Is the Presence of Honeybees Having an Impact on Solitary Bee Species Abundance?

Fatma R. Hetita [1]; Nabil S. El-Barbary[1]; Mohamed A. Shebl[2]; Mohamed E. M. Esmaeil[1]

ABSTRACT

This work is considered as a first study in Western Egypt to evaluate the effect of honeybee presence on solitary bee species abundance, a case study of four crops in Alexandria Governorate at Al Hawaria region. Our results reported that the full blooming (mid-season) was more attractive to bees than the other blooming periods during different hours especially, at noon hours from 11 a.m. to 1 p.m. in the two types of bees. In general, the visitation rates of insect pollinators were influenced by the blooming period of crops and the hours of the day. The competition between honeybees and solitary bees for floral resources was varied significantly between solitary bee species and from plant to another. However, the visitation rates of solitary bees to flowers of Egyptian clover were reached its peak in all study sites in the absence of honeybees. By analyzing the soil texture of the study area revealed that the soil texture is sandy loam which is most favorable for many ground- nesting bee species. Three different nest types were found in the study region, the first one in ground- nesting represented a nest of the tribe Anthophorinii, the second was in stem nesting bees of *Xylocopa pubescens* and the third type inside shell of a species of *Osmia*.

Key words: Honeybees, Solitary bees, Competition, Floral resources.

INTRODUCTION

Bees are one of the most diverse and important insect group. They are diverse in terms of species diversity, sociality, and nesting biology (Michener, 2007). Among 107 global crops 90 are visited by bees, being the most important group of pollinators (Klein *et al*., 2007). Certain wild bees are more superior to honeybees for pollination (Kamel *et al*., 2007). There are 20.000 species of bees are known worldwide (Michener, 2007). The high production and successful yield of apple orchards depended on insect pollinators (Garratt *et al*., 2014). Some authors found a competition between honeybees and solitary bees on floral resources (Shavit *et al.*, 2009; Ropars *et al.*, 2020 and Weekers *et al.*, 2022).

The bee fauna in the Mediterranean region is varied, which could be due to variations in size, local vegetation, temperature, rainfall, edaphic, and topographic conditions (Al Ghzawi *et al*., 2006), but for Egypt very few information is known (Shebl *et al*., 2013).

Most of the previous studies were targeting honeybees and beekeeping practices (Zaghloul *et al.*, 2017), ignoring other bee species. Therefore, there are a lot of unknown information about non-*Apis*, and more research should be done. Since then, few works were done in the last two decades intensively in Eastern Egypt. Hence, the western Egypt is expected to have diverse bee groups.

The current study is one of more steps for further research in Alexandria (Western Egypt) to evaluate the effect of honeybee presence on solitary bee species abundance.

MATERIALS AND METHODS

The study area was Al-Hawaria region 30 57’ 13” N 29 40’27” E. at Burj -Al Arab city located on the west of Alexandria in Egypt. This area was away from urbanization and other anthropogenic changes conditions. The area of study had no beekeeping activity, but one swarm of honeybees (*Apis mellifera* L.) was present in a gap between two walls.

Bee collection:

The field area was about one feddan per crop which divided into four replicates, each one was 100 m^2 , the distance between each replicate was 40 meters in case of broad bean, squash and Egyptian clover, whereas in apple the feddan also divided into four replicates, each one was represented by 5 apple trees. The distance between one replicate to another was above 40 meters. The insects visiting blooms of four crops were continuously collected at three different hours of the day, morning (9-11 a.m.), noon (11 a.m. – 1 p.m.) and afternoon (1-3 p.m.) during three different periods of blooming as shown in Table (1). Collection of bees using the sweeping method was carried out. The sweeping net had a circular opening of a 42 cm. in diameter and a hand of a 68 cm. in length. The insects were collected during the flowering periods of broad bean, squash, and Egyptian clover by taking 20 single sweeps per replicate during three times per day. The total number of sweeps which represented the samples were 240 sweeps per day for each flowering period whereas in apple trees, the insects were collected by

DOI: 10.21608/asejaiqjsae.2023.334905
[1] Department of Applied Entomology & Zoology, Faculty of Agriculture, Alexandria University.
[2]Department of Plant Protection, Faculty of Agriculture, Suez Canal University, Ismailia, 41522, Egypt.
Received, November 20, 2023, Accepted, December 30, 2023.

