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Original article

Osmia cornuta (Hymenoptera, Megachilidae) as a pollinator of pear (*Pyrus communis*): fruit- and seed-set

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Abstract – To investigate the possibility of pollinating 'Abate Fetel' and 'Max Red Bartlett' pears with *O. cornuta*, different pollination treatments were compared in 1998 and 1999: (1) trees caged with *O. cornuta bees*; (2) open pollination – uncaged trees located at various distances from *O. cornuta* nesting shelters; (3) trees caged without bees. *O. cornuta* was the most abundant pollinator species in the orchard (97.6% of the observed insects). Caged trees pollinated by *O. cornuta* set significantly more fruitlets and matured more fruits than caged trees without pollinators. The fruitlet- and fruit-set in open-pollinated trees was intermediate between caged trees with *O. cornuta* and caged trees without bees in 'Abate Fetel' in 1998 and 'Max Red Bartlett' in 1999, but did not differ from fruitlet-set in non-pollinated trees in the other two variety-years. Open-pollinated trees had seed-sets comparable to caged trees with *O. cornuta*. The pollen provisions stored in *O. cornuta* nests were almost exclusively composed of *Pyrus* pollen. As evidenced by traces of *Prunus* pollen some *O. cornuta* foraged 400 m away from the nesting shelters.

Osmia cornuta* / pollination / fruitlet-set / fruit-set / *Pyrus communis

1. INTRODUCTION

Most varieties of cultivated pear, *Pyrus communis* L., are self-incompatible (McGregor, 1976; Sedgley and Griffin, 1989; Bellini, 1993; Free, 1993; Delaplane and Mayer, 2000). Parthenocarpy is frequent in some cultivars, but, in general, high fruit-set can only be accomplished through cross-pollination (Sedgley and Griffin, 1989; Bellini, 1993; Delaplane and Mayer, 2000). Honey bee, *Apis mellifera* L., colonies are usually rented for pear pollination, but pear flowers are not very attractive to honey bees, because they produce small amounts of nectar with low sugar content (McGregor, 1976; Sedgley and Griffin, 1989; Bellini, 1993; Free, 1993; Delaplane and Mayer, 2000). Inadequate pollination is therefore one of the main causes of flower and fruitlet drop, resulting in low production content (McGregor, 1976; Bellini, 1993; Free, 1993). Since 1994, fire blight, a bacterial disease caused by *Erwinia amylovora* (Burrill) Winslow et al., has been severely affecting the Emilia-Romagna region, the main Italian pear-growing area (Bellini, 1993). To reduce the potential dispersal of *E. amylovora* by honey bees (Larue et al., 1984; De Wael et al., 1990a, 1990b), a national decree (Ministerial Decree – 27 March 1996) was issued that forbade the movement of honey bee colonies during

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bloom from fire blight infected areas to those not infected. This severely limited the use of honey bees for pear pollination and prompted the search for a native pollinator with a shorter foraging range, which might reduce the spread of *E. amylovora*.

The mason bee *Osmia cornuta* (Latreille), appeared as an obvious candidate. This solitary bee occurs in Central and Southern Europe, Turkey and Northern Africa (Peters, 1977) and has been studied for crop pollination in different European countries, both in open field and in confined environments (Bosch, 1994a; Bosch and Blas, 1994b; Krunic et al., 1995; Pinzauti et al., 1997; Ladurner et al., 2000; Vicens and Bosch, 2000a, 2000b). *O. cornuta* foraging takes place at low temperatures (10 to 12 °C) compared to *A. mellifera* (12 to 14 °C) (Free, 1993; Bosch, 1994b; Vicens and Bosch, 2000b). Because of its higher rate of stigma contact, *O. cornuta* are more efficient pollinators on almond and apple flowers than *A. mellifera* (Bosch and Blas, 1994b; Vicens and Bosch, 2000a). Mason bees move from tree to tree more readily than honey bees, are less prone to orient along rows, thus enhancing cross pollination (Bosch and Blas, 1994b), and preferentially collect pollen from Rosaceae (Tasei, 1973b; Marquez et al., 1994). *O. cornuta* nest gregariously in artificial nesting materials (Pinzauti, 1991; Bosch, 1995; Krunic et al., 1995), and they are univoltine and over-winter as adults (Tasei, 1973a, 1973b). Several studies on storage conditions have demonstrated ways to reduce mortality during over-wintering, shorten emergence periods and synchronize bee emergence and activity with bloom of the target crop, favouring both flower pollination and bee reproduction (Bosch and Blas, 1994a; Felicioli, 1995; Krunic et al., 1995).

