

THE IMPACT OF BEE EATER *Merops apiaster* ON THE BEHAVIOR OF HONEY BEE *Apis mellifera* L. DURING FORAGING

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ABSTRACT

Most beekeepers think that the bee-eaters birds are the main obstacle causing bee workers not to forage, and stay in side the hives for a long time of the day during the period extending from June to end of August. As result of some field observations bee-eaters behavior, this research have been carried out to understand foraging behavior of bee-eaters, and investigate the predation relation between honey bee and bee eater.

The study have been carried out in Eucalyptus forest in Alalous region which is located 80 Km east of Tripoli-Libya. In the study , the rate of foraging during the day hours and for all the days of study during the period which are mentioned above have been measured, also the number of the birds have been counted and presences of its perches and nest..

The study showed that the bee-eaters were not the main obstacle of bee foraging, which are opposite of what beekeepers think. Foraging rate was higher in presence of the birds than in their absence in some cases. The average bird meal consist from 90.8 % and 9.2 % of honey bee and coleoptera respectively. The study also showed that there was correlation between the foraging rate and temperature during the study period, where the foraging rate decreased as temperature increased, at the same time the study showed that there was no any correlation between foraging rate and air humidity.

Keywords: Bee eater, *Merops apiaster*, bee worker, predation, foraging

INTRODUCTION

Bird meals in general consist of insects whether it is small or large component of its diet. In this context, it is not unexpected that birds do not present a problem for the beekeeper and bees.

Aristo said that most birds are enemies of the bees, and birds of the family "Meropidae" deemed as such(15,8). Insects are the main source of protein in the diet of birds and shortage of this vital component may limit breeding of birds. Despite the damage caused by the bee eater to the bees, it has a key role in the environmental balance in the area of integrated pest management of agricultural pests by limiting the spread of some insect pests that affect some crops especially rice (15), as well as reducing the spread of different types of wasps and bee wolf. Insects may comprise 60% of bird meals and renders service to bees by catching the sick and elderly which would cause a problem for the bees and may inflict damage upon bees during winter season if not treated earlier(6). In addition, some types of bees

have significant economic value in the preparation of traditional nutritional food dishes for south East Asia particularly the dish known as "china Nest birds' soup"(15).

The predatory Bee eater birds are classified into three groups, The first group is the main predators which include birds of the two families "Indicatoridae and Meropidae" that have a significant number of species which depend for its meals on honey bee or bees wax as the main source of protein. The second group is a minor predator which includes families that have small number of varieties of birds' predator upon honeybee or families that depend partially on honey in their diet. The most important family of this group is called "Apodidae" which the bird "spine-tailed swifts" belong to. The third group is the occasional predators which do not pose problems to beekeeping(3).

The Meropidae family has three genera which comprises twenty four species (3, 13) that feeds on insects. The genus "Merops" is deem a serious danger to beekeeping, most species of this family a migrant bird, and some of them that immigrates between continents(3), The European bee eater *Merops apiaster* was regarded as the sole species in the family "Meropidae" which breeds more in moderate temperature regions than tropical one(8). The species of this family is dispersed on the continents of Europe,Australia, and Africa which contains an enormous amount of this species that it constitutes a serious threat to the apiaries if it were attacked in large groups (13). The small green bee eater bird *Merops orientalis* is regarded the most dangerous predator of the western bees since its entry to Thailand during the eighties (15). This bird prefers predation queens and drones and worker bees (15,6) because those are easily noticeable (15). also it has the ability to differentiate between different members of bees on the basis of its size and the way it fly,the congregation area deem as a protection for the queen on the occasion of mating because large numbers of drones draws the birds' attention (6). Bee eater birds fed largely on insect order "Hymenoptera" where all of its species feed on honeybees, but the percentage of honeybees in their diet differ from one species to another (8) and vary from one region to the next, In the European region, for instance, the preference for bee eater birds is to eat bumblebee instead of honeybee(11,6).

