



Foraging Behaviour of Honey Bees *Apis mellifera* Linn. Visiting The Flowers of Some Wild Plants in Eljabal Alakhder-Libya

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Abstract: This study was conducted to identify the foraging behaviour of honey bees *Apis mellifera* in the search for food during their visit to the wild flower plants *Sinapis alba*, *Pelargonium radula*, *Malva parviflora* and *Stachy stournefortii* in Eljabal Alakhder region. The results showed differences in the handling time periods with a significant difference between plant flower species. It showed a longer resting period compared with the handling time for flowers of the *Pelargonium radula*, which recorded the lowest time, also the travelling time of honey bee among the flowers of the plant species showed a significant difference. *Stachy stournefortii* recorded a longer travelling time with an average of 4.3 seconds, and *Pelargonium radula* with 3.5 seconds. *Apis mellifera* showed a different activity among the different flowers in the collection of nectar or pollen during different daytime hours.

Keywords: Foraging behaviour, Libya, *Apis mellifera*, wild flowers, Eljabal Alakhder

INTRODUCTION

Foraging activity is measured by using different parameters including, the foraging commencement or/and cessation time (Joshi & Joshi, 2010; Mattu et al., 2012; Tan et al., 2012). Other parameters related to foraging activity and the visiting of plants include the number of foragers per flower and time spent per flower (Sushil et al., 2013); nectar and pollen collection method from the blooms (MacKenzie, 1994); the proportion of pollen or nectar foragers relative to total foragers; foraging type; the load of pollen and pollen type; concentration of crop nectar sucrose (Riddell Pearce et al., 2013). The resting time of the bee on the flower is the time spent from the moment it descends to the moment when it left the flower, and the travelling time is known at the time it takes for bees to travel from a flower to another of the same plant (Steel et al., 1980). Herrera (1989) noticed that there was a relationship between

the length of the bee's mouth and the length of its resting time on the flower. Long-tongued species such as *Anthophora quadrifasciata*, whose length of mouth parts was 11.1 mm long, had a resting time of 0.8 seconds, while the honey bees which has a length of 5.1 mm of her mouth parts, had a resting time of 3.6 seconds and that indicates that the longer the bees' mouths are, the shorter the length of time needed on the flower, and (Willmer et al., 1994) confirmed that the resting time of honeybees that visited the flower of Glen Clova is 11.53 seconds, Glen Prosen 10.49 seconds, and 21.42 seconds on the Glen Moy flowers. Also, the length of travelling time in flowers is different from one plant to another. For the flower of Glen Clova it was 3.27 seconds, 4.35 seconds on Glen Moy, and 4 seconds on the flower of the plant Glen Prosen. Bataw and Lamin (2001) also noticed that the resting time length of honeybees on *Rosmarinus officinalis* was 1.32 seconds, and

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the travelling time was 1.5 seconds. Gegeer and Laverty (2004) assessed the flower constancy of *Apis mellifera* and *Bombu impatiens* during the visit to two types of flowers (yellow flowers- blue flowers), the study showed that the honey bee has a high stability on one type of the flowers and took a longer time in the movement between flowers, and the length of resting time did not differ significantly between the two types. (Fahn & Shimony, 2001) who worked on *Lysiglossum spp* and showed that honeybees spend a long resting period on *Ecballium spp*. while the *Ceratina* bees showed a short resting time on the same flowers. The difference in the resting and travelling time changes according to the type of plant and reward sponsored by the bees, and the length of time bees stand on the flowers when visiting depends on the type and quantity of nectar and pollen (Harder, 1986). YeboahGyan and Woodell pointed out in 1987 that honeybees collected pollen from the flowers of the plant of *Rubus fruticosus* in the early morning and this may be due to the low concentration of sugar in the nectar because of the high humidity and generally; collected pollen by bees increased during the day and extend to what between noon and afternoon. (Corbet & Delfosse, 1984) noticed that honeybees collect pollen of *Echium pgantagineum* only when the concentration of nectar is less than 35%. In a study conducted by Sazima and Feritas (2003) on the flower of *Viola spp*, they pointed out that the primary pollinator of the flowers of this plant are females belonging to bees *Andrena spp*, which are mainly looking at the pollen by shaking the flower, and they pointed out that the males of this species circled around the flower clusters to feed on nectar and represent secondary pollinators. (Giurfa & Núñez, 1992) concluded that honeybees used the smell of visited flowers to avoid the lack of content of the nectar. Nectar volume and concentration are the basis upon which nectar energetics are calculated, and the abundances of the dominant species of flower visitors

