm)	2.96	0.50	18.40	27.17	3.68
9.	Spathe length (cm)	2.87	0.51	17.88	27.96	3.57
10.	Spot width (cm)	0.36	0.05	13.89	36.00	2.78
11.	Anther length (cm)	0.42	0.04	10.28	48.64	2.06
12.	Ovary length (cm)	0.44	0.07	16.06	31.14	3.21
13.	Ovary width (cm)	0.29	0.03	11.52	43.42	2.30
14.	Bulb length (cm)	1.45	0.12	8.25	60.61	1.65
15.	Bulb width (cm)	1.08	0.15	13.49	37.07	2.70

Tab. 2. Morphometric parameters of *Galanthus nivalis* L. (population II – Shayan)

№	Parameters	$\overline{X}$	$S_{\bar{x}}$	*V*, %	*t*	*P*, %
1.	Assimilating leaves lengh (cm)	20.21	4.13	20.45	24.45	4.09
2.	Assimilating leaves width (cm)	0.92	0.19	20.55	24.33	4.11
3.	Outer perigonium segments lengh (cm)	2.04	0.36	17.64	28.34	3.53
4.	Outer perigonium segments width (cm)	0.69	0.16	22.45	22.28	4.49
5.	Inner perigonium segments lengh (cm)	0.98	0.11	11.58	43.24	2.31
6.	Inner perigonium segments width (cm)	0.64	0.09	13.51	37.02	2.70
7.	Flower stalk height (cm)	17.13	3.95	23.06	21.68	4.61
8.	Pedicel height (cm)	3.48	0.78	22.38	22.34	4.48
9.	Spathe length (cm)	3.31	0.76	22.92	21.81	4.58
10.	Spot width (cm)	0.47	0.06	13.41	37.31	2.68
11.	Anther length (cm)	0.44	0.05	11.24	44.50	2.25
12.	Ovary length (cm)	0.48	0.06	13.45	37.18	2.69
13.	Ovary width (cm)	0.35	0.06	16.65	30.04	3.33
14.	Bulb length (cm)	1.59	0.24	14.83	33.71	2.97
15.	Bulb width (cm)	1.16	0.17	14.30	34.98	2.86

Tab. 3. Morphometric parameters of *Galanthus nivalis* L. (population III – Antalovetska Poljana)

№	Parameters	$\overline{X}$	$S_{\overline{x}}$	*V*, %	*t*	*P*, %
1.	Assimilating leaves lengh (cm)	18.96	2.98	15.73	31.77	3.15
2.	Assimilating leaves width (cm)	0.91	0.14	15.61	32.03	3.12
3.	Outer perigonium segments lengh (cm)	2.61	0.28	10.85	46.10	2.17
4.	Outer perigonium segments width (cm)	1.21	0.17	14.32	34.91	2.86
5.	Inner perigonium segments lengh (cm)	1.21	0.16	13.36	37.42	2.67
6.	Inner perigonium segments width (cm)	1.77	0.09	12.13	41.23	2.43
7.	Flower stalk height (cm)	17.54	2.48	14.14	35.37	2.83
8.	Pedicel height (cm)	4.02	0.79	19.78	25.28	3.96
9.	Spathe length (cm)	3.99	0.62	15.50	32.25	3.10
10.	Spot width (cm)	0.48	0.08	16.53	30.25	3.31
11.	Anther length (cm)	0.49	0.03	6.80	73.57	1.36
12.	Ovary length (cm)	0.64	0.09	15.64	31.96	3.13
13.	Ovary width (cm)	0.35	0.06	18.56	26.94	3.71
14.	Bulb length (cm)	1.77	0.13	7.43	67.27	1.49
15.	Bulb width (cm)	1.41	0.10	7.26	68.88	1.45

Tab. 4. Morphometric parameters of *Galanthus nivalis* L. (population IV – Menchul-Kvasivskyj)