The damages and effects of the bee eater family "Meropidae" on bees and beekeeping varies from one place to another, while some reports suggest slight damages for the different species of the bee eater of the above mentioned family on bees and beekeeping(5,7), others show significant damages and severe impact on beekeeping. In Algeria the bee eater bird forced most beekeepers to delay breeding and queen rearing, until after the departure of bee eater *Merops apiaster* , to the months of October and November(12).

The contributions of several factors make the bee eater a dangerous threat to beekeeping in some geographical areas. Some of these factors include environmental conditions such as drought that prevents the building of big and strong bee colonies, and the path of pasture for prey and the predator(3), where a study showed that the content of the bee eater *Merops spp.* stomach of honeybee ranges between 0 and 90% (6) in accordance with

the season and when there is no other prey (15, 6). Moreover, the content of the stomach depends on the distance between the colonies of the birds and the location of beehives (14,6). The meal times vary amongst the different species of bee eater birds where *Merops spp.* Starts to eat in early morning then it decreases to the lowest rate at 1 pm., and that the biggest offensive is at 5 pm. It has been observed that a lot of bee eater birds do not attack bees in the first visit to the apiary (15).

Bee eater birds are social creatures living in large colonies of up to several thousands, and within the colony there are flocks of families consist of male, female, offspring's and their helpers which assist for feed the young ,the helpers did not reach the stage of mating, or an aged adult not capable of mating. Moreover, It has been noted that due to the birds' social nature it tends to host, and raise the offspring of other birds (6). Some reports have indicated that flocks of carmine bee eater *Merops nubicus* could nest in colonies harboring ten thousand pairs of adult birds (3). Some Spanish researchers have noted that the topography of the land surrounds apiaries could significantly increase the presence of bee eater birds, and facilitate the process of building nests in order to live and reproduction. the dramatic changes in the topography of the land, building of roads and the construction of dams may give the bee eater bird excellent opportunities to form colonies and build nests(2).

The bee eater needs from 200 to 400 insects, in the size of bee per day, to fill its needs and the needs of its dependents. It catches insects by its wing (6) and it does not eat it until killed (11). When bee eater birds forms a ring over the apiary, Bees have shown special defense techniques to escape and resist it by reducing the number of sorties undertaken from the hivel, while the second method is to fly at low altitude and in short sharp turns or angles (6).

Spanish researchers have found that the extermination of bird nests has led to the breakup of the first bird's cell into a group of nuclei which increased the geographical spread of the bird rather than reducing its number and increasing threat of the bird. In addition, they have found that the bee eater does not deliberately fly to the bee hives but eats within its path of pasture that ranges from 1 kilometer up to 12, from the nest, at times of famine(2).

There are three key environmental factors that influence bees' activities namely, temperature, intensity of light, and the power of solar radiation. These factors affect the activities of bees in terms of when to fly for foraging, stopping and when to continue foraging. On the other hand the stoppage ensued is a result of low density of light and solar radiation more than any other factor. Moreover, more reduced levels of flying were noted. Bees continue its activities to forage for food even in low levels of intensity of light, solar radiation, and temperature required to start flying. Also were noted that the density rate of bees forage for food is affected by the temperature, intensity of light, solar radiation, and fluctuation in the degree of sugar concentration which have an inverse relationship to the relative humidity. It has been observed that the highest rate of forage is between the hours of 11

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and 13, between 23-34 degrees Celsius, relative humidity between 65-87%, and The light intensity between 2700-6700 LX (Lux), and solar radiation between 24-35 mW/cm² and sugar concentration is between 40-68% (1), has been found that some nectaries plants resist fluctuations in the concentration of nectar, which produces nectar before bloom as in citrus flowers (4), so that bees find nectar in desired cocentration, before the influence of the environmental factors significantly. In addition to the previous environmental factors bees forage for food is affected by the presence of bee eater birds near the apiaries. Spanish researchers have found that the bee eater *Merops apiaster* may have prevented worker bees from forage for food (14, 6) its number of flights taken have dropped to 20 from 420 trips per hour (6) in order to gather nectar and bring water, thus raising the temperature of the brood 2 degrees for the apiary colonies subject of the study, were placed 629 meters from the place of 98 pairs of bee eater birds in comparison with a control apiary that was placed 3000 meters from the bee eater bird sanctuary. The impact on the two apiaries differs in terms of predation pressure. It was observed that 17% of the study apiary died from asphyxiation or through the impact of predation of forager bee workers or predation of queens, while in the control apiary it did not lose one set (14).