within some ecosystems are linked to the amount of energy provided by the nectar (Roubik 1989). Daily changes in available nectar clearly affect the identity and abundance of flower feeders (Potts *et al.* 2001; 2004). Relatively, a little is known about the honey bee foraging behavior in Aljabal Alakhder. Our objective was to establish a baseline foraging behavior to aid in establishing long-term monitoring pollinator programs.

MATERIALS AND METHODS

The study site was an area near the buildings of Omar Elmukhtar University,(32°45'14 N21°42'42 E; altitude 6255 m) in Albaida, Libya. The experemint was carried out during the flowering season period of the wild plants, *Sinapis alba*, *Pelargonium radula*, *Malva parviflora*, and *Stachy stournefortii*. These species are among the common wild plant flowers in the area and their flowering season extends from February until the month of August. Their flowers provide an important source of food for honeybees, where many beekeepers keep their bee hives near these areas.

Rate of food search: The time spent on a single flower was calculated once a bee touches any part of the flower (*Handling time*), as well as the time it traveled from one flower to another during the flowering season (*Travelling time*). Readings were taken during the period from 8:00 to 13:00 using a stopwatch in the same way as previously described ((Pleasants, 1981).

Nectar and pollen collection times: The behavior of honeybee workers was monitored during their visits to plant flowers, the number of visiting workers, and the times when nectar was collected by extending their mouths inside the flower or collecting the pollen through the use of its front legs from 8:00 to 13:00.

Statistical analysis: Statistical analysis of all

data were obtained by using Minitab (16), One-way ANOVA, mean and standard error (\pm SE) using the Tukeys' method.

RESULTS

Period of foraging: The results showed a clear variation in handling time with the visits of bees to the different plant flowers (One-way ANOVA) : $df = 3$, $F = 7.72$, $P < 0.005$). The *Apis mellifera* has a longer handling time on the flowers of *Sinapis alba*, which was 8.9 seconds, compared to the flowers of *Pelargonium radula*, which had a handling time of 7.2 seconds, while on the flowers of *Malva parviflora* had a period of 8.4 seconds, and on the flowers of *Stachy stournefortii* recorded 8.6 seconds. The results also revealed that there was a significant difference in the travelling time between the flowers of different plant species (One-way ANOVA : $df = 3$, $F = 22.80$, $P < 0.005$). The *Stachy stournefortii* flower recorded a longer travelling time of 4.3 seconds while the *Sinapis alba* flower recorded the lowest travelling time of 2.8 seconds. *Malva parviflora* flowers recorded an average of travelling time of 3.7 seconds and the flower of *Pelargonium radula* recorded a travelling time of 3.5 seconds.(Table 1).

Table (1). Mean (\pm SE) of the handling time of the *Apis mellifera* on the flower and the travelling time (in sec.) between different flower species.

Plant flowers	Handling time (sec.)	Travelling time (sec.)
<i>Sinapis alba</i>	8.9 \pm 0.319 ^c	2.8 \pm 0.086 ^c
<i>Pelargonium radula</i>	7.2 \pm 0.369 ^b	3.5 \pm 0.135 ^b
<i>Malva parviflora</i>	8.4 \pm 0.201 ^a	3.7 \pm 0.113 ^b
<i>Stachy stournefortii</i>	8.6 \pm 0.307 ^a	4.3 \pm 0.137 ^a

Similar letters mean that there is no significant difference within each column ($P < 0.005$)

