

STUDY ON FLOWERING BIOLOGY AND SEED SETS OF SELECTED ORNAMENTAL SPECIES FROM THE MALVACEAE FAMILY

A n n a W r ó b l e w s k a

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S u m m a r y

The investigations were carried out at the Botany Department of the Life Sciences University in Lublin, Poland (51° 14' N 22° 34' E) in the years 1992-2004. The objects of the study were four ornamental, annual species of the Malvaceae family. Each were examined during three vegetation seasons. The species were: *Alcea rosea* L., *Malope trifida* Cav., *Malva mauritiana* L. and *Malva moschata* L. The observations were focused on the time and length of the flowering period. The observations were focused, as well, on some morphological features of the flowers and seed sets when allowed free access by pollinating insects, and when the flowers were isolated.

In the climatic conditions of Lublin, the flowering period of the investigated species started in June or early July (*Malope trifida*) and lasted till late September (10.5-15.5 weeks). A single flower blooms for 2.5-5.5 days. During the vegetative season, one plant developed an average of 243-1374 flowers.

The flowers consist of numerous stamens forming a staminal tube which encloses the gynoecium. Depending on the species, one flower develops an average of from 62.5 (*Malva moschata*) to 309.1 (*Alcea rosea*) stamens. The number of ovules in one flower fluctuated between 9.7 (*Malva mauritiana*) to 54.3 (*Malope trifida*).

Seed setting was strictly dependent on insect pollination. When allowed free access by pollinating entomofauna, the flowers of the examined malvaceous developed 70.5-89.7% of seeds. In isolation only 2.8-10.4% of the seeds were developed.

Keywords: Malvaceae, flowering, flower morphology, seed setting.

INTRODUCTION

The Malvaceae family covers ca. 70 genera that in total include over 1000 plant species of various functional significance. They occur both in the semi-desert tropics or subtropics as well as in temperate climatic zones. In Poland, they are found in natural phytocoenoses or in home gardens as ornamental plants. The malvaceous plants are described by different authors as valuable apicultural plants, which in the summer season and in the early autumn provide nectar flow to insects (Rawski 1948, Maurizio and Graf 1969,

Howes 1979, Mountain et al. 1981, Bodnarčuk et al. 1993, Jabłoński and Kołtowski 2000, Ricciardelli d'Albore and Intoppa 2000, Wróblewska 1996, 2000, 2006, Ayers 2008). Their flowers are often visited by a variety of pollinating insects interested mainly in nectar harvest.

The presented study was aimed at determining the time, length and abundance of the flowering period, and at recognizing some morphological features of flowers of selected taxa of ornamental plants from the Malvaceae family.

malvaceous plants lasted until the end of September (10.5-15.5 weeks). The full bloom of the taxa analyzed occurred in the third or fourth week of their flowering period and spanned ca. two weeks. The length of the blooming of a single flower ranged from 2.5 to 5.5 days (Table 1).

The investigated plant taxa differed between one another in their abundance of flowering. This was true even though the abundance of flowering was similar in particular species in the consecutive years of the experiment. The most abundant flowering was reported for *Malva mauritiana*. In the vegetative season it produced an average of 1375 flowers per plant. Less than half of that, was recorded on one plant of *Alcea rosea*. It had an average of 659 flowers. The two other species, i.e. *Malva moschata* and *Malope trifida*, produced 461 and 243 flowers, respectively.

Flowers of the investigated malvaceous plants are large and of a similar morphological structure. A fivefold perianth is constituted by sepals provided with an additional whorl of leaves (*epicalyx*) and by colorful petals. The petals occur in colors from bright pink to dark claret. In *Alcea rosea* and *Malope trifida* the petals also occur in other colors. All the taxa contain darker or brighter streaks which indicate the pathway to nectar for the insects. Depending on the species, values of flower diameter ranged from 5.1cm in *Malva moschata* to 8.9 cm in *Alcea rosea* (Table 2).

