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Accompanying fauna of red mason bees in annual and perennial nesting sites

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Summary

Nests of red mason bees (Osmia bicornis L.) are inhabited by characteristic accompanying fauna, which to a varying extent restricts the development of the bee population. The aim of this research was to conduct a comparative analysis of nest material from four sites. At three sites artificial nests of common reed and bee cocoons were placed for the first time (M1 – Kłoda, Masovian Voivodeship, M2 – Sąpłaty, Warmian-Masurian Voivodeship, M3 – Kanie, Masovian Voivodeship). At the fourth one (M4 – an experimental apiary of the Warsaw University of Life Sciences) mason bee nests and cocoons had been placed every year for 10 years. The number of species accompanying mason bees, the number of dead larvae, fully formed cocoons and parasites/cleptoparasites at the newly populated sites was determined and compared with the perennial mason bee nesting site.

In nests M1, M2 and M3, 5-7 species of accompanying fauna were found, whereas in M4 as many as 14 species were identified. The parasites that restricted the bee population most significantly at all sites were Cacoxenus indagator, Monodontomerus obscurus and Chaetodactylus osmiae. Not all of these species caused most damage at the perennial bee nesting site. C. indagator occupied most cells in M4, whereas C. osmiae in M3. M. obscurus parasitized the same number of cells in M3 and M4. Other species identified mainly in M4 were Tribolium castaneum, Dermestes lardarius, Ptinus fur, Trichodes apiarius, Auplopus carbonarius, Chrysis ignita, Anthrax anthrax, Graphopsocus cruciatus, Lepsima saccharina, Fornicula auricularia, Bombus terrestris.

Keywords: Osmia bicornis L., nest, accompanying fauna, parasites, cleptoparasites

Nest parasites and cleptoparasites are an important factor restricting the population of mason bees, particularly in large bee aggregations (16, 21) or managed bee farms (22). The accompanying fauna was classified depending on the nutrition type: parasites feeding on eggs, larvae, pollen or nectar, causing the death of the host (12), as well as cleptobionts, cleptoparasites, parasites, predators, nest destroyers, and random nest dwellers (11). The most frequently described parasites and cleptoparasites in nests of solitary bees include *Cacoxenus indagator* (2, 4, 11), *Monodontomerus obscurus* (1, 2, 5, 11) and *Chaetodactylus osmiae* (2, 11). Parasites and cleptoparasites usually enter open brood cells at the time when the female is collecting pollen. The risk of parasitism in open cells is correlated with the provisioning time (15). Providing bees with a food base rich in flower pollen shortens the time when the nest is left unattended and results in obtaining larger and more efficient pollinators (9).

The diversity and richness of the accompanying fauna is influenced by an increase in the mason bee population (11) and the ways of using the nests (13, 14). At nesting sites existing for five years or more increased bee mortality can be observed, caused among other things by parasitism and predation (18). The aim of this research was to determine the number of fully formed cocoons and dead larvae, as well as the species and number of parasites and cleptoparasites in annual nesting sites of *O. bicornis*, and to compare these data with those for a site populated for many years.

Tab. 1. Plants growing near the nest sites at new and perennial nesting sites

M1 – Kłoda	M2 – Sąpłaty	M3 – Kanie	M4 – SGGW
Orchard (within 10 m): *Malus domestica* Borkh., *Cerasus vulgaris* Mill., *Prunus domestica* L., *Ribes rubrum* L.	Orchard (within 10 m): *Malus domestica* Borkh., *Prunus domestica* L., *Pyrus communis*, *Ribes rubrum* L.	Orchard (within 50 m): *Malus domestica* Borkh., *Prunus avium* L., *Quercus robur* L.	Orchard (within 50 m): *Malus domestica* Borkh., *Prunus domestica* L., *Quercus robur* L.
Forest (within 30 m): *Pinus* L. sp., *Quercus robur* L., *Quercus rubra* L., *Tilia cordata* Mill., *Picea abies* Dietr.	Forest (within 100 m): *Pinus* L. sp., *Quercus robur* L., *Tilia cordata* Mill., *Picea abies*. Dietr.	Forest (within 30 m): *Pinus* L. sp., *Betula* L.	Parkland (Skarpa Ursynowska Reserve) (within 30 m): *Quercus robur* L., *Betula pendula* Roth., *Populus tremula* L., *Tilia cordata* Mill., *Acer platanoides* L., *Ulmus glabra* Huds., *Acacia* Mill. sp.
Garden (within 5 m): *Crocus* L., *Primula* L., *Narcissus jonquilla* L., *Chionodoxa* Boiss.	Garden (within 5 m): *Crocus* L., *Primula* L., *Caltha palustris* L., *Narcissus jonquilla* L.	Garden (within 5 m): *Crocus* L., *Primula* L.	Parkland flowers (within 50 m): *Lilium martagon* L., *Lycopodium clavatum* L., *Convallaria* L., *Anemone nemorosa* L.