Table 1. Flowering periods of crops

Crops / Blooming periods	Broad bean	Apple	Squash	Egyptian clover
Early blooming	16-1-2022	20-3-2022	22-4-2022	29-4-2022
Mid blooming	10-2-2022	27-3-2022	1-5-2022	13-5-2022
Late blooming	7-3-2022	3-4-2022	10-5-2022	27-5-2022

taking 25 single sweeps between and down rows of apple trees for each replicate during three times per day. The total number of sweeps which represented the samples were 300 sweeps per day for each flowering period.

Cyanide jars were used for killing the captured insects from which each replicate placed in individual jar in the field and transferred to the laboratory for identification. In the lab, each specimen was pinned and attached to a separate label containing the collecting time and date, area of collection and scientific name of plant species. All collected specimens were kept in wooden boxes supplied with foam plates for pinning a long with naphthalene balls to enable long storage without pest damage.

Bee identification:

Identification of bees were done by using reference collections of Department of Entomology, Faculty of Science Ain shams University, and Department of Plant Protection, Faculty of Agriculture, Suez Canal University, Egypt. In addition, some species were sent to some European taxonomists especially tribes of Osminii and Anthidini. Online data base and Atlas of Hymenoptera were also used to confirm the identity of some species (Walsh *et al.,* 2022). Stereoscopic microscope was used to check different taxonomic characters of bees.

Soil nesting habitat analysis:

Soil samples were collected from four different sites to characterize soil properties preferred by ground nesting bees present in Al Hawaria region. Soil samples were taken on different deeps at 0-10, 10-30, and 30-50 cm. Samples were analyzed for particle size distribution, texture, pH, soluble salts and soluble cations and anions, as described by Page *et al*. (1982). The analysis was done in Soil and Water Science Department in Faculty of Agriculture, at Alexandria University.

Statistical analysis:

The experimental design in this study was split-plot design with 4 replicates. The main plots were assigned to season of blooming periods, while the sub plots were assigned to daily periods for the two types of bees (solitary and honeybees). Analysis was performed according to Gomez and Gomez (1984) using SAS (statistical Analysis System) version 9.1 (2002). Comparison of means was performed using Least Significance Difference (L.S.D) at 0.05 level of probability. Numbers of bees were transformed using square root transformation prior to analysis of variance. The Statistical analysis was done in Crop Science Department in Faculty of Agriculture, at Alexandria University.

RESULTS AND DISCUSSION

Survey of the most insect pollinators captured during the flowering period of broad bean (*Vicia faba* L.) at different hours of the day:

Honeybees were calculated as the most important abundant pollinators with higher visitation rates with (120) visits, while solitary bees recorded (90) individuals during the flowering period of broad bean from 16th of January 2022 to 7th of March 2022 at different hours of the day as shown in Table (2).

The significance between averages during different hours of the day of solitary bees showed that there were significant differences between noon hours from 11 a.m. to 1 p.m. and afternoon from 1 to 3 p.m., but insignificant differences existed between morning from 9 to 11 a.m. and noon from 11 a.m. to 1 p.m. as well as between morning from 9 to 11 a.m. and afternoon during 1 to 3 p.m. Concerning the blooming period of broad bean. The data showed that the differences between averages were not significant during the three periods of blooming.

With respect of the visitation frequency of honeybees was also estimated as shown in Table (2).

Significance of average visitation rate of honeybees revealed that insignificant differences between hours from 9-11 a.m. and 11 a.m. to 1 p.m. were existed, but significant differences were occurred at afternoon between 1-3 p.m. and morning from 9-11 a.m. The same trend was also noticed between afternoon from 1-3 p.m. and noon from 11 a.m. to 1 p.m.

Table 2. Number of insects collected during the blooming period of broad bean (*Vicia faba* L.) at different hours of the day

Bees & Hours / Season	Solitary bees Day hours 9-11	11-1	1-3	*Total	*Average	Honeybees Day hours 9-11	11-1	1-3	*Total	*Average
Early season 16-1-2022	9	13	8	30	2.50 a	12	9	9	30	2.50 b
Mid-season 10-2-2022	11	13	9	33	2.75 a	18	23	47	88	7.33 a
Late season 7-3-2022	7	12	8	27	2.25 a	1	0	1	2	0.17 c
*Total	27	38	25	90		31	32	57	120	
*Average	2.25 ab	3.16 a	2.08 b		7.50 a	2.58 b	2.66 b	4.75 a		10.00 a

*Total for four replications.

