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Osmia Spp. Reared in Artificial Nesting Sites in a Backyard Environment

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Controlled pollination in field cages is used at the United States Department of Agriculture -Agricultural Research Service North Central Regional Plant Introduction Station (NCRPIS) for seed increase of several plant species. Honey bees, *Apis mellifera* L., have been used almost exclusively for several years. Recently we began investigating other pollinating insects for controlled pollination. *Osmia cornifrons* (Radoszkowski), a solitary bee imported from Japan, has been an excellent early-season pollinator. We placed domiciles of these bees in backyards of the NCRPIS staff to aid us in providing adequate numbers of bees for use in field cages the following growing season. We used an X-ray technique to aid in counting the number of bees present in rearing straws. We also note some of the different plants which the bees visited for food.

INDEX DESCRIPTORS: hornfaced bee, mason bee, Megachilidae, X-ray, *Apis mellifera, Osmia cornifrons*

The United States Department of Agriculture-Agricultural Research Service North Central Regional Plant Introduction Station (NCRPIS) located in Ames, IA has used honey bees, *Apis mellifera* L. (Hymenoptera: Apidae), for several years to effect pollination of several species of plants in field cages. Recent tests have shown that honey bees are not the most efficient bee species for cage pollinating certain plant species maintained at the NCRPIS (Wilson et al. 1997). Knowing this, we became interested in involving other species of bees in our pollination program.

We discovered a solitary bee imported from Japan in 1977 and decided to test it's effectiveness on some of the plant species maintained at the NCRPIS. This solitary bee, *Osmia cornifrons (Radoszkowski)* (Hymenoptera, Megachilidae), (Batra 1979) requires different management methods than do our traditional honey bees. Wilson and Abel (1996) determined the proper storage conditions for overwintering *O. cornifrons* so these bees could be used for pollinating early-season crops, e.g., *Brassica* spp.

The numbers of *O. cornifrons* must be increased each growing season in order to have sufficient densities for field cage pollinations. Some population increases are realized from bees kept in field cages, but this alone does not provide enough bees for the following season (Abel and Wilson 1998). Thus, we asked the NCRPIS staff to help us increase our supply of bees for use during the next growing season. Small domiciles (Fig. 1) were provided to participating staff members for placement in their backyards. After the pollination period was completed and the domiciles were collected, we needed a method of assessing the population increase. This paper reports the results of increasing *O. cornifrons* on local backyard plants and explains the use of X-rays to determine the numbers of bees obtained.

METHODS

The *O. cornifrons* used for this study were purchased from Orchard Bees (Auburn, Indiana). The domiciles (Fig. 1) consisted of 7.6-cm PVC pipe cut into 28-cm sections. One end was capped with a PVC end cap and the other end was cut at a 45 degree angle and covered with 12-mm hardware cloth (to keep out predators such as birds and squirrels). Two 0.6 cm eyebolts inserted in the top of the domicile were used to attach the domicile to tree branches with twine. Each domicile contained 12 filled nesting straws (~ 8 bees/straw; ~ 5 males and ~ 3 females) and 24 empty nesting straws to tightly fill the PVC pipe (Fig. 2). The filled nesting straws purchased from Orchard Bees were 30-cm long × 7-mm diameter cardboard tubes bent in half, thus forming two 15-cm long nests. The cardboard tube wall was 1-mm in thickness. The empty nesting straws (Custom Paper Tubes Inc., Cleveland, Ohio) were made from a 40-cm long × 7-mm diameter cardboard tubes bent in half, forming two 20-cm long nests. The cardboard tube wall of empty straws was 1.5-mm thick.

