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BIOMETRIC ANALYSIS OF INTERSPECIFIC HYBRIDS BETWEEN *ROSA CANINA* L. AND *ROSA RUBIGINOSA* L. (SECTION *CANINAE* DC. EM. CHRIST.)

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Abstract. The article presents the biometric analysis of selected morphological features of interspecies hybrid *Rosa canina* L. × *R. rubiginosa* L. This hybrid was the result of spontaneous hybridization between the two species falling into section *Caninae* DC. em. Christ. So far, it has not been studied in terms of morphological characteristics, in particular with respect to the parental forms.

Key words: *Rosa, R. canina, R. rubiginosa, R. canina* × *R. rubiginosa*, *Caninae*, Rosaceae, morphology, spontaneous hybridization

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Introduction

Roses have a high ability to form interspecific hybrids, both within one section and between separate sections. It is relatively easy to distinguish intersectional hybrids. Separation of modern hybrids between species of one section requires great caution, especially in the case of the section *Caninae* DC. em. Christ., which is the most polymorphic group of the *Rosa* L. It is particularly difficult because their morphological characteristics are the main criterion for distinguishing, wherein none of the morphological characteristics analyzed separately have not a significant diagnostic value in the case of this section (Zieliński 1985).

Rosa canina L. is the most common and most variable species in genus *Rosa*. It creates transitional forms of species, both within the section of *Caninae*, as well as with species from other sections. There are known interspecific hybrids of *R. canina* with the species from the section *Caninae* – e.g. *R. jundzillii* Besser, *R. tomentosa* Sm., *R. dumalis* Bechst., *R. sherardii* Davies; from the section *Cinnamomeae* DC. – e.g. *R. pendulina* L.; and from the section *Rosa* – e.g. *R. gallica* L. (Zieliński 1987).

Gustafsson (1944) mentioned in his work of yet another hybrid – between *R. canina* and *R. rubiginosa* L. The possibility to form this type of hybrid has been also known from later works, regarding genetic testing of species from the entire the section *Caninae* (*inter alia* Blackhurst 1947; De Cock 2008; Ritz & Wissemann 2011). However, in the literature relating to this form of hybrid no analysis of morphological traits were found. Therefore, this study is an attempt to establish the interrelationship between *R. canina, R. rubiginosa* and their hybrid, based on morphological characteristics, diagnostic for the *Caninae* section.

Material and methods

The specimens used for morphometric studies of *R. canina* × *R. rubiginosa* hybrid and its parental forms were collected in Ukraine (Podolia region) in 2008-2009 on two localities:

Tab. 1. Overview of characters used to describe rose species in this study (according to MIJNSBRUGGE & BEECKMAN (2012), modified); **Abbr.** – abbreviations.

Organ	Character	Abbr.	Description
Leaf	Lamina length	LL	Length of leaflet lamina
	Lamina base length	LbL	Length of basal part of leaflet lamina till largest width
	Lamina width	LW	Largest width of leaflet lamina
	Rachis length	RL	Length of rachis
	Leaflet margin serration	LmSe	Serration of the leaflet margin scored from 1 (single toothed) to 3 (multiple toothed)
	Leaflet margin glands	LmG	Glands on the leaflet margin; from 1 (no glands) to 5 (densely glandular)
	Leaflet glands	LG	Glands on the underside of leaflet (outside the midrib)
	Rachis pubescence	RPu	Pubescence on the rachis; from 1 (no pubescence) to 5 (dense hairiness)
	Rachis glands	RG	Glands on rachis; from 1 (no glands) to 5 (densely glandular)
	Lamina shape	LS	LL/LW
	Lamina base shape	LbS	LbL/LW
	Lamina length ratio	LLR	LL/RL × 100
	Lamina base length ratio	LbLR	LbL/RL × 100
	Lamina width ratio	LWR	LW/RL × 100
Fruit	Hip length	HL	Length of hip
	Hip base length	HbL	Basal length of hip till largest width
	Hip width	HW	Largest width of hip
	Pedicel length	PL	Length of hip pedicel
	Orificium diameter	OD	Diameter of orifice
	Discus diameter	DD	Diameter of disc
	Discus height	DH	Height of disc
	Pedicel glands	PG	Glands on pedicel; from 1 (no glands) to 5 (densely glandular)
	Fruit length	FL	HL + PL
	Hip shape	HS	HL/HW
	Hip base shape	HbS	HbL/HW
	Hip length ratio	HLR	HL/FL × 100
	Orificium ratio	OR	OD/DD × 100

Medobory Nature Reserve and to the southeast of Sataniv (leg. A. Sołtys-Lelek, Herbarium of the Ojców National Park, Ojców, Poland) and in 2015 in Pila – in North-Western Poland (leg. W. Gruszka, Herbarium of the University School of Physical Education, Gorzow Wielkopolski, Poland).