Foraging Behavior of bees in the collection of nectar and pollen .:By observing the foraging behaviour of *Apis mellifere* during their visits to the different flower species (Table 2), We noticed on the flowers of *Stachy stournefortii* that the workers collected nectar and pollen by entering their head through the opening of the corolla and extending their mouth to the bottom of the flower to suck the nectar, and the rest of the body was out and by using the help of legs to hold on the flower. The results showed that the highest percent number of workers (75.5%) collecting nectar was recorded at 10 am, and the lowest number of workers (36.9%) collecting nectar was at 13:00 and we recorded a higher percentage number of bees collecting pollen at 13:00 with 63.1%, and the lowest percentage number was (24.5%) at 10:00 The honey bee, *Apis mellifera*, on the flowers of *Sinapis alba*, was active in collecting pollen only from 8:00 am to 13:00 by 100%. It was noticed that it moves its front legs when it stands on the flower. Honey bees also showed the same behaviour during their visit to the flowering plant *Malva parviflora* by collecting pollen grains with 100% starting from 8:00 am to 13:00. The honey bees workers showed a different activity on the flowers of the *Pelargonium radula*, by collecting nectar only from 8:00 to 13:00 at 100%.

Table (2). The ratio of the total number of honey bee workers collecting nectar and pollen from the flowers of *Malva parviflora*, *Pelargonium radula*, *Sinapis alba* and *Stachys stournefortii* during the day from 8:00 to 13:00(No. between brackets refer to no. of samples)

Time	Plant							
	<i>Malva parviflora</i>		<i>Pelargonium radula</i>		<i>Sinapis alba</i>		<i>Stachys stournefortii</i>	
	Pollen (%)	Nectar ¹ (%)	Pollen ² (%)	Nectar (%)	Pollen (%)	Nectar ³ (%)	Pollen (%)	Nectar (%)
8.00	100 (9)	-	-	100 (166)	100 (137)	-	34.6 (8)	65.4 (15)
9.00	100 (28)	-	-	100 (233)	100 (240)	-	25.4 (11)	74.6 (34)
10.00	100 (39)	-	-	100 (324)	100 (390)	-	24.5 (18)	75.5 (57)
11.00	100 (68)	-	-	100 (579)	100 (438)	-	28.3 (27)	71.7 (70)
12.00	100 (84)	-	-	100 (622)	100 (519)	-	46.3 (40)	53.7 (47)
13.00	100 (54)	-	-	100 (563)	100 (533)	-	63.1 (59)	36.9 (34)

1,2,3 No visit recorded

DISCUSSION

Time of searching for food: The period of searching for food represents the time spent by bees on the flower and the period of their traveling from one flower to another on the same plant. The resting time may be determined by the type of flower frequented by the bee species in terms of the different shape of the corolla or the available reward of nectar and pollen. The results showed that the honey bee *Apis mellifera* recorded a longer resting time on the flowers of *Sinapis alba* (8.9 seconds) compared to the flowers of *Pelargonium radula* which recorded the least of resting time (7.2 seconds). This may be due to the fact that honeybees collect pollen from *Sinapis alba* and this takes a longer time to collect nectar, while honeybees have a longer resting time on *Stachys stournefortii* flowers, 8.6 seconds than on the flowers of *Malva parviflora* 8.4 seconds, and the finding may be due to that honey bee workers collect pollen and nectar together from the first plant and therefore stay longer on this plant compared to the second plant, which provides only the pollen. The relationship between the length of parts of the mouth and limiting the resting time, floral studies have confirmed that short-tongued bees quickly forage on short-crowned flowers faster than long-tongued bees, as Herrera showed in 1989 that there was a relationship between the length of the bee's mouth and its resting time on the flower, and he noticed that the wild bee

