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INDIVIDUAL, INTRASEASONAL VARIATION IN THE NUMBER OF CARPELS/FRUITS OF *THALICTRUM MINUS* L. S. L. (*RANUNCULACEAE*)

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The samples of flowers were gathered successively seven times during the vegetation season from nine individuals of *Thalictrum minus* L. s. l. The carpels i. e. fruits were counted to ascertain the number. The average number of carpels/fruits established per flower before the fruits fell off was 5.1 — 5.6, and the absolute range was 2 — 21. The coefficient of variability during the year, was 31.5 — — 46.5. The Kruskal-Wallis test showed significant difference among specimens in the number of carpels/fruits per flower. The Kolmogorov-Smirnov test showed that the samples were not normally distributed. Early flowering specimens developed a larger number of carpels then latest flowering specimens. The time of flowering was, possibly, genetically stabilized and showed geographic variability.

Introduction

The number of carpels, i. e. fruits (achenes) on a particular individuum is a character that shows certain variability. For the species *Thalictrum minus* — complex (family *Ranunculaceae*) the number of carpels per flower in apocarpous gynoecium mentioned earlier was for example, 4—14 (Endlicher 1836—1840), 5—8 (Newsky 1953), 3—15 (Tutin 1964, Damboldt and Zimmermann 1974). It was considered that those values only partially covered the real varialibity. This type of variation was elaborated for the American species *L.*

thalictroides (L.) Eames et Boivin (Lubbers and Christensen 1986), but not specially for *T. minus* L. In the American species the number of carpels depends on the start of the flowering time, pollination quality and light availability.

The aim of this study was to define the variability in the number of fruits per flower and per individuum for *Thalictrum minus* L. s. l., its total range and the type of distribution in the whole sample.

Materials and Methods

Nine individuals of *T. minus* L. s. l. were cultivated for more than 5 years in the Botanical Garden, the University of Zagreb, (Zagreb). The specimens originated from: (1) Strahinščica, (2) Sveti Jure, Biokovo, (3) Biokovo, (4) Boračko Jezero, (5) Dinara, (6) Treskavica, (7) Deliblatska Pješčara, (8) eastern Velebit and (9) Mali Troglav. During 1989, the flowers were successively gathered seven times from each specimen, as follows: on 6 June (I), 15 June (II), 22 June (III), 18 July (IV), 1 August (V), 17 August (VI) and 5 September (VII). Each sample of each date contained 15 flowers gathered from the same part of inflorescence. The number of carpels/fruits on each flower was noted.

Individual and sample variabilities were described by standard statistical tools (average $\bar{X}$, standard error S_x, coefficient of variability CV) for each date.

The Kolmogorov-Smirnov test at $\alpha = 0.01$ was employed to count the D value and test the normality of distribution for each date and all specimens together. Since the sample number of flowers was > 100, equation according to Rohlf and Sokal (1969) was used for the critical value $D\alpha$.

The Kruskal-Wallis test at $\alpha = 0.05$ was used to count the H value and test the significance of difference in the number of carpels/fruits per specimen samples belonging to the same date.

All procedures were according to Sokal and Rohlf (1981) and all table values by Rohlf and Sokal (1969).

Results

Although cultivated under the same microclimatological conditions, the specimens showed a considerable shift in the start of the flowering time and in the shaking off of perianth elements, as well. Specimens No. 2 and 5 developed buds in inflorescence on dates I and II, and specimen no. 3 on dates II and III. Specimens No. 1, 4 and 9 flowered markedly early and already on the first date they had no buds. Similar shifts were observed in the shaking off of perianth elements including stamens between dates I and IV. From the beginning of July, the pedicels contained only achenes in all specimens. A difference in the number of carpels/fruits per flower was obvious between the specimens flowering early and later on.

Tab. 1 shows average values ($\bar{x}$) of the number of carpels/fruits for each specimen on each date. For all specimens on one date is the total $\bar{x}_t \pm s_{xt}$.