№	Parameters	$\overline{X}$	$S_{\overline{x}}$	*V*, %	*t*	*P*, %
1.	Assimilating leaves lengh (cm)	17.52	1.37	7.84	63.81	1.57
2.	Assimilating leaves width (cm)	0.80	0.08	9.55	52.37	1.91
3.	Outer perigonium segments lengh (cm)	1.83	0.14	7.83	62.68	1.60
4.	Outer perigonium segments width (cm)	0.66	0.10	14.79	33.80	2.96
5.	Inner perigonium segments lengh (cm)	0.91	0.12	13.17	37.96	2.63
6.	Inner perigonium segments width (cm)	0.55	0.10	17.44	28.67	3.49
7.	Flower stalk height (cm)	14.57	1.91	13.13	38.08	2.63
8.	Pedicel height (cm)	3.96	0.65	16.53	30.25	3.31
9.	Spathe length (cm)	3.95	0.63	15.85	31.54	3.17
10.	Spot width (cm)	0.37	0.10	23.94	20.88	4.79
11.	Anther length (cm)	0.48	0.04	9.16	54.61	1.83
12.	Ovary length (cm)	0.51	0.07	13.00	33.45	2.60
13.	Ovary width (cm)	0.32	0.07	22.10	22.63	4.42
14.	Bulb length (cm)	1.68	0.16	9.48	52.75	1.89
15.	Bulb width (cm)	1.37	0.06	4.58	09.06	9.17

Tab. 5. Morphometric parameters of *Galanthus nivalis* L. (population V – Janove)

№	Parameters	$\overline{X}$	$S_{\overline{x}}$	*V*, %	*t*	*P*, %
1.	Assimilating leaves lengh (cm)	15.05	1.97	13.08	38.24	2.62
2.	Assimilating leaves width (cm)	0.65	0.10	16.04	31.18	3.21
3.	Outer perigonium segments lengh (cm)	1.70	0.30	19.29	25.92	3.86
4.	Outer perigonium segments width (cm)	0.83	0.19	22.68	22.05	4.54
5.	Inner perigonium segments lengh (cm)	0.79	0.15	18.56	26.94	3.71
6.	Inter perigonium segments width (cm)	0.62	0.08	13.17	37.97	2.63
7.	Flower stalk height (cm)	14.54	1.89	13.02	38.42	2.60
8.	Pedicel height (cm)	3.22	0.58	18.05	27.70	3.61
9.	Spathe length (cm)	3.33	0.42	12.67	39.48	2.53
10.	Spot width (cm)	0.37	0.07	18.23	27.42	3.65
11.	Anther length (cm)	0.45	0.05	11.38	43.93	2.28
12.	Ovary length (cm)	0.43	0.07	15.98	31.29	3.20
13.	Ovary width (cm)	0.35	0.05	14.65	34.12	2.93
14.	Bulb length (cm)	1.54	0.14	8.79	56.91	1.76
15.	Bulb width (cm)	1.11	0.18	16.48	30.33	3.30

Tab. 6. Morphometric parameters of *Galanthus nivalis* L. (population VI – Jablunytsa)

№	Parameters	$\overline{X}$	Sx	*V*, %	*t*	*P*, %
1.	Assimilating leaves lengh (cm)	11.57	2.94	25.47	19.63	5.09
2.	Assimilating leaves width (cm)	0.62	0.14	21.84	22.90	4.37
3.	Outer perigonium segments lengh (cm)	2.14	0.33	15.32	32.63	3.06
4.	Outer perigonium segments width (cm)	0.86	0.19	22.01	22.72	4.40
5.	Inner perigonium segments lengh (cm)	0.99	0.11	10.66	46.89	2.13
6.	Inner perigonium segments width (cm)	0.66	0.08	12.31	40.42	2.47
7.	Flower stalk height (cm)	11.71	3.10	26.26	19.04	5.25
8.	Pedicel height (cm)	3.27	0.73	22.20	22.52	4.44
9.	Spathe length (cm)	3.00	0.60	19.15	26.11	3.83
10.	Spot width (cm)	0.44	0.05	11.36	44.00	2.27
11.	Anther length (cm)	0.43	0.05	11.02	45.37	2.20
12.	Ovary length (cm)	0.46	0.10	22.63	22.10	4.53
13.	Ovary width (cm)	0.29	0.04	13.70	36.50	2.74
14.	Bulb length (cm)	0.61	0.25	15.75	31.76	3.15
15.	Bulb width (cm)	1.13	0.17	15.04	33.25	3.01

Tab. 7. Geographycal variation of morphometric parameters of *Galanthus nivalis* L.

