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Influence of the mode of pollination on offsprings of some species of the genus *Chenopodium*

Vliv způsobu opylení na potomstvo některých druhů rodu *Chenopodium*

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Influence of autogamy and free pollination on offsprings of the genus *Chenopodium* was studied on six species (*C. album* L. *s. str.*, *C. ficifolium* Sm., *C. glaucum* L., *C. hybridum* L., *C. strictum* Roth, *C. suecicum* J. Murr). There was found no unfavourable influence of autogamy either, on weight and height of aboveground part of plant, development of inflorescence and seeds, or on the homogeneity of offsprings. Briefly discussed has been also the mode of pollination of the studied species.

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INTRODUCTION

The variability of several species of the genus *Chenopodium*, particularly the species of *C. album* agg., still causes taxonomical difficulties. There are evidently two reasons for this variability, a considerable plasticity and especially differences in the genotype of the individual populations. The general supposition has apparently been that in addition to a considerable ecoplasticity, spontaneous hybridization is one of the main causes of variability. If we were to estimate the proportion in which hybridization participates in variability, we need knowledge of the mode of pollination, a subject neglected rather in the past. Upon these data, we should be able to identify correctly both, the taxon and its taxonomic position.

The mode of pollination is among the basic knowledge of the mechanisms of pollination. This objective has been treated sparingly in the past. Savin (1957) considers *C. album* to be allogamous. In his provisional experiment, the number of seeds recovered after isolation was 20 times lower than the number of seeds from a not isolated plant. In his opinion the seeds originated from parthenogenesis. He did neither mention a possible autogamy nor did he give data on the viability of seeds produced by an isolated inflorescence. Ponomarev et Lykova (1960) suggested cleistogamy for members of the family *Chenopodiaceae*. Mulligan et Findlay (1970) from Canada tested the hypothesis suggested by Baker (1955) that most weeds are autogamous because this supports their colonization. The two authors isolated the flowers of various weeds including inflorescences of *C. album* L. and C. *glaucum* L., and noted that these plants were capable to produce viable seeds. They also considered the possibility of agamogenesis.

Members of the family *Chenopodiaceae* are regarded as more or less uniformly anemophilous (Wodehouse 1935, Aellen 1960, Williams 1963, Mulligan 1972). However, Blackwell et Powell (1981) suggested that

entomophily may occur under certain conditions with some species. Also I observed a large number of bees and other insect species on fully developed and flowering individuals of *C. album agg.*

It is obvious from the brief account that little is known of the mode of pollination in the genus *Chenopodium*. Therefore, it will be necessary to confirm the results of the mentioned authors, complete our knowledge of not investigated species and add new data on the mechanisms of pollination.

In an earlier paper by the present author (DOSTÁLEK 1983), the object of study was the influence of the mode of pollination (open pollination and spontaneous autogamy) on the germinating capacity of the seed, the rate of germination and the weight of 1000 seeds, using seven species of the genus *Chenopodium: C. album* L. s. str., *C. ficifolium* SM., *C. glaucum* L., *C. hybridum* L., *C. strictum* ROTH, *C. suecicum* J. MURR, *C. vulvaria* L. For spontaneous autogamy, the inflorescence before the opening of the flowers were covered with bags made of dense silon (nylon) commonly used in this sort of work. For control purposes, one plant always of several species was placed separately in the greenhouse in such a manner that pollination with foreign pollen could not occur. Supposing anemophily, the isolation of a larger number of plants in the greenhouse was technically impracticable. Germination on a Jacobsen apparatus was made in three replications (100 seeds each) and in three variants: after free pollination, spontaneous autogamy using nylon bags, spontaneous autogamy in the greenhouse. According to the results, *Chenopodium* species arising from autogamy produced a sufficiently large number of viable seeds. A negative influence of autogamy such as the inbreeding depression reported for allogamous plants, was not reflected in any of the characteristics investigated. On the contrary, the weight of the seeds obtained by the mentioned modes of pollination, was most above the standard, and they tended to germinate at a considerable rate.

