

BIOLOGY OF FLOWERING AND NECTAR PRODUCTION IN THE FLOWERS OF THE BEAUTY BUSH (*Kolkwitzia amabilis* Graebn.)

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Abstract

Nectar production and the morphology of the nectary and pollen grains of *Kolkwitzia amabilis* Graebn. were studied during the period 2008–2009 and in 2011. The blooming of beauty bush flowers started in the third decade of May and ended in the middle of June; flowering lasted 22–23 days. The flower life span was 4–5 days. Nectar production began at the bud break stage. The tube of the corolla in beauty bush flowers forms a spur inside which the nectary is located. The secretory surface of the nectary consists of two layers of glandular epidermal outgrowths: unicellular trichomes, with their length ranging 54.6 μm – 70.2 μm , and papillae with a length of 13.0 μm – 20.6 μm . The mean weight of nectar per 10 flowers, determined for the three years of the study, was 8.6 mg, with a sugar concentration of 50.8%. The weight of nectar sugar was on average 4.4 mg. In terms of the size, beauty bush pollen grains are classified as medium-sized. These are tricolporate grains.

Key words: nectar, morphology, nectar production, pollen morphology, *Kolkwitzia amabilis* Graebn.

INTRODUCTION

The beauty bush (*Kolkwitzia amabilis* Graebn.) is the only representative of the genus *Kolkwitzia* which is little known in Poland; this genus belongs to the family Caprifoliaceae which is represented in great numbers in moderate climate zone. The mountains of central China are the natural habitat for this plant. In Poland this species is planted mainly in botanical gardens. The beauty bush is an ornamental shrub that grows to a height of 2.5 m. Entire or slightly toothed leaves, reaching a length of up to 7 cm and hairy on both sides, grow on arching branches. This plant blooms very abundantly at the end of May or at the beginning of June (Seneta, 1983). The flowers, giving off a delicate scent, are five-sepalled and are borne in clusters of several or dozen

or so. They produce inflorescences 5–7 cm long. The calyx is fused into a long narrow tube with 5 sepals at the tip. The pink-coloured campanulate corolla has a yellow to orange spot in the throat. There are four stamens, didynamous, and one pistil.

Taking into account the structure of the ovary and the nature of the pericarp, Maciejewska (1999) says that the nut is the biological type of the beauty bush fruit. Beauty bush flowers are readily visited by Apidae (Kotowski, 2006). Górska-Zajackowska (1983) claims that this a species with seasonal growth well synchronised with the phenological seasons in Poland. She recommends the beauty bush for gardens and parks, both in the form of larger groups and solitary individuals.

The aim of the present study was to investigate nectar production as well as the morphology of the nectary and pollen grains of the beauty bush. Its decorative and functional values as well as low cultivation requirements might encourage widespread planting of the beauty bush in municipal parks and gardens, green spaces in housing estates, and home gardens.

MATERIALS AND METHODS

The study was carried out during the period 2008–2009 and in 2011. The beauty bush (*Kolkwitzia amabilis* Graebn.) shrubs grew in the Botanical Garden of the Maria Curie-Skłodowska University in Lublin, in a sunny location on loess-derived loamy soil.

Time and duration of flowering as well as the life span of a single flower were determined.

The nectar production rate was measured using the pipette method (Jabłoński and Szklanowska, 1979). In each year of the study, nectar was collected 4 times on different dates. A single sample consisted of 10 to 60 flowers. Nectar was collected during

the entire flower lifetime. The percentage nectar sugar content was determined using a refractometer. The average weight of nectar sugar produced by 10 flowers was calculated.

In order to determine the location and type of the floral nectaries, the collected flowers were fixed in 70% ethanol and subsequently semi-permanent slides were made.

Glycerol-gelatin-coated microscope slides were prepared for pollen measurements. The length of the equatorial (E) and polar (P) axis as well as exine thickness were measured under a light microscope. The P/E ratio was calculated. Using the semi-permanent slides, images of the nectaries and pollen grains of beauty bush were taken under a light microscope.

RESULTS

Irrespective of the year, flowering of *Kolkwitzia amabilis* flowers started in the third decade of May and ended after about 3 weeks (2008: 29 May – 19 June; 2009: 25 May – 16 June). In both years, the duration of flowering was very similar (22, 23 days).

The flower life span was 4–5 days. A network of orange striae was noticeable in the throat of the corolla; it formed a spot which was visible from a distance (Fig. 1A) and which became pale in an aging flower. The corollas frequently fell off before the desiccation of petals. The beauty bush flowers were visited in large numbers by honey bees and bumblebees (Fig. 1B–D).