The aim of this study was to investigate the possibility of using *O. cornuta* as pollinators of two frequently grown pear varieties in Europe, 'Abate Fetel' and 'Max Red Bartlett', both highly self-incompatible and extremely susceptible to fire blight (Bellini, 1993). The following questions were addressed: (1) does *O. cornuta* readily use pear flowers as a preferred pollen-nectar source? (2) Does the presence of *O. cornuta* populations in a pear orchard increase fruit – and seed-set?

2. MATERIALS AND METHODS

2.1. Management of *O. cornuta* populations

The *O. cornuta* populations used had been reared in 1997 and 1998 on oilseed rape (*Brassica napus* L. var. *oleifera* DC.) at the University of Pisa, Italy. Reed section bundles of *Arundo donax* L. (Poaceaee) were provided as nesting material. At the end of rape bloom (end of May), nests were taken to the laboratory and kept at room temperature (20 ± 5 °C). At the beginning of October, *O. cornuta* cocoons were stripped out of the nesting materials, cleaned from parasites and nest destroyers, and placed in an incubator (16 ± 1 °C, 70 ± 10% R.H.) in plastic boxes with perforated lids. After 30 days cocoons were transferred to a refrigerator for over-wintering (4 ± 1 °C, 70 ± 10% R.H.). Two days before expected pear bloom, cocoons were transferred to 8 °C, then to 15 °C and finally to 20 °C within 48 hours.

On March 30, 1998, 850 adult bees (280 females and 570 males), some still in their cocoons and others already emerged, were released in the study orchard. In 1999, 500 adult bees (166 females and 334 males) were released in the orchard on April 5.

The 7 year-old study orchard was located in the Po Valley (45° N latitude, 11° E longitude, 30 m above sea level) near Bologna (Northern Italy). It measured 7 ha and was composed of 70 rows. 'Abate Fetel' was the main variety, and 'Max Red Bartlett' was the interplanted pollenizer variety (1 'Max Red Bartlett' tree every 13 'Abate Fetel' trees). Distance between rows was 4 m, and distance between trees within rows was 1.2 m. In both years, there was no honey bee hive within 2 km of the orchard and the cocoons were released in 5 nesting shelters: 170 individuals per shelter in 1998, and 100 in 1999. The shelters consisted of plastic boxes (35 × 25 × 30 cm) with the front side open and facing south, held 1.5 m above the ground on wooden fence posts. The shelters were placed in the centre of the orchard on rows 31, 33, 35, 37 and 39, respectively. Each shelter was provided with 4 nesting units made of grooved wooden boards (Pinzauti, 1991; Krunic et al., 1995). Each nesting unit had 63 nesting holes in 1998 and 81 nesting holes in 1999. Holes were 15 cm long and 8 mm in diameter. Other groups of bees were released in cages (see treatment 1 below) and provided with a bundle of reed sections as nesting materials.

2.2. Foraging and nesting activity

Pollinator foraging activity was recorded daily throughout the blooming period over 7 days (from

March 31 to April 6, 1998). It was measured by walking daily along rows 1, 17, 35, 52 and 70 (20 minutes per row every 2 hours, from 09:30 h till 17:30 h local time, i.e. 5 counts of 1 hour each day), and counting insects on pear flowers or flying in or around the pear canopy. Insects were grouped in three pollinator categories: *O. cornuta*, *A. mellifera* and other. In 1999, the heavy rainfalls and strong winds that occurred during bloom prevented pollinator counts.

When pear bloom had ended (10 days after bloom initiation), the nesting materials were brought to the laboratory, and the number of occupied nesting holes and provisioned cells were counted.

To assess the extend to which *O. cornuta* females foraged on pear flowers, palynological analyses were made on a sample of 358 provisions in 1998 and 50 in 1999. One glycerol jelly slide per provision was prepared (Kearns and Inouye, 1993), and 400 pollen grains per slide were counted. For each slide (i.e. provision) the percentage of pollen grains from different plant genera was determined. Provisions were grouped in classes according to the percentage of *Pyrus* pollen found in the samples: 0–9%, 10–19%, and so forth until 90–99%, and 100%.

2.3. Fruitlet-, fruit- and seed-set

Fruitlet-set (fruitlets retained on the tree before the June drop; Sedgley and Griffin, 1989), fruit-set (fruits at harvest) and seed-set (in harvested fruits) were measured on trees exposed to different pollination treatments. Five replicates (pairs of adjacent trees: one 'Abate Fetel', one 'Max Red Bartlett') were used in each treatment. The following pollination treatments were compared:

1. pairs of trees caged with 5 female and 5 male *O. cornuta*. Cage size was 3 × 3.5 × 3 m and screen mesh size 2 × 3 mm;
2. open pollination: trees located at different distances (0, 50, 100 and 150 m) from the nesting sites;
3. pairs of trees caged as in 1, but without bees.