№	Parameters	Population					
		I	II	III	IV	V	VI
1.	Assimilating leaves lengh (cm)	11.33	20.21	18.96	17.52	15.05	11.57
2.	Assimilating leaves width (cm)	0.53	0.92	0.91	0.80	0.65	0.62
3.	Outer perigonium segments lengh (cm)	1.92	2.04	2.61	1.83	1.70	2.14
4.	Outer perigonium segments width (cm)	0.72	0.69	1.21	0.66	0.83	0.86
5.	Inner perigonium segments lengh (cm)	0.97	0.98	1.21	0.91	0.79	0.99
6.	Inner perigonium segments width (cm)	0.57	0.64	1.77	0.55	0.62	0.66
7.	Flower stalk height (cm)	11.22	17.13	17.54	14.57	14.54	11.71
8.	Pedicel height (cm)	2.96	3.48	4.02	3.96	3.22	3.27
9.	Spathe length (cm)	2.87	3.31	3.99	3.95	3.33	3.00
10.	Spot width (cm)	0.36	0.47	0.48	0.37	0.37	0.44
11.	Anther length (cm)	0.42	0.44	0.49	0.48	0.45	0.43
12.	Ovary length (cm)	0.44	0.48	0.64	0.51	0.43	0.46
13.	Ovary width (cm)	0.29	0.35	0.35	0.32	0.35	0.29
14.	Bulb length (cm)	1.45	1.59	1.77	1.68	1.54	0.61
15.	Bulb width (cm)	1.08	1.16	1.41	1.37	1.11	1.13

Tab. 8. Evaluation of reliability of difference between arithmetical mean of morphometric parameters of *Galanthus nivalis* L.

Parameter		X_1		X_2		X_3		X_4		X_5		X_6		X_7	
Population		*t*	*p*	*t*	*p*	*t*	*p*	*t*	*p*	*t*	*p*	*t*	*p*	*t*	*p*
1	2	9.13	0.001	9.62	0.001	1.37	–	0.84	–	0.12	–	3.26	0.010	5.80	0.001
1	3	9.70	0.001	11.79	0.001	9.12	0.001	11.83	0.001	5.85	0.001	8.65	0.001	7.79	0.001
1	4	10.64	0.001	12.36	0.001	1.66	–	1.90	–	1.69	–	0.85	–	4.48	0.001
1	5	5.76	0.001	4.73	0.001	2.72	0.050	2.48	0.050	4.57	0.001	2.26	0.050	4.46	0.001
1	6	0.31	–	3.05	0.010	2.62	0.050	3.11	0.010	0.48	–	4.15	0.001	0.55	–
2	3	1.22	–	0.25	–	6.19	0.001	11.10	0.001	6.07	0.001	5.01	0.001	0.45	–
2	4	3.09	0.010	3.03	0.010	2.78	0.050	0.65	–	1.94	–	3.55	0.010	2.91	0.010
2	5	5.64	0.001	6.27	0.001	3.53	0.010	2.86	0.010	4.97	0.001	1.01	–	2.95	0.010
2	6	8.51	0.001	6.42	0.001	0.98	–	3.43	0.010	0.39	–	0.67	–	5.41	0.001
3	4	2.19	0.050	3.47	0.010	12.30	0.001	13.55	0.001	7.52	0.001	8.19	0.001	4.74	0.001
3	5	5.47	0.001	7.36	0.001	10.52	0.001	7.34	0.001	9.68	0.001	6.12	0.001	4.81	0.001
3	6	8.82	0.001	7.31	0.001	5.45	0.001	6.78	0.001	5.89	0.001	4.51	0.001	7.38	0.001
4	5	5.15	0.001	5.71	0.001	1.78	–	3.85	0.001	3.16	0.010	2.69	0.050	0.05	–
4	6	9.16	0.001	5.63	0.001	4.35	0.001	4.50	0.001	2.38	0.050	4.28	0.001	3.95	0.001
5	6	4.92	0.001	0.82	–	4.74	0.001	0.52	–	5.42	0.001	1.73	–	3.92	0.001

Tab. 8. – cont.

