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Diversity of pollination in some *Rosa* species

Různé způsoby opylení u některých druhů rodu *Rosa*

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The present paper describes various modes of pollination (autogamy, geitonogamy, xenogamy, free-pollination) in seven *Rosa* species (*R. pimpinellifolia* L., *R. gallica* L., *R. jundzillii* BESS., *R. canina* L., *R. pendulina* L., *R. arvensis* HUDS., *R.* × *reversa* WALDST. et KIT.), belonging to six sections of the genus. The types of pollination were evaluated according to the development of ripened hips. The species may be divided into four groups with respect to their fertility.

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INTRODUCTION

Problems of compatibility and incompatibility in the genus *Rosa* have been studied by numerous authors, as for instance ERLANSON (1929, 1934), FAGERLIND (1940, 1942, 1944a, b, 1946, 1948, 1951), GUSTAFSSON (1942), RATHLEF (1937), RATSEK, YARNELL et FLORY (1939, 1941), etc. These authors encountered different types of pollination in crossing of species both within the same and between different sections of the genus. Certain combinations in crossing proved to be fairly compatible while the others showed partial or total incompatibility. The self-incompatibility, a special type of incompatibility, has not been considered in any of the quoted papers. KUGLER (1970) describes compatibility of *R. canina* as non-uniform, the species showing either autogamy or partial self-compatibility or even self-incompatibility.

In another paper (JIČÍNSKÁ 1976) I refer to the varying fertility in the experimental autogamization, i.e. pollination by pollen of the same flower, examined in some *Rosa* species. Observations of the resulting development or absence of fruits revealed a striking occurrence of partial or total sterility in autogamized species which were otherwise commonly fertile. This feature raised my interest in the type of pollination in roses. Therefore experiments were carried out to show whether the stigma of the flower is pollinated (1) by pollen from flowers of the same individual (geitonogamy), or (2) by pollen from flowers of other individuals of the same population (xenogamy), or (3) by a mixture of pollen from individuals of the same and or other species (free-pollination) which is typical for insect-pollinated plants.

The present paper describes diversity of pollination in seven *Rosa* species, widespread in Czechoslovakia and belonging to six sections of the genus.

MATERIAL AND METHODS

The experimental plants are grown in the rhodological collection of the Botanical Institute, Czechoslovak Academy of Sciences, Průhonice near Prague. Following species and hybrids were investigated:

Section	Species/Hybrid	Synonyms
Pimpinellifoliae DC.	*R. pimpinellifolia* L.	*R. spinosissima* L.
Gallicanae DC.	*R. gallica* L.	*R. austriaca* CRANTZ *R. pumila* JACQ.
Jundzilliae CRÉP.	*R. jundzillii* BESS.	*R. trachyphylla* RAU. *R. marginata* auct. non WALLR.
Caninae DC.	*R. canina* L.	
Cinnamomeae DC.	*R. pendulina* L.	*R. alpina* L.
Synstylae DC.	*R. arvensis* HUDS.	*R. repens* SCOP. *R. silvestris* HERRM.
Pimpinellifoliae *Cinnamomeae*	*R.* × *reversa* WALDS. et KIT.	*R. pimpinellifolia* × *R. pendulina*

All experimental shrubs have been identified by I. Klášterský, a leading expert in the taxonomy of roses.

Table 1 contains information on chromosome numbers, locality and designation of the material examined. The chromosome numbers have been determined by I. Klášterská, those marked by a cross by M. N. Končalová.

All types of pollination were evaluated according to the development of ripened hips; the percentage refers to the total number of flower buds treated.

Experiments with autogamy made it necessary for the buds to be treated before they actually opened. In most cases whole twigs with 20 to 30 buds were isolated in nylon bags. The bags were of rather large size in order to protect the flowers against lack of light, overheating or mechanical damage. Bags were kept on the twigs until the hips achieved full ripeness (JIČÍNSKÁ 1975).

Geitonogamy and xenogamy were applied in a similar way as crossing experiments. Castration had to be done before the anthers opened and shed pollen; in roses, this occurs mostly before the buds open. The petals were carefully cut off by scissors, and stamens were removed by tweezers. Undamaged and ripened stigma was subsequently smeared by a small brush covered with pollen grains loosened from a sufficient number of nearly opened flowers with immature stamens, collected 24 hours earlier, and stored in Petri-dishes. Cross-pollinated flowers were protected in the same way as those treated for autogamy.

