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Impact of Introduced Honey Bees on Native Bees at St. Katherine Protectorate, South Sinai, Egypt

FAYEZ SEMIDA AND SHEREEN ELBANNA[1]
Zoology Department, Faculty of Science, Suez Canal University, Ismailia, Egypt
[1]Corresponding author's e-mail: sh_elbana@hotmail.com

ABSTRACT

Possible negative consequences of the introduction of honey bees include competition with native pollinators for floral resources and for nest sites. The impact of the introduced honey bee hives on the wild bees at St. Katherine protectorate was studied throughout a whole year round (2004-2005). Visual path sampling was adopted using transect technique. The current study revealed that the honey bees are resource dependent in their activity. There was a negative impact on the small generalist bees while honey bees partitioned the foraging time with other medium and large sizes native bees. Meanwhile, there was no interaction with specialized native bees. As the impact of honey bees on native bees depends on the resource quality and quantity, it is recommended to assess the habitat quality in relation to its fauna by experts before any introduction of bee hives to deduce the number of hives, which can be introduced with a minimum impact.

Key Words: Honeybees; Wild bees; St. Katherine protectorate; Egypt

INTRODUCTION

The honey bee is thought to be native to Africa, Western Asia, and Southeast Europe (Michener, 1974). It has certainly been domesticated for at least 4000 years and has been introduced to almost every country in the world. More recently, bumblebees (*Bombus* spp), a group whose natural range is largely confined to the temperate northern hemisphere, have been introduced to various countries to enhance crop pollination. *Apis mellifera* is a social species, with colonies attaining sizes up to 50000 individuals. In general, honey bees appear to maintain higher population densities than semi-social and solitary species across a broad range of habitats and geographic regions. Because introduced bees are widespread, any deleterious effects of their presence are now occurring on a large scale. The diet of all bee species consists more or less of pollen and nectar collected from flowers. The colonies of honeybee are relatively long lived and so must be able to adapt to a succession of different flower sources. *A. mellifera* usually visits a hundred or more different species of plant within any geographic region. The wide distribution and polylectic diet of most introduced bees means that potentially they might compete with many thousands of different native species. It seems reasonable to predict that introduced bees are most likely to compete with native bee species. There is no clear agreement as to whether non-native bees have had a significant negative impact upon native pollinator populations. Worldwide, most research to date into honey bee/native bee competition has concerned with one or more of the following three measurements: the overlap in the resource use between honey bees and native bees; the change in the visitation rates of native bees; and the change in the level of resource harvested by native bees when honey bees are present. For the competition to occur between honey bees and native bees there must be first an overlap of floral resources, with both collecting nectar and pollen from the same flower species. Although both species might visit the same flower species, competition can be absent if the presence of honey bees fail to interfere with native bee visitation rate or if floral resources are not limiting visitation rate and level of resource harvesting of native bees will, under these conditions, remain un-changed. Even if native bees are experiencing competition from honey bees, they might not be able to change visitation rates in response and the amount of resource harvested will be reduced. Alternatively, the presence of honey bees visiting the same floral resources might cause a decrease in native bee visitation rates. However, as floral resource overlap, reduced visitation rates of native bees might not necessarily equal to a negative impact. If native bees compensate for reduced visitation rates – for example by foraging longer through the day – their level of resource harvesting could remain un-changed. Furthermore, if reduced visitation rates of native bees in a decreased resource, native bees might use an alternative floral species. If this alternative floral resource provides nectar and pollen in the same quantity and quality at no cost to survival or fecundity, then although there might be evidence of competition for one resource, there might be no evidence of a negative impact on native bees (Paini, 2004). In St Katherine Protectorate, *Anthophora sp*, Megachilid sp and *Proxylocopa* sp. are the most common bees of the area. Hives of honey bees were introduced to increase Bedouin income. The aim of the current study is to investigate if there is a negative impact of this exotic species on the native bees or not.

MATERIALS AND METHODS

Study area. This study was conducted at Bowalyia area in Wadi Gebal, and Wadi Arbaein, St. Katherine, South Sinai

with 1830 m.a.s. l. (E 588910, N 3157054) and (34 E, 26.6 N) 1640 m.a.s. l, respectively. (For description of the study site, see Willmer *et al.*, 1994). The flowering plants in Wadi Gebal during the study were *Achillia fragrantissima*, *Francoeuria cripa* (Compositae) and a few individual plants of *Mentha lavendula.* While in Wadi Arbaein, the flowering plants were Apple trees, peach trees, Almond trees, *Stachys aegyptiaca, Solanum sp, Rosemarie sp, Malva sp, Fagonia mollis, Tamarix sp, Tanacetum sp, Teucrium sp, Achillia sp, Peganum sp* and *Alkanna orientalis.* In each Wadi, Five different transects (100 x 6 m) were chosen at different distances from the bee hives (100, 300, 700, 1100 & 1500 m). The available resources inside each transect were estimated as flower density (number of flowers per unit area). Each transect was surveyed for the foraging insects three times a day (early morning, midday & late afternoon). Collected data were analyzed using SPSS package.