Material and methods

The research was conducted at four sites in four locations in Poland. At each of the three sites, i.e. in Kłoda near Kozienice, Masovian Voivodeship (M1), Sąpłaty near Szczytno, Warmian-Masurian Voivodeship (M2), Kanie near Pruszków, Masovian Voivodeship (M3), artificial nests of common reed (*Phragmites australis*) and 1500 mason bee cocoons were placed for the first time. The fourth site was an experimental apiary of the Agricultural University of Life Science in Warsaw – SGGW (M4), where red mason bees had been nesting every year for over 10 years. Every year new nest material was provided for the bees, and cocoons were selected (cocoons which were damaged, moldy or attacked by parasites/cleptoparasites).

At all three sites where artificial traps with cocoons were placed, there were many species of spring blooming plants (Tab. 1). They provided a rich food base abundant in pollen, a necessary condition for obtaining large bees and efficient pollinators (9, 23).

The artificial nests were located in dry and sunny places, 160-200 cm above the ground, with the entrance holes directed to the south-east or south.

The M2 site was located in a cooler part of Poland (the Warmian-Masurian Lake District), where the diurnal temperatures in individual months April-August were lower on average by 1.8-2°C.

The artificial nests were built of reed (*Phragmites australis*) – material most frequently chosen by mason bees (20). The diameter of reed tubes for mason bees should fall in the range of 5-7 mm (7), 6-7 mm (20), 7-8 mm (23). The nest tube diameter was varied (Tab. 2). About 80-88% of tubes used in the research had a diameter of 5-8 mm. During bees' active period (from mid-April to the end of June), species of the accompanying and parasitic fauna were observed.

In the autumn and winter of 2012, an analysis of randomly selected reed tubes was conducted, 400 tubes from each site. The numbers of cells with dead larvae, fully formed and parasitized cocoons were determined and compared. Species of accompanying fauna were determined along with their numbers at the perennial (M4) and the three annual (M1, M2, M3) red mason bee nesting sites.

Additionally, from each analyzed portion of nest material from M1, M2, M3 and M4, 400 cocoons were selected and opened with a scalpel to determine the number of cocoons containing *Anthrax anthrax*.

The data were analyzed statistically by the SPSS-17 program. The Kolmogorov-Smirnov test was applied to determine whether the distribution of the data differed significantly from the normal one. Since it differed, the nonparametric Kruskal-Wallis and Mann-Whitney and Chi-Square tests were used for statistical comparisons.

Tab. 2. Characteristics of artificial nests of common reeds for solitary bees (*O. bicornis*) at new and perennial nesting sites

Nesting site	Tubes			
	Length		Diameter	
	Min-Max	Mean	Min-Max	Mean
M1 – Kłoda	10-29	16.7	4-10	6.5
M2 – Sąpłaty	11-24	16.7	4-13	6.5
M3 – Kanie	8-22	15.4	4-12	6.0
M4 – SGGW	11-24	15.8	4-12	6.4
Total	10-29	16,1	4-13	6.3

Results and discusion

Distributions of the analyzed data. The distributions of all features analyzed differed significantly from the normal distribution (Kolmogorov-Smirnov test and Shapiro-Wilk test, $P \leq 0.00$). Tab. 4 shows that the distribution of healthy cocoons was slightly skewed (below 0.50), and that of dead larvae as well as parasites and cleptoparasites was highly skewed (above 1, Tab. 3 and Tab. 4, respectively).