When pear blossoms were in the popcorn stage, 30 inflorescence buds on each selected tree were labeled and the number of flowers in each bud was recorded. Fruitlets and mature fruits on the labeled buds were later counted. Fruitlet counts were conducted in April-May, after unfertilized flowers had been shed (Sedgley and Griffin, 1989). Fruit counts were conducted in August-September, after fruitlets had been shed (Sedgley and Griffin, 1989). Fruitlet-set is more directly correlated to pollination, but fruit-set provides a better indication of the economic value of improved pollination (Sedgley and Griffin, 1989). There is a strong correlation between pollination and seed-set in pear (Sedgley and Griffin, 1989; Bellini, 1993). In 1998, the number of seeds per fruit was counted on 20 fruits per selected tree. In 1999, due to the low number of fruits produced on the open pollinated trees and on the caged trees without bees, it was not possible to assess seed-set.

Mean fruitlet-, fruit- and seed-set were compared across treatments by means of one-way ANOVAs. To improve homoscedasticity, fruitlet- and fruit-set were arcsine $\sqrt{x}$ transformed. The Newman-Keuls Test ($P < 0.05$) was used for the posthoc comparison of means. Simple linear regression was used to analyse the relationship between distance from the *O. cornuta* nesting shelters and fruitlet-, fruit- and seed-set in the open pollination treatments. Means are reported with their standard deviation, unless indicated otherwise.

3. RESULTS

3.1. Foraging and nesting activity

In 1998, *O. cornuta* were the most frequent pollinators in the orchard (overall mean of 29.1 ± 10.2 individuals/hour; n = 35 counts). *A. mellifera* were rare (0.6 ± 1.0 individual/hour), as were other pollinating insects, mostly bumble bees and hover flies (0.4 ± 0.8 individual/hour).

In 1998, 130 nesting holes were occupied (0.5 holes per released female), amounting to 946 cells produced (3.6 cells per released female). In 1999, 136 holes were occupied (0.8 holes per released female), but only 316 cells were constructed (1.9 cells per released female).

The palynological analysis showed that *Pyrus* was by far the main pollen source utilized by *O. cornuta* females to provision their cells (Tab. I). As many as 80.2% of the 358 cells analysed in 1998 and 80.0% of the 50 cells analysed in 1999 contained 100% pear pollen. In both years, in more than 90% of the samples the content of pear pollen was higher than 80%. Traces of *Prunus, Salix,* Brassicaceae and *Taraxacum* pollen were recovered from provisions sampled in 1998, traces of *Salix,* Brassicaceae and *Taraxacum* pollen in 1999 (with frequencies in decreasing order).

Table I. Relative abundance of pear pollen in the provisions of *Osmia cornuta* placed in a 7 ha pear orchard (percentage of samples in each class).

Percent *Pyrus* pollen in the provision	Year	
	1998 (N = 358) (%)	1999 (N = 50) (%)
100	80.2	80.0
90–99	7.0	2.0
80–89	4.5	4.0
70–79	3.3	4.0
60–69	0.8	0.0
50–59	2.5	0.0
40–49	0.0	0.0
30–39	0.3	0.0
20–29	0.6	0.0
10–19	0.0	2.0
0–9	0.8	0.0

3.2. Fruitlet-, fruit- and seed-set

Fruitlet-set and fruit-set. In 1998, there were significant fruitlet-set and fruit-set differences across pollination treatments on 'Abate Fetel' (fruilet-set: $F_{(5, 24)} = 14.57$, $P < 0.0001$; fruit-set: $F_{(5, 24)}=2.93$, $P = 0.033 < 0.05$; Fig. 1). Both fruitlet- and fruit-set were highest on caged trees pollinated by *O. cornuta* and lowest on caged trees without bees, with values recorded for open-pollinated trees at different distances from the *O. cornuta* nesting shelters being intermediate. On 'Max Red Bartlett', no significant fruitlet- and fruit-set differences across pollination treatments were recorded (fruitlet-and fruit-set: $F_{(5, 24)} \leq 1.95$, $P \geq 0.123$; Fig. 2).

In 1999, there were significant fruitlet- and fruit-set differences across pollination treatments, on both 'Abate Fetel' (fruitlet-set: $F_{(5, 24)} = 3.02$, $P = 0.03$; fruit-set: $F_{(5, 24)} = 4.54$, $P = 0.005$; Fig. 3) and on 'Max Red Bartlett' (fruitlet-set: $F_{(5, 24)} = 7.23$, $P < 0.001$; fruit-set: $F_{(5, 24)} = 6.13$, $P < 0.001$; Fig. 4). In general, fruitlet- and fruit-set were higher for the caged trees pollinated by *O. cornuta* than for the caged trees without bees, with intermediate values for the open-pollinated trees.