*Average followed by the same letter are not significant according to $L.S.D_{0.05}$

Regarding the flowering period of broad bean, the significance between averages showed that there were significant differences between the three flowering periods occurred.

From the previous results, it could be reported that, the visitation rate of honeybees to flowers of broad bean was peaked at afternoon hours between 1-3 p.m. during the mid-season blooming, while in those of solitary bees, this rate was highest at noon hours from 11 a.m. to 1 p.m. and during the mid- season as well as the honeybees' visits.

All collected specimens were belonged to five genera under three families (Apidae, Andrenidae, and Megachilidae). The insect pollinators visiting flowers of broad bean include the following genera, *Anthophora* were the most bee visitors with 71 individuals (78.88% of the total abundance), followed in a descending order by *Andrena* with 9 individuals (10%), *Xylocopa* with 7 individuals (7.77%), *Melecta* with 2 individuals (2.22%). The lowest value with one individual (1.13%) was recorded belonged to the genus *Osmia*. The present results confirm those of Shebl and Farag (2015) and Badawy *et al*. (2020), they found that *Anthophora* species are the most abundant species and very good pollinators to flowers of broad bean in northern temperate and African regions especially in Egypt fauna.

Concerning the competition between solitary bees and honeybees for floral resources. The average visitation rate of honeybees to flowers of broad bean tends to be higher with (10) individuals than (7.50) individuals which was recorded in those of solitary bees. Although the visitation rate of honeybees tends to be higher than solitary bees, the differences between averages were not significant. As previously mentioned, it could be reported that *Anthophora* species (Large sized bees) were the most abundant and active pollinators to the flowers of broad bean. These results are nearly similar to those of Henry and Rodet (2018), they reported that large solitary bees are more impacted than small bees by competition from managed honeybees, and also Iwasaki and Hogendooren (2022) reported that the size of solitary bees plays an important role in the competition between honeybees and solitary bees.

Survey of the most insect pollinators captured during the flowering period of apple (*Malus domestica* Borkh.) at different hours of the day:

Honeybees were the most frequent apple blooms visitors with a total of (101) individuals followed by (84) visits were recorded in those of solitary bees during the blooming period of apple from 20th of March 2022 to 3rd of April 2022 at different hours of the day as shown in Table (3).

Table 3. Number of insects collected during the blooming period of apple (*Malus domestica*) at different hours of the day

Bees & Hours / Season	Solitary bees			*Total	*Average	Honeybees			*Total	*Average
	Day hours					Day hours				
	9-11	11-1	1-3			9-11	11-1	1-3		
Early Season 20-3-2022	2	11	3	16	1.33 b	9	11	6	26	2.16 b
Mid -Season 27-3-2022	14	15	6	35	2.91 a	17	23	16	56	4.66 a
Late Season 3-4-2022	8	16	9	33	2.75 ab	5	8	6	19	1.58 b
***Total**	**24**	**42**	**18**	**84**		**31**	**42**	**28**	**101**	
***Average**	**2.00 b**	**3.50 a**	**1.50 b**		**6.91 b**	**2.58 b**	**3.50 a**	**2.33 b**		**8.41 a**

*Total for four replications.
*Average followed by the same letter are not significant according to $L.S.D_{0.05}$

The differences between averages of solitary bees showed that there were significant differences between noon hours from 11 a.m. to 1 p.m. and morning hours during 9-11 a.m. as well as between noon hours from 11 a.m. to 1 p.m. and afternoon between 1-3 p.m., but insignificant differences between morning from 9-11 a.m. and afternoon during 1-3 p.m. were found.

Concerning the blooming period of apple, the significance of the average visitation rate revealed that there were significant differences between mid-season and early season occurred, but insignificant differences between mid – season and late season were existed as well as between late season and early season.

With respect of the foraging activity of honeybees was also studied as shown in Table (3). The differences between averages showed that there were significant differences between noon hours from 11 a.m. to 1 p.m. and morning hours between 9- 11 a.m. The same trend was noticed between noon hours from 11 a.m. to 1 p.m. and after noon hours during 1-3 p.m., but insignificant differences were existed between morning hours from 9-11 a.m. and after noon hours during 1-3 p.m.

