On the Common Sharp Decline in Honey Bee, *Apis mellifera* L. , Activity Occuring During Parts of Summer and Fall in Central and Southern Iraq , with a Particular Reference to the Role of Bee – Eaters , *Merops* spp.

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Abstract

The study was conducted in 2008 at the apiary of College of Agriculture , Karbala University to determine outside and inside activities of honey bee, *Apis mellifera* L. , colonies during the period of sharp decline which usually extends from *c.* mid – June to *c.* mid – October and find out the roles of different factors standing behind this decline , especially the bee- eaters , *Merops* spp. All outside and inside activities of honey bee colonies showed steady sharp decline . The flight activity was either at very low level sometimes or the whole colonies were confined to their hives at many other times. While mean area of sealed brood was somewhat small on 7 July (701. 9 cm^2 per colony), it decreased steadily after that to be in the range of 25.8 -152.6 . Mean size of adult bee population decreased from 7.75 and 8.14 sides of combs covered completely with adult bees per colony on 7 and 21 July , respectively to reach its lowest level , 0.59, on 26 October . There was a clear relationship between the presence of bee eaters and stopping of bee flight . The birds were found at the apiary at fluctuated levels . However , their most intensive presence was during the period extending from 1 August to 10 October ,especially at both early and late daytime hours . Many aspects of bee – eater and honey bee behaviors at the apiary were studied in details . In addition to the bee – eaters , there were also other factors participating in this decline including severe rise of ambient temperatures and shortage of nectar and pollen sources . *Vespa orientalis* L. , had no role at all in present study because it was found in very scarce numbers at the apiary .

الخلاصـــة

أجريت هذه الدراسة في منحل كلية الزراعة – جامعة كربلاء في عام 2008 من أجل تحديد النشاطات الداخلية والخارجية لطوائف نحل العسل *Apis mellifera* L. خلال فترة الهبوط الحاد التي تمتد عادة من حوالي منتصف حزيران ولغاية حوالي منتصف تشرين الاول في كل سنة في مناطق وسط وجنوب العراق . شملت الدراسة ايضاً دور العوامل المؤدية لهذا الهبوط وخاصة تواجد وهجوم طائر الوروار *Merops* spp. أظهرت النتائج بأن كل النشاطات الداخلية والخارجية لطوائف النحل قد عانت هبوطاً مضطرداً . فنشاط طيران النحل كان أما بمستوى ضعيف جداً أحياناً أو أن كل الطوائف كانت محصورة تماماً داخل خلاياها في أكثر الأحيان . أما معدلات مساحة الحضنة المقفلة فإنها كانت متدنية نوعاً ما في بداية الفترة (701.9 سم^2 لكل طائفة في 7 تموز) ثم ازدادت تدنياً فيما بعد لكي تصل الى 25.8 – 152.6 سم^2 وبينما كان معدلا مجموعة النحل الكامل 7.75 و 8.14 قرصاً شمعياً مغطى بالكامل على جانب واحد بالنحل الكامل من كل طائفة في 7 و 21 تموز , على التوالي فإن هذا المعدل قد بلغ 0.59 قرصاً في 26 تشرين الاول . لقد كانت مستويات اعداد الطير في المنحل متفاوتة خلال ساعات النهار والأسابيع المختلفة وإن أعلى مستويات التواجد الكثيف كانت خلال الفترة الممتدة من 1 آب ولغاية 10 تشرين الأول وخاصة الساعات الأولى والأخيرة من النهار . هذا واشتملت الدراسة أيضاً على دراسة سلوك الوروار والسلوك المضاد لنحل العسل بشيء من التفصيل . وبالاضافة للدور الرئيسي الذي قام بها هذا الطائر في هبوط نشاط النحل فإن هناك عاملين آخرين لعبا أيضاً دوراً في هذا المجال الا وهما الارتفاع الحاد في درجات حرارة الجو وكذلك شحة أو عدم توفر مصادر الرحيق وحبوب اللقاح في الحقل . أما الزنبور الأحمر *Vespa orientalis* L. فإنه لم يكن اطلاقاً من ضمن العوامل المؤدية لذلك الهبوط في دراستنا الحالية لان اعداده كانت في مستويات لا تذكر في المنحل .

Introduction

There are two peaks of the honey bee , *Apis mellifera* L. , colony activity in central and southern Iraq : a major , most important peak extending from about mid- February to a bout mid – June and a minor , less important peak extending from about mid – October to about end of November . The duration and strength of each peak , however , vary from year to year and from an area to another (1 ; M. K. Glaiim , unpublished data) . Between these two periods of activity there is always a period of sharp decline . Colony activity usually undergos a decline soon after major honey harvesting at about mid-June . This decline . continues steadily until final migration of bee-eaters , *Merops* spp . , at mostly sometime in October . Most of colony losses take place during August and September (pers. observ.) . Four major factors are believed to be behind this decline : (1) presence and attack of the bee- eaters, (2) severe rise of ambient temperatures , (3) shortage of nectar and pollen sources and (4) attack of the Oriental hornet , *Vespa orientalis* L. , The *Varroa* mite and foulbrood diseases are usually brought under control nowadays .

Two species of bee eaters breed in Iraq : the European bee- eater , *Merops apiaster* Linnaeus 1758 , which is usually found in the north and north – east and the blue – cheeked bee- eater , *Merops superciliosus persicus* Pallas 1773 , which is usually found in whole central and southern regions . The little green bee- eater , *Merops orientalis beludschicus* Neumann 1910 , which breeds in southern Iran , has occasionally been observed in far south of Basra province as a vagrant bird . The first two species stay in Iraq from March to October , or even early November when they complete their migration towards their winter quarters in southern Africa (2 , 3 , 4 , 5 , 6) . There have been so many researches conducted by bird scientists on the biology of bee- eaters , but little research has been carried out on the effect of these birds as well as other avian predators on apiculture in different countries (7) . The attitudes of people towards the bee- eaters vary greatly depending on the benefits these birds give sometimes and the damage they cause at other times . While most farmers consider them as beneficial birds because they attack a wide range of harmful insects , the beekeepers in many countries regard them as enemies because they are shown to consume vast numbers of honey bees and confine the bee colonies to their hives although these birds attack honey bee predating insects such as bee – wolves , *Philanthus* spp. and hornets , *Vespa* spp. (7 , 8 , 9 , 10 , 11 , 12 , 13) . As for me , and depending on decades of scientific and practical work in beekeeping , I consider the bee- eaters as one of the main factors hindering beekeeping industry in central and southern Iraq .

Vespa orientalis L. is a key pest attacking honey bee colonies in Iraq (14 , 15 , 16 , 17) . The severe rise of ambient temperatures to about 50 C̊ , especially in July and August , impairs the flight activity of honey bees ; and if they are able to fly they will concentrate their efforts on collection of water to cool the colony , especially at midday and early afternoon (18 , 19 , 20 , 21) . It is well known that the shortage of pollen and nectar in the field highly reduces the activity of brood rearing (*e.g.* 18 , 22 , 23 , 24) , thereby reduces the size of adult bee population .

The objectives of this study were : (1) determining different inside and outside activities of honey bee colonies during the period of sharp decline , (2) verifying the roles of different factors standing behind this decline , and (3) studying some aspects of bee- eater and honey bee behaviors at the apiary. As far as I know , the present study is the first work dealing in details with the impact of bee – eaters on honey bee activity in Iraq .

Materials and Methods

The study was conducted at the apiary of the College of Agriculture , Karbala University about 13 km to the north of karbala city (32̊ 35' 52" N, 44̊ 0' 58" E, 22m altitude) from 7 July to 23 November , 2008 .Ten honey bee , *Apis mellifera* L. , colonies headed by sister mated queens , nearly equal in strength , and housed in Langstroth type of hives were used . The hives were placed under a shade made of plant materials to protect the colonies from direct sunlight . Like all other honey bee colonies found in Iraq nowadays , the bees are of randomly mixed race . According to Brother Adam (cited in 25) the native race of honey bee in Iraq is a sub-division of *Apis mellifera syriaca* . Many races , especially *A. mellifera carnica* , have randomly been introduced by both of state and private sectors since about 1970' s and crossed with each other and with the native race.