Seed-set. In both varieties, there were significant seed-set differences across treatments ('Abate Fetel': $F_{(5, 24)} = 31.01$, $P < 0.0001$; 'Max Red Bartlett': $F_{(5, 24)} = 2.83$, $P = 0.038$; Fig. 5). In 'Abate Fetel', the highest seed-sets were obtained for the pollination on caged trees with bees and for the 0 m open pollination (4.3 seeds per fruit), followed by the other open pollination treatments (3.1–2.5 seeds per fruit). Pollination on caged trees without bees only averaged 0.5 seed per fruit

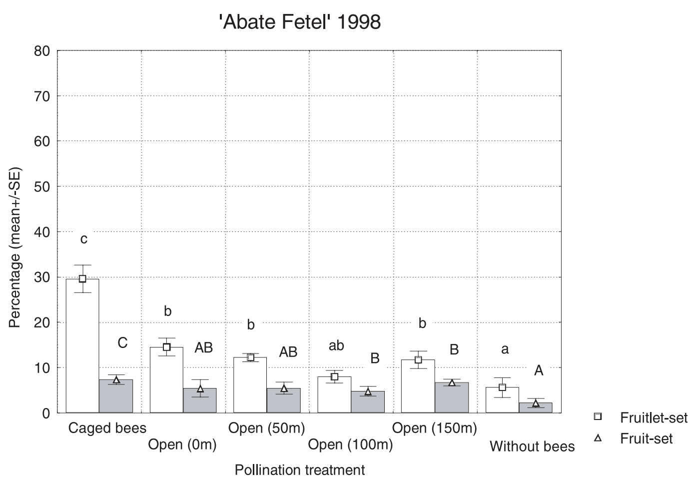

Figure 1. Percent fruitlet-set and fruit-set of 'Abate Fetel' (n = 5) exposed to different pollination treatments in 1998. Different letters within the same type indicate significant statistical differences (Newman-Keuls Test $P < 0.05$).

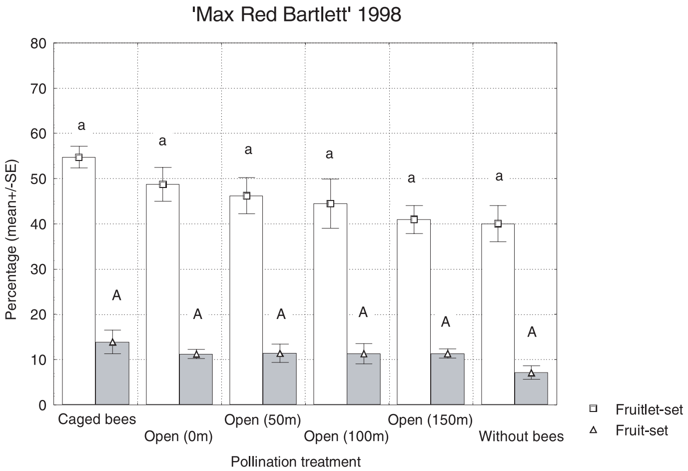

Figure 2. Percent fruitlet-set and fruit-set of 'Max Red Bartlett' (n = 5) exposed to different pollination treatments in 1998. Different letters within the same type indicate significant statistical differences (Newman-Keuls Test $P < 0.05$).

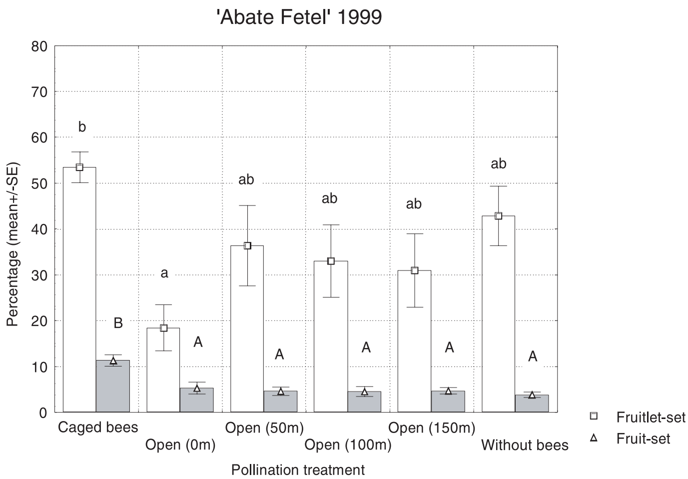

Figure 3. Percent fruitlet-set and fruit-set of 'Abate Fetel' (n = 5) exposed to different pollination treatments in 1999. Different letters within the same type indicate significant statistical differences (Newman-Keuls Test $P < 0.05$).

