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The flowering biology and apicultural value of coltsfoot (*Tussilago farfara* L. f. Asteraceae)

Biologia kwitnienia i wartość pszczelarska podbiału pospolitego (*Tussilago farfara* L. f. Asteraceae)

SUMMARY

Coltsfoot (*Tussilago farfara* L.), starting its blooming in early spring, supplies colonies of wild *Apoidea* and honeybees with pollen and nectar flow under good weather conditions.

The observations carried out in Lublin and neighbourhood concerned the number of capitula per 1 m^2 and number of florets in a capitulum. Also, the sugar and pollen efficiency was investigated. Field experiment concerned 14 sites of blooming coltsfoot. Studies on the flowering of capitula as well as blooming of nectariferous and polleniferous disc florets were conducted on plants planted out in windowboxes and Mitcherlich's pots. Pollen efficiency was determined with the ether method, nectar productivity using the washing method. Under good conditions coltsfoot may supply about 58 kg of honey and 15 kg of pollen per 1 ha area.

Floral nectary in a disc floret was located at the base of pollen presenter. Nectar was secreted through stomata. Numerous chromoplasts were present in a secretory parenchyma. A single floret bloomed 2 days whereas a capitulum — 9 days. In early spring flowering patches of coltsfoot attracted mainly females of bumblebees and solitary bees building nests after overwintering.

STRESZCZENIE

Podbiał pospolity (*Tussilago farfara* L.), zakwitający na przedwiośniu zapewnia, w warunkach odpowiedniej pogody pokarm pyłkowy i nektarowy założycielkom kolonii dzikich *Apoidea* i pszczole miodnej. Obserwacje prowadzone w Lublinie i okolicach oparto na pomiarach liczby koszyczków na 1 m^2, kwiatów w koszyczkach i ich wydajności cukrowej i pyłkowej. Badania terenowe

objęły 14 stanowisk z kwitnącym podbiałem. Egzemplarze wysadzone w skrzynkach balkonowych i w wazonach Mitscherlicha posłużyły do prześledzenia rozkwitania koszyczków, nektarujących i pylących kwiatów rurkowatych. Wydajność pyłkową określono metodą eterową, a nektarowanie metodą wypłukiwania cukrów. W optymalnych warunkach, w przeliczeniu na 1 ha, podbiał może dostarczyć około 58 kg surowca miodowego i około 15 kg pyłku.

Nektarnik znajdujący się u nasady wygarniacza kwiatu rurkowatego wydziela sekrecje przez szparki, a w parenchymie wydzielniczej zawiera liczne chromoplasty; jeden kwiat kwitnie 2 dni, a cały koszyczek 9 dni. Kwitnące płaty podbiału zwabiają wczesną wiosną głównie samice trzmieli i pszczół samotnic zakładające gniazda po zimowym spoczynku.

Key words: *Tussilago farfara*, flowering, nectar, pollen.

INTRODUCTION

Coltsfoot (*Tussilago farfara* L.) is a species designating the beginning of early spring in a plant phenology. It is also, important source of early nectar and pollen flow for insects, especially for females of bumblebees and solitary bees founding their new colonies after overwintering. Then, the number of these colonies secures an adequate pollination of entomophilous crops. Coltsfoot is mentioned as a medicine plant as well as a weed in numerous papers. The presence of this species in agrocenosis and its pioneer role in overgrowing of waste tips grounds with plants was reported by Bojarczuk and Kulczyński (2), Ziemecki and Fijałkowski (23), Świeboda and Brunerska (19), Namura-Ochalska (12). Coltsfoot plants grow in these ruderal habitats may form dense bee pastures. Gromisz (6) and Ostrowska (13) described the differences in dates of blooming start of coltsfoot capitula under environmental conditions in Poland. Coltsfoot occurs as a component of syntaxons in Senecioni-Tussilagetum Moller 1949, Matuszkiewicz (10) and Tussilaginetum farfare Oberd. 1949, Rostański (16), associations.

Plants of this species prefer Ca-rich soils. They grow on clayey (loamy) sides, banks of waters as well as on excavations and embankments (soil banks). In many papers coltsfoot is considered as a honey plant. Its melliferous value was studied by Păun and Gīlicā (14) in Romania and by Haesler (8) in Germany, and Teräs (20) in Finland. Coltsfoot pollen grains were present in Canadian honeys, Feller-Delmasy and Lamontagne (5). They were also found in pollen loads collected in Switzerland, Maurizio (11), and in Sweden, Schwan and Martinovs (18), as well as in bee-bread samples from apiaries located near Paris, Warakomska and Louveaux (22). Anasiewicz and Warakomska (1) found coltsfoot grains in pollen flow of solitary bees and bumblebees trapped in May on fruit trees and shrubs in the Lublin area. Percival (15) and Rudnianskaja (17) studied pollen presentation mechanism in the species. The recent paper concerns the flowering biology of *Tussilago farfara.* Also, its honey and pollen efficiency was investigated.