In order to supply the bee- eaters with a suitable site for perching and ensure accurate observation of their number , activity , and patterns of behavior , the following preparations were undertaken . The piece of ground in front of the hive shade was flat and open . Five tall and thick wooden posts , *c*. 6m long each , were fixed vertically in the ground, *c*. 5m apart , to form a row running parallel to the shade . The distance between this row of posts and the shade was about 22m. Then , the posts were connected by two ropes stretched horizontally, *c*. 0.5 m apart , between the posts at a height of *c*. 5 m .

Three count processes were carried out at the beginning of each hour or half an hour from early morning until nearly sunset at about one week intervals during the whole period of study . The first count process was about the number of bee – eaters perching on the ropes at the moment of count . When there were no birds on the ropes , their sounds (calls) coming from outside the apiary were recorded as well . Recording the bird sounds coming from outside the apiary may help to find out whether the confinement of honey bees to their hives is only caused by the presence of the bee-eaters themselves at the apiary or by merely their sounds even though the birds are found outside the apiary . The second process of count involved the number of *Vespa orientalis* found at the apiary at the moment of count . The third process of count was carried out at hive entrances to determine the number of outgoing , foraging bees per colony per minute . When worker bees were practicing orientation (play) flight in front of hive entrances , the count of flying bees was not taken place because it is not possible to differentiate between bees departing for foraging task and those departing just to practice the 'play' flight needed for orientation and / or defecation . In addition to those count processes , every minute note on behaviors of bee eaters and honey bees was recorded immediately .

Inside – hive activities of honey bee colonies were recorded every two weeks , but in days not devoted for the above mentioned processes of count . The parameters used for this purpose were : area of sealed brood , size of adult bee population , area of bee – collected pollen stored in the combs , and weight of whole colony . The areas of sealed brood and bee- collected pollen were measured in each hive by means of a two – centimeter square mesh wire grid (26) . Each colony with its hive was weighed by means of a movable 100-kg scales . The size of adult bee population was determined by counting number of combs covered completely with adult bees by applying the technique recommended by Gary *et al.*(27) . There were four colonies that failed to survive the period of sharp decline , so all data belonging to these colonies were excluded from the study results. The information of climatic conditions in the area of study were obtained from the Iraqi State Board of Meteorology .

Results and Discussion

1. Climatic and Agricultural Conditions of Study Area

Table 1 shows climatic elements recorded in 2008 at Karbala city , c. 13 km from present study location . The area , like other areas in central and southern Iraq , is characterized by its very hot , arid climate during the three months of summer and September . During these four months , monthly mean maximum and minimum temperatures ranged 40.6 – 45.5 and 27.0 – 30.3 C° , respectively . Monthly mean relative humidity during these four months ranged 22 – 30 per cent . Practically , no rainfall was recorded during all days of this period since rainfall total reached only 0.001 mm . The grand total of the rainfall in the whole year was very low for it reached only 76 mm .

Table 1. Climatic elements recorded in 2008 at Karbala City (*ca* 13 km from present study location) *

Climatic element	Month											
	Jan.	**Feb.**	**Mar.**	**Apr.**	**May**	**Jun.**	**Jul.**	**Aug.**	**Sep.**	**Oct.**	**Nov.**	**Dec.**
Monthly mean max. temp.(C)	**12.0**	**18.6**	**27.5**	**33.4**	**37.3**	**42.0**	**44.6**	**45.5**	**40.6**	**32.5**	**24.6**	**18.6**
Monthly mean min. temp.(C)	**2.7**	**7.0**	**14.7**	**19.9**	**23.0**	**27.7**	**29.2**	**30.3**	**27.0**	**20.3**	**12.0**	**5.8**
Monthly mean R. H. (%)	**68**	**55**	**42**	**36**	**33**	**28**	**29**	**22**	**30**	**49**	**62**	**61**
Monthly rainfall total (mm)**	**20.4**	**9.9**	**0.7**	**10.3**	**5.4**	**0.0**	**0.0**	**0.0**	**0.001**	**20.0**	**2.0**	**7.3**

* References : State Board of Meteorology , Baghdad , Iraq
** Annual rainfall total = 76.0 mm

Despite these harsh climatic conditions , the area has been famous, especially up to 1980's , for its agricultural nature because of the soil suitability for growing different crops and wide spread of irrigation canals that are fed by Euphrates River . Most of the area surrounding the location of present study is covered in plantations of date palm , citrus and deciduous fruit trees . However , alfalfa , clover and vegetable crops are grown in scattered small plots . Also , there are neither farms of sunflower nor man – created forests of *Eucalyptus* . For that reason , the area ensures well – enough sources of pollen and nectar for honey bee colonies during February , March and April but not after that . So , commercial beekeepers practice migratory beekeeping by moving their colonies at about late April to farms of clover and sunflower and man- created forests of *Eucalyptus* in neighboring provinces . However , these colonies are moved back at a bout mid- June because even those areas in neighboring provinces will be devoid of any commercial sources of pollen and nectar during July , August and September .

Moreover , many changes have happened during the last three decades , not only in the area of present study but also in other areas of central and southern Iraq . The main changes included : (1) heavy vertical and horizontal contractions in cultivated areas , (2) severe climatic changes including rise of ambient air temperatures and steady reduction in annual rain fall , and (3) spread of random , non – scientific crossing between honey bee colonies due to introduction of different races from known and unknown genetic sources . These changes might have been affecting honey bee activity in these areas . Le Conte and Navajas (21) stated "climatic change can impact on honey bees at different levels . It can have a direct influence on honey bee behaviour and physiology . It can alter the quality of the floral environment and increase or reduce colony harvesting capacity and development" . The changes in climatic conditions might have had some influences not only on *Apis mellifera* itself but also on the activities and distributions of honey bees other than *A. mellifera* and the bee- eaters . For example , the dwarf honey bee , *Apis florae* , has expanded its geographical distribution in a westward direction because its colonies were found settling in Iraq for the first time in September 1990 (28 , 29) . The European bee-eater , *Merops apiaster* , has expanded its breeding quarters towards Great Britain recently (30) and its population in Czech Republic increased 4-5 times between 1991 and 2000 (31) . Regarding the impact of random introduction of queen honey bees , Le Conte and Navajas (21) stated that although the imports of queens would incrase the genetic diversity , they would also act as vectors of new pathogens or new bee haplotypes of varying usefulness .

2. Presence and Intensity of Bee- Eaters at the Apiary

First of all , I have to mention an important notice about the species of bee – eaters I am talking about in present study . It has already been mentioned (see Introduction section) that the blue – cheeked bee- eater , *Merops superciliosus persicus* , breeds in whole central and southern regions of Iraq while the European bee- eater , *M. apiaster* , breeds in the north and north – east . When the second species practices its spring and fall migrations (from and towards its wintering quarters in southern Africa) it has to cross central and southern regions . Allouse (2) stated that the migrants of *apiaster* were recorded in central Iraq from late August to end of October during their fall migration and from mid-March to mid-May during their spring migration . Also , Kossenko and Fry (12) stated that in Oman and Central Asia these two species migrate often in mixed flocks to largly common wintering grounds in Africa . Furthermore, the migration often occurs during daytime . Cramp (3) reported that *apiaster* in Europe migrates usually in parties of 20-30 birds, passing from 30 min before sunrise to 30 min before sunset although some nocturnal movement occurs . Cramp added "when not overflying inhospitable terrain , diurnal migrants often break their journey to hawk insects before continuing" . The same author reported that the blue – cheeked bee – eater practices both of diurnal and nocturnal migrations . From these facts it could be concluded that individuals of these two species may be found together at the same apiary somtimes, and this may explain why I refer to the birds in this study as *Merops* spp. rather than *M. superciliosus persicus* . Moreover , since the study lasted till the final migration of all bee- eaters (on 2 November) , it was not possible to pursue each bird to determine the species it belonged to , especially during times of fall migration . Also , if I could do that , I would not be able to do so regarding the calls (sounds) which I was recording when they were released by birds found outside the apiary area . Of course, I could not differentiate between the sounds of these two species . Cramp (3) reported that voices of *M. superciliosus persicus* are used freely during all day-time activities and its repertoire is similar to and homologous with that of *M. apiaster*.

