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Preliminary note on the relative frequencies of two bees on wild Brassicaceae: oligolectic *Andrena agilissima vs* polylectic *Apis mellifera*

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Abstract

Bee hives presence may have negative effects on the foraging patterns of wild bees, especially when dealing with oligolectic species. Data are still missing on many of them, mainly for those species not yet included in managed programs. We approached this topic with preliminary observations in the field on a common wild bee, *Andrena agilissima* (Scopoli) (Hymenoptera Andrenidae), on its preferred flowers, two wild Brassicaceae (*Raphanus raphanistrum* L., wild radish, and *Sinapis arvensis* L., wild mustard). We recorded the relative frequencies of individuals of *Apis mellifera* L. and of the oligolectic *A. agilissima*, and carried out pollen analysis on loads of *A. agilissima* females. Notwithstanding the attractive flowering mass of the two Brassicaceae, honey bees performed a lower number of visits to these flowers compared to the wild bees. Between the two Brassicaceae, *A. agilissima* displayed a preference for wild radish: it carried out a higher number of visits on it and the wild radish pollen was dominant in the content of the loads. However, activity on wild radish was not constant during the day, with a peak around 11 AM – 1 PM. This result matches with the ones of a previous study, where females were recorded bringing nectar back to the nest mainly after 1 PM, and with the evidence, based on pollen analysis, of another species regularly visited, *Marrubium vulgare* L. (Labiatae). Data collected are not enough to draw any decisive conclusion, but are presented in order to stimulate further investigation.

Key words: oligolectic, wild bees, honey bees, Brassicaceae.

Introduction

Nowadays, the importance of pollination is world-wide recognised. Pollinators are crucial in keeping a healthy ecosystem, visiting native plants. They are also our best co-workers in commercial orchard and field crop production, urban gardening and forage production. Among other insects, the honey bee turned out to be a good general pollinator, manageable, adaptable, even producing valuable by-products of honey and wax. Bee hives may be moved in different areas to increase the pollination of certain plants of economic value or to obtain a higher quantity or a special quality of honey. The location of apiaries then follows an economic strategy that usually does not take into account the influence that foraging honey bee workers may have on the local population of wild bees. This influence may be even stronger on oligolectic species, with a reduced foraging range.

There are about 30,000 species of wild bees on the earth, most of them nesting solitarily underground or in holes in plant stems or dead wood (Cane, 1997). Many of them are oligolectic, sometimes extremely specialised on few plant species. The honey bee may dominate upon wild bees in temperate areas during spring, when fewer species are flowering (Schaffer *et al*., 1983) and, as a consequence, beekeepers move the apiaries. The honey bee is not the best pollinator for all crops, under all conditions (Westerkamp, 1991; Batra, 1995; Cane, 1997). There are numerous studies that report how native bees are superior pollinators on particular crops than the honey bee (mainly reviewed in Parker *et al*., 1987). As a result of the shortcomings of honey bees, and of a more general decrease in both number and species of pollinators, interest had turned to the fostering and management of native bees (Batra, 1995; Cane, 1997; Ladurner *et al*., 2002).

The Andrenidae is a widespread family of bees (present in all continents, apart Australia), has representatives among the specialist as well as the generalist group, nests in the soil and different levels of social organisation have been detected, from solitary to pre-social. Bees in this family are then a perfect subject for further studies on the impact of honey bee foragers on the foraging patterns of local populations of wild species. *Andrena agilissima* (Scopoli) (Hymenoptera Andrenidae) is a pre-social springtime species, oligolectic on Brassicaceae (Westrich, 1989). Females nest on earth walls, excavating subterranean tunnels and cells (Giovanetti *et al*., 1999) and collect pollen and nectar to feed the brood (Giovanetti and Lasso, 2005). A stable population, located on Isola d'Elba (Tuscany, Italy), has been studied since many years and females have been observed foraging mainly on wild radish, *Raphanus raphanistrum* L., and wild mustard, *Sinapis arvensis* L. Wild bees are known not to forage far away from the nest (Gathmann and Tscharntke, 2002). Numerous marked females of this population of *A. agilissima* were recorded while foraging 300 m away from the nesting site, at the same locality since several years. This area (Loc. Gli Alzi, Campo nell'Elba) is characterized by cultivated and abandoned fields, while the surroundings are covered mainly by *Quercus ilex* L. and bushes of *Cistus* sp. Likely depending on the flowering of wild Brassicaceae, this area resulted the elected foraging site for this population.

This is a preliminary work to investigate the relative frequencies of *A. agilissima* and *Apis mellifera* L., on

the plants on which depend the successful reproduction of the oligolectic wild bee. Considering that wild bee populations are declining world-wide, this brief local documentation can be referred to research investigating generalist vs. specialist pollinators, given rise to deeper analysis.