Picture no. (1)

It has been observed that the quality of nectar has an effect on bees forage for food. Bees preferred the sugar syrup contains equal proportions of fructose, glucose, and sucrose more than any other solution contain different

proportions (16), moreover have found that bees preferred nectar of sweet clover ,which contains balanced proportions of sugars, more than the nectar of alfalfa which contains high proportions of sucrose (14).

MATERIALS AND METHODS

Alalus area located 80 km east of Tripoli, Libya, were selected for the purpose of the study at a site adjacent to the forest srol (camphor) *Eucalypts spp.* (picture 1) suitable geographically and temporally to study the reciprocal behavior of the bee eater and honey bees , due to the fact that the forest is the type that blooms in the summer and was frequented by large numbers of bee eater birds.

The research was conducted on an apiary that comprised of 100 colonies of Italian bee *Apis mellifera ligustica* L. raised in hives on dadant system in the period from early july to early September 2007. There were 8 different days have been identified to monitor and record the reciprocal behavior of bees and bee eater with a permanent observer at the site to monitor the presence of birds and the density of forage for food. The following steps have been taken during the period of study:-

1. Recording of data, monitoring and calculation of the following:-

1. Monitoring of forage:- On a regular 2 hour interval starting at 6 a.m until 8 o'clock in the evening, 5 colonies of worker bees forage will be counted for 1 minute in accordance with Gary method (16) shown in pictures (2,3), so for days 21, 31 of the month of july, and the days of 1,15,16,25,26 in august, and on 4 of September.
2. Monitoring worker bees at source of water:- The worker bees that come to the source of water have been recorded at same dates, timing and temporal order followed in the monitoring of foraging for food (i,e step 1).
3. Monitoring of bee eater bird:- Observe and record bee eater birds visiting the apiary and monitor their location.
4. Monitor weather conditions:- Temperature and relative humidity were recorded all times at site of the study.

2. During eight days of monitoring mentioned above we run three rounds of observation in the forest to record the following:-

1. Flowers' level, blossom of flowers, and the condition of nectar in terms of drought and abundance have been recorded.
2. The behavior of bee eater birds within the forest and its density.
3. How worker bees collect nectar and how it behave with bee eater birds.

3. On the side, we have conducted two experiments as follows:-

1. At a distance of 80 meters from the apiary we have put a sucrose solution equal amounts of 1:1 concentration mixed in with cranberry flavor to stress the color red, in order to lead them into the hive, and recognize the availability of nectar in the eucalyptus flowers. This process was carried out once on day 16 from the month of August.

2. During different days of the study a group of bee eater birds were caught and autopsied to know about the components of its meal, its classification and determine whether bees are predominate in their diet.