At the apiary , the birds were seen either perching on the ropes extended in front of the shade or flying across the apiary to move towards another area . They were very rarely seen sitting on the ground . When the birds were not seen at the apiary , their calls (sounds) were sometimes heard , *i. e*. the birds were found in adjacent areas . At other times , neither the birds were present at the apiary nor their sounds were heard , but in such a case I had no idea whether the birds were present in neighboring areas or flew far away . Table 2 shows the levels of presence and absence of the bee- eaters at the apiary during whole study period . Although the bird presence was recorded during all weeks from 8 July to 2 November , the intensity and duration of this presence showed clear fluctuations during both of different weeks and daytime hours . The most intensive and continuous presences of the bee- eaters perching on the ropes were recorded on 2 and 13 August . In each of these two days the birds were recorded perching at each half an hour from 06:00 – 18:30 h except at 09:00 , 09:30 , 16:00 and 18:30 h in the first day and 09:30 – 11:00h in the second day . This means that they were staying continuously on the ropes for more than 10 hours in each of these two days . Other heavy presences were also recorded on 20 and 26 September and 10 October . The bird presence , of course led to confinement of bees to their hives as it will be shown and discussed later . One of the remarkable notes on the attendance of bee eaters at the apiary is that relating to the sharp fluctuations of this attendance from week to another . For example , the attendance was very heavy on each of 1 and 13 August (as mentioned above) , but the situation was different on 8 August when the birds were not seen sitting on the ropes for many hours , and when they were present , they were found in lesser numbers . A similar trend of somewhat weak presence was also observed on 3 October if compared with those recorded on 26 September and 10 October .

The first indication of bee- eater withdrawal from the area was noticed on 17 October because they were in a few numbers and also absent most of the day. Moreover , they were never seen at the apiary during whole daytime hours on 24 and 31 October except their sounds were heared at 08:30 and 08:00 h in these two days , respectively . This may indicate that the birds at this period were migrating towards their wintering quarters in Africa (2 , 5) . Cramp (3) reported that fall passage of *M. superciliosus persicus* across Middle East takes place from mid – August to mid – November , especially September and October . Also , it seems that the birds did not migrate all at once but in parties leaving successively . Surprisingly , and after many days of absence , seven birds were seen sitting again on the ropes at 10:30 h on 2 November although they stayed for only about 15 minutes and left all together . It seems that these birds were among migrants came from the north and broke their journey temporarily to hunt some bees at the apiary before continuing the journey towards the south (3) . No birds were seen or recorded again in the area until 7 April , 2009 (spring migration) .

Table 2 . Intensity of bee – eaters , *Merops* spp. , at the apiary at different hours and weeks in 2008 *

* Figures = numbers of bee- eaters perching on ropes in front of hive shade

+ = no birds were found at the apiary but their sounds were heard

− = neither the birds nor their sounds were present

Day	Hour																									
	6	6.30	7	7.30	8	8.30	9	9.30	10	10.30	11	11.30	12	12.30	13	13.30	14	14.30	15	15.30	16	16.30	17	17.30	18	18.30
8/7			1		1		+		+		3		3		+		+		+		+		3		3	
15/7			+		+		+		1		+		+		1		1		−		+		4		4	
25/7	1		+	+	+	−	−	+	+	−	−	−	1	2	1	2	+	+	+	−	−	−	1	2	3	4
1/8	5	2	4	3	4	3	+	−	1	2	3	3	3	2	3	1	3	4	3	1	+	1	4	2	2	−
8/8	3	3	+	−	−	+	−	−	−	2	3			−	−	1	1	1	−	−	+	+	1	3	3	1
13/8	5	2	3	5	3	4	2	−	−	−	−	1	1	2	2	1	1	1	2	1	3	2	3	4	5	5
22/8	6	8	8	6	1	−	−	+	+	+	+	−	+	−	−	+	+	1	−	−	+	+	3	4	5	−
29/8	3	5	4	5	7	−	−	−	−	−	+	−	−	−	−	1	1	1	−	1	2	5	3	2	6	−
5/9	3	2	4	4	3	+	−	−	−	−	+	1	+	−	−	−	−	−	−	−	+	1	1	3	2	
11/9	4	1	2	+	3	1	−	−	1	−	−	−	−		2	1	1		1	1	3	3	3	7	5	−
20/9	3	2	2	3	2	−	+	−	−		1	−	1		2	1	1		−	1	4	4	4	5	1	
26/9	6	1	1	4	3	3	4	2	−	+	+	−	−	−	2	4	3	2	3		3	2	3	5	−	
3/10		1	−	1	1	+	2	1	−	+	1		4	−	−	−	1	+	2	3	−	3	2	−		
10/10	2	+	2	4	2	2	7	4	6	1	4	+	+	2			2	7	1	4	4	3	6	−		
17/10			−	−	−	−	−	+	−		1		−	−	−		+	1	+	2	1	2	1	−		
24/10		−	−		−	+	−		−		−		−		−		−		−		−		−			
31/10		−	−		+		−		−		−		−		−		−		−		−		−			
2/11	Last presence of bee- eaters . Seven birds sat on the ropes for only 15 sec. at 10:30h.																									

It seems that the low intensity of the birds during July compared with those in August and September may have been due to the behavior and activity of the birds during breeding season . It seems that most of the birds were found in breeding areas at least up to early July (5) while most or probably all of them left these areas in August and September. It has been found by many workers that when the bee- eaters are still found in breeding areas , their presence and impact will be low at the apiaries , especially when the latter are found far from breeding (nesting) areas . Kossenko and Fry (12) found that each of *M. apiaster* and *M. superciliosus persicus* foraged mainly within a few hundred meters from its nest or colony (although up to 2 km away sometimes) . Cramp (3) reported that this range extended to about 5 km after fledging in some areas . Also , it seems that most of the birds found at the apiary in present study in July were the parent birds while these parents and their young were found together after that , *i.e*. during August – November . Fry (11) reported that *M. apiaster* and *M. ornatus* concentrate at apiaries in fall more than in spring because there are more birds after than before breeding .

Regarding the presence of bee- eaters at different daytime hours at the apiary (Table 2) , it was found that they were generally present in larger numbers and staying for longer times during both of morning and late afternoon hours . However , although this trend was obvious in most weeks , it was not so in some other ones . For example , this trend was very clear on 22 and 29 August but it was not so on 1 August when the birds were perching on the ropes at almost same density and duration at most of daytime hours . Cramp (3)reported that *M. apiaster* and *M. orientalis* feed much less around midday and early afternoon in hot climates , and towards evening , rates increase until departure . This author also reported patterns of alternating intense feeding and resting of M. *apiaster* : 2-hr cycle in England and 4-hr cycle in Hungary . Campobello and Hare (32) found that the feeding rate of *M. apiaster* in Sicily , Italy was significantly higher in the morning than in afternoon . Kastberger and Sharma (33) found that the flight raids of blue – bearded bee – eater , *Nyctyornis athertoni* on the nests of the giant honey bee, *Apis dorsata* , happened just after sunrise and before sunset for half an hour .

Since the birds spent many consecutive hours perching on the ropes , they may have preferred honey bees to other insects which were found in the fields and orchards surrounding the apiary . Cramp (3) reported that honey – bees may be eaten by blue – cheeked bee- eater to exclusion of other prey when plentiful . In Sardinia , Italy it was found that the overall frequency of honey bees in diet of *M. apiaster* was about 32 per cent (34) . The bee- eaters are shown to consume vast numbers of honey bees when the birds are found in areas rich in honey bee colonies (11) . It has been found that a bee- eater needs to find from 200-400 bee- sized insects a day to feed itself and its young (7) . It was found in Ukraine that a single bee- eater , *M. apiaster* , had been estimated to account for 9,000 honey bees during its summer stay in this country (Petrov , 1954- cited in 34) .