In the present study, an attempt has been made to obtain a better understanding of autogamy and allogamy in species of the genus *Chenopodium*. The present study has been based upon the assumption that forced autogamy must lead to a separation of the first generation into various groups. In addition, it may have an unfavourable effect on the growth vigour of the plant (inbreeding depression). I have tried to estimate from a comparison of autogamous and free-pollinated progenies to what degree the individual filial generations have been affected by this phenomenon, paying attention mainly to a decrease in the weight of aboveground parts of the plant and its height. Future results will show which of the two modes of pollination is the more satisfacting one.

MATERIALS AND METHODS

I used six species of the genus *Chenopodium: C. album* L. *s. str.*, *C. ficifolium* SM., *C. glaucum* L., *C. hybridum* L., *C. strictum* ROTH, *C. suecicum* J. MURR. The seeds for raising the plants were collected during an experiment in 1981 (DOSTÁLEK 1983). The genetical uniformity of the experimental material was insured in that part of the inflorescence of one plant was isolated (spontaneous autogamy), part was left for open pollination. The experiment was performed in the experimental garden of the Botanical Institute, Czechoslovak Academy of Sciences, Průhonice. Young seedlings raised from seeds were planted in garden beds at a distance of 30 cm from one another

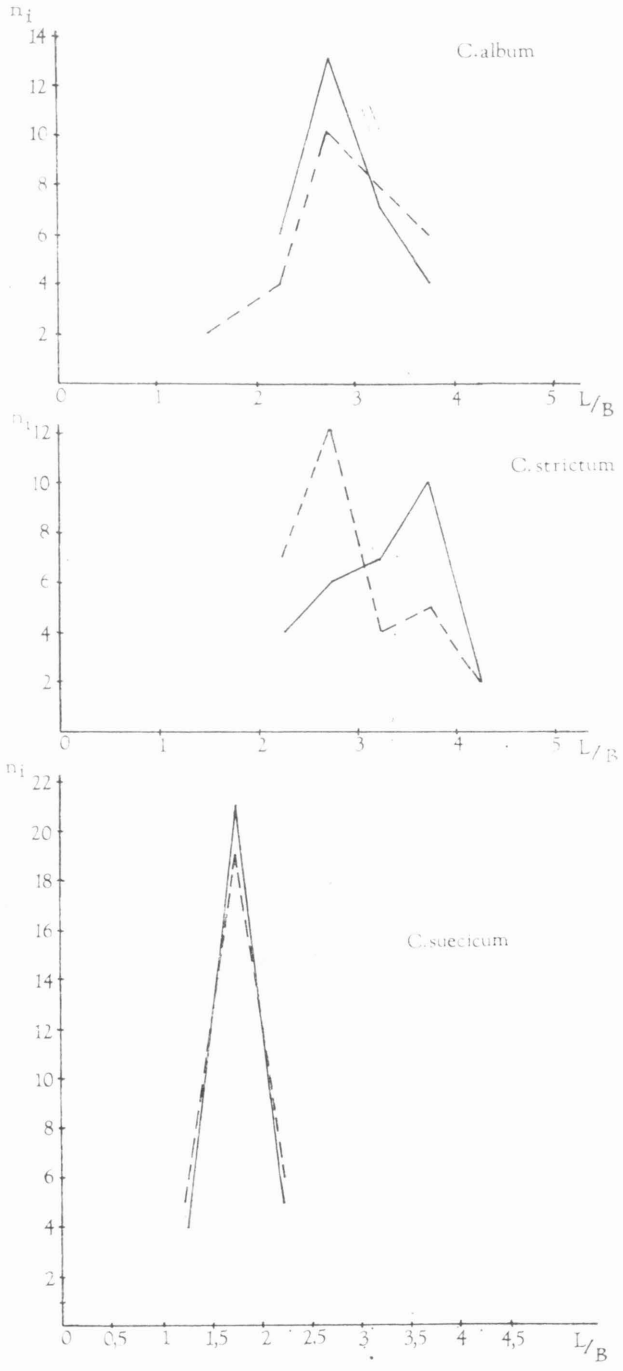

Fig. 1. — Frequency polygons of indices L/B (length/breadth) (full line — free pollination; interrupted line — autogamy)

Table 1 — Weight of aboveground dry matter — significance of differences in average values· (Variants: a — open pollinated plants, b — arising from autogamy) Significance of differences evaluated with the t-test.