Picture no. 2



picture no. 3

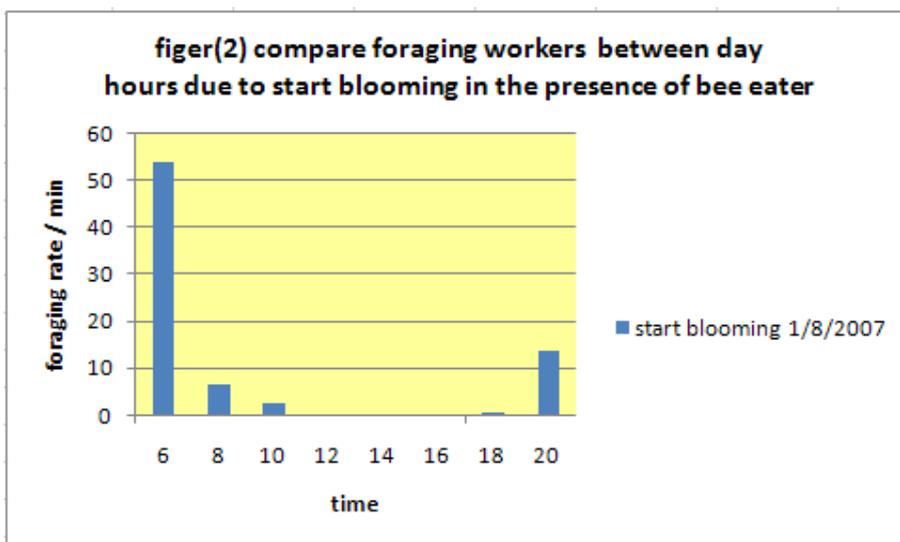
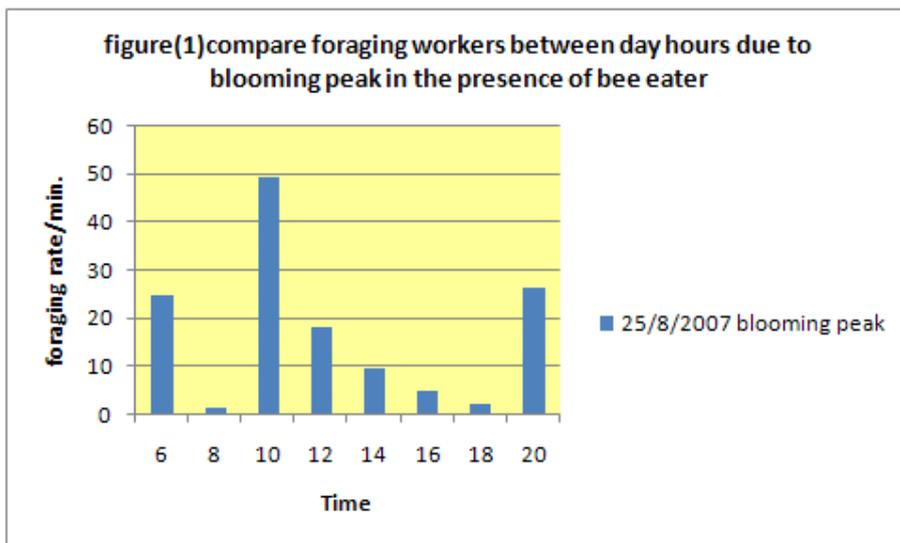
RESULTS AND DISCUSSION

Upon review of the results of 8 days of the study Shown in table 1 below which show us the average of worker bee to forage for food during daylight hours of the study since the start of the blossom of eucalyptus trees until the end of the season, we may conclude the following:-

Table (1): Number of honey bee workers / minute foraging for food during daylight Hours.

Date/time	6	8	10	12	14	16	18	20
21/7/07	0.6	0	0	0	0	0	1	8.2
31/7	55.4	69.2	5.8	0	0	0	4.2	105
1/8	54	6.6	2.6	0.2	0	0	0.4	13.8
15/8	100.8	25.8	67.4	0	0	0	1.6	80.2
16/8	75.6	34	4	0	0	0	0.4	65.8
25/8	24.6	1.2	49.4	18.2	9.4	4.8	1.8	26.2
26/8	18	1.6	11.4	14.6	8.8	1.6	9.4	16.6
4/9	27	8	2.4	3.4	10.2	0.8	9.4	4.2