(Fig. 5). In 'Max Red Bartlett', pollination on caged trees with bees again yielded the highest seed-set (6.7 seeds per fruit), followed closely by the open pollination treatments (5.9–5.6 seeds per fruit). Pollination on caged trees without bees resulted in only 1.2 seeds per fruit (Fig. 5).

Distance from the nesting site. In 'Abate Fetel', no linear decline in fruitlet- and fruit-set with increasing distance from the *O. cornuta* nesting shelters was found, in either year (fruitlet-set: $r^2 = 0.13$, $P = 0.12$ in 1998 and $r^2 = 0.05$, $P = 0.33$ in 1999; fruit-set: $r^2 = 0.016$, $P = 0.59$ in 1998 and $r^2 = 0.01$, $P = 0.67$ in 1999).

In 'Max Red Bartlett', fruitlet-set did not decline with increasing distance from the nesting site in either of the two years

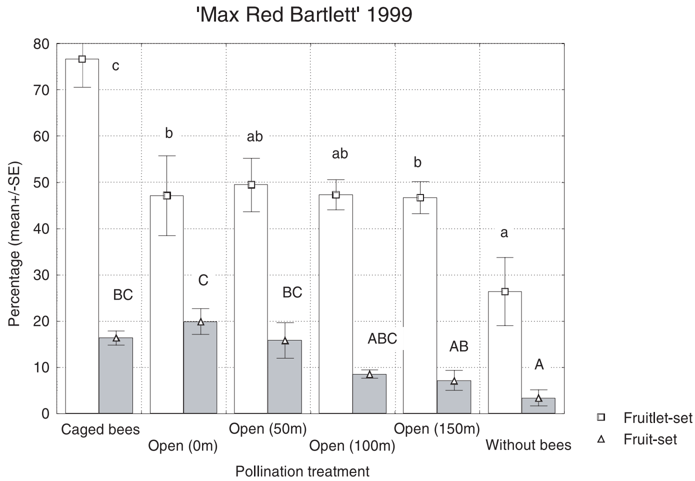

Figure 4. Percent fruitlet-set and fruit-set of 'Max Red Bartlett' (n = 5) exposed to different pollination treatments in 1999. Different letters within the same type indicate significant statistical differences (Newman-Keuls Test $P < 0.05$).

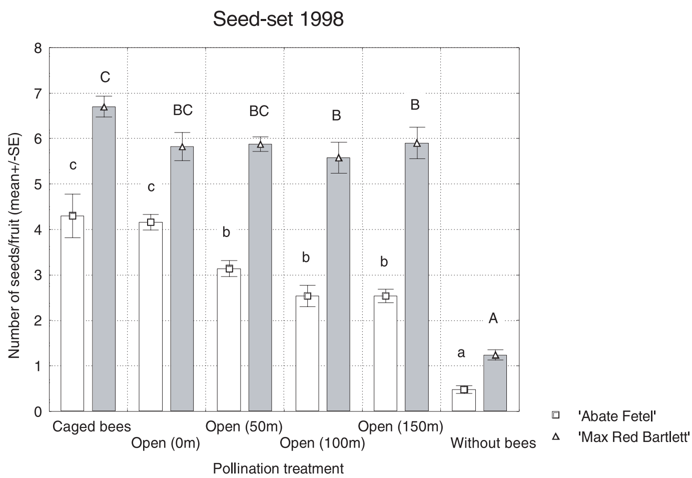

Figure 5. Seeds per fruit on 'Abate Fetel' and 'Max Red Bartlett' in 1998. Different letters within the same type indicate significant statistical differences (Newman-Keuls Test $P < 0.05$).

($P \geq 0.17$). Fruit-set declined with increasing nest distance in 1999 ($r^2 = 0.56$, $P = 0.0008$), but not in 1998 ($r^2 = 0.0001$, $P = 0.97$).

In 1998, 'Abate Fetel' seed-set declined linearly with increasing distance from the nesting shelters ($r^2 = 0.65$, $P < 0.0001$), but 'Max Red Bartlett' seed-set did not ($r^2 = 0.0001$, $P = 0.96$).