The domiciles were given to the NCRPIS staff with these handling instructions:

1. Secure the domiciles to a low-lying branch.
2. Face the domiciles to the south or southeast.
3. Place the domicile close to wet soil since the bees use mud to build their nests. Possible sources might be a small creek or even a watered garden that is well mulched. The bees will crawl down through the mulch to retrieve the mud they need. A hole or trench dug 30.5–45.7 cm deep (12″-18″) near the domicile would furnish the bees with a steady supply of mud as well.
4. Place the domicile in an area that has flowering fruit trees (e.g. apples, cherries, etc.). The bees will also visit flowers from many other plant species.
5. Do not move the domicile once it is in place. *Osmia* bees are able to recognize the location of their nests and will become disoriented and unable to find their domicile if it is moved even a short distance.
6. Two species of bees may nest in the domiciles. Bees that are dark metallic blue are a native-to-Iowa species, *Osmia lignaria lignaria* Say. Bees that have honey bee-like black and tan stripes on their abdomen are a native-to-Japan species, *Osmia cornifrons.*
7. The bees will follow this protocol when they emerge from the straws: (a) the smaller males generally emerge first, whereas the larger females will emerge later and immediately fly to the nearest blossom to gather nectar and pollen for their own use; (b) the female bees need to feed on pollen before their ovaries fully develop; and (c) after feeding they will mate with the males who have previously established a territory on surrounding structures.

Fig 1. A domicile used for rearing *Osmia* bees.

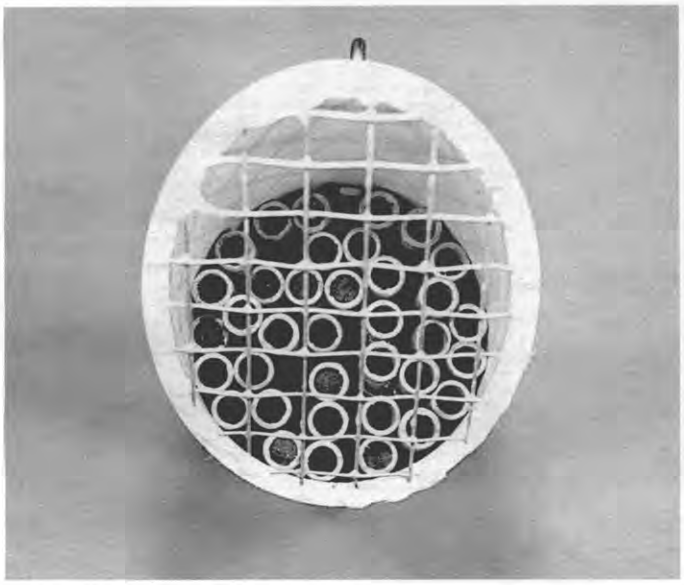

Fig. 2. A close up of a domicile showing the straws packed inside.

8. When bee activity ceases (~ 6 weeks), carefully remove the domicile and return it to the NCRPIS. Early removal will decrease predation and parasitization by other insects.
9. Do not jar or drop the domicile when returning it to the NCRPIS because the developing larvae might become dislodged from the pollen masses on which they were feeding.

The domiciles were placed outdoors beginning early May, 1996 and collected for analysis by early July, 1996. Participants were asked to record which plants the bees were foraging, other plants in the area of bee flight (ca. 91 m radius), and where the domiciles were actually placed, e.g., plant or structure and height.

When the straws were examined at the end of the project, newly filled straws were differentiated from old filled straws. Straws from the previous season, where the bees did not emerge, could be set apart by the color of the mud used to seal the straw's end. Filled straws purchased from Orchard Bees initially had a light colored clay plug in the end of the straw and newly sealed straws from Iowa increases had a dark colored silt-loam soil plug.

Table 1. Number of *Osmia* bees obtained from domiciles placed in backyards with number of days outdoors and height of domicile above ground.