Species	Plant progeny no.	Pollination variant	n	$\bar{x}$ (g)	s	F	t	Significance $p \leq 0.05$
C. album L. s. str.	1	a	108	63.5	42.5	2.70	0.18	—
		b	93	62.6	25.9			
	2	a	122	54.6	33.9	1.08	0.35	—
		b	110	53.0	35.1			
C. ficifolium	1	a	64	41.3	33.9	1.16	0.44	—
		b	68	43.9	31.3			
C. glaucum	1	a	35	40.7	15.0	1.07	1.74	—
		b	39	46.9	15.4			
C. hybridum	1	a	55	101.6	51.6	1.05	0.39	—
		b	51	105.6	52.8			
C. strictum	1	a	71	81.5	50.5	1.46	1.41	—
		b	38	67.9	41.7			
C. suecicum	1	a	24	67.6	32.8	2.10	0.20	—
		b	47	79.2	47.6			
	2	a	47	70.0	49.8	1.33	0.55	—
		b	85	75.6	57.5			

thus providing equal conditions for their development. Adult plants were measured and their biomass was collected. The plants were dried at 80 °C to a constant weight. The length/breadth index of the leaf lamina of one plant represents the average value of measurements of five leaves. The t-test was used for a biometric evaluation.

RESULTS AND DISCUSSION

The data on the influence of the mode of pollination on the aboveground dry matter weight of the plant are shown in Table 1. No statistically significant difference was found in any of the species examined between free pollination and autogamy. Minor difference occured in averages of the two variants of pollination; in their absolute value, they were once in favour of the one mode, once in favour of the second mode of pollination.

The effect of the mode of pollination on the height of the stem is reviewed in Table 2. Again, a comparison between autogamy and free pollination was found to be statistically not significant in all cases except *C. strictum* in which the stem was remarkably higher in the free-pollinated variant, and *C. glaucum* in the variant arising from autogamy. But also in the latter case no effect of autogamy could be observed in the progeny of the examined species. Admittedly, the different values between the variants of pollination in *C. strictum* and *C. glaucum* may have been due to other factors than the mode of pollination. Neither a retarded opening of the flowers nor disturbance of the development of inflorescence and flowers could be found in progenies

Table 2 — Height of stem — significance of differences in average values. (Variants: a — open pollinated plants, b — arising from autogamy) Significance of differences evaluated with the t-test.

Species	Plant progeny no.	Pollination variant	n	$\bar{x}$ (cm)	s	F	t	Significance $p \leq 0.05$
C. album L. s. str.	1	a	75	98.0	19.2	2.77	0.93	—
		b	92	95.6	11.5			
	2	a	38	97.6	16.0	1.69	0.34	—
		b	80	98.8	20.7			
C. ficifolium	1	a	64	71.4	10.1	1.49	1.07	—
		b	56	73.7	12.4			
C. glaucum	1	a	32	55.8	7.3	2.72	7.33	+
		b	42	65.9	4.5			
C. hybridum	1	a	57	96.3	13.6	1.54	0.55	—
		b	55	97.6	11.0			
C. strictum	1	a	35	128.0	10.7	1.80	4.59	+
		b	36	114.1	14.3			
C. suecicum	1	a	18	90.9	13.1	1.06	0.19	—
		b	40	91.8	12.7			
	2	a	23	90.6	13.5	1.41	0.56	—
		b	47	92.5	11.4			
	3	a	47	91.8	14.6	1.91	0.54	—
		b	85	93.0	10.5			

arising from autogamy. All plants produced standard numbers of viable seeds.

