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PRELIMINARY INVESTIGATIONS ON THE OCCUPATION OF ARTIFICIAL NESTS BY *OSMIA RUFA* L. (HYMENOPTERA, MEGACHILIDAE)

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INTRODUCTION

Several workers (e.g. Fabre 1915; Balfour-Browne 1925; Frost 1943; Kloet 1943; Levin 1957) have induced solitary bees, including species of *Osmia*, *Megachile* and *Anthidium*, to nest in glass tubes or in artificial tunnels made in bramble stems and wooden blocks. Peck & Bolton (1946) put various types of trap nests near a lucerne field to attract *Megachile* spp., which are good pollinators of lucerne, but met with little success and failed to increase the wild bee population. However, more recently *M. rotundata*, which was inadvertently introduced to North America from eastern Europe or western Asia about 1930, has been used extensively in the north-west of North America to pollinate lucerne (e.g. Bohart 1962; Stephen 1962; Hobbs 1964). If a solitary bee is to be used commercially for pollination it must ideally: readily occupy artificial domiciles, be gregarious, increase its population fairly rapidly and visit the crop concerned in preference to others. *M. rotundata* fulfils these criteria. Possibly other species with different, or wider, flower preferences could be similarly used and we are attempting to find such bees.

METHOD AND RESULTS

The trap nests used consisted of new metal food cans (72 mm in diameter and 115 mm long) without lids, filled with drinking straws. About half the cans contained straws of 7 mm diameter only (mean of seventy-six straws per can) and about half had approximately equal numbers of 7 mm and 5 mm diameter straws (mean of forty-six straws of each size). The straws were anchored by having their ends embedded in a thin layer of paraffin wax in the base of the cans. The cans were attached to the branches of trees and to fence posts at 1–2 m above ground. The open end of each can faced east or south and was tilted slightly downwards from the horizontal to prevent rain entering the straws.

In March 1966, a total of 398 cans were distributed in Hertfordshire (seven sites), Bedfordshire (three sites), Cambridgeshire (three sites), Huntingdonshire (two sites), Suffolk (two sites), Leicestershire (one site), Oxfordshire (one site) and Essex (one site). In September, 349 of these cans were recovered and forty-four (12·6%) had one or more straws occupied with *Osmia rufa* nests. In 1967, 1968 and 1969 cans were placed at six, six and three respectively of the above sites (Table 1). The variation in the percentages of success at different sites was less between different years on the same site than between different sites in the same year ($P < 0{\cdot}05$).

Straws containing nests were stored at outside temperatures during the winter, and in March three or six of them were interspersed among empty straws in some of the cans at five sites in 1967, at four sites in 1968 and at three sites in 1969 (Table 1). In September

Table 1. *Occupation of trap-nests by* Osmia rufa

Site	Cans originally containing empty straws										Cans originally containing some straws with nests					
	No. recovered				% that contained *O. rufa* nests						No. recovered			% that contained *O. rufa* nests		
	1966	1967	1968	1969	1966	1967	1968	1969	Mean 1966–68	Mean for all years	1967	1968	1969	1967	1968	1969
Rothamsted (Hertfordshire)	38	10	20	92	31·6	20·0	35·0	12·9	28·9	24·9	6	14	30	83·0	50·0	30·0
Monks Wood (Huntingdonshire)	45	76	76	138	13·3	31·6	5·3	15·2	16·7	16·4	7	15	31	71·4	66·6	51·6
Tring (Hertfordshire)	17	30	41	130	23·5	10·0	7·3	13·1	13·6	13·5	–	5	29	–	20·0	24·1
Luton Hoo (Bedfordshire)	33	36	18	–	18·1	22·5	16·7	–	19·1	–	5	5	–	100·0	60·0	–
East Hyde (Bedfordshire)	24	28	34	–	8·3	10·7	3·4	–	7·5	–	4	–	–	50·0	–	–
Kinsbourne Green (Hertfordshire)	13	16	17	–	0	0	5·9	–	2·0	–	7	–	–	85·7	–	–
All sites	170	196	206	360	17·6	24·5	9·2	13·7	17·1	18·3	29	39	90	79·3	53·8	35·2