The number of dead larvae and fully formed cocoons. Tab. 4 indicates that at the sites where mason bee colonies were set up for the first time, significantly larger numbers of fully formed cocoons were obtained

Tab. 3. Fully formed cocoons and dead larvae in nest traps for *O. bicornis* L. at new and perennial nesting sites

Nesting site (400 tubes)	Chambers								Total
	Fully formed cocoons				Dead larvae				No
	No	per 1 tube			No	per 1 tube			
		Mean ± s.e	Median	Skewnees ± s.e		Mean ± s.e	Median	Skewnees ± s.e	
M1 Kłoda	2766	6.9 ± 0.1	7^{b}*	–0.38 ± 0.1	292	0.7 ± 0.1	0^{b}	2.3 ± 0.1	3058
M2 Sąpłaty	2784	7.0 ± 0.1	7^{b}	0.2 ± 0.1	337	0.8 ± 0.1	0^{b}	1.6 ± 0.1	3121
M3 Kanie	2657	6.6 ± 0.1	7^{b}	0.2 ± 0.1	118	0.4 ± 0.1	0^{a}	–0.4 ± 0.1	2775
M4 SGGW	2308	5.8 ± 0.1	6^{a}	0.4 ± 0.1	317	0.8 ± 0.1	0^{b}	2.3 ± 0.1	2625

Explanations: * Different letters in columns indicate significant differences in mean ranks of the groups; Kruskal-Wallis test fully formed cocoons χ^2 = 59,53, df = 3, P < 0.01, dead larvae χ^2 = 52,02, df = 3, P < 0.01, U Mann-Whitney test (pairwise comparisons), P < 0.01

Tab. 4. The most common parasitoids and cleptoparasites in nest traps for *O. bicornis* L. at new and perennial nesting sites

Site	Chambers												Total
	Cacoxenus indagator				*Monodontomerus obscurus*				*Chaetodactylus osmiae*				No
	No	Per 1 tube			No	Per 1 tube			No	On 1 tube			
		Mean ± s.e	Median	Skewness ± s.e		Mean ± s.e	Median	Skewness ± s.e		Mean ± s.e	Median	Skewness ± s.e	
M1 Kłoda	113	0.28 ± 0.03	0^{A}*	1.73 ± 0.12	15	0.04 ± 0.02	0^{A}	3.38 ± 0.12	52	0.13 ± 0.02	0^{A}	3.04	180
M2 Sąpłaty	111	0.28 ± 0.04	0^{A}	3.50 ± 0.12	13	0.03 ± 0.01	0^{A}	6.95 ± 0.12	38	0.10 ± 0.02	0^{A}	4.73	162
M3 Kanie	198	0.49 ± 0.05	0^{B}	3.25 ± 0.12	57	0.14 ± 0.01	0^{B}	2.78 ± 0.12	15	0.37 ± 0.01	0^{C}	6.31 ± 0.12	261
M4 SGGW	397	0.99 ± 0.07	1^{C}	3.21 ± 0.12	62	0.16 ± 0.02	0^{B}	6.32 ± 0.12	133	0.33 ± 0.04	0^{B}	5.05	592

Explanations: * Different letters in columns indicate significant differences in mean ranks of the groups; Kruskal-Wallis test *C. indagator* χ^2 = 148,71, df = 3, P < 0.01; *M. obscurus* χ^2 = 46,69, df = 3, P < 0.01; *C. osmiae* χ^2 = 65,31, df = 3, P < 0.01; U Mann-Whitney test (pairwise comparisons), P < 0.01

– M1 = 6.9 (U = 59328, N1 = N2 = 400, P ≤ 0.01), M2 = 7.0 (U = 58091, N1 = N2 = 400, P ≤ 0.01), and M3 = 6.6 (U = 64621, P ≤ 0.01) – than at the site where *O. bicornis* had been nesting for many years (M4 = 5.8).

The average numbers of dead larvae per one tube at the M1, M2 and M4 sites were similar (0.73-0.84) (Tab. 3). The smallest number of dead larvae were found at the M3 site (only 0.4 cells/tube, U Mann-Whitney test, P ≤ 0).

The most important nest parasites and cleptoparasites. *C. indagator* occupied almost 60-70% of all parasitized cells at sites M1, M3 and M4. Only at the M2 site most cells were occupied by *C. osmiae* (56%). *M. obscurus* occupied ca. 10-20% of the infested cells (Fig. 1).