Protandrous flowers of the malvaceous plants are characterized by the presence of numerous stamens (Fig. 1), which coalesce with filaments, thus constituting a staminal tube. In all taxa, the breaking of anther and the release of pollen began at the loose bud stage, just before the bursting of a petal.

Table 2
Some morphological features of flowers of the examined malvaceous plants
(means of experimental years)

Species	Year	Flower diameter (cm)	Number of	
			stamens	ovules
			in one flower	
<i>Alcea rosea</i> L.	1992	8.5	313.5 c	34.7 c
	1993	8.9	325.7 c	38.7 c
	1995	7.9	288.2 c	37.3 c
	Mean	8.4	309.1 C	36.9 C
<i>Malope trifida</i> Cav.	1999	7.6	133.7 b	42.7 c
	2000	8.2	144.3 b	59.2 d
	2001	7.7	148.2 b	61.0 d
	Mean	7.8	142.1 B	54.3 D
<i>Malva mauritiana</i> L.	1993	7.2	71.7 a	9.5 a
	1995	6.6	70.3 a	9.8 a
	1996	6.8	68.0 a	9.8 a
	Mean	6.9	70.0 A	9.7 A
<i>Malva moschata</i> L.	2001	5.1	59.5 a	19.2 b
	2002	5.8	62.2 a	19.3 b
	2004	6.1	65.8 a	18.7 b
	Mean	5.7	62.5 A	19.1 B

Mean values followed by different letters - differences significant at $p \leq 0.05$.



Fig. 1 A fragment of a *Malva moschata* flower with visible androecium.



Fig. 2 Gynoecium *Malva moschata* – cross-section.

This process was observed to begin in the forenoon hours and lasted for a few to up to ten or so hours. The release of pollen was started by the stamens located in the top part of the androecium. Maturation and breakage of anthers proceeded towards the base of the staminal tube (Fig. 1). *Alcea rosea* had the greatest number of stamens per flower, with an average of 309.1. It also had the greatest size of flowers. *Malope trifida* had a significantly lower number of stamens. It had an average of 142.1. Flowers of the two other taxa of the genus *Malva* also produced a lower number of stamens. *M. mauritiana* had an average of 70.0 stamens and *M. moschata* had an average of 62.5 (Table 2).

In the species observed, the morphological structure of gynoecium is typical of representatives of the family Malvaceae. In *Alcea rosea* and in two taxa of the genus *Malva*, numerous carpels constitute a multilocular upper pistil with a disk-like ovary (Fig. 2) located on a flat or slightly protruding floral disc. In *Malope trifida*, the carpels constituting the gynoecium are loosely located on a strongly protruding floral disc (Fig. 3). The number of ovules in one flower differed in

particular species and reached the highest value in *Malope trifida* – 54.3. In the other taxa, it was significantly lower and accounted for an average of 36.9 in *Alcea rosea*, 19.1 in *M. moschata* and 9.7 in *M. mauritiana* (Table 2). Once the pollen release along with flower development, the numerous stigmas overgrow the staminal tube.

Flowers of the investigated taxa were very often visited by different pollinating insects. The most common were the honeybees and bumble bees which were mainly interested in the nectar harvest. The

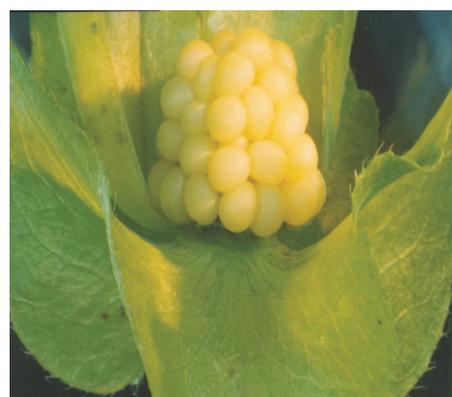


Fig. 3 Gynoecium *Malope trifida*

Table 3

Seed sets when freely accessed by pollinating insects and seed sets in flower isolation.