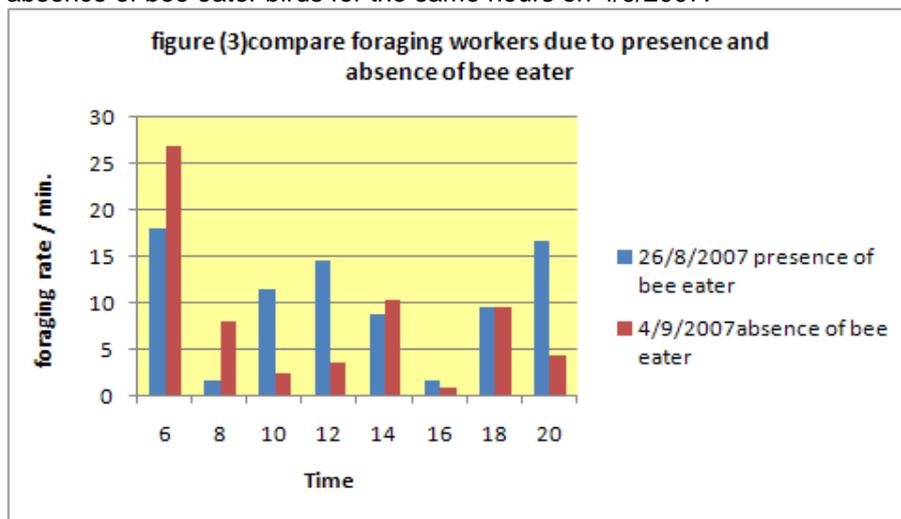
1.behavior of bees during forage and the abundance of flowers:- From the study of bees' behavior during forage for food at the start and peak of the flowering season and in the presence of bee eater that it appears as if it is an environmental factor always present. It is evident from the study of bees' behavior as described in the 2 figures (1, 2) when compared, we find that bees have focused on foraging for food at the start of the cycle in 2 periods starts at full strength in the early morning at 6 o'clock where the rate of bees foraging for food is above 50 bees / min where this period ends in steep decline at 8 o'clock in the morning. The bees start to return from the forest and this is maybe due to drying of food source ,until foraging drops to less than 10 bees / min and stops almost completely at 10 o'clock in the morning at a rate of less than 3 bees / min.



The second period is in late evening which starts at 6 o'clock and reach its peak strength at 8 o'clock in the late evening. We have observed that the behavior of bees during foraging for food at the peak of the flowering season was characterized by 3 periods instead of 2. The first starts at 6 in the morning on average strength of 25 bees / min, then witness a pause at 8 in the morning. The second period starts in full strength to reach 50 bees / min at 10 in the morning, and then starts to drop gradually to less than 2 bees / min at 6 in the evening. The third period begins at 6 and reaches its full strength at 8 in the evening which equal to the first period of the morning in terms of strength. This result seems to be in conformity with the results of

other researchers who declare that the highest rate in foraging for food among the western bees was between 11 o'clock am and 1 o'clock pm(1).

2. Behavior of bees foraging for food in the presence and absence of bee eater birds:-The rate of bee worker foraging for food during absence of bee eater birds did not consistently outperform its rate in the presence of the bird, where it is evident from table (1) and figure (3) that the rate of bees foraging for food in the presence of bee eater birds in some instances has exceeded the rate of bees foraging for food in the absence of the birds foraging for the same period of day. It has been noted that the rates of foraging for food on 26/8/2007 at the hours 10,12,16 in the presence of bee eater birds have been higher than the rates of bees foraging for food in the absence of bee eater birds for the same hours on 4/9/2007.



3. Bee eater behavior in dealing with bees:- During two days of the study on 21/7/2007 and 25/8/2007 we have observed heavy presence of bee eater birds but the remoteness or proximity from the apiary varies according to the rates of foraging for food, namely, when the foraging rates high and workers disperse in the forest for food collection, the bee eater attack it in the forest further away from the apiary. But when the rate of foraging for food is low particularly at the start of the flowering season (lack of food) we have observed the bee eater proximity or its presence inside the apiary, and that gave us an indication of the relationship between the two sides, where when we compare the average rates of forage for food of the bee worker during the hours of daylight at the peak of flowering period we have observed varying rates despite the presence of bee eater birds, despite the heavy presence of the bee eater in the forest (20-30 birds) the average rates of foraging for food were 49.4 b/m. Moreover, when we compare rates of bee worker foraging for food during hours of daylight at the beginning of flowering period we find that the bee worker forage for food is noticeable at 6 am and at 8 pm, while it diminishes or of no value during the hours 10,12,14,16,18 but in the last hours the bee eater is present in front of the apiary which demonstrates how

the bee eater attacks and when it attacks bees in the forest during high rates of forage for food, and it attacks the bees in the apiary during return of bees and low rate of forage for food. Also, it was noted that in some days bees tend to sting, and attack who come close to the apiary.

