

NECTAR SECRETION AND HONEY POTENTIAL OF HONEY PLANTS GROWING UNDER POLAND'S CONDITIONS

Part XIII

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S u m m a r y

Blooming, nectar secretion, and visitation by insects of 11 herbaceous plants grown on a podzolic light soil were investigated in Puławy in 1999-2001. The total output of sugars from 10 flowers averaged nearly 2 mg for *Gypsophila paniculata*, 5-6 mg for *Ballota nigra* and *Onobrychis arenaria*, 7-9 mg for *Stachys lanata*, *Ajuga reptans* and *Anchusa officinalis*, 15-20 mg for *Echium vulgare*, 20-30 mg for *Chamaenerion angustifolium*, 50 mg for *Geranium sylvaticum*, and 100(120) mg for *Geum rivale* and *Asclepias syriaca*.

The sugar output from 1 ha of a commonly well closed plant stand was measured at 60-70 kg for *Geranium sylvaticum* and *Geum rivale*, 100-110 kg for *Ajuga reptans* and *Stachys lanata*, 140-160 kg for *Anchusa officinalis* and *Onobrychis arenaria*, 200-250 kg for *Chamaenerion angustifolium* and *Ballota nigra*, 300 kg for *Gypsophila paniculata* and 400 kg for *Asclepias syriaca* and *Echium vulgare*.

All the species were abundantly visited by the honeybee and by wild bees. The majority of them (*Anchusa officinalis*, *Echium vulgare*, *Asclepias syriaca*, *Onobrychis arenaria*, *Gypsophila paniculata* and *Ballota nigra*) are suitable to be grown on idle lands in order to improve honeybee pastures.

Keywords: honey plants, blooming, nectar secretion, foraging by bees.

INTRODUCTION

The study is a thirteenth consecutive part of investigations started by Professor Zofia Demianowicz (1960) dealing with blooming profuseness, nectar secretion, and foraging by bees of honey plants in Poland.

MATERIAL AND METHODS

The study contains the data collected over the years 1999-2001 for 11 herbaceous plant species (Table 1). All of them grow wild in Poland, *Gypsophila paniculata* and *Onobrychis arenaria* being also cultivated. Native to America, *Asclepias syriaca* is being introduced by beekeepers to idle lands to improve bee pastures. Six species (*Anchusa officinalis*, *Ballota nigra*,

Onobrychis arenaria, *Asclepias syriaca*, *Chamaenerion angustifolium* and *Echium vulgare*) were investigated some years ago but using old methods. The remaining five species (*Geranium sylvaticum*, *Stachys lanata*, *Ajuga reptans*, *Geum rivale* and *Gypsophila paniculata*) were assessed for the first time. All taxons under investigations were grown in the honey plant garden of the Apiculture Division in Puławy located on a light podzolic soil classified as class IV.

In the study the current methods used in apicultural botany were applied (Szczepański and Jabłoński 1975, Jabłoński and Szklanowska 1979). Nectar was collected using in-house made micropipettes (Demianowicz et al. 1960).

Table 1
Time and duration of blooming, nectar secretion and sugar potential of 11 species
of plants investigated in Puławy in 1999-2001.