3. Presence and Intensity of *Vespa orientalis* L. at the Apiary

Although the Oriental hornet , *Vespa orientalis* L. , is one of the Key pests attacking honey bee, *Apis mellifera* L. , colonies in Iraq (14 , 15 , 16 , 17) , it had no any effect on the activity of honey bee in present study . The trivial presence of the hornet (Table 3) can not practically be regarded as one of the factors participating in the sharp decline of bee colonies as it will be shown later . Table 3 shows that the hornet was totally absent at most times , and when it was present at some other times it was found in very low numbers which usually ranged 1-2 hornets at the whole apiary at each moment when the count was conducted .

It is well known that the hornet could be seen attacking honey bee colonies in large numbers in many , but not all , places in Iraq , especially in August – early November . Such attacks either weaken the colonies of honey bee or force them to abscond their hives . If the attack is heavy and persistent the colony will ultimately be perished and many of worker hornets could be seen inside the hive to take the food stored in wax combs (14 , 16). Such presence and attack of the hornet did not take place in the present study as it has already been mentioned . I believe two reasons may have been responsible for this situation . Firstly , the immediate vicinity around the apiary was not suitable for hornet nesting . It is well known that while worker honey bee , *A. mellifera,* is known to forage over 5-10 km from its nest , worker hornet , *V. orientalis,* is thought to travel only c. 400m at most (14) . A similar trend could also be found in the case of many solitary bees (Apoidea) that are thought to travel only a few hundred meters at most from their nests (35 , 36) . Secondly , the date palm plantations in whole region have been sprayed continually with insecticides to control the Dubas "bug" , *Ommatissus binotatus* , by using agricultural airplanes in recent years . It seems that such heavy application of chemical control method has also affected non – target pests including the Oriental hornet .

4. Activities of Honey Bee Colonies

4.1.Honey Bee Flight Activity

Table 4 shows rates of flight activity of worker honey bees at different daytime hours in different weeks of whole study period . It is obvious that the rate of flight activity was somewhat low at the beginning of the study (8 July) , and it began to drop steadily after that . Indeed , the reduction in numbers of foraging bees was one of the most remarkable features characterizing present study . Most of the time the bees were either confined totally to their hives or flying in very trivial numbers . At some other times , the bees were either practicing orientation (play) flight or flying in somewhat noticeable numbers . It could be said that there were three major factors standing behind this sharp reduction . These factors were : (1) presence and attack of bee – eaters , *Merops* spp. , (2) extreme rise of ambient temperatures , and (3) shortage of pollen and nectar sources in the field . It has already been mentioned that *V. orientalis* was not among these factors . Also , the colonies were free from infestation of *Varroa* mite and infection of diseases such as American and European foulbrood . It is axiomatic that any fall in the flight activity of honey bees will heavily affect all inside activities of the colonies such as brood rearing and honey production as it will be shown and discussed later .

Table 3 . Numbers of worker Oriental hornets , *Vespa orientalis* L. , recorded at the beeyard at different hours and weeks in 2008 .

Day	Hour																									
	6	6.30	7	7.30	8	8.30	9	9.30	10	10.30	11	11.30	12	12.30	13	13.30	14	14.30	15	15.30	16	16.30	17	17.30	18	18.30
8/7			1		1		1		1		0		0		1		1		1		1		0		0	
15/7			0		0		0		0		0		0		0		0		0		0		4		4	
25/7	0		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1
1/8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		1
8/8	0	0	0	0	0	1	1	1	1	1	0			0	0	0	0	0	0	0	0	0	0	0	0	0
13/8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22/8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
29/8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
5/9	2	0	1	1	2	1	2	1	2	2	2	0	0	0	0	0	0	0	0	0	1	0	2	2	1	
11/9	1	0	0	1	0	0	0	0	0	0	0	0	0		0	0	0		0	0	0	0	0	0	1	0
20/9	0	0	0	0	0	0	0	0	0		0	0	0		0	0	0		0	0	0	0	0	0	0	
26/9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0	0	0	0	0	
3/10		0	0	0	0	0	0	0	0	0	0		0	0	0	0	0	0	0	0	0	0	0	0		
10/10	0	0	0	0	0	0	0	0	0	0		0	0	0	0		0	0	0	0	0	0	0	0		
17/10			0	0	0	0	0	0	0		0		0	0	0		0	0	0	0	0	0		0		
24/10		0	0		0		1		0		1		0		0		0		0		0		0			
31/10		0	0		0		0		0		2		0		1		1		0		0		0			

Table 4 Mean number of foraging honey bees , *Apis mellifera* L. , counted while leaving hive entrance per colony per minute . *

*** P** = bees practicing ((play)) flight . These data represent only the six colonies surviving the period of sharp decline

Day	Hour																								
	6	6.30	7	7.30	8	8.30	9	9.30	10	10.30	11	11.30	12	12.30	13	13.30	14	14.30	15	15.30	16	16.30	17	17.30	18	18.30
8/7			17.8		20.1		16.6		13		2.1		6.9		10.9		14.2		7.1		11		4.5		8.6	
15/7			P		P		10.7		2		0.8		0		0.8		3.3		19.8		9.7		4.3		8	
25/7	0.1		P	P	P	P	P	P	8.2	4	0.5	0.3	0.6	0.3	0.2	0.2	4		P	P	25.2		13.8		0.2	1.8
1/8	0	0.1	0.2	0.2	0.5	0.5	21.7		4.2	0.3	0.2	0.2	0.5		7.2		14.2		18.5		P		0.7		4.4	P
8/8	0		P	P	P	P	P	P	17.6	1.2	0.5			0.3	0	0	0	0.3	14.9		19.5		0.3	0	0.3	0.3
13/8	0	0	0.2	0	0	0.2	2.6	P	P	P	P		0.2	0	0	0	0	0	0.2	0	0	0.2	0.3	0	0.3	0.2
22/8	0.1	0.1	1.2	0.3	1.5	P	P	P	18		3.8		0.7	0.3	0.7	0.3	1.5		17.5		19.8		0.3		0	
29/8	0.2	0.2	0.5	0	0.5	P	P	P	P	P	2.8	0.2	0.2	0.5	0.2	0	0.2	0	0	0.5	1.5	9.2	0.2	0	0.8	
5/9	0	0	2.1	0.2	2.3	P	P	P	P	P	7.8	0.2	0.8	0	0.8	0.6	2.8		7.8		P	P	7	0	0.2	
11/9	0	0	0	2.6	0.8	0.2	P	P	P	P	4.2		1.4		0.5	0	0.2		0	0	0.2	0	0.5	0.5	0	
20/9	0	0	1.1	P	0.8		19.8	P	P		5.7		3.5		0.2	0	0		0.8	0	0.2	0	0	0	0.8	
26/9	0	0	0.2	0	0	0.2	0.5	0	P	P	13		6.4		1.75	0	0.3	0	0		0	0	1	1.1		
3/10		0	0.1		2.5	P	4		6.4		4.6		0	0.2	0.5	0.2	1.1		0.2	0	0.2	0	0.2	0.5		
10/10	0	0.2	0	0	0.3	0.3	0.5	0.3	0.2		3.1		6.4				0.5	0	0	0	0.2	0	0.3	0.2		
17/10			0	0.2	1.1	1	0.5		2.1		3.2		6.5		7.5		2.8		1		0.5		0.2			
24/10		3.6	6		5.5		3.4		5		18		4.4		13.6		10.4		14.6		13		7.5			
31/10		0	0		4.5		2.7		2		1.5		1.8		1		0.7		4.3		p		1			

Below is an attempt to find out the role of each of the above mentioned three factors in the sharp fall of flight activity . In order to facilitate more rapid recognition of factors affecting bee flight activity , the data of tables 2 and 4 are gathered together in Appendix 1.By reviewing the data in this appendix carefully one could make a conclusion that each of these three factors had its own relative participation in this issue . Sometimes the bee – eaters seemed to be fully responsible for stopping the bee flight because the bees suddenly resumed their flight soon after bird departure . At some other times the flight fell to an extraordinary low level despite the birds were totally absent . Of course , in the latter situation it is not the birds that are 'blamed' for stopping the flight but one or both of the other two factors , *i.e*. scarcity of food in the field and high degrees of ambient temperatures . If the reduction in the rate of flight activity took place at a time when there were no bee – eaters and the ambient temperature was moderate , the scarcity of food in the field would almost certainly be behind this situation . According to the data found in Appendix 1 , the following are examples verifying the responsibility of each of these factors .

