REARING AND UTILIZATION OF THE RED MASON BEE - *Osmia rufa* L. (*Hymenoptera*, *Megachilidae*) FOR ORCHARD POLLINATION

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S u m m a r y

Mason bee (*Osmia rufa*) was introduced for the orchard pollination about 15-20th April in 2000-2002. Due to very high temperatures noted last years in May the flight of *Osmia rufa* females was short and ended about 15th June. Females founded their nests equally willingly in tubes made of reeds (o 6-8 mm), and in those of paper (o 7 mm). In the year 2000 during the blooming period tubes were sampled in 7-day intervals, three on each sampling date, for microscopic palynological analysis of cells. The nests showed the presence of 26% to 31% pollen from orchard plants (apple, cherry and blackcurrant) in full blooming period only. After this period the only orchard plant-derived pollen in the nests was that from anemophilous walnut (*Juglans regia*) - up to 71%. Density of *Osmia rufa* females required to pollinate 1 hectare of some orchard plants was calculated based on pollen output from 1 flower and pollen data from the cells.

Keywords: mason bee, *Osmia rufa*, orchard, pollination, pollen analysis.

INTRODUCTION

Decreasing number of honey bee colonies in Poland from 2,600,000 in 1985 to 700,000 in 1997, and their weakness caused by the parasite *Varroa destructor* and diseases affecting up to 80-90% of brood result in insufficient pollination of plants, especially in the spring.

Lack of honey bees available for orchard pollination can be substituted by some species of solitary bees, e.g. red mason bee - *Osmia rufa*. Their rearing is very cheap and it will not demand so much work and involvement as do honey bees, because this solitary bee has a short period of development (about 2 months). Their next generation spends the remaining part of the year till the following spring in cocoons.

Osmia rufa is suitable especially for orchard pollination (Bosch, Kemp 2000; Hirashima 1963; Pinzauti et. al. 1997; Torchio 1982); besides, it visits over 130 species of plants (Ruszkowski, Biliński 1986). This bee winters in the mature stage and, after emerging from cocoons in the spring, without any incubation starts flights as soon as the beginning of orchard blooming. Cocoons of *Osmia* can also be wintered in a refrigerator, which makes possible utilization of this bee to pollinate later blooming plants.

This study will permit to define this bee as a pollinator of orchards on the basis of observation and palynological analysis of their nests (Wilkaniec, Warakomska 1992; Wilkaniec et al. 1997; Wilkaniec et al. 2002). It will make possible a better understanding of the biology of this bee and of the most willingly chosen nesting materials.

The study on the rearing and utilization of different *Osmia*-species were carried out in many countries including Europe

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(Bosch, Kemp 2000; Pinzauti et al. 1997; Wilkaniec, Radajewska 1997), America (Torchio 1982) and Japan (Hirashima 1963; Maeta 1978).

MATERIAL AND METHODS

Cocoons of *Osmia rufa* were placed in orchards in the middle April near box-hives filled up with nest materials (reed tubes 6-8 mm in diameter or paper tubes 7 mm in diameter). In 2000 as soon as the first nests were completed by females, 3 tubes were chosen for palynological analysis every 7 days. Tubes were sampled on 3 dates. After the flights cessation of *Osmia* the tubes stayed in the orchard until the autumn, and then their analysis was made. Collected cocoons were stored in the cartoon box in the refrigerator at 4°C until the spring.

RESULTS

Males started to emerge just after the exposition of cocoons in the orchard. Females emerged accordingly 6-8 days later and immediately mated. Females started putting pollen to selected tubes as soon as on the following day after emergence. Reed tubes were chosen most willingly but the mason bee founded its

Table 1

Percentage composition of pollen in the *Osmia rufa* nests in Puławy 2000

Plant species	20-27 April	28 April - 4 May	5-12 May
Orchards	**31**	**26**	-
Prunus-type*	24	7	-
Malus	6	15	-
Ribes	1	4	-
Anemophilous trees	**12**	**47**	**83**
Juglans	3	21	71
Populus	9	26	12
Trees and shrubs	**50**	**21**	**7**
Salix	41	9	-
Acer	9	4	-
Aesculus	-	2	1
Cotoneaster	-	6	3
Spirea	-	-	3
Herbs	**6**	**4**	**9**
Ranunculus	2	-	2
Viola tricolor	2	-	-
Cruciferae	2	4	7
Other	**1**	**2**	**1**
Total	100%	100%	100%