Plant species	Year of study	Blooming period	Number of plants (and sprouts) per 1 m ²	Number of flowers per 1 m ²	Concentration of sugars in nectar	Amount of sugars per 10 flowers in mg		Sugar (and honey) potential in kg/ha
						min – max	Average	
<i>Geranium sylvaticum</i> L.	1999	5.05 – 31.05	4 (43)	1 208	40 – 76	26.0 – 57.4	31.86	38 (48)
	2000	24.04 – 22.05	6 (60)	850	59 – 75	34.5 – 88.2	59.85	51 (64)
	2001	2.05 – 2.06	5 (110)	1 914	65 – 74	32.0 – 87.5	62.05	119 (148)
<i>Stachys lanata</i> JACQ.	1999	6.06 – 6.07	- (30)	10 620	48 – 67	4.7 – 17.4	8.35	87 (111)
	2000	23.05 – 2.07	- (65)	12 155	36 – 50	6.9 – 14.4	10.11	123 (153)
	2001	8.06 – 18.07	- (76)	14 136	39 – 45	6.9 – 13.7	8.97	127 (158)
<i>Ajuga reptans</i> L.	1999	1.05 – 27.05	10 (81)	11 745	36 – 68	4.7 – 13.0	7.24	85 (106)
	2000	20.04 – 15.05	10 (200)	17 100	52 – 62	4.5 – 9.7	7.30	125 (156)
	2001	4.05 – 20.05	10 (180)	14 076	47 – 70	4.1 – 10.9	7.12	100 (125)
<i>Anchusa officinalis</i> L.	1999	1.06 – 6.07	18 (63)	17 330	55 – 72	2.2 – 8.1	6.64	115 (144)
	2000	20.05 – 28.06	7 (32)	14 859	40 – 49	4.8 – 15.7	10.66	158 (198)
	2001	25.05 – 15.07	24 (73)	22 456	49 – 60	3.7 – 10.8	6.46	145 (181)
<i>Geum rivale</i> L.	1999	28.05 – 25.06	12 (130)	403	53 – 68	64.5 – 180.7	104.58	42 (53)
	2000	22.04 – 12.05	12 (154)	462	38 – 63	40.9 – 140.3	79.02	37 (46)
	2001	28.04 – 8.06	10 (150)	510	45 – 65	51.0 – 276.0	171.60	88 (109)
<i>Gypsophila paniculata</i> L.	1999	22.06 – 18.07	1 (25)	160 652	45 – 75	1.4 – 3.2	2.30	369 (462)
	2000	14.06 – 16.07	1 (26)	220 467	24 – 68	0.5 – 1.6	1.05	231 (289)
	2001	5.07 – 28.07	1 (24)	140 604	20 – 54	1.4 – 3.8	2.00	281 (352)
<i>Ballota nigra</i> L.	1999	1.07 – 25.08	2 (77)	62 310	61 – 74	2.0 – 6.8	5.02	313 (391)
	2000	18.06 – 1.08	5 (37)	52 836	33 – 59	2.1 – 8.4	5.40	285 (357)
	2001	20.07 – 15.09	4 (46)	23 414	55 – 75	3.6 – 11.3	6.81	159 (199)

RESULTS

<i>Onobrychis arenaria</i> (KIT.) SER.	1999	25.05 – 14.06	6 (141)	26 642	47 – 63	3.5 – 6.8	5.30	141 (176)
	2000	13.05 – 4.06	6 (132)	61 415	32 – 59	1.3 – 4.1	2.37	146 (182)
	2001	21.05 – 20.06	5 (136)	38 488	36 – 71	3.5 – 8.2	5.60	216 (269)
<i>Asclepias syriaca</i> L.	1999	20.06 – 12.08	- (9)	4 032	51 – 63	34.0 – 87.6	64.29	259 (324)
	2000	5.06 – 1.08	- (9)	5 085	50 – 71	44.0 – 107.4	88.60	451 (563)
	2001	4.07 – 1.08	- (9)	3 528	35 – 66	129.2 – 244.8	162.00	572 (714)
<i>Chamaenerion angustifolium</i> (L.) SCOP.	1999	4.06 – 8.08	- (10)	11 500	54 – 65	23.8 – 49.4	32.62	375 (469)
	2000	28.05 – 15.07	- (10)	3 600	21 – 77	11.1 – 26.3	15.83	57 (71)
	2001	15.06 – 20.07	- (12)	3 474	38 – 71	16.4 – 42.4	32.03	111 (139)
<i>Echium vulgare</i> L.	1999	15.06 – 16.07	5 (72)	32 610	35 – 52	11.0 – 18.7	13.90	453 (567)
	2000	1.06 – 15.07	54 (68)	21 114	23 – 66	4.6 – 25.3	15.13	319 (399)
	2001	2.06 – 15.07	1 (34)	24 816	20 – 52	4.9 – 37.5	24.03	596 (745)

Blooming. The blooming season for the investigated species occurred in May to August (Table 1). The first species to bloom were *Ajuga reptans* (28.04 to 21.05) and *Geranium sylvaticum* (30.04 - 27.05) followed by *Geum rivale* (6.05 - 4.06), *Onobrychis arenaria* (20.05 - 13.06), *Anchusa officinalis* (26.05 - 6.07), *Stachys lanata* (2.06 - 7.07), *Chamaenerion angustifolium* (5.06 - 25.07), *Echium vulgare* (6.06 - 15.07), *Asclepias syriaca* (20.06 - 5.08), *Gypsophila paniculata* (24.06 - 21.07) and *Ballota nigra* (2.07 - 24.08). The duration of blooming season was ca. 3 weeks for *Ajuga reptans*, *Gypsophila paniculata* and *Onobrychis arenaria*, 4 weeks for *Geranium sylvaticum* and *Geum rivale*, 5 weeks for *Stachys lanata*, 6 weeks for *Anchusa officinalis*, *Asclepias syriaca* and *Echium vulgare*, and 7 weeks for *Ballota nigra* and *Chamaenerion angustifolium*.