4. DISCUSSION

In 1998, optimal weather conditions during bloom allowed *O. cornuta* females to nest actively: 3.4 cells per female released were produced, a notable result considering that bloom lasted for only 10 days and the flying period of *O. cornuta* females may last over one month (Bosch, 1995; Bosch and Kemp, 2002). In 1999, adverse climatic conditions severely limited nesting activity: during the 10-day blooming period, less than 2 cells per female released were constructed. Traces of *Prunus* pollen were found in *O. cornuta* provisions in 1998, but not in 1999. A systematic survey of the plants flowering in the orchard surroundings, revealed that the nearest *Prunus* were located more than 400 m away from the nesting shelters. Other studies on *O. cornuta* indicate that most *O. cornuta* forage within a radius of 50–200 m from their nesting site (Krunic et al., 1995; Vicens and Bosch, 2000c). Thus, *O. cornuta* appears to be a suitable pollinator to limit the spread of fire blight compared to *A. mellifera*, with foraging ranges from a few hundred to several thousand meters (Gary et al., 1972, 1978; Visscher and Seeley 1982; Crane, 1984; Stern et al., 2001).

In general, fruitlet-, fruit- and seed-set were highest in the caged trees pollinated by *O. cornuta*, followed by the open-pollinated trees, and lowest in the caged trees without bees. Three *O. cornuta* females per tree (ca. 12 000 flowers per tree) are considered sufficient to pollinate almonds (Bosch, 1994b), and 1 female per 3.3–5.5 trees (ca. 2 000 flowers per tree) to pollinate apples (Vicens and Bosch, 2000a). In the pairs of trees caged with bees, five *O. cornuta* females and 5 males were provided (ca. 1 500 flowers per 'Abate Fetel' tree, ca. 1 000 flowers per 'Max Red Bartlett' tree). It can thus be assumed that pollination of trees caged with bees was actually maximum. In both 1998 and in 1999, at least some of the caged females nested actively, as proved by the brood cells constructed inside the reed sections. Although males do not participate in nest construction, visit fewer flowers and collect only nectar, they are efficient pollinators, too (Bosch, 1994b; Vicens and Bosch, 2000a; Bosch and Kemp, 2002) and they were observed visiting pear flowers in the cages almost till the end of bloom.

In 1998, no significant fruitlet- and fruit-set differences emerged across pollination treatments on 'Max Red Bartlett'. This variety is known to be highly self-incompatible, but prone to parthenocarpy (Bellini, 1993; Sedgley and Griffin, 1989). The low seed-set in the trees caged without bees in this variety-year suggests that many fruits produced in this treatment were parthenocarpic. Still, pollination would be useful in such a situation, as parthenocarpic fruits are often smaller than seeded ones, and size is an important factor in terms of consumer preference (Sedgley and Griffin, 1989).

In 1998, *O. cornuta* was the most abundant pollinator in the orchard (96.7% of insects counted). Most of the pollination in the open pollination treatments can thus be attributed to *O. cornuta*, especially since *O. cornuta* is a more efficient pollinator of rosaceous fruit tree flowers than *A. mellifera* (Bosch and Blas, 1994b; Vicens and Bosch, 2000a), the second most abundant pollinator (2.0% of insects counted), and *O. cornuta* collected mostly pear pollen. Although no pollinator counts were conducted in 1999, observations indicated that *O. cornuta* was also the most abundant pollinator that year.

Seed-set is an important factor in pear commercialization. Pears with high numbers of seeds tend to be larger, and have better shape and flavour (Sedgley and Griffin, 1989). In 1998 'Abate Fetel' and in 1999 'Max Red Bartlett' fruitlet-sets in the open-pollinated trees were higher than in the caged trees without bees, but lower than in the caged trees with *O. cornuta*. In the only year in which it was measured, seed-set in open-pollinated trees of both varieties was higher than in caged trees without bees, and at least at the closest distances to the *O. cornuta* nesting shelters, comparable to the caged trees with *O. cornuta*. These two results combined indicate that the populations released were insufficient to thoroughly pollinate the orchard, but that the flowers that were actually visited received large amounts of pollen. These results are in agreement with the recommended *O. cornuta* densities for almond and apple pollination and the high pollinating efficacy of this species on fruit tree flowers (Bosch, 1994b; Bosch and Blas, 1994b; Vicens and Bosch, 2000a).

In conclusion, *O. cornuta* has a high potential as a commercial pear pollinator. Despite the low nectar content of pear flowers (McGregor, 1976; Sedgley and Griffin, 1989; Bellini, 1993; Free, 1993; Delaplane and Mayer, 2000), *O. cornuta* forage mostly on pear flowers, and their larvae develop well on this pollen (Ladurner et al., 1999). At least in some years and cultivars, fruit- and seed-sets in trees pollinated mostly by *O. cornuta* were similar to fruit- and seed-sets in caged trees pollinated by *O. cornuta*. The 1999 results demonstrate that *O. cornuta* can provide adequate pollination even in years with unfavorable weather (Vicens and Bosch, 2000b). It is thus possible to increase pollination and pear production with *O. cornuta* populations. Because of its relatively short foraging range, *O. cornuta* would probably limit the spread of fire blight compared to other currently available commercial pollinators. Further studies should investigate ways to increase *O. cornuta* establishment and reproduction within pear orchards.