Owing to the general belief in a large heterozygosity, particularly in *C. album agg.*, I examined the influence of autogamy on the homogeneity of the I_1 population in three species, using the lenght/breadth index of the leaf lamina as the diagnostic character because a number of taxa within *C. album agg.* differ in it (Fig. 1, Table 3). Fig. 1 shows that the individual frequency

Table 3 — Length/breadth index of leaf lamina — significance of differences in average values. (Variants: a — open pollinated plants, b — arising from autogamy) Significance of differences evaluated with the t-test.

Species	Pollination variant	n	$\bar{x}$	s	F	t	Significance $p \leq 0.05$
C. album L. s. str.	a	30	2.84	0.45	1.00	0.00	—
	b	30	2.84	0.56			
C. strictum	a	30	3.12	0.72	1.44	1.92	—
	b	30	2.99	0.60			
C. suecicum	a	30	1.78	0.24	1.00	0.38	—
	b	30	1.74	0.24			

polygons of lenght/breadth indices produce a simple peak in both variants of pollination which confirms that in the I_1 population does not separate into groups differently shaped leaves. Also the shape of the leaf lamina remained unchanped in both variants (Table 3). Other features examined during the development of the I_1 generation, were the shape of inflorescence and the height of the plant. Here again, these features showed that the heterogeneity of the autogamous population was not higher than that of the free-pollinated population.

CONCLUSIONS

It has been demonstrated in this study that the I_1 generations of the *Chenopodium* species were not negatively affected by autogamy in the weight of aboveground parts of the plant, its height, the development of inflorescence, the production of viable seeds. The homogeneity in the shape of the leaf was not disturbed by autogamy; no increased heterogenity was observed in the heigt of the plant, the weight of aboveground parts of the plant and the shape of inflorescence. It has been confirmed in experiments that autogamy exists in the genus *Chenopodium* consequently, the populations arising from autogamy may be relatively homozygous and morphologically relatively balanced. It remains to be seen how the specificities of the populations (originating lines) will assert themselves in the taxonomy of the genus *Chenopodium*. Autogamy may explain the complicated variability particularly in *C. album* agg. The problem of a possible participation of apomixis in the variability of the genus will be in need of investigation.

SOUHRN

Práce je příspěvkem ke studiu oplozovacích poměrů šesti druhů rodu *Chenopodium* (*Ch. album* L. *s. str.*, *Ch. ficifolium* Sm., *Ch. glaucum* L., *Ch. hybridum* L., *Ch. strictum* Roth, *Ch. suecicum* J. Murr). U všech zkoumaných druhů rodu *Chenopodium* se neprojevil v I_1 generaci nepříznivý vliv autogamie na hmotnost nadzemní části rostliny, výšku rostliny, vývoj květenství a vznik dostatečného množství životaschopných semen. Autogamií nebyla porušena homogenita populace ve tvaru listů. Ani ve výšce lodyhy, hmotnosti nadzemní části rostliny a tvaru květenství nebyla pozorována větší heterogenita I_1 generací, než u populací vzniklých ze semen z volného opylení. Výsledky potvrzují předpoklad, že zkoumané druhy rodu *Chenopodium* mají schopnost produkovat po samosprášení životaschopná semena. Nebyl také pozorován vliv autogamie na další generaci.

Bylo tedy experimenálně dokázáno, že u rodu *Chenopodium* existuje možnost samosprášení, a v důsledku toho mohou vznikat populace poměrně homozygotní, morfologicky relativně vyrovnané. Je problém, do jaké míry se osobitosti populací (vznikající linie) uplatňují v taxonomii rodu *Chenopodium*. Autogamie může být vysvětlením komplikovanosti variability, zvláště u *Ch. album* agg. Zda se neuplatňuje také apomixe, bude třeba zjistit v další práci.