* Plum, cherry, sweet-cherry etc

Table 2

Results of *Osmia rufa* rearing in Puławy 2000-2002

Year and place of experiment	Number of given cocoons	Emerging of bees from cocoons (in %)	Number of received cocoons after season	Coefficient of population increase
2000				
Apple-orchard	4,200	98.7	12,929	3.1
Cherry-orchard	-	-	-	-
Garden*	2,650	96.3	11,900	4.5
2001				
Apple-orchard	3,314	98.2	12,000	3.6
Cherry-orchard	8,124	98.4	14,266	1.7
Garden*	5,350	74.7	9,692	1.8
2002				
Apple-orchard	3,885	98.3	12,831	3.3
Cherry-orchard	8,406	93.1	24,177	2.9
Garden*	7,154	88.0	21,652	3.0

* Various fruit trees and shrubs

nests in paper tubes especially when reed tubes were placed among paper tubes, which lured females of *Osmia*. The advantage of paper tubes is that they are semi-transparent, sterile and have the same diameter along their entire length.

Completion of the first nest of *Osmia rufa* was recorded ten days after the females emerged and at that time tubes were sampled for analysis at weekly intervals. Palynological analysis of pollen collected in cells of nest (tubes) are presented in Table 1. Pollen of plum and cherry-tree was combined as *Prunus*-type, because pollen of those plants is very difficult to distinguish from each other.

Very high temperature in 2000 caused all species of orchard plants to bloom almost at the same time and the period of blooming was short. Therefore their pollen was found only on the first and the second analysis date. Pollen from orchard plants accounted for 31% in *Osmia* nests completed by 27th April and 26% - by 4th May. After 4th May such pollen was not found except that of the anemophilous nut-tree - *Juglans regia*, the percentage of which in the nest sampled on 12th of May was 71%.

The results of *Osmia rufa* rearing in 2000-2002 are shown in Table 2. Rate of imago emergence was 93-98% except for the cocoons from the garden in 2001, because in the preceding year the tubes with those cocoons were knocked off to the ground by birds. Annual coefficient of population reproducing fluctuated from 1.7 to 4.5. The attempt to determine the number of *Osmia* females necessary to pollinate 1 hectare of apple, cherry and blackcurrant is shown in table 3. It was based on the assumption that every female assembles an average of 33% of accessible pollen in the flower (Szklanowska, Pluta 1984; Szklanowska et al. 1997; Szklanowska 1987) during 1 visit and provides 15 cells with pollen. Consequently the number of

T a b l e 3

Calculation of necessary *Osma rufa* number to pollinate some orchard plants

Plant	Average number of cells founded by 1 female of *O. rufa*	Mass of pollen per 1 cell (mg)	Mass of pollen collected by 1 female (mg)	Average mass of pollen in mg		Number of visited flowers to fill with pollen 15 cells	Number of flowers per 1 hectare (millions)	Proportion of florescence to life-span of *Osmia*-females	Necessery to pollination 1 hectare of orchard	
				per 1 flower	collected during 1 flower visit				number of females	number of cocoons
a	b	c	d	e	f	g	h	i	j	k
Apple	15	204	3,060	1.03	0.34	9,000	2.5	0.5	556	1,668
Cherry				0.47	0.16	19,125	20.0	0.33	3,137	9,411
Blackcurrant				0.17	0.06	51,000	19.7	0.4	966	2,898

d = b × c; f = 33% of e (e × 0.33); g = d/f; j = h/g/i; k = 3 × j (33% of females in the *O. rufa* population)

females necessary to pollinate 1 hectare of orchard is from about 550 to 3,100, as it depends on species of plant. Taking into account about 95% of bees emerging from cocoons and the female participation in population of 33%, the number of *O. rufa* cocoons needed to pollinate 1 hectare is about: 1,670 for apple orchard, 9,400 for cherry-tree and 2,900 for blackcurrant.