Fig. 1. A–D. Flowers of *Kolkwitzia amabilis*. A. Orange striae (arrow) are visible by the inlet to the corolla throat. B,C. Insects visiting the beauty bush flowers. D. The location of the nectary is marked with an arrow in the figure.

Nectar was observed in the corolla tube of the flowers already at bud break. At the base of the corolla tube, there is a one-sided projection in the shape of

a rounded spur (Fig. 1D). The nectary occupies the inside part of this spur (Fig. 2A). The secretory surface of the nectary consists of two layers of glandular

epidermal outgrowths of varying height. The upper layer is composed of unicellular trichomes, while the lower layer is made up of papillae that are smaller than the trichomes. The glandular trichomes are oval- or club-shaped, and they are often arched. Their length ranges 54.6–70.2 μm . The length of the epidermal outgrowths in the form of papillae is 13.0–20.6 μm (Fig. 2B–F).

The mean weight of nectar per 10 flowers, determined for the three years of the study, was 8.6 mg,

with a sugar concentration of 50.8%. The highest amount of nectar was recorded in the first year of the study – 2008 (9.5 mg), while the lowest one in 2011 (7.4 mg). The nectar sugar concentration in 2009 was lower than in the years 2008 and 2011 by 26% and 39%, respectively. The lower percentage sugar content recorded in 2009 could have resulted from higher rainfall in June of that year. The mean weight of nectar sugar during the study years was 4.4 mg (Table 1).

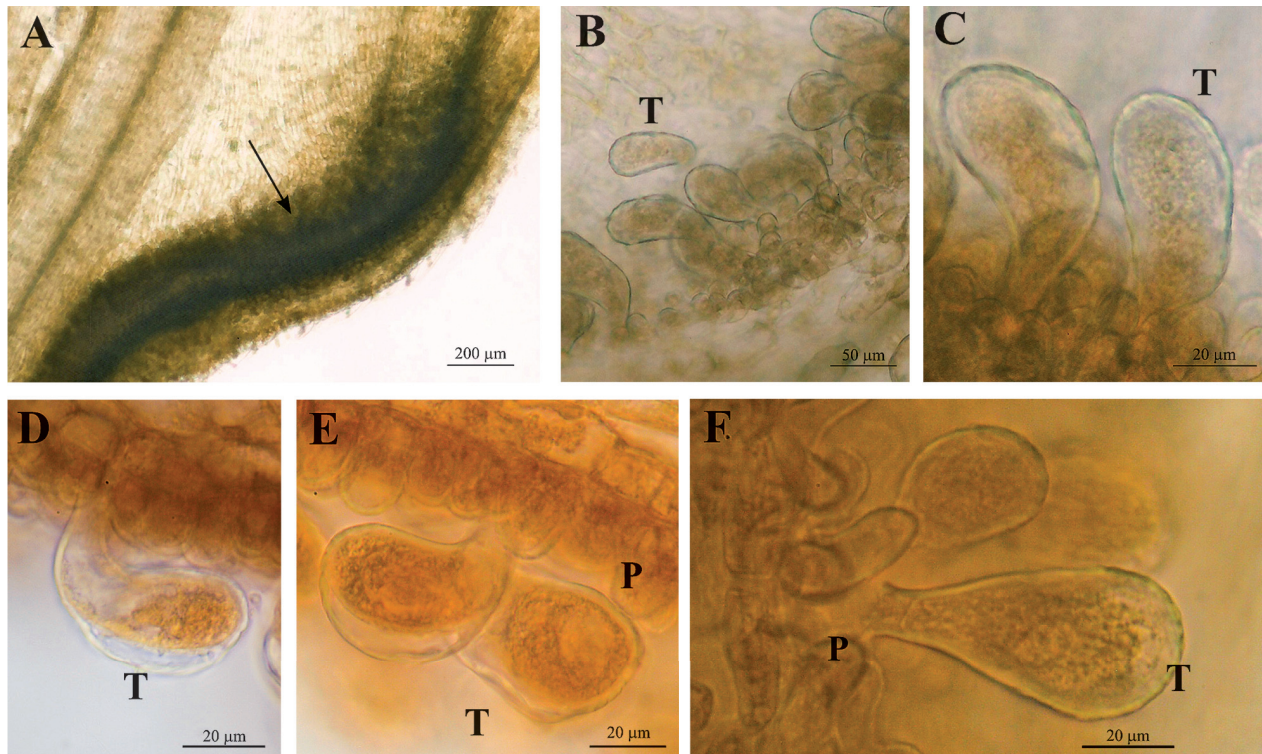


Fig 2. A–F. Portions of the nectary of beauty bush. A. Location of the nectary in the spur of the flower (arrow). B–F. Secretory trichomes (T) and papillae (P) of the nectary.