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M. Zohary et D. Heller:

The Genus *Trifolium*

The Israel Academy of Sciences and Humanities, Jerusalem 1984, 10 + 606 str., 231 tab., 13 fig., 9 map. (Kniha je v knihovně ČSBS.)

Rod *Trifolium* je jedním z největších rodů ekonomicky důležité čeledi *Fabaceae*. Jeho zástupci tvoří významnou součást vegetačního krytu hlavně v Mediteránu a v přilehlé mírné oblasti a některé jeho druhy jsou významnými pícninami. Přesto však dosud scházelo dílo, které by se monograficky tomuto rodu v celém jeho rozsahu důkladněji věnovalo. I když rod je hospodářsky významný, byl z jeho druhového bohatství (nejméně 250 druhů) zaveden do kultury zatím jen malý počet druhů (c. 15). Starší autor z autorské dvojice M. Zohary zpracoval tento rod nejdříve pro dílo Flora Palaestina (47 druhů) a pak do dalšího flórového díla Flora of Turkey (100 druhů); při těchto jeho pracech vznikla idea vypracovat monografii celého rodu. Vydání knihy se tento autor již nedožil; zemřel po skončení korektur této monografie. Hlavní účel knihy vidí její autoři v tom, podat referenční příručku s co možná úplnými popisy a dále vyobrazeními všech druhů rodu; přitom autoři chápou svou knihu jen jako bázi pro další výzkum rodu. Kniha představuje klasickou monografii, v níž je rod zpracován hlavně z hlediska taxonomického a chorologického.

Rod *Trifolium* nepatří mezi kritické rody; je pro něj charakteristický výskyt jen malého počtu kříženců mezi jeho druhy. Jeho sekce jsou morfologicky velmi zřetelné, takže jsou některými autory chápány i jako samostatné rody. Vývojové centrum rodu je bezesporu ve Středozemní oblasti, kde je zastoupeno 120 druhů, tj. ± polovina z celkového počtu druhů rodu, patřících zde k 7 z 8 sekcí rodu. Autoři chápou rod *Trifolium* jako morfologicky přirozenou jednotku, která nemůže být rozčleněna do nějakých dalších samostatných rodů a také by neměla být přiřazena (ani zčásti) do žádné jiné taxonomické skupiny (shluku) než je tribus *Trifolieae*. Tím se autoři liší od názoru sovětského monografa jetelů Bobrova i některých našich autorů (včetně recenzenta). Celkem autoři rozeznávají v rodu 8 sekcí; některé z nich jsou však poměrně široce pojaté a svým obsahem též dosti heterogenní. Celkový počet druhů přijatých autory je 237, k nimž přistupuje ještě 80 významných infraspecifických taxonů (zpravidla vyšší taxonomické hodnoty než jim přisoudili autoři). Jedná se tedy o dosti rozsáhlý rod (se širším geografickým rozšířením) a monografické zpracování je tímto jeho rozsahem podstatně ztíženo. V poslední době monografie tak rozsáhlých rodů z botanické literatury vymizely; badatelé se vyhýbají jejich zpracovávání. Je však nutno uvést, že autoři pojednávají o rodu velmi stručně a že ani dosti značný rozsah jejich knihy (přes 600 stran) nemůže stačit pro dostatečné zpracování jetelů ve světovém měřítku.

V obecné části knihy probírají autoři historii taxonomické klasifikace rodu; zde z našich botaniků jsou zmíněny názory K. B. Presla a Čelakovského. Při řešení otázky infragenerického členění rodu je zde vysloven kritický postoj autorů k rozčlenění jetelů do více rodů provedenému Preslem a později převzatému Bobrovem, jež v naší novější literatuře rozvinul hlavně nomenklatoricky Soják a plně přejal Dostál do jeho „Seznamu". Je zde také probrán vztah rodu *Trifolium*