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Original article

Assessment of natural enemies of honeybee (*Apis mellifera jemenitica*) in the Asir region, Southwestern, Saudi Arabia

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ABSTRACT

The occurrence and status of natural enemies of honey bee *Apis mellifera* (Hymenoptera: Apidae) in the southwestern region of Saudi Arabia was conducted during 2019 and 2020. The existence of natural enemies, particularly pests and predators, is one of the most significant problem for beekeepers in the Asir region. A total of 78 apiaries were selected from two different geographical locations (Sarat and Tihama) in the Asir region. Honey bee colonies were attacked by 17 pests and predators species in the Tihama region, compared to 15 in Sarwat mountain region of southwestern Saudi Arabia. In order of significance, wasp (*Philanthus triangulum*), bee-eating bird (*Merops apiaster*), Varroa-mite (*Varroa destructor*), wax moth (*Achroia grisella*), and spider (*Misumena* sp.) are the most prevalent pests that inflict major harm to apiaries in southwestern Saudi Arabia. There were also some other pests and predators that had insignificant effect on bees. Generally, the recorded natural enemy's incidences usually occurred in the months of September-October and December to February.

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1. Introduction

Asir or Aseer region is is a part of the Sarawat mountain ranges located in the southwestern part of the Kingdom between latitudes of 17° 25́ north and 19° 50́ north and between longitudes of 50° 00́ east and 41° 50́ east. It comprises one of the unique ecoregions in the kingdom with highest species diversity and endemism of both plants and animal species (NCWCD, 2005; JICA, 2007). Based on annual rainfall, the area of Tihamah was classified as arid while the high mountains as semi-arid (Abdullah & Al-Mazroui, 1998). Asir region comprises of unique geographical territories. The area encompasses typically into two main subdivisions, towards the western red sea coast, it is a lowland coastal plain known as Tihama, a hot and humid region, which leads to the rocky highlands called the Sarat mountainous area which is semi-arid zone with an elevation of about 3,000 m highlands at its peak (Abuzinada et al., 2005; Jaber and Marzuki, 2018). The other subdivision lies towards the eastern side of the mountains emerges as the Arabian tableland, which forms the fertile area of the highlands with significant presence of deserts lie downs (Mauger, 2002; Abuzinada et al., 2005; Jaber and Marzuki, 2018). The average temperature and the climate of this region differs substantially subjected to the altitude and season. This region has the highest average rainfall in Saudi Arabia, probably ranges from 300 to 500 mm (12 to 20 in) annually (Miller, 1994; Abdullah and al-Mazroui, 1998; Jaber and Marzuki, 2018). This area is home to the biggest natural forest in the country, making it an excellent location for beekeeping. Traditionally, terraces agriculture is practised in almost all the region, which supports all beekeeping requirements in this region (Ghramh and Khan, 2023; Abuzinada et al., 2005; Collenelte, 1998; Miller, 1994; Mallon, 2011).

Honey production through beekeeping has developed into a promising rural industry in Saudi Arabia because of its minimum investment and maximum employment potential and quick turnover for investment. When compared to other farming endeavors, it is one of the most lucrative in terms of income generation and self-employment (Al-Ghamdi and Nuru, 2013a,b; Alqarni et al., 2011; Ghramh et al., 2023; Sharma et al., 2020). Saudi Arabia is one of the largest honey-consuming countries in the world and the beekeeping practice in the kingdom is fairly organized, with an approximately 5656 beekeepers and around 1,809,920 bee

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hives in the Asir region, as per the recent revealed data by the Asir branch of Ministry of Environment, Water and Agriculture (Adgaba et al., 2014). The major types of honey bee (*Apis mellifera*) races used in the production of honey in Asir are the native honeybees *A.m. jemenitica* and the imported hybrid bees, *A.m. carnica* (Alqarni et al., 2011; Al-Ghamdi et al., 2017; Alabdali et al., 2021).