Concerning the blooming period of apple, the significance reported that there were significant differences between mid-season and early season occurred as well as between mid-season and late season, but insignificant differences were existed between early season and late season. Generally, the data strongly showed that, the visitation frequencies of solitary bees and honeybees were significantly higher in mid -season blooming than the other periods of blooms, and the largest number of insect pollinators were observed during noon hours from 11 a.m.- 1 p.m.

All collected specimens were belonged to five genera related to three families (Andrenidae, Halictidae and Apidae). The insect pollinators visiting flowers of apple include the following genera, *Andrena* were the most bee visitors with 78 bees (92.85% of the entire catch), followed by *Lasioglossum* with 2 bees (2.38%), *Sphecodes* with 2 bees (2.38%), *Anthophora* with one bee (1.19%), finally *Xylocopa* with one bee (1.19%).

With respect of competition between solitary bees and honeybees for floral resources, the data showed that the average visitation rate of honeybees to flowers of apple was significantly higher with (8.41) individuals than those recorded in solitary bees with (6.91) individuals. From the previous data, it could be mentioned that *Andrena* sp (small-sized bees) were the most abundant and active pollinators of apple flowers. These results corroborate those of Smith *et al*. (2013), they reported that managed honeybees might limit small solitary bees to exploit cucumber blooms as a food source.

Survey of the most insect pollinators captured during the flowering period of squash (*Cucurbita pepo* L.) at different hours of the day:

We surveyed a total of (30) solitary bees and (26) visits by honeybees during the blooming period of squash from 22nd of April 2022 to 10th of May 2022 at different hours of the day as shown in **Table (4)**. In general, the data showed a low attractiveness of squash to insect pollinators, this may be due to the little number of flowers which open each day.

The significance of average visitation rate of solitary bees showed that there were significant differences between morning from 9-11 a.m. and afternoon hours during 1-3 p.m. occurred as well as between noon from 11 a.m. to 1 p.m. and afternoon hours during 1-3 p.m., but insignificant differences were found between morning from 9-11 a.m. and noon from 11 a.m. to 1 p.m.

Table 4. Number of insects collected during the blooming period of Squash (*Cucurbita pepo L.*) at different hours of the day

Bees & Hours / Season	Solitary bees			*Total	*Average	Honeybees			*Total	*Average
	Day hours					Day hours				
	9-11	11-1	1-3			9-11	11-1	1-3		
Early season 22-4-2022	3	3	0	6	0.50 b	2	6	0	8	0.66 a
Mid- season 1-5-2022	8	4	1	13	1.08 a	4	6	1	11	0.91 a
Late season 10-5-2022	6	5	0	11	0.91 ab	5	2	0	7	0.58 a
***Total**	**17**	**12**	**1**	**30**		**11**	**14**	**1**	**26**	
***Average**	**1.41 a**	**1.00 a**	**0.08 b**		**2.50 a**	**0.91 a**	**1.16 a**	**0.08 b**		**2.16 a**

*Total for four replications.
*Average followed by the same letter are not significant according to $L.S.D_{0.05}$

Concerning the blooming period of squash, the significance between averages revealed that there were significant differences between mid-season and early season occurred, but insignificant differences were existed between mid-season and late season as well as between early season and late season.

With respect of the visitation rate of honeybees was also estimated and the data are given in Table (4).

The different between averages reported that there were significant differences between morning hours from 9-11 a.m. and afternoon from 1-3 p.m. occurred as well as between noon during 11 a.m. – 1 p.m. and afternoon from 1-3 p.m., but insignificant differences were existed between morning hours from 9-11 a.m. and noon from 11 a.m. – 1 p.m.

Regarding the blooming period of squash, the significance of average visitation rate of honeybees showed that insignificant differences between the three flowering periods were existed.

All specimens were belonging to five genera related to four families (Andrenidae, Apidae, Megachilidae and Halictidae). The insect pollinators visiting flowers of squash include the following genera, *Andrena* were most abundant one with 13 individuals (43.3% of the entire catch), *Xylocopa* came next in frequency being 11 individuals (36.6%), *Osmia* with 3 individuals (10%), *Halictus* with 2 individuals (6.6%), lastly *Nomada* with one individual (3.3%).