Parameter		X_8		X_9		X_{10}		X_{11}		X_{12}		X_{13}		X_{14}		X_{15}	
Population		*t*	*p*	*t*	*p*	*t*	*p*	*t*	*p*	*t*	*p*	*t*	*p*	*t*	*p*	*t*	*p*
1	2	2.74	0.050	2.40	0.050	6.73	0.001	0.91	–	2.31	0.050	4.75	0.001	2.72	0.050	1.91	–
1	3	5.52	0.001	7.01	0.001	6.57	0.001	5.84	0.001	8.22	0.001	4.37	0.001	9.01	0.001	9.56	0.001
1	4	5.85	0.001	6.99	0.001	0.59	–	4.22	0.001	3.93	0.001	2.05	–	5.74	0.001	9.23	0.001
1	5	1.66	–	3.49	0.010	0.71	–	1.79	–	0.20	–	4.93	0.001	2.66	0.050	0.77	–
1	6	1.70	–	0.86	–	5.66	0.001	0.62	–	0.96	–	0.38	–	2.86	0.010	1.16	–
2	3	2.44	0.050	3.51	0.010	0.79	–	4.39	0.001	6.58	0.001	0.00	–	3.26	0.010	6.56	0.001
2	4	2.34	0.050	3.27	0.010	4.41	0.001	3.05	0.001	1.73	–	1.74	–	1.48	–	5.87	0.001
2	5	1.32	–	0.14	–	5.20	0.001	0.85	–	2.54	0.050	0.36	–	0.88	–	0.97	–
2	6	1.00	–	1.62	–	1.75	–	0.29	–	0.82	–	4.23	0.001	0.23	–	0.67	–
3	4	0.33	–	0.25	–	4.68	0.001	1.10	–	5.18	0.001	1.66	–	2.23	0.050	1.99	–
3	5	4.06	0.001	4.43	0.001	5.34	0.001	3.29	0.001	8.42	0.001	0.24	–	5.93	0.001	7.23	0.001
3	6	3.51	0.010	5.89	0.001	2.33	0.050	4.83	0.001	6.11	0.001	3.92	0.001	2.80	0.010	7.26	0.001
4	5	4.18	0.001	4.10	0.001	0.00	–	2.09	0.050	4.17	0.001	1.61	–	2.16	0.050	6.61	0.001
4	6	3.52	0.001	5.60	0.001	3.33	0.001	3.41	0.010	2.10	0.050	1.72	–	1.14	–	6.64	0.001
5	6	0.24	–	2.33	0.050	4.04	0.001	1.15	–	1.12	–	4.32	0.001	1.16	–	0.32	–

Tab. 9. Correlation matrix of morphometric parameters of *Galanthus nivalis* L. (population I – Vorochevo)