Table 2. *Relationship between the number of straws containing nests at the beginning and end of the season in cans with occupied straws in March*

Site	1967			1968			1969		
	No. cans	No. straws containing *Osmia rufa* nests		No. cans	No. straws containing *Osmia rufa* nests		No. cans	No. straws containing *Osmia rufa* nests	
		In March	In September		In March	In September		In March	In September
Rothamsted	6	15	25	14	42	42	9	27	56
Monks Wood	7	15	102	15	63	179	16	48	101
Tring	0	–	–	5	21	3	7	21	14
Luton Hoo	5	15	14	5	15	16	0	–	–
East Hyde	4	6	11	0	–	–	0	–	–
Kinsbourne Green	7	18	21	0	–	–	0	–	–
All sites	29	69	173	39	141	240	32	96	171

APP E F

1967 a total of twenty-three out of twenty-nine (79%) cans given occupied straws contained new *O. rufa* nests, whereas only forty-five cans out of 166 (27%) at the same sites that were given empty straws only did so ($P < 0{\cdot}001$). In September 1968 twenty-one out of thirty-nine (54%) cans given occupied straws, and only seventeen out of 155 (11%) given only empty straws, contained new *O. rufa* nests ($P < 0{\cdot}001$). In 1969, thirty-two of ninety (36%) cans given occupied straws were later nested in, compared with fifty out of 360 (14%) of cans put out with empty straws only ($P < 0{\cdot}001$). In each year, the numbers of cells per occupied straw were similar in the two types of can. There were significant differences between the attractiveness of cans with and without nests at Kinsbourne Green in 1967 and at Monks Wood in 1968 and 1969 ($P < 0{\cdot}001$ for each comparison). In 1968 at Monks Wood, nine cans given three occupied straws each initially had a mean of 11·1 occupied straws later, and six cans given six occupied straws each had a mean of 11·7 later.

At most sites the number of straws that were occupied was on average similar to the number of occupied straws put in the can at the beginning of the season; however, at Monks Wood there was a seven-fold increase in 1967, a three-fold increase in 1968 and a two-fold increase in 1969 (Table 2). The weather during the early summer in 1969 was exceptionally unfavourable for bee flight.

Cans with occupied straws in autumn tended to contain more when they had contained some occupied straws in the spring than when they had contained empty straws only in the spring (mean of 6·0 and 5·1 occupied straws per can in 1967, difference not significant; means of 12·0 and 3·6 occupied straws per can in 1968, $P < 0{\cdot}01$; means of 5·3 and 5·2 occupied straws per can in 1969, difference not significant).

The 141 straws with nests in spring in 1968 were distributed in a total of thirty-nine cans, which also contained a total of 3192 empty straws. In autumn thirty-five of these straws with nests contained dead bees, so there were only 106 empty straws that had previously contained nests available to the nesting bees. *O. rufa* subsequently occupied fourteen of the 106 straws (13·2%) compared with 226 of the 3192 (7·1%) ($P < 0{\cdot}05$). There had been a mean of 4·6 bees per straw in the 141 straws with nests at the beginning of the season, and at the end of the season the thirty-five straws with dead bees had a mean of 2·3 dead ones per straw, a mortality of 12%.

The tendency of cans that have already been occupied by *O. rufa* to be reoccupied may be either because bees that emerged from them orientated on leaving and returned later from memory of the precise or approximate positions of the cans, or because the smell of a previously occupied nest attracts searching bees, or both. An attempt to investigate attractiveness, by giving twenty-one of the cans used in 1969 (seven at each site) three empty straws from which *O. rufa* had already emerged, gave no evidence for it. The proportion of these cans that were occupied by *O. rufa* (24%) did not differ significantly from that of cans put out with clean empty straws (14%) or of cans put out containing three straws with *O. rufa* nests (36%).