DOMICILE ID[a]	NO. BEES	NO. DAYS OUTDOORS	HEIGHT OF DOMICILE (m)
1R	17	26	1.8
2R	22	54	1.5
3R	38	53	1.5
4R	44	53	1.5
5U	64	54	1.5
6U	68	54	1.5
7R	98	59	1.5
8R	114	59	1.5
9U	115	54	1.7
10R	116	59	1.5
11U	119	52	2.1
12U	176	53	2.1
13U	179	60	1.7
14U	184	53	1.5
15U	185	54	2.1
16U	259	54	2.4
17U	278	52	2.4
Avg.[b]	122 ± 78	53.1 ± 7.5	1.75 ± 0.33

[a]Data were arranged from low to high numbers of bees, then numbers were assigned to domiciles. R means domicile placed in a rural environment; U means domicile placed in urban environment
[b]Average ± standard deviation

We used a Hewlett-Packard Faxitron® Shielded Cabinet X-ray system to determine the actual number of bees in each straw. About 10, 15-cm, or 20-cm doubled straws were arranged lengthwise on a 20.3 × 25.4 cm X-ray exposure holder containing unexposed X-ray film. The straws were subjected to a voltage of 16 kVp for 3 min 30 s. The radiographs were developed in a Kodak® Industrex instant processor.

After drying, radiographs were examined in the following manner: The apparent fill depth of each side of each straw was measured in cm. From the radiograph, the number of cells was counted in each half of the doubled straw, and the contents of those cells were categorized as empty or containing previous year's pollen (no bees), nonemerged (dead) bees from last year, this year's pollen (no bees), or this year's diapausing adults.

Another method using a wire inserted into the straw to probe its contents was attempted. A measurement of how far the wire was inserted into the straw before encountering a cell wall gave an approximation of the depth of fill by the bees. This information was compared with the fill depth measured on the radiograph to determine if the wire could be used as a rapid check of the number of bees produced.

RESULTS AND DISCUSSION

The period of time the domiciles were outdoors ranged from 26 to 60 days, with the average time being 53.1 days, and the range of *Osmia* population increase was from 17 to 278 bees per domicile (Table 1). Five domiciles were not included in the analysis because of poor placement, storms knocking domiciles from trees, and ant infestations that seemed to result in little or no bee increase.

The peak bee increases were obtained from domiciles placed at a height of 2.4 m (Table 1). At this height, the domiciles were un-