Several characters were measured, counted, or observed on the leaves and hips (Tab. 1; Fig. 1). Selection of characters was based on previous studies (DE COCK *et al.* 2007, 2008; MIJNSBRUGGE & BEECKMAN 2012). The measurements were made in thirty random samples. For all measured characteristics, arithmetic means and standard deviations were calculated. The differences between the mean values for the analyzed parental forms and their hybrid were tested using non-parametric Kruskal-Wallis test at $P \leq 0.05$. The statistical analyses were done by software Statistica 10.0 for Windows.

The systematic approach and the nomenclature are basing on the work of POPEK (1996).

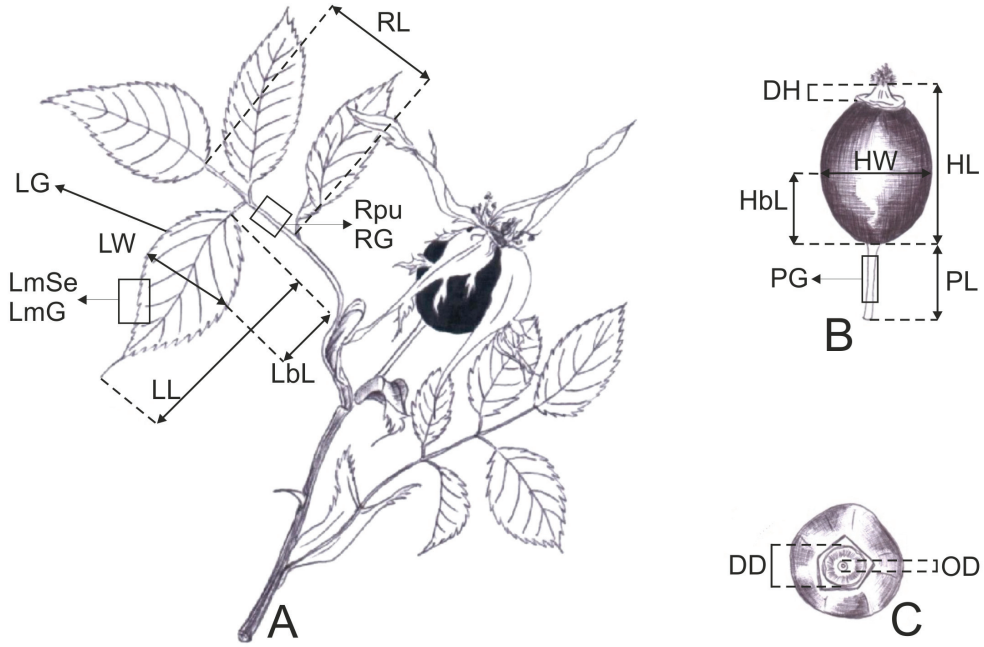

Fig. 1. Morphological characteristics of leaf (**A**) and fruit (**B, C**), that were measured or observed; **C** – upper part of hip; abbreviations are listed in Tab. 1.

Results

A hybrid form of *R. canina* × *R. rubiginosa* is characterized by a combination of morphological features of both parental species (Tab. 2). The size and shape of leaves (LL, LbL, LS, LbS) and the glanding of the pedicel (PG) it refers to *R. canina*. For example, the length of the leaf of the hybrid (LL) is within the range from 15.40 mm to 31.60 mm – 23.60 mm on average, and the lamina base length (LbL) from 6.40 mm to 18.30 mm – 11.00 mm on average. For *R. canina* LL values are within the range of 18.50 mm to 32.00 mm – 24.62 mm on average, and LbL from 7.20 mm to 14.60 mm – 11.05 mm on average (Tab. 3).

In the case of *R. rubiginosa*, the hybrid is similar in such features as: length of the rachis (RL), serration of the leaflet margin (LmSe), the diameter of the orifice (OD), hip shape (HS) and the orificium ratio (OR). For example, the length of the rachis (RL) for the hybrid is between 10.40 mm and 39.55 mm – 19.42 mm on average, and for *R. rubiginosa* from 9.40 to 32.00 mm – 21.13 mm on average. The diameter of the orifice (OD) for the hybrid is within the range of 1.35 mm to 2.90 mm – average of 1.93 and for *R. rubiginosa* from 1.25 mm to 2.55 mm – 1.86 mm on average (Tab. 3).