Table 1. Average means ($\bar{x}$) for each specimen and each term (* specimen lack)

No. spec.	Data						
	I	II	III	IV	V	VI	VII
1	6.066	6.000	5.866	5.666	6.533	5.933	6.133
2	4.466	4.600	4.933	4.533	4.533	5.066	*
3	4.200	3.666	4.400	3.800	4.200	39.33	5.266
4	7.333	6.866	7.400	7.933	9.533	7.533	3.466
5	4.000	4.200	3.733	3.666	3.733	3.200	2.933
6	5.066	5.066	4.866	46.00	5.133	4.800	4.066
7	3.600	4.400	4.533	3.866	4.400	3.400	*
8	4.066	3.666	3.666	4.066	4.066	3.866	2.800
9	8.866	7.400	9.266	9.133	8.733	9.066	2.666
$\bar{X}$ total	5.296	5.096	5.407	5.251	5.651	5.200	3.904
$\pm S_{\bar{x}}$	0.168	0.138	0.191	0.177	0.193	0.191	0.177

Table 2. Coefficients of variability for each specimen and each term (* specimen lack)

No. spec.	Data						
	I	II	III	IV	V	VI	VII
1	21.99	16.66	19.19	14.40	19.93	21.55	17.28
2	20.48	13.73	25.92	16.39	14.09	13.87	*
3	31.42	28.53	17.72	20.36	13.33	15.07	29.11
4	14.26	21.92	8.54	15.40	11.11	15.75	57.55
5	23.12	16.09	21.37	16.83	15.88	29.40	20.21
6	9.02	11.70	18.80	21.41	12.44	12.60	32.80
7	23.00	22.38	16.39	29.10	15.47	34.79	*
8	19.62	22.25	24.52	14.58	14.58	29.10	45.14
9	14.04	16.78	37.03	10.84	20.50	24.46	50.45
total	36.98	31.51	41.24	39.32	39.81	42.73	46.51

It can be noticed that the number of carpels/fruits was constant at the beginning of August when the first fruits, like a matured ovary, started to shake off. Until that moment, the average range for this period was 3.6 — 9.5, and the absolute range was 2 — 21 (Fig. 1).

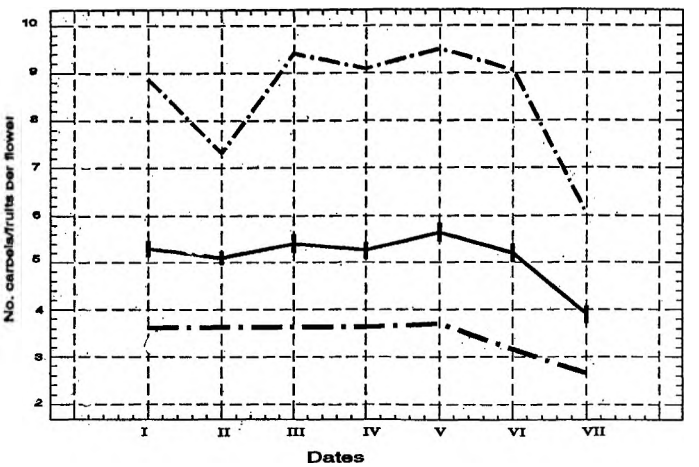

Fig. 1. Average with standard errors ($\overline{X} \pm S_x$) (solid line) and average minimum and maximum (dotted line) during season.

Table 3. H values according to Kruskal-Wallis test for each term

Dates	H values
I	91.55
II	88.62
III	91.54
IV	94.96
V	101.27
VI	92.49
VII	48.69

$\chi^2_{\cdot 05(8)} = 15.507$

Table 4. D values according to Kolomogorov-Smirnov test for each term

Dates	D values
I	0.211
II	0.190
III	0.224
IV	0.214
V	0.258
VI	0.158
VII	0.155

$D_{.01(adj\cdot 135)} = 15.507$

The variability coefficient shows considerable changes between single plants (Tab. 2). The individual variability for the whole period was 9 — 57.5%. It can be seen that an increase in the variability coefficient occurred towards the end of the vegetation season. Total variability per each term was 31.5—46.5%.