MATERIAL AND METHODS

Field observations were carried out on blooming coltsfoot patches grown in the Lublin area (Table 1). The consecutive flowering stages were monitored on 15 plants replanted from their natural habitat into windowboxes and Mitcherlich's pots. Individuals in windowboxes were grown outdoor at a balcony with southern exposure, whereas plants in pots were placed in a laboratory. Studies were conducted during spring in the years 1975, 1978 and 1979. The abundance of flowering was

Tab. 1. Sites of blooming *Tussilago farfara* L. patches and number of capitula per 1 m^2

No	Locality	Date	Site	Number of capitula in 1 m^2
1	Lublin	23.03.1975	Loess-side in Wieniawa quarter	110
2	Lublin	19.04.1975	Loess area, Stara Cegielnia	244
3	Lublin	23.04.1975	Loess-side nearby LSM quarter	203
4	Lublin	15.04.1978	Lawn near ambulatory, LSM quarter	29
5	Dys	18.04.1978	Loess-side by a road	125
6	Dys	18.04.1978	Loess-side by a road	55
7	Lublin	20.04.1978	Orchard-Konopnicka housing estate	142
8	Lublin	20.04.1978	Lawn, Pana Balcera street	56
9	Janowice k. Zamościa	22.04.1978	Roadside zone, limestone soil	35
10	Janowice k. Zamościa	22.04.1978	Roadside zone, limestone soil	50
11	Lublin	23.04.1978	Sodded and clay rubble heap in Kalinowszczyzna quarter	127
12	Lublin	25.04.1978	Lawn, Rymwida street	100
13	Lublin	27.04.1978	Lawn, Rymwida street	29
14	Lublin	28.04.1978	Valley nearby Piastowskie housing estate	95

estimated by counting a number of capitula per 1 m^2 of blooming patch, in 14 different sites. The number of disc florets was also counted in 25 capitula. Disc florets produced nectar and pollen in a capitulum whereas ray florets placed along an inflorescence margin only set wind-dispersed fruits with hairs. The dynamics of capitula development was studied both in plants from windowboxes and from laboratory. The progress in inflorescences opening was noted every hour. To determine sugar production nectar samples were collected from capitula isolated for 24 hours. Nectar samples were gathered from plants grown outdoor in Mitcherlich's pots located under a net in a vegetation room. The amount of sugars in nectar was determined using the washing method. Thirty disc florets at a stage of pollen exposure commence were removed from capitula throughout 5 days in 6 replications. After anthers removal the disc florets were placed in vials containing 1 ml of distillated water and samples were shaken 30 minutes. Then, the obtained solution was filtered and evaporated to dryness at 70°C to prevent yeasts development. Dried sugars were diluted in 0.5 ml of distillated water and then sugar concentration was measured with a refractometer. Sugar mass was calculated assuming that 1 ml of distillated water weighs 1 g at 20°C. On this basis the sugar efficiency of a flower i.e. amount of sugars (in mg) secreted in nectar per 24 hours was calculated. Moreover, the fluorescence of pure sugars and longitudinally sectioned disc florets dried with nectar was compared under UV-lamp with Woode's filter. To determine pollen productivity flowers samples were collected from different natural sites and transported to a laboratory. Then, anthers starting to dehisce were removed from flowers. The samples were gathered in 6 replications and each sample contained 10 flowers. Pollen amount (in mg) was determined using the ether method (21). Then, on the basis of obtained results, coltsfoot honey and pollen yield per area units as well as per 1,000 capitula was estimated with regard to the extreme numbers of disc florets per capitulum and different densities of capitula per 1 m^2 area. The sugar and honey productivity was calculated using the Gubin's formula (7). In the case of very small flowers (corolla tube diameter approx. 0.5 mm) a collection of nectar with pipettes was impossible. Instead, a maximum volume of secreted nectar

was calculated. For this purpose, overall internal dimensions of disk floret were measured and then the volume of nectar (in mm^3) was calculated using equations for cylinder and spherical cap volume. The measurements were made on 25 longitudinal sections of florets under a binocular with 0.1 mm scale. The standard error as well as the mean variation coefficient was calculated. Moreover, drawings of consecutive stages of a disc floret development and a schema of longitudinal section of this flower were made. Also, pollen grains were photographed and a floral nectary was described. The range of honey and pollen productivity values is shown in Table 2.

Tab. 2. Abundance of honey and pollen flow from *Tussilago farfara* L.

Flow		Number of disc flowers in a capitulum			
		28		50	
		Number of capitula in 1 m^2			
from area of	flow				
*from capitula	type	29	244	29	244
m^2 (g)	M	0.38	3.24	0.68	5.80
	P	0.09	0.81	0.17	1.46
ar (g)	M	38.58	324.52	68.88	579.50
	P	9.00	81.00	17.00	146.00
ha (kg)	M	3.86	32.44	6.88	57.96
	P	0.90	8.10	1.70	14.60
* 1,000 capitula (g)	M	13.30		23.72	
	P	3.36		6.00	

Explanation: M — honey, P — pollen.