Species	Year	Number		%	
		of seeds in one flower			
		non-isolated	isolated	non-isolated	isolated
<i>Alcea rosea</i> L.	1992	34.4	2.1	91.7 ef	5.2 ab
	1993	33.2	0.9	93.9 f	2.7 ab
	1995	29.3	3.4	83.5 def	3.6 ab
	Mean	32.3	2.1	89.7 C	3.8 A
<i>Malope trifida</i> Cav.	1999	33.0	9.0	81.1 cdef	21.8 b
	2000	36.0	5.0	60.8 c	8.4 ab
	2001	41.4	0.7	69.7 cd	1.1 a
	Mean	36.8	4.9	70.5 B	10.4 A
<i>Malva mauritiana</i> L.	1993	8.5	0.1	89.4 def	3.5 ab
	1995	7.6	0.0	76.9 cdef	3.2 ab
	1996	9.0	0.4	89.6 def	1.6 ab
	Mean	8.4	0.1	85.3 C	2.8 A
<i>Malva moschata</i> L.	2001	14.0	0.8	72.5 cde	4.3 ab
	2002	13.7	0.3	71.7 cde	1.5 a
	2004	15.2	0.9	81.5 def	4.5 ab
	Mean	14.3	0.7	75.2 B	3.4 A

Mean values followed by different letters - differences significant at $p < 0.05$.

intensity of visiting was observed to increase at noon.

The conducted experiment demonstrated great differences in seed setting (Table 3). Under conditions of free access by the pollinating insects, flowers of the investigated taxa produced substantially more seeds compared to the isolated flowers. The respective average values ranged from 70.5% (*Malope trifida*) to 89.7% (*Alcea rosea*) of seeds under free access by the pollinating insects and barely from 2.8% (*Malva mauritiana*) to 10.4% (*Malope trifida*) under isolators (Table 3). The greatest differences were noted in *Malva mauritiana*, whose flowers set 30 times less seeds without the pollinators.

DISCUSSION

The malvaceous plants assayed in the study are included amongst nectar secreting plants of the summer season as their flowering begins in June and spans until the second half of September. In all of the experimental years the latest flowering species was *Malope trifida*. In this species the first flowers developed in July. According to Rutkowski (1998), that species blooms as early as in the last week of June. The time of blooming and the length of flowering reported for the other taxa examined are similar to data reported by various authors (Rutkowski 1998, Jabłoński and Kołtowski 2000) for the climatic conditions of Poland.

Flowers of the discussed taxa differ in the number of generative elements in a flower. The most abundant *androecium*

was observed in *Alcea rosea*, which developed almost twice as many stamens (309.1) than did *Malope trifida* (142.1) and over four times more stamens than the other investigated species of the genus *Malva* (70.0 and 62.5). Amongst the malvaceous plants, a similar number of stamens (74.5 on average) was developed by the flower of *Lavatera trimestris* (Wróblewska 1996), whereas a considerably lower one – by *Sida hermaphrodita* (43.0) (Wróblewska and Kolasa 1991), *Malva silvestris* (50.3) and *M. crispa* (10.1) (Wróblewska 2000).

Gynoeceum of the analyzed taxa consists of a multilocular, disk-like pistil formed by numerous connate carpels. The number of ovules per flower differed considerably in the particular species. The highest number of ovules was reported in *Malope trifida* (54.3) and in *Alcea rosea* (36.9), whereas a substantially lesser number – in *M. moschata* (19.1) and *M. mauritiana* (9.7). Data obtained for the two latter taxa are similar to those reported for other malvaceous plants, in which the number of ovules per flower were reported to be: 14.0 in *Lavatera trimestris*, 13.7 in *Malva silvestris* and 10.8 in *M. crispa* (Wróblewska and Kolasa 1991, Wróblewska 1996, 2000).