Honeybees are susceptible to a variety of diseases and pests, and controlling them is important to maintain healthy bee colonies (Kaur et al., 2021; Neov et al., 2019; Peña-Chora et al., 2023; Kaur et al., 2023). One of the major challenges occurred in beekeeping industry in Arabian region is the problem of natural enemies, which often causes great harm by interfering in the life cycle of honeybees (Al-Chzawi, et. al., 2009; El-Niweiri, et. al., 2009; Oyerinde and Ande, 2009; Muli et. al., 2014; Al-Ghamdi et al., 2016; Pirk et.al., 2016). In Saudi Arabia, no detailed study has been performed on the pests and predators of honeybees. The first comprehensive information of honeybee pests and predators in the kingdom was reported by Al-Ghamdi (1990), who recorded ten common pests and predatory species, which later updated and extended to eighteen species by again Al-Ghamdi (2004). Further, the occurrence of the phorid parasitoid (Diptera: Phoridae) attacking on the non-native honey bee for the first time in the kingdom (Mohammed, 2018). Excepting these sources, no other comprehensive study in Kingdom regarding honeybee pests and predators till date. To address this problem, it is very essential to recognize the common pests and predatory agents affecting the beekeeping industry in the Kingdom. Therefore, this study's objectives were to identify and evaluate the status of honey bee enemies (pests and predators) in the southwestern region of Saudi Arabia.

2. Material and methods

2.1. Study area and sample collection

Asir region has an area of 81,000 km^2, situated on Southwest region of Saudi Arabia and lies between latitudes 17°25‘ and 19° 50‘ in the north and 50°00‘ and 41°50‘ east longitude (NCWCD & JICA 2007). The apiaries that were sampled were chosen based on the altitudinal gradients and land use which supports beekeeping in Asir region. The sampled apiaries were located between 8 and 2,200 m above sea level. To reduce the mixing of the sampled honeybees in the foraging regions, the separate apiaries were at least 25 km apart. A global positioning system (GPS) receiver was used to record the elevation and geographic coordinates at each apiary location.

The present study was conducted during the year of 2019 to 2020. A total of 78 (27 Serat + 51 Tihama) apiaries were chosen from two different geographical regions of beekeeping areas in Southwestern Saudi Arabia. Apiary distribution was as follows; 27 apiaries were selected from Serat region, covering Lsaan College, Abha (18.237629; 42.587570), and Rijal Alma (18.186262; 42.2857755), 51 apiaries were selected from Tihama region which occupied at Maraba (17.888742; 42.312424), Al-darb Al-Fatiha (17.668369; 42.520710) and Shuqaiq (17.744053; 42.199223) were also included in this experiment. From each apiary, five honeybee colonies were randomly selected for disease and pests visual inspection.

2.2. Record of pests and predators of honey bee

In order to inspect for pest infestations pests and predators (Wasps, wax moths, beetles, ants, spider and lizards) infestation, selected beehives were carefully smoked and opened. Presence of any pests or predator of honey bee was ascertained by physically searching of each sampled beehive. Once a pest was identified, counts were done on it and samples were taken. Various techniques, including hand picking, sweeping, aerial netting, and aspirator procedures, were utilized to sample natural enemies from slected apiaries. Following this, 25–50 capped drone and worker brood cells from each selected colonies were examined for the presence of any brood mites, as well as 50–100 adult bees were randomly collected and examined in the laboratory under a research binocular for infestation with any arthropodal mites. Collected samples of bees as well as pests and predators were taken to the plastic vials and were examined later in the laboratory under a stereomicroscope. Information regarding the incidence seasons of pests and vertebrates predators were gathered from professional trained beekeepers working in their respective localities.

2.3. Identification of pests and predators

For proper identification, every specimen of an insect pest and predator was killed, stretched, and pinned. The identification process was assisted by prior records of Unit of Bee Research and Honey Production, Faculty of Science, King Khalid University, Abha, Saudi Arabia. Later, these findings were confirmed by other taxonomists at King Khalid University in Abha, Saudi Arabia, as well as the author, whose principal area of expertise is insect taxonomy. The identification of honeybee mite pests was carried out in accordance with Anderson and Trueman (2000).

2.4. Methods of data analysis

All data was entered in to Ms- Excel spread sheets after the completion of data collection work from the study areas. Then the analysis work will be done using SPSS version 16. The data will be summarized using descriptive statistics (means, standard errors and percentages).