C. indagator, occupied 2-3 times as many brood cells at the perennial (M4) site as at the new mason bee nesting sites (M1, M2 and M3), (U Mann-Whitney test, P ≤ 0.01). *M. obscurus* occupied a similar number of brood cells at the M3 and M4 sites (0.14 and 0.16 cells/tube, respectively), (U Mann-Whitney test, P ≤ 0.01). A significantly larger number of cells parasitized by *C. osmiae* was determined not at the perennial site, but at one of the new nesting sites: M3 (0.37 cells/tube), (Tab. 4).

Other species of accompanying fauna. Apart from *C. indagator*, *M. obscurus* and *C. osmiae*, 2-4 other accompanying fauna species were identified at sites M1, M2 and M3, whereas at site M4 as many as 11 species were found (Tab. 5).

Other species found in the mason bee nests occupied 2-9% of the infested brood cells (Fig. 1). Some of them were also found at the bottom of the cases in which the nest material was placed (*Tribolium castaneum*, *Ptinus fur*, *Trogoderma glabrum*) or were observed while penetrating the nests (*Chrysis ignita*, *Anthrax anthrax*), (Tab. 5).

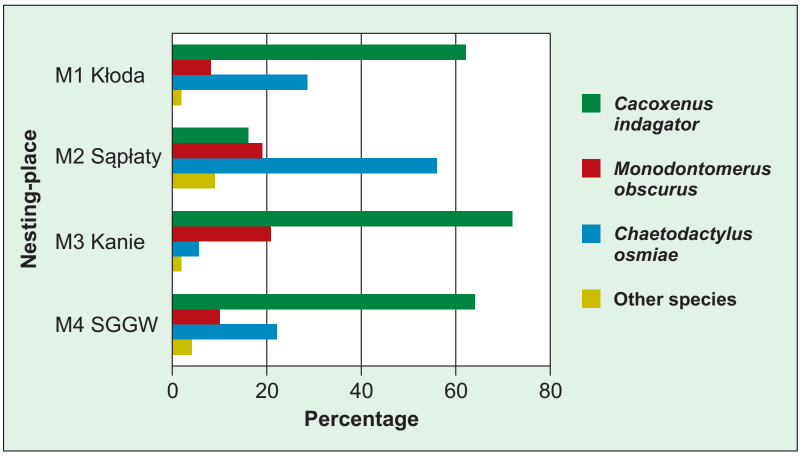

Fig. 1. Percentage of parasites in infested chambers in nest traps for *O. bicornis* at new and perennial nesting sites

Tab. 5. All species found in the nests (not only in cells) in nest traps for *O. bicornis* L. at new and perennial nesting sites

	Species	M1 Kłoda	M2 Sąpłaty	M3 Kanie	M4 SGGW
1	*Cacoxenus indagator* (Loew, 1858)	+	+	+	+
2	*Monodontomerus obscures* (Westwood, 1833)	+	+	+	+
3	*Chaetodactylus osmiae* (Dufour, 1839)	+	+	+	+
4	*Tribolium castaneum* (Herbst, 1797)	+	–	+	+
5	*Dermestes lardarius* (L. 1758)	+	–	–	+
6	*Ptinus fur* (L. 1758)	–	–	–	+
7	*Trichodes apiaries* (L. 1758)	–	–	–	+
8	*Auplopus carbonarius* (Scopoli, 1763)	–	–	–	+
9	*Chrysis ignite* (L. 1758)	–	+	–	–
10	*Anthrax anthrax* (Scopoli, 1763)	–	–	–	+
11	*Graphopsocus cruciatus* (L. 1768)	–	+	+	+
12	*Lepisma saccharina* (L. 1758)	+	+	–	+
13	*Forficula auricularia* (L. 1758)	+	+	–	+
14	*Bombus terrestris* (L. 1758)	–	–	–	+

Larvae and imagines of the beetles *Tribolium castaneum* (identified in M1, M2 and M4) and *Dermestes lardiarius* (identified in M1 and M3) were found inside the cases with nest material (larvae and imagines). Imagines of the beetle *Ptinus fur* were observed in July/August in tubes opened by other pests. They fed on pollen spilled from cells and dead bee larvae (at the M4 site).

In summer (July/August), mason bee nests at the M1 site were visited by hymenopterans *Chrysis ignita*. At the M4 site, hymenopterans *Auplopus carbonarius* were observed to steal mortar, thus opening the outermost brood cells of the nests.