Literature lacks data on the effect of pollinating entomofauna on the seed yield of the taxa discussed. In the successive vegetative seasons, seed settings when allowed free visiting by insects was considerably higher than under conditions of flowers isolated from pollinators. In the case of the malvaceous plants examined, the non-isolated flowers produced 70.5-89.7% of seeds, whereas the isolated ones – barely 2.8-10.4% of seeds in respect to the number of ovules in a flower. These results are comparable with data reported for *Lavatera trimestris*, *Malva silvestris* and *M. crispa* (Wróblewska 1996, 2000). The isolated flowers of *Sida hermaphrodita*

were reported not to set seeds at all (Wróblewska and Kolasa 1991). The significant effect of pollinating insects on seed setting and an increase in seed yield in the malvaceous plants was also determined by Njoya et al. (2005) for *Abelmoschus esculentus* in Cameroon.

CONCLUSION

1. Under the climatic conditions of Lublin, the flowering of *Alcea rosea* and two species of the genus *Malva* begins in June, and that of *Malope trifida* in July. The flowering continues until the latter half of September, depending on the species and weather conditions.
2. The malvaceous plants differ in terms of the number of ovules and stamens in a flower. Pollen-release by stamens begins at the bud stage, in the forenoon hours, and spans for a few to ten or so hours. The maturation and pollen release proceed from the top to the base of the staminal tube.
3. Flowers of the taxa discussed in the study are outstandingly entomophilic. When the flowers were able to be freely accessed by insects they produced considerably more seeds compared to the isolated flowers. While predicting yields on a seed plantation, attention should thus be paid to the necessary contribution of the pollinating entomofauna.

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BADANIA BIOLOGII KWITNIENIA I ZAWIĄZYWANIA NASION WYBRANYCH GATUNKÓW OZDOBNYCH Z RODZINY MALVACEAE

Wróblewska A.

S t r e s z c z e n i e

Badania prowadzono w Katedrze Botaniki Uniwersytetu Przyrodniczego w Lublinie (51° 14' N 22° 34' E) w latach 1992-2004. Obiekt badań stanowiły 4 gatunki ozdobnych, jednorocznych roślin z rodziny Malvaceae, każdy z nich badano przez trzy sezony wegetacyjne. Były to: *Alcea rosea* L., *Malope trifida* Cav., *Malva mauritiana* L. and *Malva moschata* L. Obserwacje miały na celu poznanie okresu i długości kwitnienia gatunków, opracowanie niektórych cech morfologicznych ich kwiatów oraz zbadanie zawiązywania nasion w warunkach swobodnego oblotu roślin i w warunkach izolowania kwiatów przed dostępem owadów.

W warunkach klimatycznych Lublina, kwitnienie badanych taksonów rozpoczynało się w czerwcu lub na początku lipca (*Malope trifida*) i trwało do ostatnich dni września (10.5-15.5 tygodni). Kwitnienie kwiatu trwało 2.5-5.5 dni. W sezonie wegetacyjnym jedna roślina wytwarzała, w zależności od gatunku, średnio 243-1374 kwiatów.

Kwiaty zawierają liczne pręciki zrosnięte nitkami w rurkę otaczającą słupkowie. Jeden kwiat wytwarza, w zależności od gatunku średnio od 62.5 (*Malva moschata*) do 309.1 (*Alcea rosea*) pręcików. Liczba zalążków w kwiecie zawierała się w granicach od 9.8 (*Malva mauritiana*) do 54.3 (*Malope trifida*).

Zawiązywanie nasion było ściśle uzależnione od zapylenia przez owady. W warunkach swobodnego dostępu zapylaczy, kwiaty badanych ślazowatych wytworzyły 70.5-89.7% nasion, podczas gdy w warunkach izolowania tylko 2.8-10.4% w stosunku do liczby zalążków w kwiecie.

Słowa kluczowe: Malvaceae, kwitnienie, morfologia kwiatu, zawiązywanie nasion.