RESULTS

At wadi gebal. The mean number of honey bees increased significantly to a maximum value at the area of 300 m far from the bee hives during August, while there were very few individuals at transect I (100 m from the bee hives). None was found at either transect III (700 m from the bee hives), transect IV (1100 m from the hives) or V (1500 m from the hives) with ($F_{4, 34}$ = 4.2, P < 0.003) as in Fig. 1. This showed that the mean number of honey bees was higher than the mean number of wild bees at transect II, while there were none of them in both transect III and IV. Numbers of both honey bees and wild bees started to increase at transect V. There was a negative correlation between mean number of honey bee and distance from the hives (r = -0.65, P < 0.003 as in fig. Meanwhile, there is no correlation between the number of foraging honeybees and number of foraging wild bees in the study area. Fig. 2 illustrated that the foraging behavior of honeybee increased during late afternoon (4:00 - 6:00 p.m) while the foraging behavior of the wild bee and the other insects *(Eristalis aenus, Eristlis quiquelinatus, Eupodis corollea, phelanthus sp., Bombyliid* flies) increased around midday (10:00 - 12:00).

At Wadi El Arbaein

Resource specificity. The investigation at Wadi El Arbaein revealed that the mean number of *Anthophora sp* was higher in a site without honey bees than at the one near the honey bee hives (Fig. 3). Honey bees' activities seem to concentrate on feeding on the flowering Apple, peach, Malva, *Centauria, Tamarix, Stachys sp Rosemarie* sp and Almond trees. Honeybee visits were higher on the plants with more flowers than those of fewer flowers (r = 0.962). While, the native bees *Anthophora pauperata* seem to feed mainly on *Alkanna orientalis*. Native bees seem to feed also on the Apple, *Centauria, Tamarix, Stachys sp,* peach and almond trees. Honey bees seem to displace native species from flowers near its hives but without any aggressive interactions.

Fig. 1. The abundance of both honey bees and wild bees at different distances from the hives in the study area

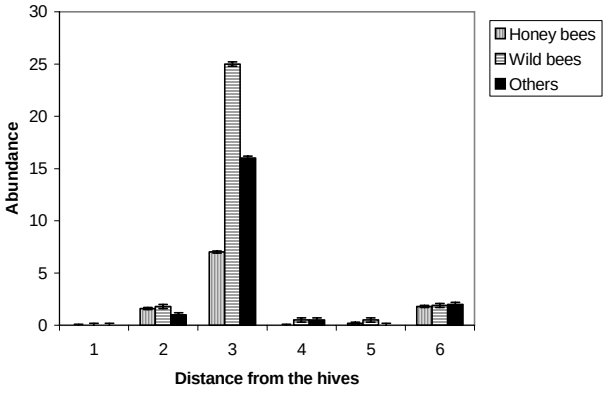


Fig. 2. Daily abundance of both wild bees and honey bees in the study area

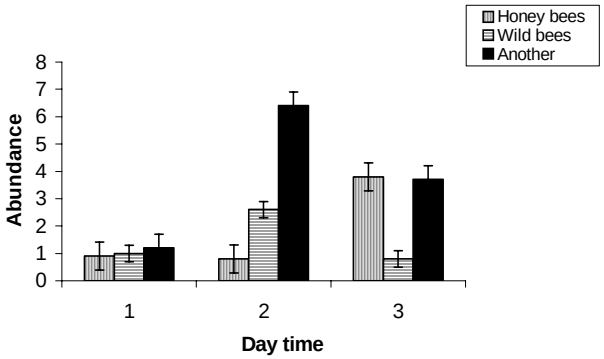
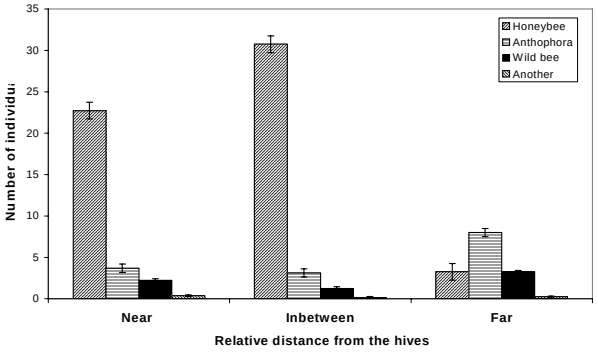