Concerning the competition between solitary bees and honeybees for floral resources. The average visitation rate of solitary bees to the flowers of squash tends to be higher with (2.50) individuals than those was recorded in honeybees with (2.16) individuals. The differences between averages were not significant. As previously mentioned, it could be reported that the two solitary bee genera, *Andrena* (small- sized bees) and *Xylocopa* (large- sized bees) were the most abundant visitors to the flowers of squash, and the solitary bees may compete with honeybees for floral resources, especially during morning hours from 9-11 a.m. and noon hours between 11 a.m.- 1 p.m., respectively, while the lowest abundance of bee visits was recorded at afternoon hours during 1-3 p.m. These results confirm those of Shemetkov (1960); Amaral *et al*. (1963) and Hossain *et al*. (2018), they reported that cucurbit flowers remained open for one day and the bees gathered cucurbit pollen grains heavily at morning hours from 8-10 a.m. and nectar between 10 a.m.- noon hours. Once flowers closed at afternoon hours, they never reopened. Also, the report of Henry and Rodet (2018) suggested that large -sized solitary bees were more impacted by competition from honeybees than small -sized bees. The competitive effects of honeybees on solitary bees to exploit the wild *Cistus creticus* plants as a food source was mostly expected, but without any significant differences (Goras *et al*., 2016).

Survey of the most insect pollinators captured during the flowering period of Egyptian clover (*Trifolium alexandrinum* L.) at different hours of the day:

The foraging activity of solitary bees to flowers of Egyptian clover was reached its peak in all studied sites with (678) individuals in the absence of honeybees. This might be due to solitary bees did not find any impact from honeybees on their visitation rates, during the blooming period of clover from 29th of April 2022 to 27th of May 2022 at different hours of the day as shown in Table (5).

Table 5. Number of insects collected during the blooming period of Egyptian clover (*Trifolium alexandrinum* L.) at different hours of the day

Bees & Hours / Season	Solitary bees			*Total	*Average
	Day hours				
	9-11	11-1	1-3		
Early -season 29-4-2022	49	54	44	147	12.25 b
Mid- season 13-5-2022	148	129	78	355	29.58 a
Late season 27-5-2022	81	57	38	176	14.66 b
***Total**	**278**	**240**	**160**	**678**	
***Average**	**23.16 a**	**20.00 a**	**13.33 b**		

*Total for four replications.

*Average followed by the same letter are not significant according to $L.S.D_{0.05}$

The significance between averages during different hours of the day showed that there were significant differences between noon from 11 a.m.-1 p.m. and afternoon during 1-3 p.m. occurred as well as between morning from 9-11 a.m. and afternoon between 1-3 p.m. But insignificant differences between morning from 9-11 a.m. and noon from 11 a.m. to 1 p.m. were existed.

With respect of the flowering period of Egyptian clover, the data revealed that there were significant differences between mid-season and early season existed. The same trend was noticed between mid-season and late season, but insignificant differences were existed between early season and late season. As previously mentioned, the full bloom (mid-season) was more attractive to bees than the other blooming periods during different hours of the day, especially at noon hours from 11 a.m. to 1 p.m. in the two types of bees. In general, the data strongly showed that the visitation rates of insect pollinators were influenced by the blooming period of crops and the hours of the day.

All collected specimens were belonging to 11 genera under five families (Andrenidae, Halictidae, Megachilidae, Colletidae and Apidae). The insect pollinators visiting flowers of clover were included the following genera, *Andrena* were most abundant one with 564 individuals (83.18% of the total abundance) followed by *Halictus* with 47 individuals (6.93%), *Megachile* with 34 individuals (5.01%), *Colletes* with 10 individuals (1.47%), *Sphecodes* 8 individuals (1.17%), *Pseudoapis* with 5 individuals (0.73%), *Xylocopa* with 4 individuals (0.58%), *Lasioglossum* with 2 individuals (0.29%), *Nomada* with 2 individuals (0.29%), *Eucera* with one individual (0.14%), and lastly the genus *Osmia* with one individual (0.14%).

These results agree with they of El Aaser (2013); Shebl and Farag (2015) and Hossain *et al*. (2018), they found that the largest number of bees recorded on the flowers of Egyptian clover was the genera *Andrena* and the foraging activity of insect pollinators were increased gradually during the season progressed and were reached its peak in mid-season blooming at noon hours from 11 a.m. to 1 p.m.