On the other hand, in relation to both parental species, *R. canina* × *R. rubiginosa* hybrid shows statistically significant differences with respect to such morphological features as: glands of the leaf margin (LmG), glands on the underside of leaflet (LuG) glands on rachis (RG) and height of a disc (HD). In these cases, the hybrid has intermediate characteristics between parental forms, which are however statistically different from them. For example, the height of disc (HD) for the hybrid is within the range of 0.50 mm to 1.70 mm – 0.86 mm on average, for *R. rubiginosa* it ranges from 0.00 mm to 0.50 mm – average of 0.03 and for *R. canina* from 1.50 to 3.30 – an average of 2.16 mm. In the hybrid, this parameter reaches a significantly higher value in relation to *R. rubiginosa* and in relation to *R. canina* the value is significantly lower (Tab. 3).

There were no statistically significant differences between these three taxa, with

Tab. 2. Characteristics of study taxa based on diagnostic features in the sect. *Caninae*.

Characteristics	Parental form (1)	Hybrid	Parental form (2)
	R. rubiginosa	*R. canina* × *R. rubiginosa*	*R. canina*
Shrub	0,5-2(-3) m	to 2 (-3) m *ca.*	to 3 m *ca.*
Type of prickles	heteracantha	homoioacantha, ± heteracantha	homoioacantha
Prickles	hooked, ± recurvate, falcate usually mixed with aciculae and glandular setae	hooked, curved, occasionally mixed with aciculi and glandular setae on flowering short shoot	
Petiole	densely glandular	without glands or ± glandular	
Leaflet base	usually rounded	wedge-shaped or rounded	
Leaflet apex	acute to obtuse		acute
Leaflet shape	mostly suborbiculate or broadly oval or broadly elliptical	elliptical, ovoid, broadly ovoid, roundish	elliptical, ovoid, broadly ovoid, roundish
Leaflet margin serration	multiple toothed		singe-, double- to multiple toothed
Leaflet margin glands	densely stipitate-glandular	± densely stipitate-glandular	from no glandular to ± densely stipitate-glandular
Rachis glands	densely stipitate-glandular	± densely stipitate-glandular	from no glandular to ± glandular
Under side of leaflet	densely glandular	some leaves no glandular, some ± glandular	without glands, exceptionally ± glandular
Pedicel	stipitate-glandular, exceptionally glandless	without glands or occasionally ± stipitate-glandular	without glands or occasionally ± stipitate-glandular
Receptacle	stipitate-glandular or without glands	without glands	without glands or exceptionally ± glandular
Discus	plain	± plain or conically convex	conically convex
Orifice	broadly, > 1 mm diameter		narrow, to 1 mm diameter
Rose hip	egg shaped, subglobose, broadly ovoid	egg shaped, rarely round, ovate	
Sepals	usually erected	irregularly spreaded, partly erected	reflexed

respect to such morphological features as: the lamina width (LW), the length of the hip (HL), basal length of the hip (HbL), hip width (HW), length of pedicel (PL), diameter of disc (DD), fruit length (FL) (Tab. 3).

Discussion

Until now, information on spontaneous *R. canina* and *R. rubiginosa* hybrids have not appeared in the literature too often, even though the possibility of forming of hybrid forms between these species, carried out by artificial hybridization, was mentioned many times (e.g. GUSTAFSSON 1944; BLACKHURST 1947; WISSEMANN 2006). Perhaps this is due to the fact that the frequency of spontaneous hybridization between the two species is rather low (RITZ & WISSEMANN 2011), and some authors even looked for the existence of a genetic barrier (ZIELIŃSKI 1985). Certainly the geographical barrier between these species does

Tab. 3. Comparison of morphometric characteristics between parental forms and their hybrid (*Rosa canina* × *R. rubiginosa*); the average (x) of 30 replicates ± SD; **a, b, c** (in row) – statistical significance with Kruskal-Wallis test, P≤0.05; abbreviations are listed in Tab. 1.