4.Sucrose solution experiment :- When the sucrose solution were offered at 7.30 am the bees were drawn heavily and again when it was given at 10 in the morning, the rate of foraging for food reached 67.4 bees / min. the bees focus on the direction of the sucrose solution was followed by the bee eater where concentrated its presence as well on the way leading to the solution. This act has led to the suspension of the process of foraging for food completely which is consistent with the finding of Spanish researchers (6); where they stated that one of methods used by the bees to diminish the effects of bee eater is to reduce the periods of forage for food. Meantime it has been observed that when bee eater birds left the site at 6 pm bees began foraging on the sucrose solution for the second time, but shortly the bee eater returned to attack the bee workers again, where we consider this behavior to be a trick in order to eat large amounts of bees. The forage for food has continued to reach an average of 80.2 bees / min at 8 pm. The results of the experiment has made it clear that the high rate of bees forage on sucrose solution is an evidence of drought in the source of food, also showed that if the source of food is concentrated in one area, it gives the bee eater bird an opportunity to focus on the route of bee workers in order to devour as many in a limited space consequently foraging for food stops.

5.Effect of temperature and air humidity on bees forage for food:-During the study period extended from early july to early septemper the correlation analysis have showed singnificant correlation at the 1% level between bees forage for food and the degree of temperature referred to in table no.2 , The temperature at this time of the year is at its peak wherein we see a drop in the rate of bees forage for food as the temperature rises . The rates of bees forage drop maybe due to the drought of nectar and lack of pollen that the bees had gathered in the early hours of the day .

Table (2): Temperatur degree and relative humidity % in the study area

Date/time	6	8	10	12	14	16	18	20
31/7/07	23* 61%	30 51	32 45	32 46	34 34	34 36	30 35	26 58
1/8	215. 70	27.6 58	29 46	30.9 50	32 49	30 55	24 63	26 41
15/8	21 81	28.9 53	34.8 30	34.6 45	31.5 53	30.6 64	29 69	27 78
16/8	21 95	26.4 79	33.6 47	33.8 49	31.8 57	31 61	29 61	27.3 73
25/8	22.1 91	26.4 90	32 63	34 57	32 60	31.7 57	29.5 70	27.5 80
26/8	21 95	27 87	30 71	32 66	32 68	30 65	30 77	27 84
4/9	22.5 83	26.6 71	32.6 42	36.5 26	35.6 67	31.9 67	29 77	27 83

*temperature c°

This is in contrast to the findings of other researchers (1) that the rate of forage for food increases in high temperature, and this is perhaps due to other factors such as different environmental conditions, geography and timing of studies. Moreover, the statistical analysis showed that there was no correlation between forage for food and air humidity in the period and place of study.

6. Bee eater birds migration : Researchers and beekeepers in nearby areas have noted that after the disappearance of the bee eater birds in the first of September it has reemerged on the eighth of September. According to some bird experts (11) the appearance can be considered for new swarms of migrant birds on the way back to their homes in Africa after spending the summer in southern Europe (14.6). This act might explain the strong appearance of bee eater birds at the beginning of April and the appearance decline after two weeks, wherein a number of swarms of birds continue en route to Europe. The bird re-appears heavily from the end of June and beginning of July. The nurturing of numerous offspring was one of the reasons which reduced the appearance of bee eater birds in the above mentioned period.