With its tiny flowers *Gypsophila paniculata* had the highest number of flowers per 1 m² of a closed stand (140,000-220,000). The numbers of flowers per 1 m² for the remaining species were a fraction of that value: 30,000 to 60,000 for *Onobrychis arenaria* and *Ballota nigra*, 20,000 to 30,000 for *Echium vulgare*, 15,000 to 20,000 for *Anchusa officinalis*, 10,000 to 15,000 for *Stachys lanata* and *Ajuga reptans*, 4,000 to 10,000 for *Chamaenerion angustifolium*, 3,000 to 5,000 for *Asclepias syriaca*, 1,000 to 2,000 for *Geranium sylvaticum* and 400 to 500 for *Geum rivale*.

Nectar secretion. The concentration of sugars in the nectar of the surveyed species, while being always dependent on the current relative humidity, ranged from 20 (30-40) to 50-60(70)% (Table 1).

The average amount of sugars secreted by 10 flowers was nearly 2 mg in *Gypsophila paniculata*, 4-6 mg in *Ballota nigra* and *Onobrychis arenaria*, 7-9 mg in

Stachys lanata, *Ajuga reptans* and *Anchusa officinalis*, 18-27 mg in *Chamaenerion angustifolium* and *Echium vulgare*, 50 mg in *Geranium sylvaticum*, 100 mg in *Asclepias syriaca*, and nearly 120 mg in *Geum rivale*. The year-to-year differences over the 3-year period of the study were only 3% for *Ajuga reptans*, 20% for *Stachys lanata*, nearly 40% for *Ballota nigra*, ca. 60% for *Anchusa officinalis* and *Echium vulgare*, 100% for *Chamaenerion angustifolium*, 120% for *Geum rivale* and *Gypsophila paniculata* and 150% for *Onobrychis arenaria* and *Asclepias syriaca*. The differences in nectar secretion rate are governed to the greatest extent by weather conditions prevailing in the blooming period.

Honey potential. The value of that characteristic is obtained by dividing by four the amount of sugars yielded by plants grown on a defined surface area (e.g. 1 ha) and multiplying the outcome by five. In order to calculate the amount of sugars yielded by 1 ha of the crop one needs to know the number of flowers in that area and the nectar secretion rate of one flower. The average honey potential of 1 ha of the crop was 70-80 kg for *Geranium sylvaticum* and *Geum rivale*, 130-140 kg for *Stachys lanata* and *Ajuga reptans*, 170-220 kg for *Anchusa officinalis*, *Onobrychis arenaria* and *Chamaenerion angustifolium*, over 300 kg for *Gypsophila paniculata* and *Ballota nigra*, and over 500 kg for *Asclepias syriaca* and *Echium vulgare*.

Apart from the total honey potential of a plant as measured over the whole blooming period the day-to-day potentials are also important. The amount of the so-called daily honey potential for the full blooming period is obtained by dividing the total potential by the number of days equal to 75% of the total blooming period of a given species. Average daily potentials were 3-6 kg for *Geranium sylvaticum*, *Anchusa officinalis*, *Geum rivale* and *Chamaenerion*

angustifolium, 8-12 kg for *Ajuga reptans*, *Ballota nigra* and *Onobrychis arenaria*, 16-20 kg for *Gypsophila paniculata*, *Asclepias syriaca* and *Echium vulgare*.

Flower foraging by bees. Honeybees dominated on flowers of all species, especially on those of *Gypsophila paniculata* and *Asclepias syriaca*. Only on *Stachys lanata* and *Ballota nigra* bumblebees were occasionally the prevalent visitors. Normally, flower visitation lasted from the morning until the evening with peak visitation at mid-day. The weather being favourable, at full blooming and at the peak visitation hours 10-20 (30 and more) insects worked 1 m² of a closed plant stand collecting nectar and also pollen (the exception was *Asclepias syriaca*, which does not yield pollen).