RESULTS AND DISCUSSION

The capitula of *Tussilago farfara* are monoecious. The number of disk florets in a single capitulum ranged from 28 to 50. The number of ray florets were not estimated. Ray florets did not produce neither nectar nor pollen, however they attracted insects. The daily rhythm of capitula opening was observed both in a laboratory and windowboxes. Under laboratory conditions at 20°C and relative humidity 60%, full opening of 7 tagged inflorescences was completed after one and half hour. At 10 a.m. all observed capitula were shut, at 11 a.m. — half-open and at 11.30 a.m. they opened completely. In windowboxes, the observations of plants blooming were carried out from 24th April till 4th May 1978. The progress in capitula opening was monitored every hour (Summer Time). Air temperatures and weather conditions were also recorded. Coltsfoot capitula opened in the morning between 9 a.m. and 10 a.m., at temperature above 10°C. At lower temperature inflorescences remained closed despite a full sun. All capitula closed at about 5 p.m. irrespective of temperature and light intensity. The observed

Fig. 2. Schema of nectar volume measurement in disc flower of *Tussilago farfara* L.

dynamics of coltsfoot capitula opening was relevant to that described by Percival (15) in England. The length of capitulum's life (from full opening until complete senescence) was 9 days.

Fig. 3. A. Longitudinal section of sterile ovary, corolla tube and nectary (N) of *Tussilago farfara* L., B. Cross section of nectary. C. Nectary parenchyma with chromoplasts

Coltsfoot plant blooming in windowboxes attracted numerous insects. At midday, mainly honeybees, solitary bees and bumblebees visited flowers. Capitula closed if suddenly overcast or during rainfalls (for example at 4°C, at fog or rain).

At a bud stage, in a disc floret corolla lobes were tightly closed and pollen presenter reached a half-way of a stamen cylinder. At this stage the anthers

were closed and connectives were vaulted. S-shaped filaments were curved in a corolla tube. The length of the presenter was 1.2 mm. A furrow — the trace of carpels fusion, divided a conical, papillate apex of pollen presenter. At the following stage the presenter elongated as a result of cell divisions occurred in an intercalary meristem located at the base of the presenter neck (Fig. 4). Then, the anthers dehisced, their filaments straightened and the presenter pushed pollen through the cylinder. The connectives spread and pollen covered both the surface of anthers and head of presenter. In others capitula ray florets expanded their receptive style lobes ready for pollination. An ovary in disc floret developed seemingly. In fact it was sterile without an embryo.

Fig. 4. A, B, C. Successive stages of disc floret development in *Tussilago farfara* L. (longitudinal section). W — presenter

Coltsfoot pollen grains were isodiametric, trizonocolporate and echinate. Their diameter, without echinae, ranged from 28.5 μm to 29.5 μm. The grains covered with pollen kit easily adhered to insect's body (Fig. 1). When corolla lobes expanded, nectar rose to the upper part of the corolla. In a floret dried at this stage, secreted sugars located at the base of longitudinal sectioned corolla tube fluoresced intensely in a bluish tint under UV irradiation whereas the fluorescence of control samples of pure sucrose, glucose and fructose was light-blue, violet and chalky brick-red, respectively. Thus, nectar secreted in coltsfoot seems to be sucrose-dominant.

Each disc floret possessed a ring-shaped, orange nectary placed at the presenter base. The ring was 324.1 μm wide and 262.5 μm high. At the surface atop the nectary stomata secreted nectar was dispersed. The cells of gland secretory parenchyma contained numerous oval chromoplasts (Fig. 3). The vascular bundles supplying the floral nectary also penetrated the other floret parts and the wall of a sterile ovary. Eight bundles at the base of corolla tube and four inside the neck of pollen presenter were found. After branching, these bundles

supplied the stamens and corolla lobes. The pappus hairs in disc florets were shorter than those in ray florets.

The number of capitula per 1 m^2 area ranged from 29 to 244 in the observed patches. In a particular patch 2–27 inflorescences may bloom. If accumulated nectar is risen up to the level of corolla lobes incision, an insect can collect approx. 2.283 mm^3 of nectar from a single disc floret. Life-span of a disc floret was 2 days. Throughout this period, 1,000 capitula, each containing 28–50 florets, may secrete 127.84–228.28 cm^3 of nectar.

The calculated mean nectar volume per floret (n = 25) was 2.2828 mm^3 (S.E. = 0.294, a variation coefficient = 12.81%). The values of honey yield in regard to the number of disc florets in a capitulum and the number of capitula per area unit are shown in Table 2.

Coltsfoot does not grow in extensive patches in their natural habitats. However, these patches are dense and during flowering plants may supply approx. 58 kg of honey raw and approx. 15 kg of pollen per 1 ha. This is a significant food source for females of *Apoidea* building their new nests in spring and also for worker bees feeding a brood. Pollen analysis showed 9% of coltsfoot pollen in honeys from an apiary located by Obroki forest, Lubelskie District. Those honeys were collected at the beginning of May 2000. This is a proof that honeybees visited coltsfoot plants at that time.

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