Parameter	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1		0.488	0.308	0.364	0.308	0.261	0.964	0.401	0.700	-0.114	-0.196	0.233	0.185	0.167	0.334
		0.050	–	–	–	–	0.001	–	0.001	–	–	–	–	–	–
2			0.366	0.353	0.320	0.540	0.466	0.481	0.392	-0.021	-0.203	0.412	0.133	0.204	0.424
			–	–	–	0.010	0.050	0.050	–	–	–	–	–	–	0.050
3				0.331	0.752	0.560	0.387	0.616	0.506	0.583	-0.017	0.475	0.390	0.549	0.628
				–	0.001	0.010	–	0.010	0.050	0.010	–	0.050	–	0.010	0.010
4					-0.009	0.545	0.376	0.487	0.483	0.260	0.049	-0.009	-0.147	0.164	0.301
					–	0.010	–	0.050	0.050	–	–	–	–	–	–
5						0.425	0.382	0.557	0.458	0.523	-0.023	0.524	0.496	0.410	0.556
						0.050	–	0.010	0.050	0.050	–	0.050	0.050	–	0.010
6							0.351	0.702	0.464	0.393	0.096	0.397	0.215	0.276	0.437
							–	0.001	0.050	–	–	–	–	–	0.050
7								0.492	0.747	0.008	-0.087	0.327	0.241	0.236	0.459
								0.050	0.001	–	–	–	–	–	0.050
8									0.733	0.398	0.270	0.509	0.341	0.518	0.567
									0.001	–	–	0.050	–	0.050	0.010
9										0.273	0.241	0.382	0.221	0.421	0.583
										–	–	–	–	0.050	0.010
10											0.268	0.190	-0.050	0.544	0.551
											–	–	–	0.010	0.010
11												0.115	-0.081	0.090	0.095
												–	–	–	–
12													0.732	0.383	0.581
													0.001	–	0.001
13														0.046	0.197
														–	–
14															0.646
															0.010
15															

Tab. 10. Correlation matrix of morphometric parameters of *Galanthus nivalis* L. (population II – Shayan)

Parameter	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1		0.263	0.164	0.382	0.224	0.103	0.836	0.286	0.417	0.132	0.346	0.052	0.353	0.246	0.342
		–	–	–	–	–	0.001	–	0.050	–	–	–	–	–	–
2			0.501	0.614	0.592	0.614	0.396	0.429	0.305	0.557	0.620	0.449	0.595	0.590	0.667
			0.050	0.010	0.010	0.010	–	0.050	–	0.010	0.010	0.050	0.010	0.010	0.001
3				0.632	0.682	0.494	0.339	0.616	0.360	0.433	0.638	0.737	0.498	0.469	0.532
				0.010	0.001	0.050	–	0.010	–	0.050	0.010	0.001	0.050	0.050	0.050
4					0.536	0.644	0.482	0.478	0.450	0.615	0.697	0.607	0.460	0.578	0.732
					0.010	0.010	0.050	0.050	0.050	0.010	0.001	0.010	0.050	0.010	0.001
5						0.452	0.427	0.620	0.494	0.535	0.540	0.675	0.575	0.634	0.548
						0.050	0.050	0.010	0.050	0.010	0.010	0.001	0.010	0.010	0.010
6							0.195	0.469	0.424	0.803	0.493	0.386	0.268	0.383	0.445
							–	0.050	0.050	0.001	0.050	–	–	–	0.050
7								0.384	0.620	0.288	0.537	0.352	0.487	0.383	0.498
								–	0.010	–	0.010	–	0.050	–	0.050
8									0.647	0.293	0.522	0.48 9	0.389	0.674	0.645
									0.010	–	0.050	0.050	–	0.001	0.010
9										0.444	0.598	0.446	0.13 1	0.554	0.510
										0.050	0.010	0.050	–	0.010	0.050
10											0.526	0.453	0.358	0.404	0.473
											0.050	0.050	–	–	0.050
11												0.501	0.337	0.710	0.646
												0.050	–	0.001	0.010
12													0.507	0.372	0.467
													0.050	–	0.050
13														0.483	0.609
														0.050	0.010
14															0.811
															0.001
15															

Tab. 11. Correlation matrix of morphometric parameters of *Galanthus nivalis* L. (population III – Antalovetska Poljana)