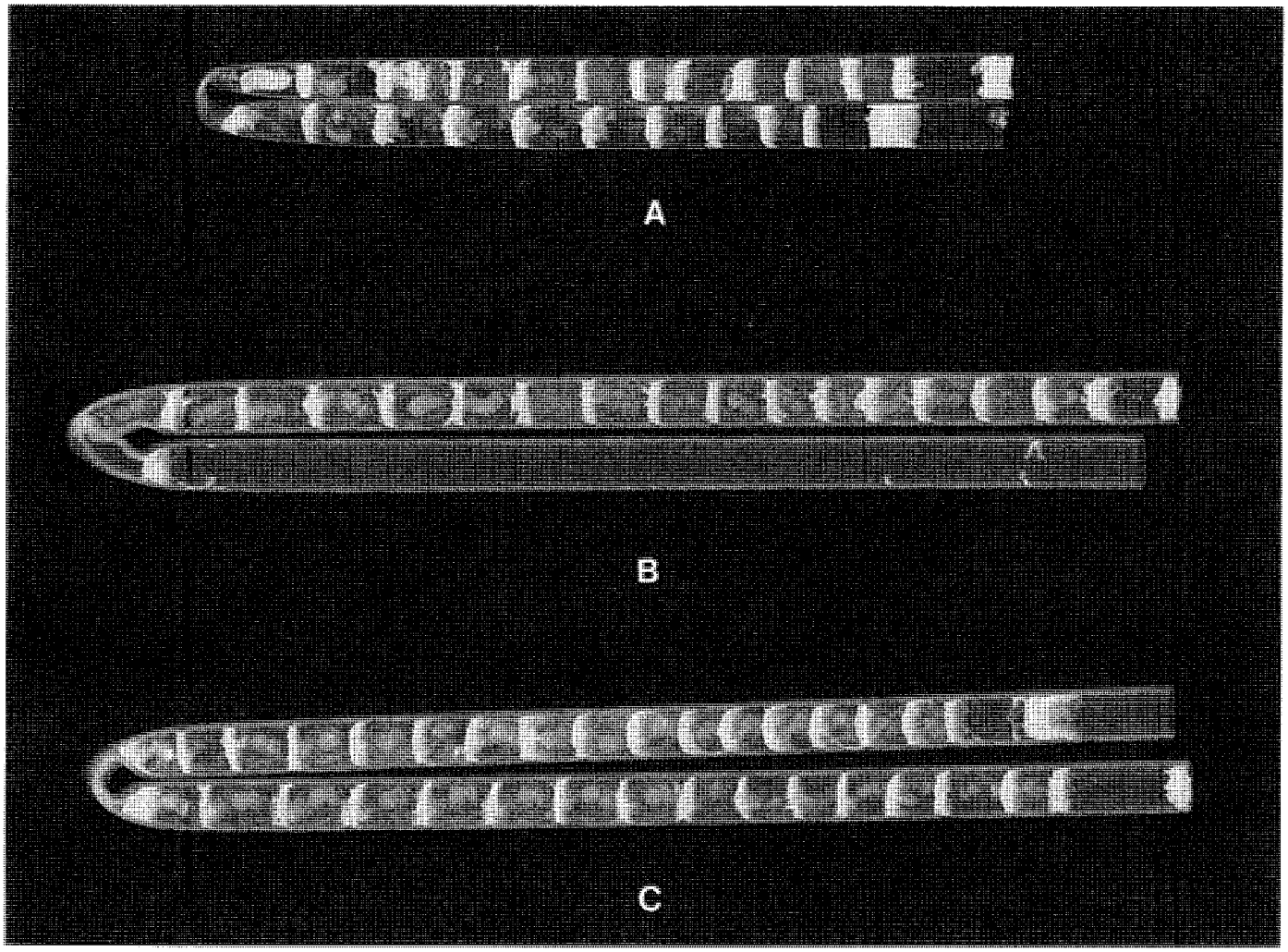

Fig. 3. A. Original straw obtained from Orchard Bees. B. A partly filled straw. C. A full straw showing adult bees inside the cells.

disturbed by normal backyard activities, e.g., mowing grass, children playing, etc. In the future, we recommend that the domiciles be placed at this height or higher.

Figure 3 shows a typical radiograph of the straws. Results varied in the two methods of measuring straw fill depth (i.e., how much of the straw was used by the female). Old cell dividers present in the previously used straws impeded the wire tool. We determined that this would not be a reliable method of determining bee numbers. Using the radiograph method is more expensive and time consuming, but the results are more dependable.

When we examined the backyard locations of where the domiciles were placed, the largest increase of bees was produced in landscaped residential areas. This might be due to the large diversity of plants that frequent a home landscape. Table 2 lists the genera and common names of plants where *Osmia* bees were actually observed foraging, however, the number and diversity of flowers available to the bees was much greater than those listed in Table 2. The bees may have utilized plants other than those listed in Table 2, but were jusr not observed on those plants.

We feel confident that landscape plants within a city, along with furnishing a domicile, provide conditions suirable for *O. cornifrons* to increase their numbers. Using this method will help provide an in-

Table 2. Genera and common names of plants observed with *Osmia* bees on their flowers.

GENUS	COMMON NAME
Acer	maple
Amelanchier	serviceberry
Berberis	barberry
Cornus	dogwood
Linum	flax
Malus	apple, crabapple
Nepeta	catnip
Paeonia	peony
Prunus	cherry, plum
Rosa	rose
Spiraea	spirea
Taraxacum	dandelion
Viburnum	viburnum

crease in bees for our use the following growing season in controlled pollination cages at the NCRPIS.

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