RESULTS

Results of experiments with autogamy carried out in 1967—1973 are presented in Tables 2 and 3, the former providing the data for experimental plants investigated for several years, the latter summarizing all individual observations.

Mean percentage of the ripened hips varies considerably, from 98,5% for *R. jundzillii*, to 0% for *R. arvensis*. The comparison of figures in Tables 3 and 4 suggests a reasonable coincidence, with the exception of *R. pimpinellifolia*. Considering the general trend of these figures it may be assumed that autogamy in *R. canina* and *R. jundzillii* yielded good results (about 80 and 90%, respectively). Very good fertility in autogamy is also shown in *R. reversa* (about 55%). Figures for *R. pimpinellifolia* and *R. gallica* are rather low (about 15 and 11%, respectively). The fertility of *R. pimpinellifolia* varied, e.g., from 45.3% for individual R 317 in 1968, to 0% for the same individual in 1969. The figures for *R. gallica* may have been influenced by a lower number of isolated buds due to smaller growth of the individual which was transplanted into the rhodological collection only recently. Absence of ripened hips in *R. pendulina* and *R. arvensis* (1% and 0%, respectively) indicates almost complete self-incompatibility (self-sterility) of these two species.

In 1972 and 1973 incompatibility and self-incompatibility experiments were carried out in order to determine the type of pollination, i.e. autogamy,

Tab. 1. — List of plants used in the experiments

Species	Designation	Source	Chromosome number
R. pimpinellifolia	R 5	Transplanted from Slovakian Karst, E. Slovakia	2n = 28
	R 317	Seedling from a nursery, Ďáblice, C. Bohemia	2n = 28
R. gallica	R 663	Transplanted from the Krupina Hills, C. Slovakia	2n = 28 +
	R 822	Transplanted from Niffy Hill near Timoradza, E. Slovakia	2n = 28 +
	R 965	Transplanted from the vicinity of Srbsko, Bohemian Karst, C. Bohemia	2n = 28
R. jundzillii	R 392	Grown from seed collected near Kundrátov, near Cheb, W. Bohemia	2n = 42
	R 394	As above	2n = 42
	R 396	As above	2n = 42
R. canina	R 83	Grown from seed collected on Richterstein Hill, České středohoří Mts., NW. Bohemia	2n = 35
	R 376	Seedling from a nursery, Ďáblice, C. Bohemia	2n = 35
R. pendulina	R 511	Grown from seed collected on the top of Stengelberg Hill, Doupov Hills, NW. Bohemia	2n = 28
	R 524	Cutting from Stengelberg Hill, Doupov Hills, NW. Bohemia	2n = 28
	R 528	As above	2n = 28
	R 532	As above	2n = 28
R. arvensis	R 116	Transplanted from Zobor Hill near Nitra, S. Slovakia	2n = 14
	R 117	As above	2n = 28
R. reversa	R 258	Transplanted from the top of Tanád Hill near Banská Štiavnica, C. Slovakia	2n = 28
	R 259	As above	2n = 28

Tab. 3. — Results of autogamization in selected plants investigated for several years

Year	1967	1968	1969	1971	1972	1973	1967—73
Species	*R. pimpinellifolia* R 317						
Number of buds	—	53	31	51	51	100	274
Number of hips	—	24	0	14	14	23	67
% successful	—	45.3	0	27.5	27.5	23.0	24.8
Species	*R. gallica* R 965						
Number of buds	—	—	—	—	41	30	71
Number of hips	—	—	—	—	2	6	8
% successful	—	—	—	—	4.9	20.0	11.3
Species	*R. jundzillii* R 394						
Number of buds	—	39	40	50	45	33	207
Number of hips	—	39	39	49	45	32	204
% successful	—	100.0	97.5	98.0	100.0	97.0	98.5
Species	*R. canina* R 376						
Number of buds	—	—	33	38	53	102	226
Number of hips	—	—	27	27	36	93	183
% successful	—	—	81.8	71.1	67.9	91.1	81.0
Species	*R. pendulina* R 528						
Number of buds	26	38	15	45	52	100	276
Number of hips	0	1	1	1	0	0	3
% successful	0	2.6	6.7	2.2	0	0	1.1
Species	*R. arvensis* R 116						
Number of buds	32	40	20	19	40	37	158
Number of hips	0	0	0	0	0	0	0
% successful	0	0	0	0	0	0	0
Species	*R. reversa* R 259						
Number of buds	16	84	45	30	52	100	327
Number of hips	0	47	28	16	28	57	176
% successful	0	56.0	62.2	53.3	53.8	57.0	53.8

geitonogamy and xenogamy. In 1973 these species were found to be normally fertile by counting the ratio of ripened hips and flowers when free-pollinated. Results of the above experiments are presented in Table 4. It follows from Table 4 that the species studied may be divided into several groups according to the type of pollination.