Table 1
Nectar production per 10 flowers of *Kolkwitzia amabilis* Graebn.

Year	Day and month	Nectar amount [mg]		Sugars content in nectar [%]		Weight of sugars in nectar [mg]	
		Range min.–max.	Mean SD	Range min.–max.	Mean SD	Range min.–max.	Mean SD
2008	16.06	6.0-10.0	8.4 ± 1.93	51.0-51.0	51.0 ± 0.04	3.06-5.1	4.3 ± 0.83
	23.06	10.0-11.0	10.5 ± 0.41	40.0-63.0	51.0 ± 8.21	4.0-6.93	5.4 ± 0.78
	Mean		9.5 ± 1.7		51.2 ± 5.38		4.8 ± 1.0
2009	9.06	5.7-17.3	10.3 ± 4.97	42.5-50.0	46.7 ± 3.84	2.41-8.63	4.8 ± 2.67
	14.06	6.3-8.7	7.7 ± 0.27	29.5-30.5	30.0 ± 0.4	1.87-2.64	2.5 ± 0.11
	Mean		9.0 ± 3.42		38.3 ± 9.3		3.6 ± 2.16
2011	3.06	5.2-8.3	6.9 ± 1.33	56.5-60.0	58.2 ± 1.43	2.95-5.0	4.0 ± 0.75
	14.06	8.0-8.1	8.0 ± 0.04	65.0-70.0	67.5 ± 2.04	5.2-5.67	5.4 ± 0.19
	Mean		7.4 ± 1.1		62.8 ± 5.21		4.7 ± 0.91
Mean			8.6 ± 2.37		50.8 ± 12.16		4.4 ± 1.49

There are four didynamous stamens in the beauty bush flower. Pollen shed begins after the corolla lobes become fully open. Bees sprinkled with pollen form light-coloured pollen loads. In beauty bush pollen grains, the average length of the equatorial axis is 49.7 μm , while that of the polar axis is 39.5 μm . In terms of their

dimension, they are classified as medium-size. Due to the equatorial to polar axis ratio (P/E ratio), which is 0.8, these pollen grains are considered to be suboblate. These are tricolporate grains and the average length of the colpi is 21.7 μm , while their average width is 10.5 μm . The exine thickness is 1.9 μm (Fig. 3A–C, Table 2).

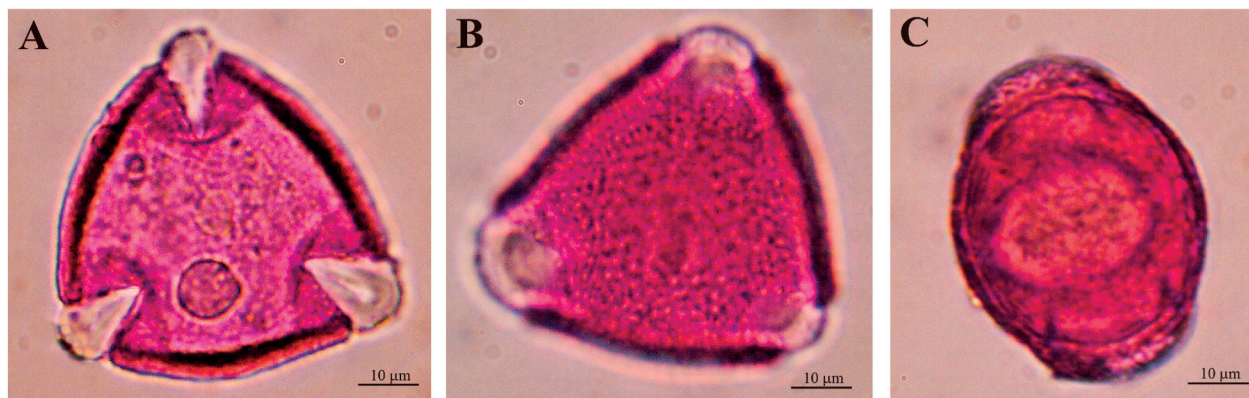


Fig. 3. A–C. Pollen grains of *Kolkwitzia amabilis*. A. In polar view. B. A view that shows the exine surface. C. In equatorial view.

Table 2
Characteristics of pollen grains of *Kolkwitzia amabilis* Graebn.