Characteristics	*R. canina* [mm]		*R. rubiginosa* [mm]		*R. canina* × *R. rubiginosa* [mm]	
	x	± SD	x	± SD	x	± SD
LL	24.62[a]	3.31	20.23[b]	4.07	23.60[a]	4.80
LbL	11.05[a]	1.85	9.51[b]	1.99	11.00[a]	2.65
LW	14.79[a]	2.36	14.96[a]	3.46	14.69[a]	2.61
RL	22.65[a]	4.99	21.13[ab]	6.54	19.42[b]	5.18
LmSe (1-3)	2.17[b]	0.38	3.00[a]	0.00	3.00[a]	0.00
LmG (1-5)	2.07[c]	0.45	4.93[a]	0.25	3.60[b]	0.56
LG (1-5)	1.00[c]	0.00	4.97[a]	0.18	2.00[b]	0.79
Rpu (1-5)	1.10[b]	0.31	3.97[a]	0.81	1.23[b]	0.43
RG (1-5)	1.33[c]	0.48	4.77[a]	0.50	3.47[b]	1.14
LS (LL/LW)	1.68[a]	0.16	1.37[b]	0.16	1.61[a]	0.18
LbS (LbL/LW)	0.75[a]	0.10	0.64[b]	0.07	0.74[a]	0.10
LLR (LL/RL × 100)	112.73[ab]	22.84	102.09[b]	26.79	128.24[a]	30.28
LbLR (LbL/RL × 100)	50.25[ab]	10.62	47.83[b]	12.15	58.60[a]	15.78
LWR (LW/RL × 100)	67.42[b]	13.84	74.83[ab]	19.27	78.02[a]	16.36
HL	14.94[a]	3.04	13.78[a]	2.82	13.82[a]	2.50
HbL	7.25[a]	2.24	7.02[a]	1.77	7.10[a]	1.68
HW	9.65[a]	1.38	10.47[a]	1.69	10.35[a]	1.98
PL	8.83[a]	3.09	9.89[a]	2.30	8.49[a]	2.56
OD	0.96[c]	0.11	1.86[ab]	0.32	1.93[a]	0.46
DD	4.41[a]	0.45	4.30[a]	0.54	4.39[a]	0.48
DH	2.16[a]	0.42	0.03[c]	0.13	0.86[b]	0.48
PG (1-5. 1=0)	1.00[c]	0.00	4.70[a]	0.47	1.93[bc]	1.14
FL (HL + PL)	23.76[a]	3.90	23.67[a]	3.96	22.31[a]	3.81
HS (HL/HW)	1.56[a]	0.29	1.32[b]	0.19	1.35[b]	0.22
HbS (HbL/HW)	0.75[a]	0.22	0.67[a]	0.11	0.69[a]	0.13
HRL (HL/FL × 100)	63.26[a]	10.15	58.19[a]	6.50	62.30[a]	7.66
OR (OD/DD × 100)	22.17[c]	3.86	43.79[ab]	8.53	43.84[a]	9.76

not exist. Both species have a broad range of occurrence, wherein the acreage of *R. rubiginosa* is in a range within *R. canina* (Popek 2007).

Isolation of modern hybrids within the *Caninae* section is extremely complex, both for the crossing of closely related species, as well as for remote taxa of this section. This concerns especially hybrids derived from *R. canina*, characterized by a morphological similarity with other species of this section (Zieliński 1985). In the early nineteenth century, a stabilized hybrid between *R. canina* and *R. rubiginosa* was described in the rank of species under the name of *R. obtusifolia* Desv. Currently, it falls within the form of *R. canina* var. *obtusifolia* Desv. (Popek 1996). This form is characterized by leaves which are glandular underneath ± and pinnate leaves folded glandularly, which refers to the characteristics of *R. rubiginosa*. Kerényi-Nagy (2012) also lists other hybrids between

R. canina and *R. rubiginosa* in the rank of species. They are: *R. squarrosa* (Rau) Boreau, *R. blondeana* Ripart and *R. andegavensis* Bastard – according to other taxonomic approaches also classified to glandular forms of *R. canina* (Popek 1996).

The analyzed hybrid displays intermediate characteristics between *R. canina* and *R. rubiginosa*, but also specimens closer to one of parental forms or almost indistinguishable from them occur as well (Tabs 2 & 3). It depends on which of the species produced seeds and which only gave pollen. The genetic material given by the maternal specimen makes up to 80% of genotype (Wissemann 2006). The similarity scale of the test hybrid to the parental species primarily concerns with the shape and size of the leaf, which may be more elliptical or oval, as in *R. canina* or more rounded as in *R. rubiginosa*. Also, stalks can be glandular, as in *R. rubiginosa* or without glands as usually is with *R. canina*.

The essential features that distinguish *R. canina* × *R. rubiginosa* hybrid are: glandular in various degree underside of the lamina (whole lamina or only part of it) – usually found only in the case of some leaves, which margins are serrated, quite rich glandular of the axis of leaf and the height of the disk, which is usually ± conical (Fig. 2). However, on one of the flower shoots flowers had clearly conical disk (approx. 2.00 mm in height) and the some of the disk near flat (approx. 0.50 mm in height). The shape of the disk and the size of orificium is one of the most important diagnostic features for different kinds of roses.