Parameter	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1		0.322	0.55 4	0.059	0.33 4	-0.105	0.927	0.602	0.415	0.285	0.118	0.205	0.294	0.485	0.184
		–	0.010	–	–	–	0.001	0.010	0.050	–	–	–	–	0.050	–
2			0.296	0.588	0.496	0.433	0.356	0.604	0.114	0.420	0.297	0.174	0.647	0.422	0.300
			–	0.010	0.050	0.050	–	0.010	–	0.050	–	–	0.010	0.050	–
3				0.397	0.602	0.265	0.608	0.575	0.791	0.193	0.326	0.575	0.393	0.694	0.50 8
				–	0.010	–	0.010	0.010	0.001	–	–	0.010	–	0.001	0.050
4					0.455	0.709	0.107	0.340	0.296	0.311	0.380	0.055	0.330	0.452	0.391
					0.050	0.001	–	–	–	–	–	–	–	0.050	–
5						0.441	0.486	0.673	0.531	-0.012	0.424	0.195	0.429	0.630	0.333
						0.050	0.050	0.001	0.050	–	0.050	–	0.050	0.010	–
6							-0.073	0.104	0.070	-0.007	0.290	0.068	0.452	0.364	0.395
							–	–	–	–	–	–	0.050	–	–
7								0.658	0.465	0.342	0.230	0.230	0.410	0.489	0.291
								0.010	0.050	–	–	–	–	0.050	–
8									0.578	0.347	0.422	0.146	0.392	0.541	0.178
									0.010	–	0.050	–	–	0.010	–
9										0.293	0.241	0.496	0.067	0.485	0.400
										–	–	0.050	–	0.050	–
10											0.396	0.128	0.246	0.068	0.387
											–	–	–	–	–
11												0.010	0.300	0.099	0.303
												–	–	–	–
12													0.341	0.251	0.430
													–	–	0.050
13														0.39 6	0.429
														–	0.050
14															0.533
															0.010
15															

Tab. 12. Correlation matrix of morphometric parameters of *Galanthus nivalis* L. (population IV – Menchul-Kvasivskyj)

Parameter	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1		0.783	0.679	0.595	0.455	0.132	0.635	0.370	0.426	0.346	0.108	0.762	0.081	0.645	0.246
		0.001	0.001	0.010	0.050	–	0.010	–	0.050	–	–	0.001	–	0.010	–
2			0.561	0.718	0.318	0.113	0.642	0.434	0.470	0.306	0.000	0.819	0.309	0.618	0.17 4
			0.010	0.001	–	–	0.010	0.050	0.050	–	–	0.001	–	0.010	–
3				0.527	0.836	0.159	0.475	0.529	0.531	-0.098	0.045	0.736	-0.097	0.300	-0.035
				0.050	0.001	–	0.050	0.050	0.050	–	–	0.001	–	–	–
4					0.350	-0.212	0.513	0.461	0.412	0.178	0.201	0.694	0.036	0.506	0.097
					–	–	0.050	0.050	–	–	–	0.001	–	0.050	–
5						0.052	0.431	0.315	0.235	-0.123	-0.102	0.554	-0.078	0.038	-0.279
						–	0.050	–	–	–	–	0.010	–	–	–
6							-0.028	0.183	0.091	-0.115	0.110	0.029	0.147	-0.242	0.149
							–	–	–	–	–	–	–	–	–
7								0.276	0.130	0.208	-0.193	0.520	0.087	0.217	0.079
								–	–	–	–	0.050	–	–	–
8									0.854	-0.280	0.225	0.453	-0.278	0.330	0.361
									0.001	–	–	0.050	–	–	–
9										-0.115	0.200	0.544	-0.156	0.407	0.373
										–	–	0.010	–	–	–
10											0.034	0.270	0.357	0.274	-0.092
											–	–	–	–	–
11												0.103	-0.379	0.154	0.469
												–	–	–	0.050
12													0.124	0.619	0.196
													–	0.010	–
13														-0.030	-0.225
														–	–
14															0.296
															–
15															

Tab. 13. Correlation matrix of morphometric parameters of *Galanthus nivalis* L. (population V – Janove)