To find the proportions of the different types of pollen collected by *O. rufa*, the faecal and uneaten pollen was removed from ten cells at each of the six different sites used in 1968 and 500 pollen grains from each cell were identified (Table 3). Only few of the species flowering at a site were visited. At four sites the most abundant pollen collected was *Quercus robur*, at two sites it was *Ranunculus* spp. and at one site was *Rubus* spp.

In 1968 and 1969 records were made of nests built by other Hymenoptera; these included the bees *Osmia coerulescens* and *Megachile* spp. and solitary wasps, *Ancistrocerus* spp. (Table 4). When straws of both diameters were present together in the same

Table 3. *The percentage of different pollens collected at the different sites*

Site	*Quercus robur* L.	*Ranunculus* spp.	*Rubus* spp.	*Acer pseudo-platanus* L.	*Syringa vulgaris* L.	*Aesculus hippocastanum* L.	Cruciferae spp.	*Trifolium repens* L.	*Ilex aquifolium* L.	*Fragaria* × *ananassa* Duchesne	*Clematis montana* D.C.	*Pyrus malus* L.	*Crataegus monogyna* Jacq	Unidentified
Rothamsted	29·1	62·2	0	4·6	0	0·2	3·0	0	0	0	0·9	0	0	0
Luton Hoo	45·5	3·7	0	44·6	6·1	>0·1	>0·1	0	0	0	0	0	0	0
Monks Wood	55·8	40·9	0	0	0	0	0	2·9	0	0	0	0	0·4	0
Tring	11·3	43·2	44·9	0	0·3	>0·1	>0·1	0·2	0	0	0	0	0	0
East Hyde	87·5	0·9	0	0	0	3·6	0·9	0	0	0	0	0·8	0	6·3
Kinsbourne Green	75·9	17·8	1·0	>0·1	0	0·2	0	0	1·8	1·2	0	0·5	0	1·6

Table 4. *Distribution of different species of Hymenoptera among straws of different diameters (number of cells, when known, given in parentheses)*

Diameter of straws in can		No. *Osmia rufa*		No. *O. coerulescens*		No. *Megachile* spp.		No. *Ancistrocerus* spp.	
		5 mm straws	7 mm straws	5 mm straws	7 mm straws	5 mm straws	7 mm straws	5 mm straws	7 mm straws
5 mm only	1968	–	–	–	–	–	–	–	–
	1969	5(7)	–	41(181)	–	0	–	26(56)	–
7 mm only	1968	–	80(346)	–	2(16)	–	28	–	10
	1969	–	190(737)	–	7(50)	–	18(85)	–	10(44)
5 and 7 mm	1968	49(122)	179(811)	43(187)	1(5)	2	17	85	15
	1969	21(62)	229(1017)	71(401)	11(69)	1(4)	63(227)	200(590)	18(98)

cans *Osmia coerulescens* and *Ancistrocerus* spp. preferred straws of the smaller diameter and *Osmia rufa* and *Megachile* spp. the larger diameter ($P < 0{\cdot}01$ for each comparison for each year). When *Osmia rufa* did nest in the smaller straws it built only 2·4 and 3·0 cells per straw, compared to 4·5 and 4·4 in the larger ones in 1968 and 1969 respectively ($P < 0{\cdot}001$). *O. coerulescens* and *Ancistrocerus* spp. also built fewer cells per small than per large straw (5·2 : 6·6 and 2·9 : 5·1 respectively).

In 1968 the number of cans with only large diameter straws and the number with equal quantities of straws of both diameters were similar, so there were approximately twice as many large diameter straws in the former cans. However, despite this ratio, cans with straws of both diameters contained more *Osmia rufa* nests ($P < 0{\cdot}001$) than cans with only large straws. Why the bees preferred 7 mm straws in the presence of the smaller straws is difficult to explain; perhaps the uneven appearance created by a mixture of straws of different diameters may have facilitated nest site selection and orientation.