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Résumé – ***Osmia cornuta*** **(Hymenoptera, Megachilidae), pollinisateur du poirier (*Pyrus communis*) : fructification et production grainière.** Afin d'étudier la possibilité d'utiliser l'abeille *Osmia cornuta* Latreille comme pollinisateur des poiriers 'Abate Fetel' et 'Max Red Bartlett', nous nous sommes posés les questions suivantes : (i) *O. cornuta* utilise-t-elle les fleurs de poiriers comme source préférée de pollen et de nectar ?, (ii) la présence d'*O. cornuta* dans un verger de poiriers augmente-telle la fructification et la production grainière ?

Les cellules approvisionnées par des femelles d'*O. cornuta* lâchées dans un verger ont été dénombrées. En 1998 des conditions météorologiques favorables ont permis aux femelles de d'*O. cornuta* de nidifier activement (3,4 cellules par femelle). En 1999, par contre, les mauvaises conditions ont sérieusement limité l'activité de nidification (<2 cellules par femelle). En 1998 et 1999, les analyses palynologiques d'échantillons des provisions de pollen ont montré que *Pyrus* était de loin la principale source de pollen utilisée par les femelles d'*O. cornuta* pour approvisionner les cellules (Tab. I).

La nouaison des jeunes fruits, la fructification (fruits récoltés) et la production grainière ont été mesurées sur des arbres exposés à différents traitements de pollinisation : (1) pollinisation sous cage (paires d'arbres adjacents, 1 'Abate Fetel', 1 'Max Red Bartlett', encagés avec cinq femelles et cinq mâles d'*O. cornuta*), (2) pollinisation libre (paires d'arbres comme en 1, situées à diverses distance, 0, 50, 100 et 150 m, des sites de nidification), (3) pollinisation minimale (comme en 1 mais sans insectes pollinisateurs). En général, le traitement 1 a fourni le plus grand nombre de jeunes fruits, de fruits récoltés et de graines, suivi par le traitement 2 et le traitement 3 (Figs. 1–5). Trois femelles d'*O. cornuta* par arbre (≈ 12 000 fleurs par arbre) sont suffisantes pour les amandiers et une femelle pour 3,3 à 5,5 arbres (≈ 2 000 fleurs par arbre) pour les pommiers. Le traitement 1 comportait 5 femelles par cage (≈ 1 500 fleurs par arbre) et l'on peut considérer que la pollinisation maximale a été atteinte. En 1998 sur 'Max Red Bartlett', les arbres encagés sans abeilles (traitement 3) ont produit un nombre considérable de fruits (Fig. 2). Cette variété étant sujette à la parthénocarpie, la faible production grainière de ces mêmes arbres suggère que la plupart des fruits étaient parthénocarpiques.

La production grainière est un facteur important pour la commercialisation car les poires ayant un nombre élevé de graines ont tendance à être de taille plus grosse et de forme et saveurs meilleures. En 1998, *O. cornuta* a été le pollinisateur le plus abondant dans le vergers (96,7 % des insectes comptés). La majeure partie de la pollinisation effectuée dans le traitement 2 (pollinisation libre) peut donc être attribuée à *O. cornuta.* Bien qu'on n'ait pas compté les pollinisateurs en 1999, les observations indiquent qu'*O. cornuta* était aussi le pollinisateur le plus abondant. Pour les deux variétés la pollinisation libre a conduit à une production grainière plus forte (Fig. 5).

En conclusion, *O cornuta* possède un potentiel élevé comme pollinisateur commercial du poirier. Au moins certaines années et pour certains cultivars, la nouaison des jeunes fruits, la fructification et la production grainière des arbres pollinisés librement principalement par *O. cornuta* étaient semblables à celles des arbres encagés avec des abeilles. Il est donc possible d'accroître la pollinisation et la production de poires en utilisant *O. cornuta*.

Osmia cornuta **/ pollinisation / nouaison des jeunes fruits / fructification / *Pyrus communis***

Zusammenfassung – ***Osmia cornuta*** **(Hymenoptera, Megachilidae) als Bestäuber von Birnen (*Pyrus communis*): Frucht- und Samenansatz.** Zur Prüfung, ob *Osmia cornuta* Latreille möglicherweise als Bestäuber von 'Abate Fetel' und 'Max Red Bartlett' Birnen geeignet ist, wurden folgende Fragen untersucht: (1) nutzt *O. cornuta* Blüten der Birnen bevorzugt als Quelle für Pollen und Nektar, (2) erhöht die Anwesenheit von *O. cornuta* in Birnbaumplantagen den Ansatz von Früchten und Samen?