Parameter	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1		0.401	0.642	0.489	0.549	0.411	0.83 4	0.357	0.323	0.149	-0.042	0.254	-0.213	0.217	0.198
		–	0.010	0.050	0.010	–	0.001	–	–	–	–	–	–	–	–
2			0.365	0.377	0.028	0.117	0.420	0.492	0.744	0.214	0.216	0.626	0.528	0.243	0.314
			–	–	–	–	0.050	0.050	0.001	–	–	0.010	0.050	–	–
3				0.72 1	0.674	0.638	0.604	0.618	0.419	0.244	0.174	0.405	0.025	0.262	-0.007
				0.001	0.001	0.010	0.010	0.010	0.050	–	–	–	–	–	–
4					0.566	0.687	0.541	0.611	0.442	0.464	0.483	0.590	0.310	0.268	-0.036
					0.010	0.001	0.010	0.010	0.050	0.050	0.050	0.010	–	–	–
5						0.465	0.684	0.451	0.219	0.478	0.165	0.191	-0.169	0.102	-0.043
						0.050	0.001	0.050	–	0.050	–	–	–	–	–
6							0.396	0.253	-0.007	0.331	0.560	0.325	0.160	0.130	0.122
							–	–	–	–	0.010	–	–	–	–
7								0.530	0.417	0.425	0.210	0.263	-0.148	0.255	0.008
								0.050	0.050	0.050	–	–	–	–	–
8									0.696	0.345	0.311	0.468	0.198	0.430	-0.124
									0.001	–	–	0.050	–	0.050	–
9										0.309	0.081	0.578	0.448	0.440	0.027
										–	–	0.010	0.050	0.050	–
10											0.525	0.377	0.164	0.321	-0.005
											0.050	–	–	–	–
11												0.256	0.359	0.164	-0.064
												–	–	–	–
12													0.729	0.288	0.298
													0.001	–	–
13														0.104	0.203
														–	–
14															-0.173
															–
15															

Tab. 14. Correlation matrix of morphometric parameters of *Galanthus nivalis* L. (population VI – Jablunytsa)

Parameter	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1		0.735	0.353	0.715	0.588	0.491	0.978	0.680	0.770	0.532	0.429	0.727	0.500	0.623	0.523
		0.001	–	0.001	0.010	0.050	0.001	0.001	0.001	0.050	0.050	0.001	0.050	0.010	0.050
2			0.547	0.750	0.427	0.577	0.737	0.501	0.617	0.587	0.647	0.599	0.419	0.719	0.673
			0.010	0.010	0.050	0.010	0.001	0.050	0.010	0.010	0.010	0.010	0.050	0.001	0.001
3				0.577	0.545	0.591	0.340	0.396	0.535	0.407	0.475	0.513	0.343	0.367	0.429
				0.010	0.010	0.010	–	–	0.010	–	0.010	0.050	–	–	0.050
4					0.643	0.593	0.734	0.636	0.774	0.616	0.518	0.634	0.396	0.668	0.711
					0.010	0.010	0.001	0.010	0.001	0.010	0.050	0.010	–	0.001	0.001
5						0.426	0.552	0.622	0.702	0.411	0.163	0.486	0.372	0.363	0.416
						0.050	0.010	0.010	0.001	–	–	0.050	–	–	0.050
6							0.496	0.371	0.435	0.306	0.236	0.441	0.281	0.359	0.566
							0.050	–	0.050	–	–	0.050	–	–	0.010
7								0.649	0.733	0.522	0.424	0.697	0.438	0.616	0.556
								0.010	0.001	0.050	0.050	0.001	0.050	0.010	0.010
8									0.864	0.657	0.393	0.600	0.536	0.559	0.421
									0.001	0.010	–	0.010	0.010	0.010	0.050
9										0.711	0.396	0.662	0.526	0.627	0.552
										0.001	–	0.001	0.050	0.010	0.010
10											0.665	0.480	0.375	0.599	0.599
											0.001	0.050	–	0.010	0.010
11												0.605	0.359	0.358	0.297
												0.010	–	–	–
12													0.721	0.440	0.349
													0.001	0.050	–
13														0.253	0.157
														–	–
14															0.839
															0.010
15															

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