Data on *Megachile* spp. were insufficient to compare the attractiveness to them of cans that had been occupied previously with those that had not, but in 1969, 31% of fourteen cans that were put out containing *Osmia coerulescens* nests were reoccupied by *O. coerulescens* and only 4% of 477 previously unoccupied ones ($P < 0{\cdot}001$). *Ancistrocerus* spp. showed no tendency to favour previously occupied sites. In 1968, a total of 101 straws containing *Ancistrocerus* nests was distributed between eighteen cans in three sites; wasps nested again in four of these cans and occupied a total of only ten straws. At the same three sites, eight out of eighty-eight cans containing only empty straws were nested in by wasps, which occupied a total of thirty straws. In 1969, 9% of twelve cans put out occupied by *Ancistrocerus* spp. were reoccupied by *Ancistrocerus* spp. and 16% of 479 cans put out with empty straws.

DISCUSSION AND CONCLUSIONS

There is no evidence whether *Osmia rufa* learns the site of its parental nest on leaving it, but as straws previously nested in were favoured by the searching bees, the smell of such straws seems important, although we could not demonstrate this. Also, although twice as many bees emerged from cans with six as with three straws, similar numbers of bees nested in the two types of cans, which further suggests that any tendency of individual bees to learn their site of emergence and return to it, is less important than the attraction of the smell of previously occupied straws.

There was no evidence that the population of *O. rufa* in any area was limited by lack of nesting sites; in the year when there were fewest cans at a particular site, the proportion of occupied ones did not increase, nor did the number of nests they contained.

In the favourable circumstances, as existed at Monks Wood, *O. rufa* showed a strong tendency to nest gregariously and the trap nest population increased at a rate that does not compare too unfavourably with the five-fold increase per season of *Megachile rotundata* (Bohart 1962; Stephen 1962). In contrast, *Ancistrocerus* spp. showed no tendency to nest gregariously.

The proportion of cans occupied by bees in a given site probably reflects the bee population present. Although *Osmia rufa* is not an oligolectic species it shows strong preferences for collecting pollen from *Ranunculus* spp. and *Quercus robur*. Probably the abundance of these species partly accounts for differences in the *Osmia rufa* population at different sites, and the particular conditions favourable for increase of the population in artificial nests at Monks Wood may be associated with an abundance of

suitable flower species within short foraging distance of the nests. At one site a large proportion of pollen came from *Rubus* spp., so the population of *Osmia rufa* could possibly be increased with benefit near commercial plantations of *Rubus idaeus*. Because of its adaptability to different plants, *Osmia rufa* might prove useful for pollinating other species grown commercially.

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SUMMARY

Initial trials indicated that *Osmia rufa* tends to nest at sites it has previously occupied and in some places rapidly increased its nesting population in artificial domiciles.

REFERENCES

Balfour-Browne, F. (1925). *Concerning the Habitats of Insects.* Cambridge.

Bohart, G. E. (1962). How to manage the alfalfa leaf-cutting bee (*Megachile rotundata* Fabr.) for alfalfa pollination. *Circ. Utah agric. Exp. Stn*, No. 144, pp. 1–7.

Fabre, J. H. (1915). *Bramble-bees and Others* (Translated by A. Mattos). London.

Frost, S. W. (1943). An observation box for solitary bees and wasps. *J. econ. Ent.* **36,** 803–4.

Hobbs, G. A. (1964). Importing and managing the alfalfa leaf-cutter bee. *Publs Dep. Agric. Can.* No. 1209, pp. 1–8.

Kloet, G. S. (1943). Some improved rearing devices. *Amat. Ent.* **7,** 94–101.

Levin, M. D. (1957). Artificial nesting burrows for *Osmia lignaria* Say. *J. econ. Ent.* **50,** 506–7.

Peck, O. & Bolton, J. L. (1946). Alfalfa seed production in northern Saskatchewan as affected by bees with a report on means of increasing the populations of native bees. *Scient. Agric.* **26,** 338–418.

Stephen, W. P. (1962). Propagation of the leaf-cutter bee for alfalfa seed production. *Stn Bull. Ore. agric. Exp. Stn*, No. 586, pp. 1–16.

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