Methods

Data were collected in May 2003, during the peak of activity of *A. agilissima*: the entire activity of this bee lasts about four weeks during springtime, and included in this period there are often numerous days of bad weather (rain or clouds). Data refers only to days of full sun (May 3-5) to guarantee a comparison based on optimal foraging conditions for both species.

The area was a broad beans field (about 60 x 25 m). The field appeared as an uniform yellow flowering mass, with wild radish (*R. raphanistrum*) plants more frequent and clumped, while wild mustard (*S. arvensis*) plants were dispersed among the wild radish ones. The beans were not flowering during the observations. Other flowering species in the field were *Papaver somniferum* L. (Papaveraceae) and some unidentified yellow Asteraceae. During this study, some bee hives were located at a distance of 150 m, while the colony of *A. agilissima* was located about 300 m away.

To evaluate pollinators frequency, observations of 15 minutes (n = 49 on wild radish and n = 42 on wild mustard) were performed from 9 AM to 4 PM (solar hour) focusing on the visits of *A. agilissima* and *A. mellifera*. Some other bee species were observed visiting the Brassicaceae and a list will be provided. Plants to be observed were chosen randomly, but in different days the same spot could be re-observed. Each individual visiting the spot corresponded to a record, independently from the number of flowers it visited. The same individual may have been counted twice, if re-visiting the plant after leaving the spot.

Some *A. agilissima* females returning to the nest have been captured and kept in a vial, in darkness, for about 30 minutes. In this way they spontaneously released the pollen from their legs. The majority of females returned with recognisable yellow loads, but some individuals were observed with orange loads. Females with loads of both colours have been collected. Dr C. Ravazzi and his staff kindly analysed three samples with orange pollen and three samples with yellow pollen, providing percentages of pollen species in each sample.

Statistical analysis was performed using non-parametric tests (Kruskal-Wallis and Mann-Whitney) following Zar (1974).

Results

Concerning resource gathering behaviour, all species looked for pollen and nectar. Bees visited both plant species (table 1). *A. mellifera* did not show any preference between them (Mann-Whitney $U = 806$, $n_1 = 49$, $n_2 = 42$, n.s., figure 1), while *A. agilissima* dedicated more visits to wild radish (Mann-Whitney $U = 527$, $n_1 = 49$, $n_2 = 42$, $P < 0.001$, figure 2). *A. mellifera* visits (figure 1) were equally distributed during the day on wild radish (Kruskal-Wallis $H_{(6,\ n=49)} = 12.492$, n.s.) as well as on wild mustard (Kruskal-Wallis $H_{(6,\ n=42)} = 6.781$, n.s.). *A. agilissima* (figure 2) showed the same pattern on wild mustard (Kruskal-Wallis $H_{(6,\ n=42)} = 8.187$, n.s.), but its presence was different during the day on wild radish (Kruskal-Wallis $H_{(6,\ n=49)} = 29.62$, $P < 0.001$), with a peak of activity between 11 AM -1 PM (solar hour).

The pollen analysis evidenced that the species found in the yellow samples were: *R. raphanistrum* and *Marrubium vulgare* L., with traces of Compositae. In the orange samples, two more species were found: *S. arvensis* and *Cistus albidus* L. Probably the last one is responsible for the recognisable orange colour of the load. Their relative percentage are reported in table 2.

We collected 8 species of bees in the area. *A. mellifera*, *A. agilissima*, *Andrena congruens* Schmiedeknecht and *Andrena flavipes* Panzer were found on flowers of both *R. raphanistrum* and *S. arvensis*. Exclusively on *R. raphanistrum* were collected *Eucera numida* Lepeletier (Apidae), two unidentified species of *Andrena* (Andrenidae) and one unidentified Halictidae.

Discussion

Some differences emerged from these preliminary data regarding the comparison of the activity of *A. agilissima*, an oligolectic bee, and *A. mellifera*, known for being a generalist species, on two wild Brassicaceae. *A. mellifera* visited both species, as well as *A. agilissima*, but the average number of visits on wild radish was lower than the average of the wild bee. Notwithstanding the fact that the flowering mass of wild radish was very attractive, many different plant species were blooming in the same period and honey bee crops rarely consist of only one pollen type (Fortunato *et al*., 2006). Other factors may have been influencing *A. mellifera* forager's choices, as protein content of pollen grains or nectar content in other species flowering concurrently.