- **Responsibility of Bee – Eaters**

At each daybreak of each of the different eleven days representing the eleven weeks in the period extending from 25 July – 10 October there were always bee – eaters perching on the ropes . At the same time there was either no bee flight at all (in eight different days) or just trivial flight means ranging 0.1 – 0.2 bee per minute per colony (in three different days) . On the other hand , the bees were observed resuming their flight activity soon after bird departure , especially when that departure took place before sharp rise of ambient tempenatures . The bee flight was for either ordinary foraging or foraging accompanied by orientation (play) flight . At late afternoon hours in all weeks the bee – eaters were always returning to the apiary in high numbers and resuming their persistent perching on the ropes . In all weeks no remarkable bee flight activity (including play flight) was recorded during those hours as long as even one bird was perching persistently on the rope . Once again , the factor of high ambient temperatures could not be held responsible for preventing bees from flying at early and late daytime hours because the ambient temperatures were somewhat moderate and suitable for bee flight .

On very rare occasions the bees were recorded flying in relatively remarkable numbers despite a continuous presence of the bee – eaters on the ropes . This happened at each of 14:00 and 15:00h on 1 August (see Appendix 1) . The interpretation of such a situation might be as follows : the presence of bee – eaters in that day was unusual because they were seen sitting on the ropes at all daytime , from 06:00 – 18:00h (except 09:00 – 09:30h) . No noticeable flight was recorded at all hours except 09:00 , 14:00 and 16:00h . The flight rate of 21.7 bee per colony per min at 09:00h was expected because no birds were found on the ropes (only their sounds were heared) . The flight rates of 14.2 and 18.5 bee per colony per min at 14:00 and 15:00h , respectively were not expected because there were three birds sitting persistently on the ropes at each of these two hours . I may speculate that the bees could not withstand such an extraordinarily long period of confinement , especially the bees were surely in urgent need for defecation and also for water which is necessary for colony thermoregulation (20,37).Very little work has been done worldwide on the impact of *Merops supercilosus persicus* on the flight activity of honey bee colonies. On the other hand, there have been works on the impact caused by *M. apiaster* ,especially in Europe and central Asia countries but the size of such works can not be compared with the huge amount of work conducted on the biology and breeding of this species (3 , 11 , 12). Cramp (7) stated that bees do exhibit certain defensive maneuvers when an apiary site is plagued by bee- eaters , and these are to reduce the number of fights from the hive (450 flights per hour down to 20 flights per hour, in one case), and secondly to fly at low levels.

- **Responsibility of Severe Rise of Ambient Temperatures**

It seems that severe rise of ambient temperature played an effective role in the reduction of bee flight activity ,especially around midday. Although the presence of bee eaters at these hours was usually much more lighter than those recorded in the morning and late afternoon ,it was also noticed that the rates of bee flight were very low too (see Appendix 1). During the whole period extending from mid – july to about mid-September ,which represented the hottest weather, there was no any noticeable bee flight at any time from 11.30- 13.30h whether the bee- eaters were present or not. Tha maximum degrees of ambient temperatures always exceeded 40 C ,and even 45 C° in many days during that period .

Flight activity at the hive entrance is used for many purposes includimg the effect of climatic factors (38). It has been found that air temperature and solar radiation intensity are the most important factors among all other factors affecting flight activity of honey bee (39) although the combination of climatic factors is more important than any single factor on honey bee flight activity (40) . Although *A. mellifera* can fly at ambient temperature as high as 46 C° (19) its rate of flight is highly affected when ambient temperature exceeds 40 C° ,and the bees concentrate their activity for collecting water rather than pollen and / or nectar (18 , 19 , 38).

- **Responsibility of Shortage of Honey Bee Food in the Field**

The responsibility of food shortage in the field was very obvious in mornings of 17 , 24 and 31 October. At these hours the ambient temperatures were moderate and very appropriate for honey bee flight and foraging. Monthly mean minimum and maximum ambient temperatures in October , were 20.3 and 32.5 C° , respectively (Table1). Bodenheimer and Ben-Nerya (18) found that the optimal activity for collecting nectar and pollen in Palestine was at the range of 16- 32 C° (66 flights per minute). Moreover , no bee- eaters were seen at all on the ropes. But ,despite having such suitable conditions, the bees were flying at very low rates (Appendix 1). It seems that the shortage of food in the field stood behind this reduction in flight rate. It is worth mentioning ,however , that the decline of flight activity rates at the above mentioned times was not only caused by the shortage of food in the field but also because of high reduction in the size of adult populations of bee colonies (see Figure1).

There was also another important indication of the responsibility of food shortage. After the bee –eaters moved away from the apiary, the honey bees were usually engaging very quickly in intense activity of 'play' flight in front of hive entrances. Such an activity would be expected if it took place for a reasonable time, especially the bees needed to defecate outside the hive after long period of confinement . Amazingly ,this activity of "play" flight usually continued for along period of time which often reached two –three consecutive hours(Appendix 1). Although many of those flying bees were observed gathering at water sources or scattering on some vegetable flowers found in the vicinity ,the majority of flying bees were only hovering forwards and backwards in front of hive entrances. If there were sufficient sources of nectar and pollen in the field ,the bees would not devote such high energy for 'play' flight. It is well known that honey bees practice this type of flight throughout whole year (20) but such a flight usually does not last such a long period .

Another indication of severe shortage of food was noticed at 09.00h , 20 September. In front of the hive shade there was a small piece of ground covered with awild plant, *Schanginia aegyptiaca* (Chenopodiaceae) . Hundreds of worker bees were congregating on the tiny flowers of this plant ; desperately seeking food in these flowers ! This plant is not familiar to beekeepers in Iraq as a source of pollen and / or nectar. In addition, the bees were often seen congregating in large numbers on discarded cans of juice and sweet soft drinks in waste-baskets. Such desperate behaviors surely indicate a sharp shortage of pollen and nectar sources in the field.