Species of *Caninae* section are of hybrid origin, no doubt, and were formed in the late Tertiary. However, spontaneous interspecific hybrids within this section occur also today, although hybridization of extant species of this section is limited to a large extent by the occurrence of autogamous (Zieliński 1985; Popek 2007).

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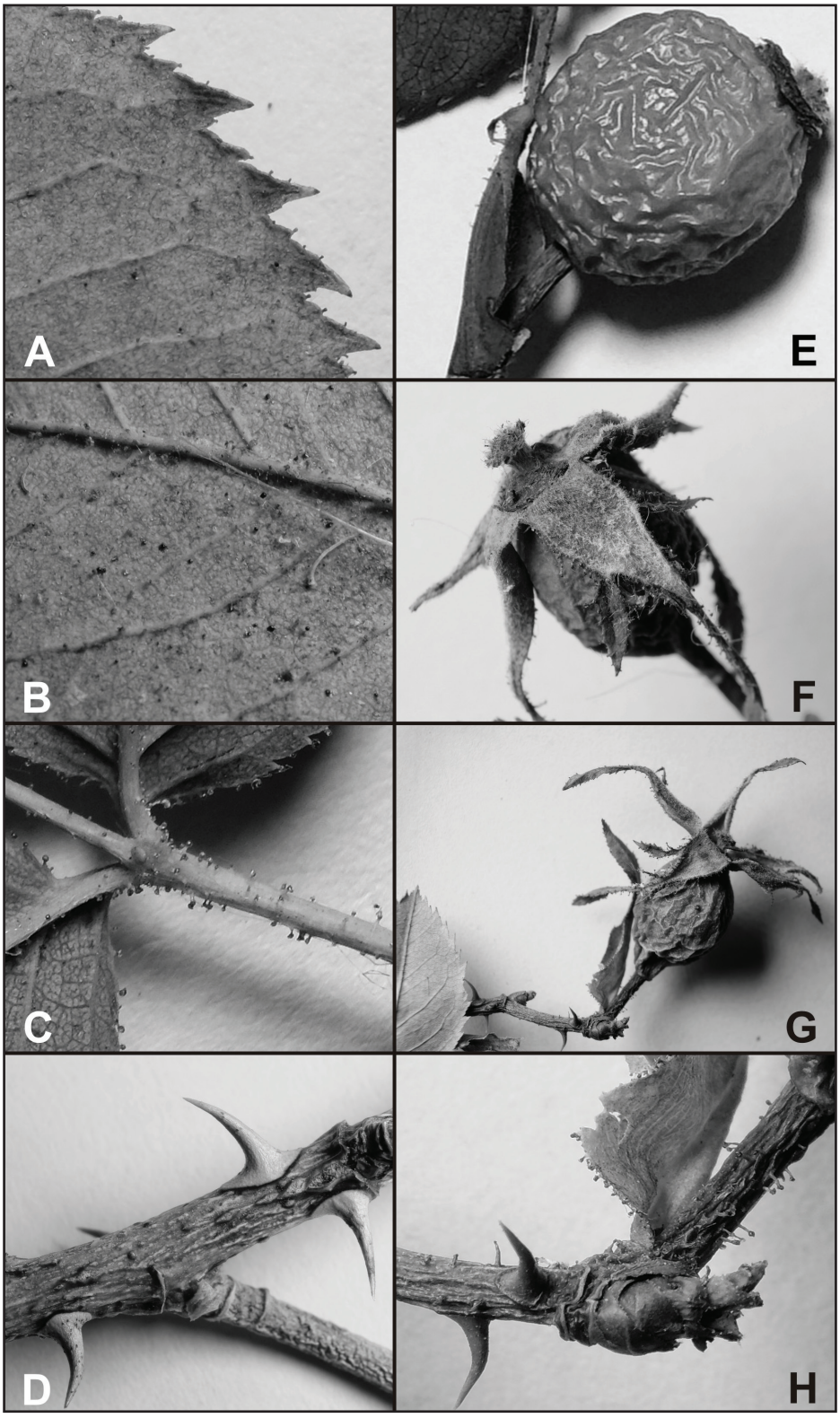
Fig. 2. The characteristics of the hybrid *Rosa canina* × *R. rubiginosa*. **A** – serration of the leaflet margin; **B** – glands on the underside of leaflet; **C** – part of axis of leaf; **D** – part of flowering short shoot; **E** – fruit with no glandular pedicel; **F** – disc shape and sepals; **G** – sepals; **H** – glandular pedicel. Specimen from Herbarium of the University School of Physical Education, Gorzów Wielkopolski, Poland, Piła, leg. W. Gruszka, 2015. ▸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