3. Results

Honeybee natural enemy species recorded during the present survey and their incidence rates are presented in Table 1. A field survey of 27 apiaries in Sarat mountain region and 51 in Tihama region revealed that 17 types of pests and predatory species attacks honeybees in Southern region of KSA. In Sarat mountain region, our data showed that honeybees are majorly affected by Varroa-mite (Arachnida: Varroidae), *Merops apiaster* (Aves: Meropidae), and Greater wax moth, *Galleria melonella* (L.) (Lepidoptera:Pyralidae) with infestation rate of 70.3%, 62.9% and 55.5% respectively (Fig. 1A). Apart from these five other pests which includes *Philanthus triangulum* (Hymenoptera: Crabronidae) (48.14%), *Vespa orientalis* (Hymenoptera: Crabronidae) (33.3%), *Achroia grisella* (Lepidoptera:Pyralidae) (25.9%). *Merops orientalis cyanophrys* (Aves: Meropidae) (40.7%) *Misumena* sp. (Arachnida: Thomisidae) (25.9%) are of the moderate incidence in this region. Among the major honey bee pests in the Tihama region, European beewolf (*Philanthus triangulum*) and European Bee-eater bird (*Merops apiaster*) were observed from all apiaries. 84% and 68.6% of the inspected colonies were infested with *Achroia grisella*, lesser wax moth (Lepidoptera:Pyralidae) and Varroa-mite, respectively (Fig. 1B). Recorded in 72.5% of the apiaries, white spider, *Misumena* sp., was the most copious predaceous spider of the worker honeybee in the surrounding fields and trees near apiaries as compared to other spider species like *Araneus* sp (Arachnida: Araneidae) and camel spider (Arachnida: Solifugae). Moreover, greater wax moth, *Galleria melonella*, little green bee eater (*Merops orientalis,* Aves: Meropidae), bee pirate (*Palarus latifrons,* Hymenoptera: Crabronidae) and *Vespa orientalis* (Hymenoptera: Vespidae) were present between the apiaries at 37.2%, 45%, 41.1% and 35.2%,

Table 1
Percentage of natural enemies (Pests and predators) recorded in the Asir region during 2019–2020.

No.	Category	Scientific name	Common name	Local name	Incidence duration	Sarat Mountains n = 27				Tihama plains n = 51			
						Exam.	Incidence.	%	Status	Exam	Incidence.	%	Status
1	*Wasps*	*Philanthus triangulum*	European beewolf	Dheeb-Al-nahel	Mid Jan. to Feb. End; Sometime in summers	27	13	48.14	++	51	51	100	+++
2		*Vespa orientalis*	Hornet	Dabour-Alballah	Mid Jan. to Feb. End	27	9	33.3	++	51	18	35.2	++
3		*Palarus latifrons*,	Bee -pirates	Abu-Garn	Early Sept. Mid Oct. to	27	5	18.5	+	51	21	41.1	++
4	*Moths*	*Galleria melonella* (L.)	Greater wax moth	Dooda-shama	Summers	27	19	70.3	+++	51	19	37.2	++
5		*Achroia grisella* Fab.	Lesser wax moth	Dooda-shama	Summers	27	7	25.9	++	51	43	84.3	+++
6		*Acherontia atropos*	Death's Hawk moth	Farashat Al-simsim	Summers	27	4	14.8	+	51	9	17.6	+
7	*Birds*	*Merops apiaster*	European Bee eater	Wir War, Lagu	Ist Sept to 20 Oct.	27	17	62.9	+++	51	51	100	+++
8		*Merops orientalis cyanophrys*	Little green bee eater		Summers	27	11	40.7	++	51	23	45.0	++
9	Mites	*Varroa destructor*	Varroa mite		Summers	27	15	55.5	+++	51	35	68.6	+++
10	*Spiders*	*Misumena* sp.		Ankabout abyat	Summers	27	7	25.9	++	51	37	72.5	+++
11		*Araneus* sp.		Alqafaz ankboot	Summers	27	1	3.7	+	51	3	5.8	+
12		Camel Spider		Ankabout al agrab		27	2	7.4	+	51	10	19.6	+
13	Vertebrates	*Papio hamadryas*	Hamadryas baboon		–	27	1	3.7	+	51	2	3.9	+
14		*Acanthodactylus*	Lizards	Wazgah	Summers	27	1	3.7	+	51	5	9.8	+
15		Snakes			–	27	0	0	+	51	1	1.9	+
16	Ants	Black Ants		Namel aswad	Summers	27	1	3,7	+	51	7	13.7	+
17		Red ants		Namel ahmer		27	0	0	+	51	7	13.7	+

Occurrence status (+++ Severe; ++ moderate; + minor).