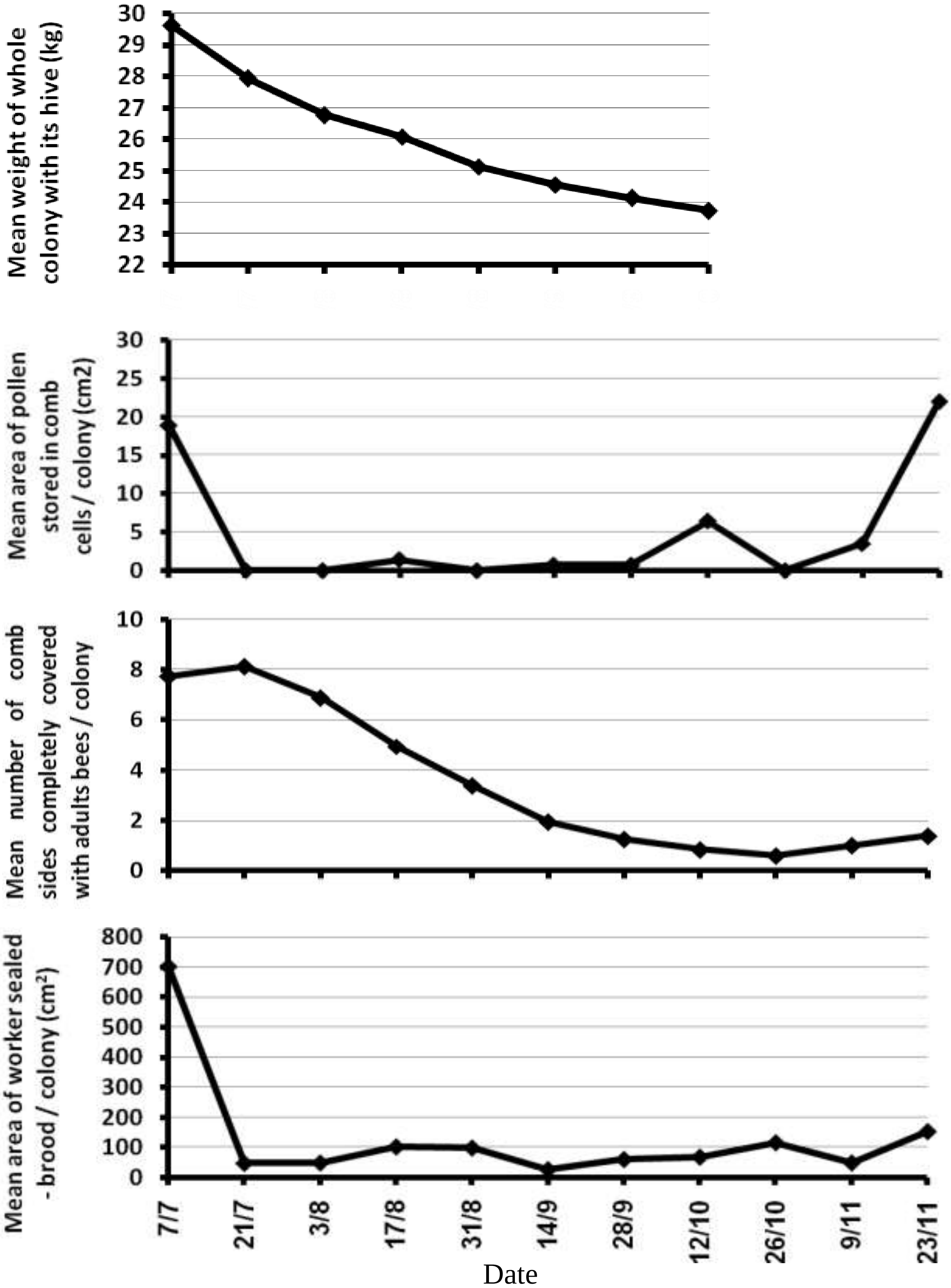
4.2 Inside – Activities of Honey Bee Colonies

Because of the sharp reduction in bee foraging rates , all the rates of inside activities were steadily falling to such an extent that four out of ten colonies perished. I believe that if there were large numbers of *Vespa orientalis* at the apiary all the ten colonies would be wiped out ! It should be mentioned ,however, that if I was not carrying out a scientific research on these colonies , I would surely move them to another area where the surrounding conditions could relatively be more appropriate for foraging activity ,or at least I would support the colonies through taking some necessary measures such as artificial feeding . Moreover, the presence of ropes in front of the colonies provided the bee- eaters with a typical site for perching and swooping down on flying bees, especially the piece of ground in front of the hives was completely flat and open . It is worth mentioning , however , that the presence of such a perch for bee – eaters in front of the apiary is not unique to this study because there are many apiaries in Iraq which are found along country roads, thereby along telephone and electricity wires. These wires are among the most typical sites for bee-eater perching (3).

Figure (1) shows the levels of different inside activities of honey bee colonies. Mean sealed brood area was 710.9 cm^2 per colony on 7 July and then declined sharply to reach only 46.6 cm^2 after two weeks which was equivalent to 5.8 percent of initial area. After that the rates stayed at almost same trend of weakness until the end of study on 23 November . Mean size of adult bee population was 7.75 sides of combs completely covered with adult bees per colony on 7 July. After two weeks (on 21 July) the mean increased slightly to be 8.14 combs. It seems that this increase was a result of the sealed brood which was occupying a relatively noticeable area on 7 July. After that the size of adult population decreased steadily week after another to reach its lowest mean on 26 October (0.59 comb sides per colony) and then increased slightly to reach 1.38 combs on 23 November. Of course, such a continuous reduction in the size of adult population was quietly expected because of many factors including the sharp reduction in brood rearing activity in addition to natural mortality of adult bees and loss of flying bees due to hunting carried out by the bee –eaters. Mean weight of whole colony with its hive started at 29.26 kg per colony on 7 July and then decreased steadily to reach 23.73 kg per colony on 12 October. It is known that periodic weighing of colonies is considered to be one of the reliable parameters used by researchers and beekeepers to evaluate the amount of nectar collected by bees at different times ,simply because nectar, or honey , is the most important component determining colony weight (41). The cells of wax combs in all colonies were practically empty of stored bee –collected pollen during the whole period of study even at its beginning . Mean area of stored pollen was only 18.9 cm^2 per colony on 7 July and this level of pollen scarcity remained firmly until 23 November.

According to decades of work in beekeeping in Iraq , I am not surprised about these sharp reduction rates of all activities during August and September ,simply because all adverse conditions usually take place in these two months in central and southern Iraq. But it was not expected to observe such a sharp decline taking place in the period extending from *c*.mid – October on. Research apiculturists and practical beekeepers in Iraq are familiar with the minor peak of honey bee activity which usually starts at *c*.mid – October and continues throughout November due to many positive changes in conditions surrounding the colonies : the bee – eaters usually complete all, or at least most, of their departure towards wintering quarters at the beginning of this period; the ambient temperatures become moderate ,and nectar and pollen sources become more available in the fields, especially wild plants flowers . In present study the bee- eaters migrated later than usual. Although their presence at the apiary was negligible in the last week of October ,but I did see seven of them sitting on the ropes on 2 November. Also the sharp contraction of cultivated areas which has been happening vertically and horizontally in recent years surely participated in this decline. This recent contraction of cultivated crop areas as well as severe natural drought (76mm annual rainfall) have severely affected not only beekeeping industry in Iraq but also the whole sectors of plant and animal productions . The prevailing drought has highly affected foraging activities of honey bee. It is well known that uncultivated (wild) plants are among the important sources of pollen and nectar (23 , 42 , 43 , 44). Severe drought in recent years has deprived the honey bees in Iraq of these important sources , especially in fall, winter and early spring (pers.observ.). It is well known that the shortage of nectar and pollen in the field highly reduce the activity of brood earing ,hence reduce the size of adult bee population (*e.g.* 24 , 26 , 45 , 46 , 47) and force the bees to consume their reserves of honey and pollen stored in the combs .

It has been an axiom that while honeybees in a mild tropical climate have no need to amass large amounts of honey and pollen, simply because the bees can find flowers throughout the year, the European races of *A. mellifera* have evolved towards honey storage strategy in order to survive harsh cold climate in winter (for details see Ruttner, 1988 and Louveausx *et.al*. 1973 - cited in 21). In my opinion *A. mellifera* living in areas such as central and southern Iraq amass large amounts of food in spring and early summer to survive not mild winter season but the above mentioned harsh conditions prevailing throughout the remaining part of summer and early fall. According to a study I conducted in 1987 /88 about activity of honey bees during winter season in central Iraq (48) and according to my personal observations , I could conclude that the contraction of honey bee activity in winter is much more lighter than the sharp decline happens in parts of summer and fall .