The first group consists of *R. pendulina* (Sect. *Cinnamomeae*) and *R. arvensis* (Sect. *Synstylae*) with the highest percentage of ripened hips when free-pollinated (*R. pendulina* 42,9%, *R. arvensis* 18.2%). When other types of pollination had been applied the number of the ripened hips decreased to zero, indicating the prevalence of free-pollination and presence of inhibition preventing self-pollination.

The second group involving *R. gallica* (Sect. *Gallicanae*) and *R. pimpinellifolia* (Sect. *Pimpinellifoliae*) showed good fertility in all kinds of cross-pollination xenogamy: 85.0 and 67.3%, free-pollinated 60.7 and 64.8%, geitono-

Tab. 3. Results of autogamization (summarized)

Year	1967	1968	1969	1971	1972	1973	1967—73
Species	*R. pimpinellifolia*						
Number of individuals	1	2	1	7	1	1	
Number of buds	22	111	31	184	51	100	499
Number of hips	0	25	0	12	14	23	74
% successful	0	22.5	0	6.5	27.5	23.0	14.8
Species	*R. gallica*						
Number of individuals	—	—	—	—	1	1	
Number of buds	—	—	—	—	41	30	71
Number of hips	—	—	—	—	2	6	8
% successful	—	—	—	—	4.9	20.0	11.3
Species	*R. jundzillii*						
Number of individuals	1	1	2	1	1	1	
Number of buds	33	39	69	50	45	53	289
Number of hips	11	39	59	49	45	49	252
% successful	33.3	100.0	85.5	98.0	100.0	92.5	87.2
Species	*R. canina*						
Number of individuals	—	1	1	1	1	1	
Number of buds	—	56	33	38	53	102	282
Number of hips	—	51	27	27	36	93	234
% successful	—	91.1	81.8	71.1	67.9	91.1	82.3
Species	*R. pendulina*						
Number of individuals	11	11	7	6	1	1	
Number of buds	237	312	142	158	52	100	1001
Number of hips	1	6	3	10	0	0	20
% successful	0.4	1.9	2.1	6.3	0	0	2.0
Species	*R. arvensis*						
Number of individuals	3	3	1	4	1	1	
Number of buds	79	101	20	91	10	37	338
Number of hips	0	0	0	0	0	0	0
% successful	0	0	0	0	0	0	0
Species	*R. reversa*						
Number of individuals	2	3	2	2	1	1	
Number of buds	49	242	76	89	62	100	608
Number of hips	18	152	48	41	28	57	344
% successful	36.7	62.8	63.2	46.1	53.8	57.0	56.6

gamy 52.7 and 63.0%, respectively. The percentage of ripened hips produced after autogamy was rather low (11.3% and 24.5%, respectively). This fact may be attributed to the scant supply of pollen in flowers of these species, as genetic inhibitions causing partial self-sterility probably do not exist.

The hybrid *R. reversa* is the only member in the third group differing from the second one only by higher percentage of successful autogamy (55.9%) which may be due to the hybrid origin of the species. Other types of pollination yielded also high percentages of ripened hips: xenogamy 40.0%,

Tab. 4. — Results of autogamy (A), geitonogamy (G). xenogamy (X) and free-pollination (FP). Number of isolated buds = 100%