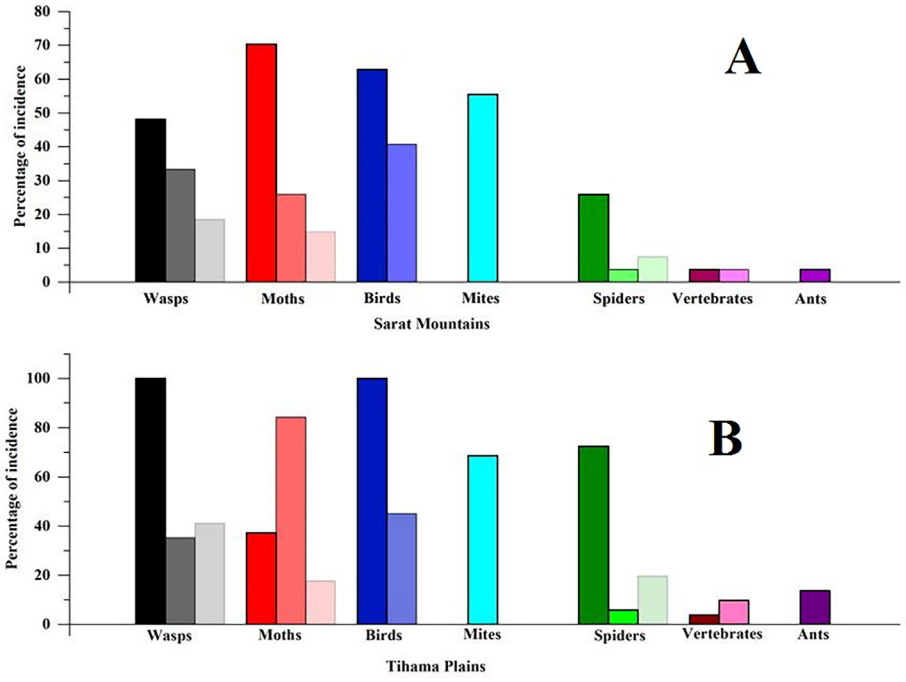

Fig. 1. Status and percentage incidence of Pests and Predators in the Asir region (A: Serat Mountain region; B: Tihama region).

respectively. Still, the infestation rate of the colonies remains less than 50%, thus, these species attained the status of only moderate pests. Death head hawk moth (*Acherontia atrops,* Lepidoptera: Sphingidae), spider (*Misumena* sp.) and white spider (*Araneus* sp.), Baboon (*Papio hamadryas,* Primates: Cercopithecidae), lizard (*Acanthodactylus* sp., Squamata: Lacertidae), snakes and ants were of minor importance to beekeeping in Tihama region. Similarly, *Palarus latifrons* (18.5%), *Acherontia atropos* (14.8%), Camel spider

(7.4%), *Araneus* sp. (3.7%) and *Acanthodactylus* sp. (3.7%) are of the minor importance in Sarat region, while snakes and ants have no presence in this region. Therefore, the number of recorded pest species decreased to 15 out of 17 in Sarat region (Table 1). The distribution of snakes and red ants was restricted to only Tihama region.

Overall, the distribution of the identified honeybee pests in the two different topographical regions of Asir province shows that a total 17 pests appeared in both the Sarat mountain and Tihama coastal plain regions. Among wasps, bee wolf, *Philanthus triangulum* was the most precarious in both the region. Bee eater (*Merops apiaster*) was the most abundant predaceous bird encountered in 65.4% of studied apiaries, whereas among spiders, *Misumena* sp. is the biggest threat of honey bee apiaries in Asir region. Occurrence of Varroa-mite has been reported significantly with high infestation rate in many parts of bee keeping world, this region is no exception.

4. Discussion

Revealing from the present study that honeybees are attacked by 17 pest species in two different areas of Asir province in southern Saudi Arabia. The recorded data confirms the presence of 3 honeybee pest species for the first time in this region, which is the addition to the existing lists of honeybee pests in Saudi Arabia. In this investigation, the new identified pests include 3 species of spider, and baboon (Table. 1). Although one species of spider has been reported earlier (Al-Ghamdi, 2004), but without any specific identification. In the present study, white spider and camel spiders are new additions to pests along with the existence of baboons in this region. Most of the detected natural enemies were also reported to attack the colonies of honeybee in the kingdom as well as neighbouring countries (Al-Ghamdi, 1990; Al-Ghamdi 2004; Yakobson & Rosenthal, 1990; Yazbek, 1990; Al-Chzawi et al., 2009). In agreement with data made by (Al-Ghamdi, 1990; Al-Ghamdi 2004), European beewolf (*Philanthus triangulum*) and European Bee-eater bird (*Merops apiaster*), Bee wax moths (*Galleria melonella, Achroia grisella*) and Varroa destructor are still main pests of the honeybee, showing their universal and regional distribution within all studied apiaries.

Varroa-mite in Saudi Arabia is becoming a severe problem for beekeepers, the epidemic spread of the mite within kingdom is a consequence of mass importation of package bees from neighbouring countries mainly Egypt and Syria. Apart from poor management practices in Varroa-mite control, an uncontrolled migration of bee colonies among locations increases the spread from highly infested colonies to others (Muli et al., 2014), especially in the regions near Jazan and Abha, where the bee migration is practiced quite oftenly (Alattal et al., 2017; Sajid et al., 2020; Taha, et al., 2020).