Figure(1). Levels of different inside activities of honey bee, *Apis mellifera* L., colonies during the period of sharp decline in 2008*

*****These data represent only the six colonies which got through this period

5. Some Aspects of Behaviors of Bee - Eaters and Honey Bee at the Apiary

5.1 Some Behaviors of Bee –Eaters

- **Rates of Successful Raids**

Some of the birds perching on the ropes were being watched individually while they were swooping down on flying bees. Table (5) shows the results of these observations. Although the total number of these observations may not be large enough to build a decisive conclusion, it is obvious that the bird raids were not always successful. In other words, the bees can sometime manage to maneuver and escape bee- eater hunting. Grand mean of successful and unsuccessful raids of bee – eaters were 68.5 and 31.5 percent , respectively . Mean number of raids ranged 0.87-2.00 raid per bee –eater per minute with a grand mean of 1.28 raids. Cramp (3) reported the following information about this subject in other countries : a *Merops orientalis* bird caught 12 insects (9 probably bees *Apis*) in 12 minutes. Of 153 hunting flights of this species from perch there was 68 percent successful raids. These findings agree with those found in present study. On the other hand ,Fry (11) stated that about one –third of sorties from a look- out perch were successful. There was also a remarkable piece of information in this domain : it seems that hunting performance of inexperienced young bird is not as effective as that achieved by its experienced parents . For example , observations on birds no. 6 and 7 (Table 5) were taken at nearly same time. The bird under observation no. 6 was obviously smaller in size than that under observation no.7.The successful raids of these two birds were 55.6 and 85.7 percent , respectively.

Table 5 . Rates of successful and unsuccessful raids carried out by bee – eaters on flying honey bees

Bird no. .	Period of Observation (Minute)	Number of Raids	Mean Number of raids/bird / min	Successful Raids		Unsuccessful Raids	
				Number	%	Number	%
1	12	15	1.25	13	86.7	2	13.3
2	10	12	1.20	5	41.7	7	58.3
3	18	29	1.61	19	65.5	10	34.5
4	2	4	2.00	4	100.0	0	0.0
5	4	4	1.00	4	100.0	0	0.0
6	19	18	0.95	10	55.6	8	44.4
7	8	7	0.87	6	85.7	1	14.3
Grand Total	73	89		61		28	
Grand Mean			1.2		68.5 %		31.5 %

- **Duration of a Single Stay on the Perch**

One of the remarkable characters of the bee- eater behavior was their changeable levels of "patience" and perseverance while waiting on the ropes to hunt bees. Sometimes it was clearly found that the birds had the ability to spend long periods of time waiting on the ropes even if there were no bees, or at most only a few bees leaving the hives. On the contrary ,it was observed some other times that bee-eaters came and sit on the rope but they quickly left the apiary despite the bees were flying in remarkable numbers. Once again ,there were many evidences proving this trend of changeable persistence .

For example , at 12.55 h , 11 September there were two birds on the rope. One of them left the area at 13:16 h because of physical disturbance carried out by the another bird. The remaining bird continued staying on that rope until 14:08 h , *i.e*. it stayed continuously for 73 consecutive minutes. Amazingly , beside sitting under direct sunlight ,that bird rarely swooped down on a flying bee, simply because the great majority of bees were forced by this bird to be confined to their hives. It clearly seemed that the bird never gave up "hope" that it would find, sooner or later, a bee and swoop down on it. On the contrary, at 11:17h, 5 September there were no be-eaters on the ropes and the bees were flying in noticeable numbers. After about one minute a bird came and alighted on the rope but it left after only a few seconds without a clear reason. The bird never tried to swoop down on a bee ,but if it stayed it would surely be able to catch many bees. The question is: why did the bird come and why did it leave? I could not find an interpretation for this point of bee- eater behavior in the literature.

- **Fast Reaction and Daring Attack**

It was clearly observed that the bee-eaters have a very acute sense of vision and are characterized by their fast reaction and daring attack. There were so many evidences proving these characters. At about 16:39h, 11 September ,I was watching flight activity of colony no.5. There were three bee- eaters sitting on the rope, c.22 meters in front of the hive ,and there were no bees leaving the hive. After about one minute a bee left that hive but it was immediately caught by one of these birds at about 2-2.5m from hive entrance. This example clearly shows that these birds possess an acute sense of vision and very fast reaction . At about 17:00h , 1 August I was standing beside a hive . The bees were flying in very low numbers because there were four bee – eaters perching persistently on the ropes . It seemed that one of these birds got too desperate, so it left the rope and without any hesitation stood on the ground just about three meters in front of me and the hive. Another example of bird daring attack was observed at 13:05h , 26 September . I was sitting on a chair beside a hive . There were two bee-eaters on the rope and there were only a few bees leaving the hives . One of these birds left the rope desperately and flew across the hive shade and passed just about 25cm over my head.

The literature are rich in information on this aspect of behavior. Cramp (3) reported the following information found by other workers in this domain:1. *Merops orientalis* birds are quite fearless of man, coming close to take bees *Apis* when hives being examined. 2. in Netherlands blue- cheeked bee- eaters were found as vagrant birds and they remained on perch when sparrow hawk, *Accipiter nisus*, appeared ;

when raptor overhead , momentarily adopted an erect and elongated posture , with bill pointed up and plumage sleeked. *3.M. apiaster* and *M. philippines* are apparently able to spot flying insect c.50-100 and 80-95m away, respectively. Cramp (7) stated that when a bee- eater spots an insect it will take off in an instant, and with a twisting, gliding flight, pursue and capture the insect.

- **Typical Sites for Perching at the Apiary**

One of the obvious aspects of bee- eater behavior was that concerning the sites used by these birds for perching and swooping down on flying bees at the apiary . It has been mentioned before that the bee- eaters were rarely seen sitting on the ground at the apiary because they were often using a perch to watch , rest or carry out their sorties on flying honey bees . But , what kinds of perches were preferred by these birds at the apiary ? It was very clear that the bee-eaters prefer an exposed perch occupying a commanding position at or near the apiary .

In the present study the bee- eaters were usually seen sitting on the ropes extended between wooden posts in the open in front of the hive shade . The roof of this shade was coverd with long date – palm fronds which were extending further to more than one meter from the shade front . Also, there was a row of small trees of olive extending at a bout two meters in front of the shade . During the whole study period I never saw bee- eaters using these fronds or small trees as perches for resting and / or carrying out raids on flying bees . In order to verify this pattern of behavior , I visited other apiaries in the area and I observed the same pattern . At one of these apiaries , for example , the colonies were placed at a row of date- palm trees . There were also many other rows of these trees in front of that row and there were electricity wires extending in the open along a country road at about 40 meters behind the row of bee colonies . I saw many bee- eaters using these wires for resting , watching and carrying out their sorties but I never saw a bee – eater using a date – palm frond as a perch although the fronds were very close to the colonies while the wires were relatively far from them . Cramp (3) reported the following information which were obtained by scientific studies conducted abroad : 1. *Merops orientalis* makes no attempt to seek shade on perches , 2. *M. superciliosus persicus* normally hunts from perch such as a dead branch of tree or , especially , telegraph wire , and 3. *M. apiaster* prefers to rest for long periods on commanding perches such as telephone wires . Fry (11)stated "bee- eaters are sentinel feeders , keeping watch for passing insects from an exposed perch" .

5.2 Some Behaviors of Honey Bees

- **Response to Bee- Eater Sounds**

Many beekeepers in Iraq believe that not only the presence of bee- eaters at the apiary can prevent the flight of honey bees but also the bee- eater sounds alone can do so even the bee- eaters themselves are found outside the apiary. The data in Appendix(1) disprove this belief. It was clearly found in this study that only persistent presence of at least one bee- eater on perches (ropes) was able to prevent or reduce bee flight. The presence of more bee- eaters on the ropes ,however, was speeding up the confinement of bees to their hives. But when the birds were found outside the apiary ,their air - born sounds which I could hear clearly at the apiary were not affecting the rates of bee flight. At 9:00 h, 20 September ,for example ,there was a remarkable flight rate of honey bees (19.8 bee per colony per min) and at the same time I was receiving successive bee- eater calls (sounds) which were being issued from an adjacent location. Appendix(1) shows many other evidences about this subject. Unfortunately , I could not find information about this point in the literature.