A. anthrax was classified by (11) as an important organism restricting populations of *O. cornuta* and *O. rufa*. These flies were found only at the M4 site. Cocoons from the M4 site infested by this parasite constituted 2% (8 out of 400) of the analyzed cocoons. At the other sites (M1, M2 and M3), these flies were not observed in the vicinity of the nests or in opened cocoons.

Other insects found in the nests of mason bees were psocids *Graphopsocus cruciatus* (in M2, M3 and M4), silverfish *Lepsima saccharina* (in M1, M2 and M4) and earwigs *Fornicula auricularia* (in M1, M2 and M4). In one nest tube at the M4 site, a wintering *Bombus terrestris* queen was found.

C. indagator, *M. obscurus*, and *C. osmiae* are among the parasites most frequently found in the nests of *O. cornuta* (1, 2), *O. lignarnia* (3) and *O. bicornis* (11), as well as *Megachile rotundata* Fabr. (5). This research confirmed that it is these species that most frequently infested the nests of *O. bicornis* at several locations in Poland, at both perennial (M4) and annual sites (M1, M2 and M3).

C. indagator occupied significantly more cells at the M4 site than at the sites where mason bee nests and cocoons were placed for the first time (M1, M2 and M3). In M4 *C. indagator* was present in almost every reed tube. *C. osmiae* parasitized significantly more brood cells in M3 than at other sites. *M. obscurus* parasitized a similar number of cells in M3 and M4.

The results of this study show that only the cleptoparasite *C. indagator* occupies significantly more brood cells at sites where a mason bee population has been maintained for many years. On the other hand, the level of nest parasitization by *M. obscurus* and *C. osmiae* is most probably dependent on the biotope (6) or other environmental factors. It can be concluded, therefore, that the number of parasites and cleptoparasites threatening the population of mason bees can be successfully limited by using new nest material (reed tubes) every year and by selecting cocoons (13, 14).

Nests of solitary bees (genera *Osmia* and *Megachile*) are inhabited by beetles from the families *Ptinae* (*Ptinae* L.), *Dermestidae* (*Dermestes*, *Trogoderma*) and *Cleridae* (*Trichodes*), (10, 11 17). The research confirmed the occurrence of beetles from the genera *Dermestes* (*Dermestes lardarius*) and *Trichodes* (*Trichodes apiarus*) at sites M1 and M4 and from the genera *Ptinus* (*Ptinus fur*) and *Tribolium* (*Tribolium castaneum*) at the M1 site. Moreover, in M4 nests nymphs and imagines of *Graphopsocus cruciatus* and flies of the species *Anthrax anthrax* were found. At none of the four nesting sites were the flies of the species *Hemipenthes morio* L. observed, described in bee nests located in Poznań by Fliszkiewicz et al. 2012 (6).

The nests of *O. bicornis* are frequently inhabited by other species from the genera *Magachile*, *Chalicodoma*, *Anthidium* (11), *Coelioxys*, *Stelis*, *Nomada*, *Melecta*, and *Crosica* (8). In this research, no insects belonging to the genera listed above were identified in any of the nesting sites. The observed insects, however, included hymenopterans from the genera *Auplopus* and *Chrysis*.

This research confirms that growth of a mason bee population is accompanied by an increase in the diversity of the accompanying fauna (11). At the new nesting sites, a total of 5-7 species were found, whereas at the perennial site as many as 14 species were identified.

References

1. *Bosch J.*: Improvement of field management of Osmia cornuta (Latreille) (Hymanoptera, Megachilidae) to pollinate almond. Apidologie 1994, 25, 71-83.
2. *Bosch J.*: Parasitism in wild and managed populations of the almond pollinator Osmia cornuta Latr. (Hymenoptera: Megachilidae). J. Apic. Res. 1992, 31(2), 77-82.