The nectar content of the wild radish may represent a factor on which concentrate further investigations. In fact, it is usually low and variable: 0.55 ± 0.04 µl/flower in yellow flowers and 0.61 ± 0.05 µl/flower in white

Table 1. Descriptive statistics (average and standard deviation) of *A. agilissima* and *A. mellifera* visits/15 minutes, on plants of wild radish, *R. raphanistrum* and wild mustard, *S. arvensis*.

	Andrena agilissima visits/15 minutes	*Apis mellifera* visits/15 minutes
Raphanus raphanistrum	1.98 ± 2.09	1.14 ± 1.63
Sinapis arvensis	0.36 ± 0.73	0.45 ± 0.8

Table 2. Relative percentages of different flowering species found in pollen loads of *A. agilissima*.

	Yellow samples pollen grains percentage			Orange samples pollen grains percentage		
	sample 1	sample 2	sample 3	sample 1	sample 2	sample 3
Raphanus raphanistrum	82.9 %	86.1%	100%	22.8%	44.9%	62.7%
Sinapis arvensis	-	-	-	3.2%	4.2%	0.7%
Marrubium vulgare	17.1%	13.9%	traces	2.7%	6.8%	20.6%
Cistus albidus	-	-	-	71.3%	44.1%	16.0%
Compositae	-	-	traces	-	-	-

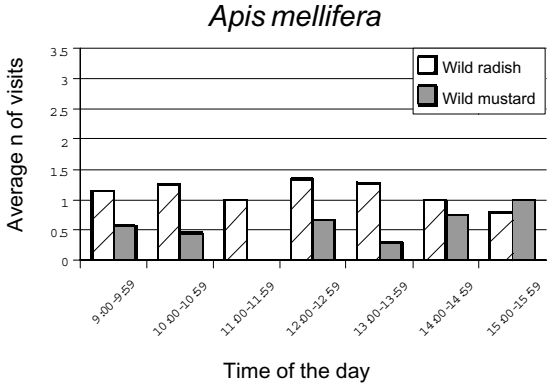

Figure 1. Average distribution of *A. mellifera* visits on wild radish, *R. raphanistrum* and wild mustard, *S. arvensis*, during the day. Time is solar hour.

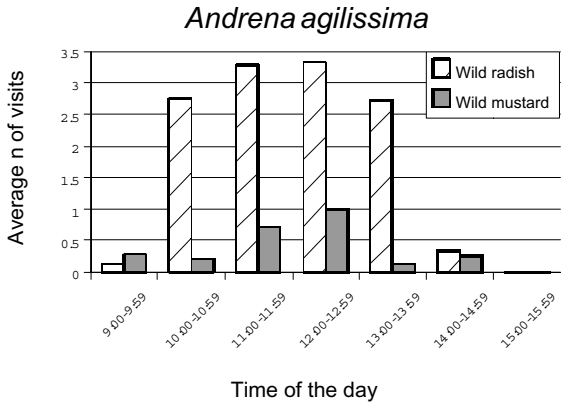

Figure 2. Average distribution of *A. agilissima* visits on wild radish, *R. raphanistrum* and wild mustard, *S. arvensis*, during the day. Time is solar hour.

flowers, as reported by Pierre (2001). The same author also found low density of honey bees on wild radish if compared to oilseed rape, present in the same field and offering more profitable resources. During the day, the activity of *A. agilissima* on wild radish flowers showed a peak between 11 AM and 1 PM. Giovanetti and Lasso (2005) found that *A. agilissima* females returning to the nest where carrying nectar more frequently in the afternoon, after 1 PM. Considering the low amount of nectar in wild radish, it is possible that females pay less visits to it when looking for nectar, in presence of alternative sources (*M. vulgare*?) which can be visited before returning to the nest.

Notwithstanding the low amount of nectar in its flowers, *A. agilissima* carried out a significant higher number of visits on wild radish than on wild mustard. The existence of a strong preference of *A. agilissima* between the two Brassicaceae is confirmed also by the pollen analysis, where wild mustard, when present, never reach high percentages of pollen grains. So far, no studies have investigated the energetic value of wild radish pollen, which could be a significant element to understand the observed preference. Moreover, the results of pollen analysis, even though few pollen samples were examined, open new questions related to the oligolecticity of this species, as well as to the importance of the various sources in relation to the collection of pollen and nectar.

Conclusions

This explorative study refers to a wild oligolectic bee and its foraging preferences, and to the possible influence of honey bee foragers during resource collection. Some interesting questions arise and stimulate further investigations. For what concerns these data, we could advise that:

- for the oligolectic species *A. agilissima,* preliminary data do not support the hypothesis of a competition with honey bee also in close proximity of apiaries,
- based on pollen analysis of few samples, the strong preference of *A. agilissima* for Brassicaceae is confirmed, but it also emerged a substantial presence of pollen grains of other flowering species, that need to be deeper investigated.

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