Observation made by Al-Ghamdi & Nuru (2013a) indicated that bee-eater birds, wasps and wax moths were the most prominent threats to the beekeeping industry in the kingdom, which is in agreement with our results. In addition to these major threats, spiders are now in attainment of the similar status at least in Asir region as observed in the current study (Fig. 1A, B). Among the wasps *Philanthus triangulum* emerges as the most notorious problem in both the studied region. Their incidence is although much higher in Tihama region (Fig. 1B) where the maximum prevalence was observed in winters as compare to the summers. *Vespa orientalis* is considered less dangerous when compare to the beewolves, but its incidence rate is showing some serious attentions in both the studied region, it has a capability of destroying 80% of colonies in some of the neighbouring countries (Yakobson & Rosenthal, 1990; Al-Chzawi et al., 2009).

Bee-eating birds were reported in all Arabian region, threatening bees by hunting foraging bees at nearby foraging fields by *M. orientalis*, while *M. apiaster* raiding at apiaries and devour both workers and queens during mating flights (Ali and Taha, 2012; Glaiim, 2014; Yakobson and Rosenthal 1990; Al-Chzawi et al., 2009). These two species are migratory in nature and have a specific timing of appearance in this region during spring and autumn (Ali and Taha, 2012). European Bee eater, *M. apiaster* cause the most trouble, almost 100% appearance in the apiaries in Tihama region (Fig. 1B), where it stays long due to their further journey to east African countries by crossing the red sea channel. Their stopover at Asir region was recorded very precisely by some of the beekeepers, which is started from first September and ended on 20th of October in spring season. Among the spiders which cause most serious trouble in the apiaries is the *Misumena* sp., usually found in the surrounding fields near apiary. Other spider's incidence rate like camel spider, ranked in the second followed by *Araneus* sp., ranked at third place among all spiders which is in agreement of the finding of Al-Chzawi et al. (2009) in Jordan.

Among the vertebrates Himadryas baboon, *Papio hamadryas* was restricted in distribution to all Sarat and Tihama region, in the present study, it was observed that a few individuals of baboon involved in the hive damage and honey theft activities like opening and overturning beehives and take away the honey frames from beehive.

In summary, majority of the documented pests were commonly distributed in the kingdom. The infestation rate of the apiaries by honeybee pests and predators was significantly higher in the Tihama coastal plains in comparison to the Sarat mountain regions. This may be due to the beekeeping practice of transferring beehives from Tihama and Sarat regions or vice versa in the honey harvest seasons. Generally, in the winter season beekeepers place the hive in the low-lying Tihama area due to the dry and moderate weather, and in the summer the beekeepers move their bees to the Sarat area at the top of the mountains for moderate weather. Observed in this study are other factors which exacerbates the pest problems such as poor hygiene practice of apiaries and pesticide usage. For controlling hornet and beewolves, they usually put a mosquito net around the apiaries or putting bait traps around hive. Mesh net fencing are also being practiced by some of the beekeepers to minimize the effect of bee-eating birds. Conventionally, beekeepers practiced different preventive measures to combat natural enemies problem, but their effectiveness largely depends on the efficacy of device and successful planning managements. Considering that the beekeepers in Asir practiced traditional way of beekeeping, which is highly affected by these pests and predators, importance should be given to adapt modern beekeeping technologies in order to fully benefit the beekeepers and to avoid natural enimies problem in this region.

5. Conclusion

Asir region of southwestern Saudi Arabia has adequate natural resources and a long tradition and culture of beekeeping. However, honeybee pests and predators are major biotic factors which posing substantial challenges and impede the beekeeping practice for local bee keeping industry. Scientific approaches of managing such abiotic and biotic factors are very necessary to escalate the production of honey and its by-products. The best strategy to avoid honeybee diseases, insects, and other pests is to use cultural apiary management practices in combination with safer honeybee protection techniques like removal of infected brood, beehive hygiene, proper ventilation, supply of water, supplementary food and maintenance of humidity and temperature of the hive. In the Asir region the most common pests and predators of a honeybees including

birds, *Merops* (also known as bee-eaters), beewolves, mites, and wax moths. To mitigate the consequences of these pests and predators, effective scientifically recommended control and management strategies should be utilized. It is also important to note that the control techniques application will vary depending on the specific pests, predator and the situation. Overall, it is important to maintain healthy bee colonies by using appropriate management techniques, providing adequate nutrition, and monitoring for diseases, pests, and predators.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary data

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