Die von freigelassenen *O. cornuta* Weibchen mit Proviant versehenen Zellen wurden gezählt. Die optimalen Wetterbedingungen von 1998 ermöglichten den *O. cornuta* Weibchen aktiv Nester zu bauen (3,4 Zellen pro Weibchen). Im Jahr 1999 dagegen begrenzten schlechte klimatische Bedingungen die Nistaktivität beträchtlich (weniger als 2 Zellen pro Weibchen). Palynologische Analysen von Pollenproben aus den Zellen zeigten in beiden Jahren, dass *Pyrus* bei weitem die häufigste Pollenquelle von den *O. cornuta* Weibchen war (Tab. I). Spuren von *Prunus* Pollen wiesen auf das Pollensammeln von einigen *O. cornuta* Weibchen in 400 m Entfernung von ihren geschützten Nestern hin.

Der Ansatz von jungen Früchten, reifen Birnen und ihre Samenzahl wurden bei Bäumen unter unterschiedlichen Bedingungen für die Bestäubung bestimmt: 1. Paare von benachbarten Bäumen (1 'Abate Fetel', 1 'Max Red Bartlett') in Zelten mit 5 Weibchen und 5 Männchen von *O. cornuta*; 2. Offene Bestäubung: Paare von Bäumen wie in 1. aber in unterschiedlichen Abständen von den Nestern (0, 50, 100 und 150 m); 3. minimale Bestäubung: wie 1., aber ohne bestäubende Insekten.

Bei einer Knospengröße eines Popcorns wurden 30 Blütenstände mit Knospen auf jedem getesteten Baum markiert und die Anzahl der Blüten in jedem Stand bestimmt. Junge Früchte und reife Birnen der markierten Blütenstände wurden später gezählt. 1998 wurde der Samenansatz durch Zählung der Samenzahl pro Frucht bei 20 Birnen der Versuchsbäume bestimmt.

Im allgemeinen war der Ansatz von jungen Früchten, reifen Birnen und die Samenzahl bei den Bäumen in den Zelten mit *O. cornuta* am höchsten, gefolgt von Ansätzen unter Bedingung 2 bzw. 3 (Abb. 1–5). Drei *O. cornuta* Weibchen pro Baum (ca. 12 000 Blüten pro Baum) werden als ausreichend angesehen, um Mandeln zu bestäuben und 1 Weibchen bei 3,3–5,5 Bäumen mit je ca. 2 000 Blüten zur Bestäubung von Äpfeln. Bei den Birnbaumpaaren setzten wir 5 Weibchen in das Zelt (ca. 1 500 Blüten pro Baum) und deshalb kann man annehmen, dass damit ein Maximum an Bestäubung erreicht wurde.

Im Jahr 1998 erbrachten Bäume der Sorte 'Max Red Bartlett' im Zelt ohne Bienen eine beträchtliche Anzahl an Früchten (Abb. 2). Der geringe Samenansatz dieser Sorte mit der Fähigkeit zur Reifung von Früchten ohne Bestäubung, führt zur Vermutung, dass viele Früchte parthenokarp sind.

Der Samensatz ist ein wichtiger Faktor beim Handel mit Birnen, denn Birnen mit mehr Samen tendieren dazu größer zu sein, eine schönere Form zu haben und besser zu schmecken. 1998 war *O. cornuta* der häufigste Bestäuber in der Obstplantage (96,7 % der gezählten Insekten). Der größte Teil bei der offenen Bestäubung konnte deshalb *O. cornuta* zugeschrieben werden. Obwohl 1999 keine Bestimmung der Bestäuber durchgeführt wurde, ließen Beobachtungen vermuten, dass *O. cornuta* ebenfalls der häufigste Bestäuber war. Bei den offen bestäubten Bäumen war der Samenansatz bei beiden Sorten höher als bei Bäumen in Zelten ohne Bienen und fast so hoch wie in Zelten mit Bienen (Abb. 5).

Aus den Versuchen lässt sich auf ein hohes Potential von *O. cornuta* als kommerzieller Bestäuber von Birnen schließen. Zumindest für einige Jahre und bei einigen Sorten erwies sich der Frucht- und Samenansatz der frei stehenden Bäume mit *O. cornuta* als häufigstem Bestäuber als ähnlich gut wie unter Zeltbedingungen mit diesen Bienen. Demnach ist es möglich die Bestäubung und die Produktion von Birnen durch *O. cornuta* zu erhöhen.

Osmia cornuta* / Bestäubung / Ansatz junger Früchte / Ansatz reifer Früchte / *Pyrus communis

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