Generally, it could be reported that the impact of honeybees on solitary bees varied significantly between solitary bee species and from plant to another. The present results corroborate those of Shavit *et al*. (2009); Ropars *et al*. (2020) and Weekers *et al*. (2022), they found that solitary bee's diversity was decreased in the presence of beehives and the honeybees had a significant and negative effect on the species richness of wild bees in some cases, while in other cases, they did not find evidence for such competition. Finally, the competition between honeybees and solitary bees for floral resources remain unclear and need for further research to have an overview with other crops in other regions especially in Egypt fauna. Therefore, future plans could be prepared for developing migratory beekeeping in order to protect wild bee fauna and their pollination services.

Bee nesting habitats:

Most of wild bee nest in soil and stay underground most of its life cycle. The nest construction differs between ground- nesting bee species and this construction depends mainly on abiotic factors such as soil texture, soil compaction, soil moisture, temperature, and soil surface features. Other biotic factors such as floral and nesting resources, natural enemies, and presence of conspecifics (Antoine and Forrest, 2020).

Soil samples at 0-10, 10-30 and 30-50 cm deeps. were collected from four sites represented the study area. Samples were analyzed for particle size distribution, texture, pH, soluble salts, soluble cations and anions. Results were illustrated in Tables (6 & 7). The data showed that the soil texture was sandy loam

Table 6. Particle size distribution and texture

Texture	Sandy	Silt	Clay
Sandy loam	70.5 %	11 %	18.5 %

*Average of the different depth and sites.

Table 7. Chemical properties of the soil extract

EC	pH	Na	Ca	Mg	K	Cl	Hco_3	Co_3	So_4
ds/m		meq. /L							
1.85	8.28	10.6	3.9	3.7	1.1	6.5	2.7	0.0	9.3

*Average of the different depth and sites.

with relative high sand content (70.5 %) while silt and clay was 11 and 18.5 %, respectively as shown in Table (6).

The results agree with those obtained by Shebl *et al*. (2016) and Antoine & Forrest (2020). They found that the soil texture (sandy loam) is most favorable for many ground- nesting bee species.

Concerning soil salinity, data exhibited that soil was non- saline since EC was less than 4 ds/ m (1.85 ds/m). the dominant soluble cation as sodium (10.6 meq. /L) followed by calcium and magnesium while potassium was low as shown in Table (7). On the other hand, sulfate and chloride were the main anions. However no obvious change was observed with depth or between different sites

As previously mentioned, soil properties reflect moderate aeration, water movement hardness which enhance the penetration of insects into the soil to build their nests.

Three different nest types were found in the study region. The first type was ground- nesting represented a nest of the tribe Anthophorinii in April 2022.

The second type was stem nesting bees, three wood nests of *Xylocopa pubescens* were found at three different seasons, one nest in winter, one in spring and one in summer 2022. So, it is expected that *Xylocopa pubescens* are active during the whole year. A lot of holes were noticed and opened to several brood chambers full of pollen balls and the one larva for each chamber**.** The same trend of nesting biology was found on other species such as *Xylocopa fenestrate* (Ali *et al*., 2016). The third type of nest was noticed inside shell of a species of the genus *Osmia*. Inside the snail shell a yellowish pollen ball was noticed in May of 2022. Many *Osminii* and other Megachilids need snail nest and other materials for building their nests, most of the species are cavity nesting bees (Shebl *et al*., 2018).

There are several advantages in Al- Hawaria region which encourage solitary bee's populations such as less beekeeping activities and less anthropogenic effects. So, with more field expeditions more information could be explored with more opportunities to discover several nests and new taxa of the region.

CONCLUSION

The visitation rates of insect pollinators were influenced by the blooming periods of crops and the hours of the day.

The impact of honeybees on solitary bees varied significantly between solitary bee species and from plant to another. Finally, the competition between honeybees and solitary bees remains unclear and need for further researches to an overview with other crops in other regions especially in Egypt fauna. However, it is difficult to reach a conclusion in this respect.

There are several advantages in Al- Hawaria region which encourage solitary bee's populations such as less beekeeping activities and less anthropogenic effects. So, with more field expeditions more information could be explored with more opportunities to discover several nests and new taxa of the region.

REFERENCES

Al Ghzawi, A., S. Zaitoun, S. Mazary, M. Schindler and D. Wittmann. 2006. Diversity of bees (Hymenoptera, Apiformes) in extensive orchards in the highlands of Jordan. Arxius de Miscel·lània Zoològica, 4(8):42-48.

Ali, H., M. Shebl, A. S. Alqarni, A. A. Owayss and M. J. Ansari. 2016. Nesting biology of two species of the large carpenter bees *Xylocopa pubescens* and *Xylocopa fenestrata* (Hymenoptera: Apidae) in northwestern Pakistan. *Oriental Insects*, 51(2):185-196.