Species	Type of pollination	1972			1973			1972–73		
		Number of buds	hips	% succ.	Number of buds	hips	% succ.	Number of buds	hips	% succ.
R. pimpinellifolia	A R317	51	14	27.5	100	23	23.0	151	37	24.5
	G R317 × R317	39	26	66.7	53	32	60.4	92	58	63.0
	X R317 × R235	11	5	45.5	—	—	—	101	68	67.3
	X R317 × R5	36	23	63.9	54	40	74.8			
	FP R317	—	—	—	88	57	64.8	88	57	64.8
R. gallica	A R965	41	2	4.9	30	6	20.0	71	8	11.3
	G R965 × R965	43	21	48.8	31	18	58.1	74	39	52.7
	X R965 × R822	40	35	87.5	20	16	80.0	60	51	85.0
	FP R965	—	—	—	28	17	60.7	28	17	60.7
R. jundzillii	A R394	45	45	100.0	33	32	97.0	98	94	95.9
	A R392	—	—	—	20	17	85.0			
	G R394 × R394	41	40	97.6	25	19	76.0	66	59	89.4
	X R394 × R396	46	35	76.1	—	—	—	71	60	84.5
	X R394 × R392	—	—	—	25	25	100.0			
	FP R394	—	—	—	23	19	82.6	74	65	87.0
	FP R392	—	—	—	51	46	90.2			
R. canina	A R376	53	36	67.9	102	93	91.1	155	129	83.2
	G R376 × R376	47	19	40.4	57	33	57.9	104	52	50.0
	X R376 × R83	48	2	4.2	50	35	70.0	98	37	37.8
	FP R376	—	—	—	97	79	81.4	97	79	81.4
R. pendulina	A R528	52	0	0	100	0	0	152	0	0
	G R528 × R528	43	0	0	100	2	2.0	143	2	1.4
	X R528 × R524	24	1	4.2	—	—	—			
	X R528 × R532	25	0	0	—	—	—	149	12	8.1
	X R528 × R511	—	—	—	100	11	11.0			
	FP R528	—	—	—	98	42	42.9	98	42	42.9
R. arvensis	A R116	59	0	0	37	0	0	96	0	0
	G R116 × R116	50	1	2.0	33	1	3.0	83	2	2.4
	X R116 × R117	52	2	3.9	31	1	3.2	83	3	3.6
	FP R116	—	—	—	66	12	18.2	66	12	18.2
R. reversa	A R259	52	28	53.8	100	57	57.0	152	85	55.9
	G R259 × R259	51	0	0	100	71	71.0	151	71	47.0
	X R259 × R258	40	5	12.5	100	51	51.0	140	56	40.0
	FP R259	—	—	—	100	80	80.0	100	80	80.0

geitonogamy 47.0% (0 in 1972, though), and free-pollination 80.0%. The species probably exihibits no resistance to autogamy.

The fourth group consists of *R. canina* (Sect. *Caninae*) and *R. jundzillii* (Sect. *Jundzilliae*). These species showed best results when autogamized: 83.2% and 95.2%, respectively. Results of free-pollination (81.4% and 87.8%), geitonogamy (50.0% and 89.4) and xenogamy (33.8% and 84.5%) may indicate prevalent autogamy in *R. canina* even when free-pollinated, whilst for *R. jundzillii* all types of pollination seem to be equivalent. The

possibility of pollination of both species by pollen from another species was tested in 1968 by growing F_1 generation from the hips obtained from free-pollination. The results of the experiments showed that F_1 generation bore features of the maternal plants, and that no hybrid occurred; it may be deduced therefore that no pollen from other species was involved. Even though apomixis is common in many rosaceous genera, such as *Rubus*, *Sorbus*, *Potentilla* (see RUTISHAUSER 1967, BRIGGS et WALTERS 1969), GUSTAFSSON (1931, 1942, 1944) and FAGERLIND (1940, 1942) found no evidence of it in the genus *Rosa*. They compared genetical data from different crossings with cytological results but only pure hybrids appeared. This was verified not only by the negative results of their castration experiments but also by those of the present author (carried out in 1967—1973), who obtained negative results in *Caninae* section, too. Thus autogamy in *Rosa* has been experimentally proved. The presence of autogamy as the main type of pollination seems to confirm the putative hybrid origin of *R. canina* and *R. jundzillii*. Their behaviour during meiosis is also different (balanced heterogamy, see TÄCKHOLM 1920, 1922).

CONCLUSIONS

Experimental pollination of seven *Rosa* species demonstrated that some of them are partially or totally self-sterile, i.e., capable of self-pollination. *R. pendulina* (Sect. *Cinnamomeae*) and *R. arvensis* (Sect. *Synstylae*) are self-sterile, but fairly fertile when free-pollinated. Even xenogamy and geitonogamy may give rise to a limited number of ripened hips. *R. gallica* (Sect. *Gallicanae*), *R. pimpinellifolia* (Sect. *Pimpinellifoliae*) and *R. reversa* develop hips from any type of pollination, the two former species preferring xenogamy and geitonogamy, the latter one preferring autogamy. *R. canina* (Sect. *Caninae*) and *R. jundzillii* (Sect. *Jundzilliae*) are mainly self-pollinated; autogamy prevails even in free-pollination as pollen of other species is not accepted in rivalry with their own pollen.