- **Variation in Honey Bee Reaction to Bee- Eater Presence and Attack**

It seems that there is a sort of variation among different colonies and /or different worker bees of the same colony regarding the reaction against the presence and attack of bee – eaters. It has been mentioned many times that the continuous and persistent presence of the bee – eaters usually led up to confinement of bees to their hives. However, two levels of confinement were noticed in present study: a complete, solid confinement when no bees at all leaving the hive such as that recorded ,for example ,at 6:30 h and 07:00h ,11 September (see Appendix 1) . The second sort of confinement is an incomplete confinement when most bees were being confined but a few of them ((took a risk and challenged)) the bee – eaters such as that recorded, for example, at 06:30 – 08:30h , 1 August. It seems that there were variations among the bees regarding this " adventurous" attitude. Such a variation was noticed among bees belonging to same colony when only a few bees left the hive while the other hundreds or thousands of bees gave up their regular flight . Also, such a variation was noticed among different colonies when at least a low level of flight was observed in a colony while the other neighboring colonies were in complete "quietness". It should be mentioned ,however ,that this "challenge" was temporary because it was collapsed later under continuous presence and attack of bee – eaters. The following examples may illustrate this aspect of honey bee behavior (see Appendix 1).

At 16:00h, 29 August there were two bee – eaters on the ropes and the bee flight rates were very low in all bee colonies. At 16:24h the number of bee- eaters increased to be five but , surprisingly , the flight rate in colony no.2 increased radically to be 37 bee per minute although the rates of all other colonies stayed at their low level. However, the "challenge" practiced by colony no.2 did not last for long time because its flight rate decreased gradually to be 1 bee per minute at 17:00h. At 17:30h the number of bee – eaters decreased to be two on the ropes and there were no bees at all leaving the hives including colony no.2. At 17:52 – 17:54h six birds were on the ropes and eight bees from colony no.2 left the hive during these three minutes while only one bee left from another colony and no bees at all left all other colonies . It should be emphasized here that each one of those eight bees of colony no.2 was immediately picked up by one of those bee eaters at no more than three- four meters from hive entrance .

The question is : why did only colony no.2 ((take a risk and challenge)) the bee-eaters at 16:24h and why did only eight bees out of thousands in this colony resume the "challenge" at 17:52 – 17:54h? Was this character of "challenge" a result of environmental factors or genetic factors? One may ask : if the factors standing behind this character are genetic , is it possible to breed lines of honey bees which are somewhat resistant to bee- eaters? It seems that this subject deserves deep scientific researches .

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Appendix (1) Effect of bee- eater , *Merops* spp. , presence on honey bee, *Apis mellifera* , L. , flight activity*

*Signs for bee- eaters **(B.E.)**

Figures = numbers of bee- eaters perching on the ropes in front of hive shade

+ = no birds were found at the apiary but their sounds were heared .

– = neither the birds nor their sounds were present .

Signs for honey bees **(H.B.)**

Figures = mean number of foraging honey bees counted while leaving hive entrance per colony per minute .

P = bees practicing ((play)) flight .

Day		Hour																									
		6	6.30	7	7.30	8	8.30	9	9.30	10	10.30	11	11.30	12	12.30	13	13.30	14	14.30	15	15.30	16	16.30	17	17.30	18	18.30
8/7	B.E.			1		1		+		+		3		3		+		+		+		+		3		3	
	H.B.			17.8		20.1		16.6		13		2.1		6.9		10.9		14.2		7.1		11		4.5		8.6	
15/7	B.E.			+		+		+		1		+		+		1		1		–		+		4		4	
	H.B			P		P		10.7		2		0.8		0		0.8		3.3		19.8		9.7		4.3		8	
25/7	B.E	1		+	+	+	–	–	+	+	–	–	–	1	2	1	2	+	+	+	–	–	–	1	2	3	4
	H.B.	0.1		P	P	P	P	P	P	8.2	4	0.5	0.3	0.6	0.3	0.2	0.2	4		P	P	25.2		13.8		0.2	1.8
1/8	B.E	5	2	4	3	4	3	+	–	1	2	3	3	3	2	3	1	3	4	3	1	+	1	4	2	2	–
	H.B.	0	0.1	0.2	0.2	0.5	0.5	21.7		4.2	0.3	0.2	0.2	0.5		7.2		14.2		18.5		P		0.7		4.4	P
8/8	B.E.	3	3	+	–	–	+	–	–	–	2	3			–	–	1	1	1	–	–	+	+	1	3	3	1
	H.B.	0		P	P	P	P	P	P	17.6	1.2	0.5			0.3	0	0	0	0.3	14.9		19.5		0.3	0	0.3	0.3
13/8	B.E	5	2	3	5	3	4	2	–	–	–	–	1	1	2	2	1	1	1	2	1	3	2	3	4	5	5
	H.B.	0	0	0.2	0	0	0.2	2.6	P	P	P	P		0.2	0	0	0	0	0	0.2	0	0	0.2	0.3	0	0.3	0.2
22/8	B.E	6	8	8	6	1	–	–	+	+	+	+	–	+	–	–	+	+	1	–	–	+	+	3	4	5	–
	H.B.	0.1	0.1	1.2	0.3	1.5	P	P	P	18		3.8		0.7	0.3	0.7	0.3	1.5		17.5		19.8		0.3		0	

Appendix 1. Cont'd.

Day		Hour																									
		6	6.30	7	7.30	8	8.30	9	9.30	10	10.30	11	11.30	12	12.30	13	13.30	14	14.30	15	15.30	16	16.30	17	17.30	18	18.30
29/8	B.E	3	5	4	5	7	—	—	—	—	—	+	—	—	—	—	1	1	1	—	1	2	5	3	2	6	—
	H.B.	0.2	0.2	0.5	0	0.5	P	P	P	P	P	2.8	0.2	0.2	0.5	0.2	0	0.2	0	0	0.5	1.5	9.2	0.2	0	0.8	
5/9	B.E	3	2	4	4	3	+	—	—	—	—	+	1	+	—	—	—	—	—	—	—	+	1	1	3	2	
	H.B.	0	0	2.1	0.2	2.3	P	P	P	P	P	7.8	0.2	0.8	0	0.8	0.6	2.8		7.8		P	P	7	0	0.2	
11/9	B.E	4	1	2	+	3	1	—	—	1	—	—	—	—		2	1	1		1	1	3	3	3	7	5	—
	H.B.	0	0	0	2.6	0.8	0.2	P	P	P	P	4.2		1.4		0.5	0	0.2		0	0	0.2	0	0.5	0.5	0	
20/9	B.E	3	2	2	3	2	—	+	—	—		1	—	1		2	1	1		—	1	4	4	4	5	1	
	H.B.	0	0	1.1	P	0.8		19.8	P	P		5.7		3.5		0.2	0	0		0.8	0	0.2	0	0	0	0.8	
26/9	B.E	6	1	1	4	3	3	4	2	—	+	+	—	—	—	2	4	3	2	3		3	2	3	5	—	
	H.B.	0	0	0.2	0	0	0.2	0.5	0	P	P	13		6.4		1.75	0	0.3	0	0		0	0	1	1.1		
3/10	B.E		1	—	1	1	+	2	1	—	+	1		4	—	—	—	1	+	2	3	—	3	2	—		
	H.B.		0	0.1		2.5	P	4		6.4		4.6		0	0.2	0.5	0.2	1.1		0.2	0	0.2	0	0.2	0.5		
10/10	B.E	2	+	2	4	2	2	7	4	6	1	4	+	+	2			2	7	1	4	4	3	6	—		
	H.B.	0	0.2	0	0	0.3	0.3	0.5	0.3	0.2		3.1		6.4				0.5	0	0	0	0.2	0	0.3	0.2		
17/10	B.E.			—	—	—	—	—	+	—		1		—	—	—		+	1	+	2	1	2	1	—		
	H.B			0	0.2	1.1	1	0.5		2.1		3.2		6.5		7.5		2.8		1		0.5		0.2			
24/10	B.E		—	—		—	+	—		—		—		—		—		—		—		—		—			
	H.B.		3.6	6		5.5		3.4		5		18		4.4		13.6		10.4		14.6		13		7.5			
31/10	B.E		—	—		+		—		—		—		—		—		—		—		—		—			
	H.B.		0	0		4.5		2.7		2		1.5		1.8		1		0.7		4.3		p		1			