Amaral, E., J. Mitidieri and R. Vencousky. 1963. Studies on the activities of *Apis mellifera* L. while visiting the flowers of Cucumis satival. *Olericultura (Barzil)* 3: 181- 193.

Antoine, C. M. and J. R. K. Forrest. 2020.Nesting habitat of ground – nesting bees: a review *Ecological Entomology*. 46 (2): 143-159.

Badawy, R. M., M. A.Shebl, H. M.Mahfouz, M. N. EL-Bassiony and M. M. Ismael. 2020. Taxonomic revision of Subgenus *Pyganthophora* Brooks (Hymenoptera–Apidae) of Egypt. J. American Sci.16(5):15-23.

El- Aaser, R. M. A. 2013. Survey of non-*Apis* bees on some cultivated areas. M.Sc. thesis, of Agriculture Sciences. Suez Canal University, 110 pp.

Garratt, M.P.D., T.D. Breeze, N. Jenner, G. Polce, J.G. Biesmeiher and S.G. Potts. 2014.Avoiding a bad apple: insect pollination enhances fruit quality and economic value. *Agric. Ecosyst. Environ*. 184:43-40. https://doi.org/101016/j.agee.2013.10.032.

Gomez, K.A. and A.A. Gomez. 1984. Statistical Procedures for Agricultural Research (2nd edition). John Wiley and Sons. New York. USA: 139-153.

Goras, G., C. Tananaki, M. Dimou, T. Tscheulin, T. Petanidou and A. Thrasyvoulou. 2016. Impact of honeybee (*Apis mellifera* L.) density on wild bee foraging behaviour. *J. Apiculture sci.*60(1): 49-62.

Henry, M. and G. Rodet. 2018. Controlling the impact of the managed honeybee on wild bees in protected areas. *Scientific Reports*, 8(1): 1- 10.

Hossain, M. S., F. Yeasmin, M. M. Rahman, S. Akhtar and M. A. Hasnat. 2018. Role of insect visits on cucumber (*Cucumis sativus*) yield. *J. of biodiversity Conservation and Bioresource Management*, 4 (2):81-88.

Iwasaki J. M. and Hogendroon. 2022. Mounting evidence that managed and introduced bees have negative impacts on wild bees: an updated review. *Current research in insect sci.*100043

Kamel S. M., T. A. Abu Hashesh, M. A. Osman and M. A. Shebl. 2007. A new model of polystyrene foam for renesting leafcutting bees (*Megachile* spp., Megachilidae, Hymenoptera*). Agric. Res. J*., 7(2):97-101.

Klein, A.-M., B.E. Vaissiere, J.H. Cane, I. SteffanDewenter, S.A. Cunningham, C. Kremen and T. Tscharntke. 2007. Importance of pollinators in changing landscapes for world crops. Proc. R. Soc. Lond. B *Biol Sci*. 274: 303–313.

Michener, C. D. 2007. - Bees of the world. The John Hopkins Uni. Press, Baltimore & London, 992 pp.

Page, A.L., R.H. Miller and D.R. Keeney. 1982.Methods of soil analysis: chemical and microbiological properities, *American Society of Agronomy*, (2).

Ropars, L., L. S. Affre, L. F. Flacher, D. Genoud, C. Mutillod and B. Geslin. 2020. Land cover composition, local plant community composition and honeybee colony density affect wild bee species assemblages in a Mediterranean biodiversity hot- spot. *Acta Oecologica*, 104, 103546.

SAS (Statistical Analysis Software). 2002. Statistical Analysis Software Guide for Personal Computers. Release 9.1, SAS Institute Inc., Cary.

Shavit, O., A.Dafni and G. Ne'emanc. 2009. Competition between honeybees (*Apis mellifera*) and native solitary bees in the Mediterranean region of Israel— Implications for conservation. *Israel J. of Plant Sci.*57: 171–183.

Shebl, M. A. and M. Farag. 2015.Bee diversity (Hymenoptera: Apoidea) visiting broad bean (Vicia faba L.) flowers in Egypt. *Zoology in the middle East*. 61 (3):256-263.

Shebl, M. A., R.M. El Aaser and A. Ibrahim. 2016. nesting biology and seasonality of long horned bee *Eucera nigrilabris* Lepeletier (Hymenoptera, Apidae). *Sociology J.*63 (4):1031- 1037.