Anthophora quadrifasciata has a mouth length of 11.1 mm and a resting time of 0.8 seconds compared with short-tongued species such *Apis mellifera* with length of the mouthparts (5.1 mm), and the period of resting time is 3.6 seconds and this indicates that the longer the mouths of bees the shorter of the resting time on the flower. While the bee workers recorded a longer time of travelling between the flowers of *Stachys stournefortii* (4.3 seconds) comparing to other plant flowers, the *Sinapis alba* flower recorded a mean travelling time of 2.8 seconds due to the proximity of flowers. *Malva parviflora* flowers recorded a longer travelling time with an average of 3.7 seconds and the *Pelargonium radula* plant recorded a travelling time of less than 3.5 seconds. In general, all species of bees recorded a time of travelling shorter than the time of resting on all plant flowers as a result of the arrangement of flowers and convergence within the flowering flower. resting and travelling time varies with the type of plant and the reward sponsored by the bees studied by Harder in 1986, which indicated that the length of time bees stand on the flowers at their visits depends on the type and quantity of nectar and pollen.

Behaviour of bees in searching for food: The results showed that the flowers of *Stachys stournefortii* were visited by the honey bees at 10 am by 75.5% of the (57) workers who gather the nectar, then this percentage decreased and the percentage of workers who collect pollen increased to 63.1% from (59) workers at 13.00 at noon while

the percentage of workers that brings nectar decreased to 36.9% due to the gradually opening of the flora because of the high temperature and therefore a sufficient available amount of pollen. This behavior is consistent with what Bataw and Lamin (2001) pointed out that honey bee workers collect pollen from the *Rosmarinus officinalis* flowers after 10:00 am where pollen is available after this time. The bee collected only the pollen grains of *Sinapis alba* and that could be due to the undesirable nectar of this plant or to the lower nectar concentration, and this phenomenon was noticed by (Corbet & Delfosse, 1984) during their study on *Echium pplantagineum* flowers where honeybees collect pollen only when the concentration of nectar is less than 35%. As for the plant of *Pelargonium radula*, the workers collected only the nectar and we did not notice any worker collecting the pollen. The reason may be due to the low nutritional value of the pollen of this plant as well as the availability of other sources of pollen on adjacent plants, and this corresponds to what (Freitas & Sazima, 2003) found in the study of the mechanization of pollination in the violet flower *Viola* spp, which has an amount of nectar of 0.14 µl produced per 24 hours, but the results were different on the flowers of the berry plant. (Tian et al., 2004), indicated that the main pollinators, honey bees and *Bombus* spp, forage early in the morning on the flowers of *Impatiens reptans* to obtain pollen during the first hours of opening the anthers, and return for the nectar when its concentration reaches 29.5% in the flowers of this plant.

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سلوك البحث عن الغذاء لشغالة نحل العسل *Apis mellifera* Linn. الزائرة لأزهار بعض النباتات البرية بمنطقة الجبل الأخضر - ليبيا

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المستخلص : اجريت هذه الدراسة للتعرف علي شغالة نحل العسل *Apis mellifera* في البحث عن غذائها خلال زيارتها لأزهار نباتات الحارة *Sinapis alba* والعطر شان *Pelargonium radula* والخبيز *Malva parviflora* وكذلك أزهار نبات *Stachy stournefortii*. وقد سجلت النتائج تفاوتاً في فترات البحث عن الغذاء بفرق معنوي واضح بين أزهار النباتات وبينت الدراسة أن الشغالة تقضي أطول فترة على أزهار نبات الحارة مقارنة بأزهار نبات العطر شان *Pelargonium radula* الذي سجلت أقل فترة بقاء، أما زمن انتقال نحل العسل من زهرة إلى أخرى فأظهرت النتائج إن هناك فرقاً معنوياً واضحاً حيث سجلت الشغالات في انتقالها بين أزهار نبات *Stachy stournefortii* فترة أطول وبمتوسط 4.3 ثانية وسجل أزهار نبات العطر شان فترة انتقال بمتوسط 3.5 ثانية، وأظهر نحل العسل *Apis mellifera* نشاطاً مغايراً بين الأزهار المختلفة في جمعه للرحيق أو حبوب اللقاح خلال ساعات النهار المختلفة.

الكلمات المفتاحية : سلوك البحث عن الغذاء، ليبيا ، *Apis mellifera*، الأزهار البرية ، الجبل الاخضر.

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