SOUHRN

Experimentálně byly potvrzeny rozdíly ve způsobu opylení u sedmi druhů ze šesti sekcí rodu *Rosa*. Zatímco *R. pendulina* (sekce *Cinnamomeae*) a *R. arvensis* (sekce *Synstylae*) jsou cizosprašné, *R. gallica* (sekce *Gallicanae*), *R. pimpinellifolia* (sekce *Pimpinellifoliae*), *R. reversa* mohou být samosprašné i cizosprašné a *R. canina* (sekce *Caninae*) s *R. jundzillii* (sekce *Jundzilliae*) jsou samosprašné i když opylení cizím pylem je při křížení možné. Autogamie však pravděpodobně převažuje i při volném sprášení, kdy blizna dává při opylení přednost vlastnímu pylu.

REFERENCES

BRIGGS D. et S. M. WALTERS (1969): Plant variation and evolution. — London.

ERLANSON E. W. (1929): Cytological conditions and evidences for hybridity in North American Roses. — Bot. Gaz., London, 57 : 443—506.

— (1934): Experimental data for a revision of the North American wild Roses. — Bot. Gaz., London, 96 : 197—259.

FAGERLIND F. (1940): Sind die Canina-Rosen agamospermische Bastarde? — Svensk Bot. Tidskr., Stockholm, 34 : 334—353.

— (1942): Kommt Agamospermie bei den Canina Rosen vor? — Hereditas, Lund, 38 : 224—227.

— (1944a): Kompatibilität und Inkompatibilität in der Gattung Rosa. — Act. Hort. Berg., Stockholm, 13 : 247—302.

— (1944b): Die Zertationverhältnisse bei Rosa. — Svensk Bot. Tidskr., Stockholm, 38 : 226—228.

— (1946): Pollenkonkurrenz und Bastardierungsschwierigkeiten in der Gattung Rosa. — Svensk Bot. Tidskr., Stockholm, 40 : 284—292.

— (1948): Compatibility, eu- and pseudo-incompatibility in the genus Rosa. — Acta Hort. Berg., Stockholm, 15 : 1—36.
— (1951): Influence of the pollen giver on the production of hips, achenes and seeds in the Canina Roses. — Acta Hort. Berg., Stockholm, 16 : 121—168.
Gustafsson A. (1942): Cross-experiments in the genus Rosa. — Hereditas, Lund, 28 : 235—238.
Jičínská D. (1976): Autogamy in various species of the genus Rosa. — Preslia, Praha (in press.)
Kugler H. (1970): Blütenökologie. Ed. 2. — Stuttgart.
Rathlef H. (1937): Die Rosen als Objekt der Züchtung. — Arb. Zentralstelle f. Rosenforschung, Sangerhausen, I. Jena.
Ratsek J. C., S. H. Yarnell et W. S. Flory (1939): Crossing relations of some diploid species of roses. — Proc. Amer. Soc. Hort. Sci., Geneva et New York, 37 : 983—992.
— (1941): Crossing relations of some diploid and polyploid species of roses. — Proc. Amer. Soc. Hort. Sci., Geneva et New York, 38 : 637—654.
Rutishauser A. (1967): Fortpflanzungsmodus und Meiose apomiktischer Blütenplanzen. — Wien et New York.
Täckholm G. (1920): On the cytology of the genus Rosa. — Svensk Bot. Tidskr., Stockholm, 14 : 300—311.
— (1922): Zytologische Studien über die Gattung Rosa. — Acta. Hort. Berg., Stockholm, 7 : 97—381.

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Původem obuvnický dělník, který se vypracoval díky nevšední píli a houževnatosti v předního floristu a uznávaného pracovníka v lichenologii. Důkladnému průzkumu podrobil především Ždárské vrchy, později i nížinnou Hanou a jiné kraje Moravy. Od r. 1908 začal pracovat na popud prof. Podpěry jako kustod olomouckého muzea. Pečlivý preparátor a obětavý ochránce muzejních sbírek zaplatil nakonec daň intenzivní práci do nočních hodin — oslepl na jedno oko. Jeho nejvýznamnější prací je monografické zpracování moravských druhů rodu *Cladonia*; kromě toho publikoval i přehled moravských druhů rodu *Peltigera*, příspěvky k ostatním moravským lišejníkům, práce o vegetačních poměrech Ždárska aj. Připravovaný soupis všech druhů československých lišejníků zůstal rozpracován v rukopise.