Shebl, M. A., H. A. Hassan, S. M. Kamel, M. A. Osman and M. S. Engel. 2018. Biology of *Osmia latreillei* Spinola under artificial nesting conditions in Egypt. *Asia Pacific Entomology*. 21(3):754–759.

Shebl, M., S. Kamel and H. Mahfouz. 2013. Bee fauna (Apoidea: Hymenoptera) of the Suez Canal Region, Egypt. *J. Apicultural Sci*.57(1): 33–44.

Shemetkov, M. F. 1960. Pollinating activity of bees in greenhouse. *Pchelovodstvo*, 37 (1): 28-31.

Smith, A. A, M. Bently and H. L. Reynolds. 2013. Wild bees visiting cucumber on midwestern U. S. organic farms benefit from near – farm semi natural areas. *J. Economic Entomology*, 106 (1): 97-106.

Walsh, A.T., D.A. Triant, J.J. Le Tourneau, M. Shamimuzzaman and C.G. Elsik. 2022. Hymenoptera Genome Database: new genomes and annotation datasets for improved go enrichment and orthologue analyses. Nucleic Acids Research, 50(D1), pp.D1032-D1039.

Weekers, T., L. Marshall, N. Leclercq, T. J. Wood, D. Cejas, B. Drepper and N. J. Vereecken. 2022. Dominance of honeybees in negatively associated with wild bee diversity in commercial apple orchard regardless of management practices short title: Honeybees affect wild bees in apple orchards. *Agriculture Ecosystem and Environment*, 323, 107697.

Zaghloul, A. O., N.A. El-Sayed, N.M. Hassona, A. K. Mourad and B. A. Abdel-Razek. 2017. Enhancement of Honey Production of *Apis mellifera* L. Colonies in Egypt. Alex. Sci. Exch. J. 38.3. pp.426-432.

الملخص العربي

هل لوجود نحل العسل تأثير على الوفرة العددية للنحل الإنفرادى؟

فاطمة رمضان حتيته ، نبيل سالم البربرى ، محمد عبد الفتاح شبل ، محمد عصام محمد اسماعيل

تعتبر هذه الدراسة هى الأولى من نوعها فى غرب مصرلتقييم تأثير وجود نحل العسل على الوفرة العددية لأنواع النحل الإنفرادى. وقد تمت هذه الدراسة على أربعة محاصيل هى: الفول البلدى، والتفاح، والقرع، والبرسيم المصرى وذلك فى منطقة الهوارية بمدينة برج العرب بمحافظة الاسكندرية. وقد أوضحت النتائج أن فترة منتصف التزهير للمحاصيل الأربعة كانت أكثر الفترات من حيث الوفرة العددية للنحل بنوعيه، وذلك خلال ساعات النهار من الساعة الحادية عشر صباحاً إلى الواحدة ظهراً.

وعموما يمكن القول أن معدل زيارات الحشرات للنباتات تتأثر بفترات التزهيروكذلك ساعات النهار. وفى ضوء ما سبق تم دراسة المنافسة ما بين نحل العسل والنحل الإنفرادى على المصادر الغذائية المتمثلة فى المحاصيل الأربعة، ووجد أن معنوية المنافسة تختلف بإختلاف أنواع النحل الإنفرادى وكذلك من نبات لأخر. وتبعا لذلك وجد أن معدل زيارات النحل الإنفرادى لمحصول البرسيم وصل إلى أقصى معدلات فى ظل غياب نحل العسل.

كما تم دراسة مواطن عشوش النحل ووجد أن معظم أنواع النحل الإنفرادى تبنى عشوشها فى التربة. وبتحليل تربة منطقة الدراسة وعلى أعماق مختلفة تبين أنها من النوع الرملية اللومية. ويعتبر هذا النوع من التربة من أكثر أنواع الأراضى المفضلة لدى أنواع كثيرة من النحل الإنفرادى لبناء العشوش. كما وجد ثلاثة عشوش للنحل الإنفرادى، الأول عش أرضى لنوع من جنس الانثوفورا، والثانى عش لنحلة الخشب فى أحد سيقان شجرة جافة، والثالث عش بداخل قوقع لنحلة من جنس الأوزميا.

الكلمات الإفتتاحية: نحل العسل، النحل الإنفرادى، المنافسة، مصادر الغذاء.