Feature of pollen grains			
Length of axis [μm]	equatorial [E]	min.–max. mean	46.80–54.60 49.68
	polar [P]	min.–max. mean	36.20–44.20 39.55
P/E			0.80

DISCUSSION

In the literature, I did not find any data on the apicultural value of the beauty bush. Kołtowski (2006) mentions that the species in question is a nectariferous plant that is readily visited by Apidae, but its sugar and pollen yield have not been investigated. Many studies on nectar production, total pollen production, and the morphology of nectaries and pollen grains of other representatives of the family Caprifoliaceae have been conducted. Serological analysis of proteins in seeds of individual species within the family Caprifoliaceae has shown that *Kolkwitzia* is most closely related to the genera *Lonicera* and *Diervilla* (Hillebrand and Fairbrothers, 1970).

Maciejewska (1997) examined the morphology of pollen grains of several species of the family Caprifoliaceae. She determined the size of pollen grains of the following species: *Lonicera nigra* (E-40.8; P-50.7 μm), *L. tataria* (E-47.5; P-52 μm), and *L. xylosteum* (E-45.1; P-50.6 μm). In terms of their morphology and the length of the polar (E – 39.5 μm) and

equatorial axis (P – 49.7 μm), pollen grains of *Kolkwitzia* are similar to those of the above-mentioned species of the genus *Lonicera*.

The beauty bush flowers secrete nectar in the tubular corolla and accumulate it in the place of its production. Pacini and Nepi (2007) termed this method of offering nectar in *Lonicera japonica* as primary presentation. Smet (1986) mentions nectaria trichomalia as one of the nectary types occurring in *Lonicera*. Weryszko-Chmielewska and Bożek (2008) found a trichomatous nectary to occur in the spur of the corolla tube in *Lonicera kamtschatica*. This nectary consists of unicellular trichomes and smaller papillae. The above-mentioned authors presented the structure of such a nectary also at the ultrastructural level. The secretory surface of the nectary of beauty bush is composed of two layers of glandular epidermal outgrowths: trichomes and papillae.

The beauty bush flowers produced 8.74 mg of nectar per 10 flowers and the weight of nectar sugar ranged from 1.87 to 8.63 mg. In the case of European

fly honeysuckle, Jabłoński and Kołtowski (1993) give higher values of sugar weight which averaged 22.2 mg/10 flowers, similarly as Bożek and Wieniarska (2006) reported the values of 17.77–28.32 mg for different varieties of blue honeysuckle. Szklanowska (1978) showed that the weight of nectar sugar in the flowers of *Lonicera xylosteum* was 8.74 mg, while for *L. tatarica* it was 1.95 mg. The sugar concentration for the studied varieties of *Lonicera kamschatica* was 33–36% (Bożek and Wieniarska, 2006). In the present study, a higher sugar concentration was found in the nectar of beauty bush than in the nectar of other representatives of Caprifoliaceae (30.0% – 62.85%).

CONCLUSIONS

1. The nectary is located in the inner part of the spur formed by the corolla tube of the beauty bush flowers. The secretory surface consists of unicellular trichomes with a length of 54.6 μm – 70.2 μm and smaller papillae reaching 13.0 μm – 20.6 μm in length.
2. The beauty bush flowers produced on average 8.7 mg of nectar with a sugar concentration of 50.8%. The weight of nectar sugar was on average 4.4 mg.
3. Pollen grains of *Kolkwitzia amabilis* are classified as medium-sized and suboblate.

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Biologia kwitnienia i nektarowanie kwiatów kolkwicii chińskiej (*Kolkwitzia amabilis* Graebn.)

Streszczenie

W latach 2008–2009 i 2011 badano nektarowanie, morfologię nektarnika i ziaren pyłku *Kolkwitzia amabilis* Graebn. Kwitnienie kwiatów kolkwicii rozpoczynało się w trzeciej dekadzie maja a kończyło się w połowie czerwca i trwało 22–23 dni. Długość życia kwiatu wynosiła 4–5 dni. Nektarowanie rozpoczynało się w stadium luźnego pąka. Rurka korony kwiatów kolkwicii tworzy ostrogę, wewnątrz której znajduje się nektarnik. Powierzchnię sekrecyjną nektarnika stanowią dwie warstwy wydzielniczych wytworów epidermy: jednokomórkowe trichomy, o długości zawartej w przedziale 54,6 μm – 70,2 μm , oraz papille o długości 13,0 μm – 20,6 μm . Średnia masa nektaru z 10 kwiatów określona w ciągu trzech lat wynosiła 8,6 mg, przy koncentracji cukrów 50,8%. Masa cukrów wynosiła średnio 4,4 mg. Ze względu na wielkość ziarna pyłku kolkwicii zaliczane są do średnich. Są to ziarna trójbrzdowoporowe (tricolporate).