3. *Bosch J., Kemp W.*: How to Manage the Blue Orchard Bee as an Orchard Pollinator, Sustainable Agriculture Network Handbook Series 5, National Agricultural Library, Bestville 2001.
4. *Countin R., Desmier de Chenon R.*: Biologie et comportement de Cacoxenus indagator Loew (Dipt., Drosophilidae) cleptoparasite d'Osmia cornuta Latr. (Hym., Megachilidae), Apidologie 1983, 14(3), 233-240.
5. *Eves J.*: Biology of Monodontomerus Westwood, a parasite of the Alfalfa Leafcutting, Megachile rotundata (Fabricius). Melanderia 1970, 4, 1-18.
6. *Fliszkiewicz M., Kuśnierczak A., Szymaś B.*: The accompanying fauna of solitary bee Osmia Bicornis (L.) Syn. Osmia Rufa (L.) nests settled in different biotopes. J. Apic. Sc. 2012, 56 (1), 51-58.
7. *Free J. B., Williams I. H.*: Preliminary investigations on the occupation of artificial nests by Osmia rufa L. (Hymenoptera, Megachilidae). J. Appl. Ecol. 1970, 73, 559-566.
8. *Friese H.*: Die Bienien, Wespen. Grab. – und Goldwespen. Stuttgart. Franklische Verlagshandlung. Stuttgart 1926, s.192.
9. *Giejdasz K., Wilkaniec Z., Piech K.*: Effects of seed onion pollination by red mason bee females Osmia rufa L. (Apoidea: Megachilidae) with different body weights. J. Apic. Sc. 2005, 49 (2), 21-27.
10. *Grassl R. F., Johansen C. A.*: Insecticidal baits tested for controlling Trogoderma variabile and Tribolium audax in nests of alfalfa leafcutting bees. J. Econ. Ent. 1973, 66 (2), 454-456.
11. *Krunić M., Stanisavljević L., Pinzauti M., Felicioli M.*: The accompanying fauna of Osmia cornuta and Osmia rufa and effective measures of protection. Bulletin of Insectology 2005, 58 (2), 141-152.
12. *Linsley E. G.*: The ecology of solitary bees. Hilgardia (Berkeley) 1958, 27(19), 543-599.
13. *Madras-Majewska B., Zajdel B., Grygo M.*: Section analysis of after born mason bee (Osmia rufa L.). Ann. Warsaw Univ. of Life Sc. – SGGW 2011, 49, 103-108.
14. *Madras-Majewska B., Zajdel B., Boczkowska A.*: The influence of nests usage on mason bee (Osmia rufa L.) survival. Ann. Warsaw Univ. of Life Sc. – SGGW 2011, 49, 115-119.
15. *Seidelmann K.*: Open-cell parasitism shapes maternal investment patterns in the red mason bee Osmia rufa. Behav. Ecol. 2006, 17(5), 839-848.
16. *Szymaś B.*: Entomofauna pasożytnicza ograniczająca populację pszczół samotnie żyjących (Apidae solitariae). (Parasitis entomofauna as a factor limiting the population of solitary bees.). Przegląd zoologiczny 1991, 35(3-5), 307-313.
17. *Tasei J. B.*: Observations sur le développement d'Osmia cornuta Latr. et Osmia rufa L. (Hym., Megachilidae). Apidologie 1975, 4(4), 295-315.
18. *Tscharntke T., Gathmann A., Steffan-Dewenter I.*: Bioindication using trap--nesting bees and wasps and their natural enemies: community structure and interactions. J. Appl. Ecol. 1998, 35(5), 708-719.
19. *Wilkaniec Z., Giejdasz K.*: Suitability of nesting substrates for the cavity-nesting bee Osmia rufa. J. Apic. Res. 2003, 42, 29-31.
20. *Wilkaniec Z., Giejdasz K., Fliszkiewicz M.*: The influence of food amount consumed during the larval development on the body weight of the imago of the red mason bee (Osmia rufa L., Megachilidae). J. Apic. Sc. 2004, 48 (1), 47-54.
21. *Wójtowski F., Szymaś B.*: Entomofauna pasożytnicza i towarzysząca pszczołom samotniczym (Apoidea solitariae) w pułapkach gniazdowych. Rocz. AR. w Poznaniu 1973, 66, 171-179.
22. *Wójtowski F., Wilkaniec Z.*: Próby hodowli pszczół miesiarek i murarek (Hymenoptera, Apoidea, Megachilidae) w pułapkach gniazdowych. Rocz. AR. w Poznaniu 1969, 42, 153-165.
23. *Wójtowski F., Wilkaniec Z., Szymaś B.*: Increasing the total number of Osmia rufa (L.) (Megachilidae) in selected biotopes by controlled introduction method, [in:] Banaszak J. (Eds): Changes in the fauna of wild bees in Europe. Pedagogical University 1995, s. 177.

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