7. Dissection of bee eater stomach : As its name suggests, it eats honey bees. Table (3) shows the number of insects which have been extracted from the stomach of a bee eater, where we find bee workers comprise large part of its diet. It has consumed 90.8% of bee workers and 9.2% were from the order of Coleoptera. In a previous study it has been estimated that (6) the bird feeds on insects from 200 to 400 per day in the size of bees for its consumption to fill their needs as well as the needs of their offspring. Now, the question arises here is: How many flights can the bee eater bird fly per day? We may answer this question in the next research paper.

Table (3): The insects that have been extracted from the stomach of a bee eater

No.	date	time	Type and no. of insects
1	11/7/07	19:30	12 Coleoptera
2	12/7	7:30	20 honey bee
3	12/7	18	5 honey bee
4	11/8	15:45	5 honey bee
5	15/8	13	3 honey bee
6	15/8	14	9 honey bee
7	15/8	15	4 honey bee
8	16/8	18:30	5 honey bee+1 Coleop.
9	17/8	10	9 honey bee
10	17/8	10	19 honey bee
11	17/8	10	19 honey bee
12	17/8	16:30	10 honey bee
13	17/8	17	12 honey bee
14	20/8	10	9 honey bee

Conclusion

The study concludes that bee eater birds are not the main obstacle in preventing bees from forage , but the principal factors in the process of foraging for food are the abundance of sources of food ,the degree of its density, and to what extent sources of food are spread out in the region ? the spread of food in the region reduces the risk of bee eater on worker bees. When sources of food are limited and confined to a small areas or the region were sparsely vegetated , it will increase predation of bees ,block their route and lead to the suspension of forage , and all of this may occur in an open area . on the other hand , in the case of forage in areas of dense vegetation such as forests , the bee eater is present as a result of searching for food where it follows worker bees during return to their hives after gathering nectar of the flowers. Thus . the bee eater is not the main obstacle in the prevention of forage . the worker bees will continue foraging as long as there are source of food . but when the beekeeper observes the presence of the bee eater at the apiary, he assumes mistakenly that the bee eater bird is the reason .

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تأثير طائر الوروار علي سلوك شغالات نحل العسل أثناء البحث عن الغذاء

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3 وزارة الزراعة بالمغرب

يعتقد الكثير من مربي النحل أن طائر الوروار، هو العائق الرئيسي الذي يسبب في امتناع شغالات نحل العسل عن السروح، وبقاتها بالخلايا لفترات طويلة من النهار خلال الفترة الممتدة من شهر يونيو وإلى نهاية شهر أغسطس، ونتيجة لبعض الملاحظات الحقلية على السلوك الذي يتبعه طائر الوروار مع النحل والتي تخالف اعتقاد المربين، أجري هذا البحث لفهم سلوك النحل في السروح، والتعرف على العلاقة الإفتراضية بين طائر الوروار ونحل العسل.

أنجزت هذه الدراسة بغاية السروح *Eucalyptus spp.* الواقعة بمنطقة العلووس شرق مدينة طرابلس 80 كم، وتم خلالها قياس معدلات سروح شغالات النحل في مختلف ساعات النهار ولأيام مختلفة خلال المدة الذكورة، كما قدرت أعداد طائر الوروار، ومكان تواجده.

وقد أظهرت النتائج المتحصل عليها، أن طائر الوروار ليس العائق الرئيسي لسروح شغالات النحل، حيث سجلت معدلات سروح عالية خلال تواجد الطائر ومعدلات سروح منخفضة عند غيابه والعكس. تألفت متوسط وجبة الطائر من 90.8% و 9.2% لنحل العسل وغمدية الأجنحة على التوالي. كذلك أظهرت الدراسة ارتباط إحصائي بين سروح النحل ودرجة الحرارة خلال فترة الدراسة حيث كلما ارتفعت درجة الحرارة انخفض معدل سروح النحل، كما أوضحت الدراسة عدم وجود أي ارتباط بين السروح والرطوبة الجوية.

كلمات البحث: أكل النحل ، الوروار *Merops apiaster* ، شغالة النحل ، اقتراس ، سروح

قام بتحكيم البحث

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كلية الزراعة - جامعة المنصورة

كلية الزراعة - جامعة الإسكندرية