With regard to Kruskal-Wallis tests, for all terms $H \gg X^2_{.05(8)} = 15.507$, Ho: specimens are not significantly different in carpels/fruits number per flower (Tab. 3).

With regard to Kolmogorov-Smirnov test, for all terms $D > D_{01.\,(adj.\,135)} = 0.14011$, and Ho: sample are normally distributed in each term.

Discussion

The results show that in the flowers of *Thalictrum minus* L. s. l. an average of 5.29—5.65 carpels appeared with a considerable boundary range: 2—21, and a relatively large coefficient of variability, 31—43%. This is partially in agreement with some other authors. The total range of the number of carpels/fruits per flower was larger than the data registered so far, by Endlicher (1836—1849) 4—14, Newsky (1953) 5—8, Tutin (1964) 3—15, Trinajstić (1973) 5—10, and Damboldt and Zimermann (1974) 3—15. This is especially interesting in comparison with the larger average number of carpels/fruits per flower (7.4—9.26) and the quickly declined specimen No. 9 from Mali Troglav. Some authors, however, do not mention at all the number of carpels in their descriptions of the species (Garcke 1903, Hayek 1911, Degen 1937 Nyárády 1953, Gajić 1970, Pignatti 1982).

The time established for the falling off of the fruits is the beginning of August. The specimens investigated clearly show a shift in the start of the flowering time and in the period of the declination of perianth elements, although they grew under the same conditions for a long period. This may show the genetic control of this character.

Individuals, all of the same species, all growing under the same conditions, differ considerably, according to the results of the Kruskal-Wallis test, in the carpels/fruits number per flower in each term. Lubbers and Christensen (1986) consider the direct dependence of seed production on light availability, the position of some flowers in inflorescence and the flowering time as a likely cause for this variability in the species *T. thalictroides* (L.) Eames et Boivin. The early flowering specimens (No. 1, 4, 9) have evidently a greater number of carpels/fruits than the individuals flowering later (No. 2, 3, 5); this shows the flowering time dependence also in the European species *T. minus*, which renders the taxonomical usage of this character more difficult (Nyárády 1953, Trinajstić 1973).

The fact that all individuals retained individual periods of flowering, although they grew under the same conditions for a long time, indicates a possibility of genetic control. If this is so, this characteristic stabilized in natural habitats must show geographic variability within the area of distribution of the species.

The results of the Kolmogorov-Smirnov test show the absence of the expected normal distribution of the carpels/fruits number per flower. This may suggest the activity of directional selection of this character (Mettler and Gregg 1969).

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SAŽETAK

INDIVIDUALNA UNUTARSEZONSKA VARIJABILNOST U BROJU PLODNICA/PLODOVA KOD VRSTE *THALICTRUM MINUS* L. S. L. (*RANUNCULACEAE*)

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S devet primjeraka vrste *Thalictrum minus* L. (s. l.) sukcesivno je tijekom vegetacijske sezone sedam puta sabiran uzorak cvjetova. Registriran je broj plodnica/plodova. Biljke pokazuju jasne pomake početka cvatnje. Ustanovljen prosječan broj plodnica/plodova po cvijetu prije perioda opadanja plodova (početkom kolovoza) je 5.1 do 5.6 s apsolutnim rasponom od 2 do 21. Koeficijent varijabilnosti tijekom godine kreće se od 31.5 do 46.5%. Testom Kruskal-Wallis pokazano je da se pojedini primjerci signifikantno razlikuju prema broju plodnica/plodova po cvijetu, a testom Kolomogorov-Smirnov ustanovljeno je da uzorci nisu normalno distribuirani. Ranocvatući primjerci razvijaju veći broj plodnica od kasnocvatućih. Vrijeme cvatnje je vjerojatno genetski uvjetovana osobina i pokazuje geografsku varijabilnost.

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