CONCLUSIONS

1. The mason bee (*Osmia rufa*) spends the winter as imago stage and in the spring, in natural condition, starts emerging when trees and fruit-shrubs start to bloom.
2. Every female founds about 15 cells in which it gathers over 3 g of pollen for food for her brood.
3. In 2000, up to 31% of pollen gathered by *Osmia rufa* in their nests came from orchard plants.
4. To pollinate 1 hectare of orchard is necessary from about 560 (apple), 970 (blackcurrant) to 3,100 (cherry) of *Osmia rufa* females or 3 times as many cocoons.

REFERENCES

Bosch J., Kemp W. P. (2000)- Developmental biology and rearing methods for *Osmia* bees used as crop pollinators. *Insect pollination in greenhouses*: Proceeding of the specialists' meeting held in Soesterberg, The Netherlands, 30 September - 2 October 1999, eds. Sommeijer M. J. and Ruijter de A., Koninklijke Bibliotheek, Den Haag.: 119-126.

Hirashima Y. (1963)- *Osmia cornifrons* as a pollinator of apples utilized by horticulturist in Japan. *Kontyu*, 31 (4): 280-296.

Maeta Y. (1978)- Comparative studies on biology of the bees of the genus *Osmia* in Japan, with special references to their management for pollination of crops (*Hymenoptera*, *Megachilidae*). *Bull. Tahoku Nat. Agric. Exp. Sta.*, 57: 1-221.

Pinzauti M., Lazzarini D., Felicioli A. (1997)- Preliminary investigations of *Osmia cornuta* Latr. (*Hymenoptera*, *Megachilidae*) as a potential pollinator for blackberry (*Rubus fruticosus* L.) under confined environment. *Acta Horticulture*, 437: 329-333.

Ruszkowski A., Bilinski M. (1986)- Food plants and economical importance of mason-bee (*Osmia* Pz., *Hoplitis* Klug, *Anthocopa* Lep. - *Hymenoptera*, *Megachilidae*). *Pszczeln. Zesz. Nauk.*, 30: 63-87.

Szklanowska K., Pluta S. (1984)- Pollen productivity of sour cherry cultivars Kerezer, Nefris and Łutówka. *Pszczeln. Zesz. Nauk.*, 28: 163-174.

Szklanowska K., Jabłoński B., Kołtowski Z. (1997)- Pollen production of eight black currant cultivars (*Ribes nigrum* L.). *Pszczeln. Zesz. Nauk.*, 41: 33-41.

Szklanowska K. (1987)- The apicultural valve of ornamental apple trees applied as pollinators in orchards production. *Pszczeln. Zesz. Nauk*., 31: 189-206.

Torchio P. F. (1982)- Fields experiments with the pollinator species, *Osmia lignaria propinqua* Cresson in apple orchards: II. 1976 studies (*Hymenoptera*: *Megachilidae*). *J. Kansas Entomol. Soc*., 55: 136-144.

Wilkaniec Z., Warakomska Z. (1992)- Host plants of *Osmia rufa* L. defined on the basis of pollen stored by female bees. *Natural resources of bees in Poland.* Pedagogical Univ. Bydgoszcz: 133-141.

Wilkaniec Z., Warakomska Z., Giejdasz K. (1997)- Forage plants of *Osmia rufa* L. (*Apoidea*, *Megachilidae*) population localized in big commodity farm. Postępy apidologii w Polsce. *Wyd. Uczelniane WSP w Bydgoszczy*: 273-282.

Wilkaniec Z., Warakomska Z., Giejdasz K. (2002)- Host plants of solitary bee *Osmia rufa* L. (*Apoidea*, *Megachilidae*) defined on the basis of brood cell pollen analysis. Prace Komisji Nauk Roln. i Leśnych. *Poznańskie Tow. Przyj. Nauk, Wydz. Nauk Roln. i Leśnych.*, 93: 199-206.

Wilkaniec Z., Radajewska B. (1997)- Solitary bee *Osmia rufa* L. (*Apoidea*, *Megachilidae*) as pollinator of strawberry cultivated in an unheated plastic tunnel. *Acta Hort.*: 439 (1): 489-493.