DISCUSSION

The honey potentials of five of the investigated species can be compared with the relevant data obtained 40 years ago in Skierniewice (Demianowicz et al. 1960 and 1963). The Puławy data turned out to be 50-70% lower for *Anchusa officinalis* and *Asclepias syriaca* and several times higher for *Onobrychis arenaria*, *Chamaenerion angustifolium* and *Echium vulgare*. It was due to different blooming profuseness and to different nectar secretion rates. It should also be remembered that the former data on nectar secretion rate were calculated from daily quantities of secreted sugars and flower longevities, which did not always yield results that were accurate enough.

This study was the first to report honey potential data for *Geranium sylvaticum* and *Geum rivale*. The values of 70-80 kg/ha can be considered as fairly high. Honey potentials of 140-220 kg/ha for *Stachys lanata*, *Ajuga reptans*, *Anchusa officinalis*, *Onobrychis arenaria* and *Chamaenerion angustifolium* can be regarded as high

whereas those for *Gypsophila paniculata*, *Ballota nigra*, *Asclepias syriaca* and *Echium vulgare* reaching 300-500 kg/ha as very high.

CONCLUSIONS

The plant species investigated in this study can be arranged in the following increasing order according to their average nectar secretion measured as sugar weight per 10 flowers: *Gypsophila paniculata* 1-2 mg, *Ballota nigra* and *Onobrychis arenaria* - 5-6 mg, *Stachys lanata*, *Ajuga reptans* and *Anchusa officinalis* - 7-9 mg, *Echium vulgare* - 15-20 mg, *Chamaenerion angustifolium* - 20-30 mg, *Geranium sylvaticum* - 50 mg, *Geum rivale* and *Asclepias syriaca* - 100(120) mg.

According to sugar output of 1 ha of a closed plant stand the investigated species are sorted in the following increasing order: *Geum rivale* and *Geranium sylvaticum* 60-70 kg, *Ajuga reptans* and *Stachys lanata* 100-110 kg, *Anchusa officinalis* and *Onobrychis arenaria* 140-160 kg, *Chamaenerion angustifolium* and *Ballota nigra* 200-250 kg, *Gypsophila paniculata* 300 kg, *Asclepias syriaca* and *Echium vulgare* 400 kg.

All species discussed in this study were abundantly visited by honeybees as well as by bumbles and solitary bees. The plants provide a good beekeeping value for those insects. Half of them - *Anchusa officinalis*, *Echium vulgare*, *Onobrychis arenaria*, *Asclepias syriaca*, *Gypsophila paniculata*, *Ballota nigra* - have a potential as bee pastures to be established on idle lands.

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**NEKTAROWANIE I WYDAJNOŚĆ MIODOWA ROŚLIN
MIODODAJNYCH W WARUNKACH POLSKI
Część XIII**

J a b ł o ń s k i B . , K o ł t o w s k i Z .

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

W latach 1999-2001 w Puławach badano kwitnienie, nektarowanie i oblot przez owady pszczołowe 11 gatunków zielnych, rosnących na glebie bielicowej lekkiej.

Stwierdzono, że całkowita ilość cukrów z 10 kwiatów łąszcza wiechowatego wynosiła średnio blisko 2 mg, mierznicy czarnej i sparcety piaskowej 5-6 mg, czyścica wełnistego, dąbrówki rozłogowej i farbownika lekarskiego 7-9 mg, żmijowca zwyczajnego 15-20 mg, wierzbówki koprzyca 20-30 mg, bodziszka leśnego 50 mg, a kuklika zwistego i trojeści amerykańskiej 100(120) mg.

Wydajność cukrową z 1 ha przeciętnie dobrze zwartego łąnu określono średnio dla bodziszka i kuklika na 60-70 kg, dąbrówki i czyścica 100-110 kg, farbownika i sparcety 140-160 kg, wierzbówki i mierznicy 200-250 kg, łąszcza około 300 kg, a trojeści i żmijowca około 400 kg.

Wszystkie badane gatunki były dobrze oblatywane przez pszczołę miodną i przez dzikie pszczołowe. Większość z nich (farbownik, żmijowiec, trojeść, sparceta, łąszczec, mierznica) nadaje się do rozpowszechniania na nieużytkach w celu poprawy pożytków pszczelich.

Słowa kluczowe: rośliny miododajne, kwitnienie, nektarowanie, oblot przez pszczoły.