Fig. 3. Abundance of honey bees, wild bees and different other insect species at different distances from the hives in wai El Arbaein during the study



During May, it is the end of the season of *Anthophora puaperata* as the *Alkanna orientalis* had few flowers. Honey bees seem to be very active more than the previous month with no competition with *Anthophora sp*. During June, numbers of wild bees were very few while, honey bees still active visiting *Methembrianthum sp, Teuchrium sp, Stachys aegyptiaca, Peganum harmala,* and *Achillia* sp with no

interaction with wild bee.

Resource Overlap

Apis mellifera-proxylocopa sp* interaction on *capparis. It was found that there is a time partitioning between both honeybees and wild bees. As in Fig. 4 and 5, during early morning, *Proxylocopa* sp was active foraging on *Capparis* sp taking nectar, later on and during noon, neither *Proxylocopa* sp nor honey bee was found on the plant. During late afternoon and around 7:00 p.m., honey bee was active on *Capparis* taking nectar and pollen, later on and around 7:30 p.m., *Proxylocopa* started to be active and foraging taking both nectar and pollen. From 8:00 p.m. *Proxylocopa* was dominant with a peak of activity at 8:30 on *Capparis* and there were no honey bee at that time. No competition or fighting was noticed between *Proxylocopa* and honey bees.

Competition and displacement. As in Table I, it is clear that there are some plant flowers visited by both honey bees and wild bees, while honey bees are the only group of visitor to some native plant flowers (*Teuchrium sp*., *Peganum harmala*, *Achillia fragmentalis*, *Methembrianthum* sp., *Matthiola Arabica*, *Reseda sp*., *Eruca sativa*., *Jasonia sp*. and *Cornulaca monacantha*)

DISCUSSION

Densities are no doubt greatly influenced by variation in habitat quality and availability of nest sites. In general both honeybees and *B. terrestris* appear to maintain higher population densities than semi-social and solitary species across a broad range of habitats and geographic regions (Wilms *et al*., 1997). Because introduced bees are widespread, any deleterious effects of their presence are now occurring on a large scale. The abundance of honey bees makes such effects more probable. It seems almost certain that abundant and widespread exotic organisms that single-handedly utilize a large proportion of the available floral resources do impact on local flower-visiting fauna. Some researchers have concluded that competition with native organisms is inevitable (Sugden *et al.*, 1996). The diet of all bee species consists more or less exclusively of pollen and nectar collected from flowers (occasionally supplemented by honeydew, plant sap, waxes and resins, and water) (Michener, 1974). The two bee species that have proved to be most adaptable in colonizing new habitats, *A. mellifera* and *B. terrestris* have done so because they are generalists. The colonies of both species are relatively long lived and so must be able to adapt to a succession of different flower sources as they become available. *A. mellifera* usually visits a hundred or more different species of plant within any geographic regions (Coffey & Breen, 1997). It seems reasonable to predict that introduced bees are most likely to compete with native bee species, because these are likely to be most similar in terms of their ecological niche (Hingston & McQuillan, 1998). Studies of niche overlap in terms of flowers visited have all concluded that both honey bees and bumblebees overlap substantially

Fig. 4. The correlation between honey bees and wild bees on *Capparis* sp plant in St. Katherine area

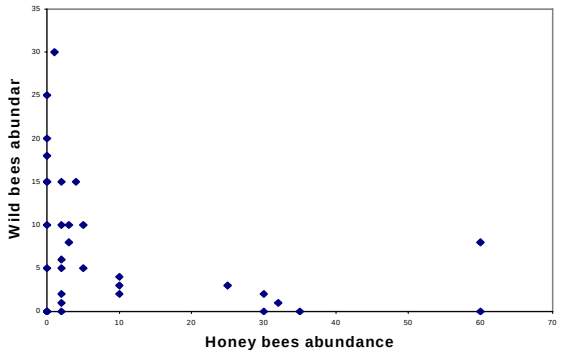
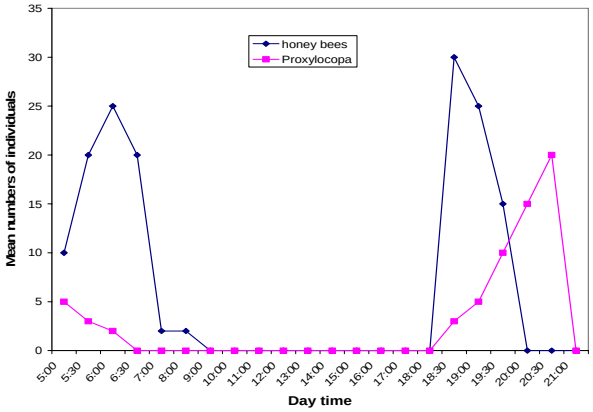