CHÓW I WYKORZYSTANIE MURARKI OGRODOWEJ - *Osmia rufa* (*Hymenoptera*, *Megachilidae*) DO ZAPYLANIA SADÓW

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

Spadek liczby rodzin pszczoły miodnej, ich osłabienie z powodu pasożytów i chorób czerwiu, oddalenie sadów od pasiek i niski zakres wynajmu rodzin pszczelich - jest przyczyną niskiego zagęszczenia zapylaczy w sadach. Do tego dochodzi obserwowany często w ostatnich latach jednoczesny i krótki okres kwitnienia wielu gatunków roślin, spowodowany występującą na przełomie kwietnia i maja bardzo wysoką temperaturą, co zwiększa jeszcze zapotrzebowanie na owady zapylające. Niedostatek pszczoły miodnej do zapylania sadów mogą uzupełnić niektóre gatunki pszczół samotnic, jak murarka ogrodowa (*Osmia rufa* L.). Pszczoła ta zimuje w stadium dojrzałym i wiosną wylęga się z kokonów w początkach kwitnienia sadów. Po około 2-miesięcznych lotach pozostawia w gniazdach nowe pokolenie, które przed zimowlą przekształca się w postać dorosłą (imago). Jej chów jest bardzo łatwy i tani (wymaga jedynie przygotowania materiału gniazdowego w postaci trzcinowych lub papierowych rurek). Nie atakuje ludzi i dlatego może być wykorzystana nawet w małych ogrodach przydomowych i na działkach. Na całym świecie zainteresowanie różnymi gatunkami murarek jest bardzo duże.

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Niniejsza praca przedstawia doświadczenia z chowem i wykorzystaniem murarki ogrodowej prowadzone w Puławach i okolicy w latach 2000-2002. Kokony i megachilniki z rurkami do gnieżdżenia się samic wykładano corocznie w połowie kwietnia w sadzie jabłoniowym, wiśniowym i w ogrodzie z różnymi drzewami i krzewami owocowymi. Poza tym w 2000 roku w kolejnych 7-dniowych terminach wybierano po 10 rurek do analizy palinologicznej. Wykazały one (Tab. 1) obecność w gniazdach murarki pyłków z drzew i krzewów owocowych (od 26 do 31%) jedynie do 4 maja, co potwierdza krótki okres kwitnienia sadów. Samice murarki zbierały pyłek początkowo głównie z wierzb, a po przekwitnięciu sadów z wiatropylnych drzew i co ciekawe był to głównie orzech włoski, który rósł w dużym rozproszeniu poza sadem jabłoniowym. Wyniki chowu (Tab. 2) były zadowalające zarówno w procencie wylęgu pszczół z kokonów (ponad 90%), jak i współczynniku wzrostu populacji (1,7-4,5) mierzonym stosunkiem kokonów zebranych po sezonie do wyłożonych w sadzie. Słabszy wylęg murarek w 2001 roku (74,7 %) spowodowany był wyrzuceniem znacznej liczby rurek z megachilników przez sikorkę poprzedniego roku. Upadek na ziemię z wysokości ponad 3 m był przyczyną większej śmiertelności larw oderwanych od pokarmu. Z tego względu wszystkie megachilniki zabezpieczane są od tej pory przed ptakami cienką metalową siatką o takiej wielkości oczek, które nie przeszkadzają murarkom w locie. Zebrane gniazda (rurki) analizowano na przełomie roku i do wiosny pozostawiano w chłodziarce (w temperaturze 4°C) jedynie zdrowe kokony.

Szybkość oblotu kwiatów przez samice murarki w niedostępnej do szczegółowej obserwacji koronie drzew nasunęło myśl skalkulowania koniecznego jej zagęszczenia do zapylenia 1 hektara sadu na podstawie danych z gniazd i wydajności pyłkowej oblatywanych roślin, co przedstawiono w tabeli 3. Obliczenia wykazały, że do dobrego zapylenia sadu jabłoniowego, wiśniowego i porzeczki czarnej potrzeba odpowiednio 556, 3 137 i 966 samic lub 3-krotnie więcej kokonów, ponieważ w wylęgłej populacji murarek samice stanowią około 33%.

Słowa kluczowe: murarka ogrodowa, *Osmia rufa*, sady, zapylanie, analiza pyłkowa.