Fig. 5. Daily activity patterns of honey bees and wild bees on *Capparis* sp in St. Katherine area



with native bees and with other flower visitors (Wilms & Wiechers, 1997). Honey bees commonly deter other bee species from foraging on the richest sources of forage (Gross, 2001). Most authors concur that honey bees are not particularly aggressive to other insects while foraging, so that impacts on other species occur primarily through exploitative competition (Roubik, 1991). However, honey bees have been found to displace smaller species from flowers by physical disturbance (Gross & Mackay, 1998). Asymmetries in competition may not be stable, because the relative competitive abilities of bee species are likely to vary during the day according to temperature and resource availability and are likely to vary spatially according to the types of flowers available (Corbet *et al*., 1995). Some studies failed to find any impact on native bee visitation rates in response to honey bees. Roubik (1996) followed up an investigation and he had predicted that competition from honey bees might lead to a population decline in native pollinators. There was no evidence for local extinction or population decline of native bees resulting from bee competition. In an Australian study, Paton (1999) found no impact of honey bees on visitation rates of native pollinating insects, and Horskins and Turner (1999) showed that honey

Table I. The flowering plants and their visitors throughout the study period

Time of the year (Month)	Flowering plants	Wild bees	Honey bees
March	Apple trees	+	+
	Apricot	+	+
	Almond	+	+
	Alkanna orientalis	+	-
April	*Rosmarie sp*	-	+
	Malva sp	-	+
	Alkanna orientalis	+	-
	Stachys aegyptiaca	+	+
	Zella spinosa	+	-
	Apple tree	-	+
	Fagonia mollis	+	-
	Centauria sp.	+	+
	Tamarix sp.	+	+
May	*Malva sp.*	-	+
	Capparis sp.	+	+
	Zella spinosa	+	+
	Peganum harmala	-	+
	Stachys aegyptiaca	+	+
	Fagonia mollis	+	+
	Teuchrium sp	-	+
June	*Tanacetum sp*	-	+
	Solanum sp	+	-
	Achillia sp	-	+
	Peganum harmala	-	+
	Methembrianthum sp	-	+
	Stachys aegyptiaca	+	+
	Teuchrium sp	-	+
	Teen Shoki	-	+
	Matthiola arabica	-	+
	Reseda sp	-	+
	Eruca sativa	-	+
	Jasonia sp	-	+
	Cornulaca monacantha	-	+
	Solanum nigrum	-	+

bees rarely depleted nectar resources completely. Our data conclude that the honey bees are resource dependent in their activity and restrict their foraging on early morning and late afternoon avoiding heat around the midday and before native bees have become active that is in agreement with (Horskins & Turner, 1999) who found honey bees begin foraging earlier in the morning than many native bee species. In contrast, some wild bees forage in the absence of the honey bees around the midday kind of escape from competition with the honey bees by partitioning the day time activity. The other insects seem to have no stress from the honey bees synchronizing with them in foraging safely. It is hard to conceive how the introduction of these exotic species and their associated pathogens could not have substantially altered the diversity and abundance of native bees. It is quite possible that some, perhaps many, native bee species were driven to extinction by the introduction of this numerically dominant species or by exotic pathogens that arrived with it. It must be known that introduced bees provide benefits to man in terms of pollination of crops, and in case of the honey bees, in providing honey. These benefits should be weighed against the likely costs.

***Alkanna orientalis-Anthophora sp* specificity.** Numbers of native bees were higher on *Alkanna* while, honey bees were more frequent on the other plants. *Alkanna orientalis* only visited by *Anthophora pauperata*. This due to the long tongue of *Anthophora* while, *Apis mellifera* has short tongue. The structure of *Alkanna* corolla i.e. long corolla gives the wild bees the advantage of being the only visitor to the plant flowers where there is a co-evolutionary strategy governs the *Anthophora* activity pattern with the *Alkanna* flowering pattern (Semida, 1994; Gilbert *et al.*, 1999). The small open flowers (e.g. *Teuchreum*, *Peganum*, etc) are good and easy resources to honey bees to exploit. The asymmetric competition deprives the small wild bees from exploiting these resources due to the presence of honey bees with large densities.

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