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Prevalence of *Varroa mites (Varroa destructor Anderson & Trueman)* and bee lice (*Brualia coeca Nitzsch*) in honey bee (*Apis mellifera L.*) colonies in Libya

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Abstract

Background: Primary key pest affecting the apiculture business in many areas of the globe is the ecto parasite *Varroa* mite (*Varroa destructor*), recently, bee lice have become a considerable bee pest.

Aim: In this study, the ecto parasites that infest honey bees, were investigated during the spring of 2013.

Methods: A total of 66 apiaries were investigated from different geographical regions in Libya: 34 apiaries from the southern region, 21 apiaries from the north-eastern region, and 11 apiaries from the north-western region. Three bee colonies were randomly chosen from each apiary (316 colonies). From each colony, 300 worker bees were taken as samples, put in container filled with 100 ml of alcohol, and transported to the Honey bee Laboratory—Plant Protection Department at the University of Tripoli's. The parasites were separated from the bees and identified, and the infestation rates were calculated.

Results: The study of the parasite distribution clearly showed that *Varroa* mites were present in all regions. However, the degree of mite density varies not only between apiaries but also between colonies in the same apiary, while the bee louse, *Barulla coeca*, was detected in 23.1% and 5.8% of apiaries in the western region and southern region of Libya, respectively. On the other hand, all the inspected apiaries in the northern region were not infested.

Conclusion: Lack of knowledge about honey bee parasites, poor management practices, and the lack of proper distance between hives of migrated apiaries have been attributed as the possible reason for the spread of these two parasites, especially the *Varroa* mites in the country.

Keywords: Prevalence, *Apis mellifera*, *Varroa destructor*, *Brualia coeca*, Libya.

Introduction

Many pathogens and parasites infect honey bee, *Apis mellifera*, colonies (Rosenkranz *et al.*, 2010). Most parasites and pathogens that harm honey bees are fairly globally distributed (Hepburn and Radloff, 1998). However, it is difficult to define the honey bee health state in Africa (Hepburn and Radloff, 1998; Dietemann *et al.*, 2009).

Varroa mites *Varroa destructor* (Rosenkranz *et al.*, 2010) and bee lice *Brualia coeca* are pests to honey bees (Ellis, 2008). *Varroa destructor* lives on the hemolymph of mature and developing bees, it poses a significant danger to beekeepers by spreading diseases to honey bees and reducing their longevity (Fries *et al.*, 2006), while bee louse (*B. coeca*), a cosmopolitan inhabitant of adult honey bees, is generally regarded as a minor pest (Hepburn, 1978).

Although the presence of *V. destructor* worldwide (Ellis and Munn, 2005), few surveys on honey bee s' parasites have been undertaken in African countries. According to Crane (1979), Libya had *V. destructor* in 1976. It

was introduced to the Algabal Elakder area (Northeast) through imported bee packages from Bulgaria, where it was established and spread across the country (Keshlaf, 2017).

The first mention of *B. coeca* in Africa was in Tunisia in 1978 (Smith Jr and Caron, 1985), the parasite was then reported in 1981 in Algeria and Egypt (El-Niweiri *et al.*, 2008), and subsequently in Libya and Morocco (Neumann and Elzen, 2004).

Beekeeping has been practiced in Libya for a very long time (Crane, 1999), However, beekeeping methods of using modern hives have only recently become popular (Brittan, 1956). Beekeepers in Libya have recently expressed concern over the sharp decline in honey output, the collapse of honey bee colonies, and the negative effects these factors are having on agriculture and food production (Keshlaf, 2017). In this regard, studies on the significance of parasitism on beekeepers by *V. destructor* and *B. coeca* were very infrequently conducted. We report here the first survey of the prevalence of *V. destructor* and *B. coeca* in Libyan

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apiaries based on a large-scale sampling of adult bees with different geographical origins.

Materials and Methods

To identify the prevalence of *Varroa* mite and bee louse in Libya, a survey was performed in March 2013. A total of 66 apiaries from different geographical regions in Libya were investigated. 34 apiaries from the southern region, covering Sabha, Obaray, Brakeshati, Sookna, Hoon, Ghat, Morzik, and Omlaraneb. From the north-eastern region, 21 apiaries were included: Sert, Bangazi, Shehat, Tobrug, Derna Al-Marg, and Al-jabal Al-akdar. 11 apiaries represented the north-western region, including Tripoli, Tajora, WadiRabee, Ain Zara, and Yefrin.

At least three bee hives from each apiary were randomly selected, making a total of 316 hives that were examined across all apiaries. Thereafter, approximately 300 adult worker bees were then brushed off the comb and placed immediately into a vial containing about 100 ml of 70% ethanol before being transported to the honey bee laboratory at the Department of Plant Protection, University of Tripoli, Libya, where containers were placed on a shaker for 30 minutes to dislodge ecto parasites. The content was poured over sieves to collect the parasites (De Jong *et al.*, 1982). To distinguish between the bee lice and the *Varroa* mite, the parasites were then inspected under a microscope at a 40× magnification.

Infestation rates were calculated as: the number of the bee lice and the *Varroa* mite in each sample divided by the number of honey bees in each sample and multiplied by 100.

Ethical approval

This study was approved by the Graduate School of the University of Tripoli, Faculty of Agriculture, Department of Plant Protection. All animal welfare protocols were followed.

Results

Distribution of *Varroa* mites in Libya

The overall infestation rate of *V. destructor* in honey bee colonies was 3.5% in the adult worker bees (i.e., 1,355 mites per 38,657 bees). Our study revealed that *V. destructor* was found in 81.8% of investigated apiaries and in 53.8% of the inspected colonies (Table 1).

All inspected apiaries of the North Western region were infested with *Varroa* mites (100%), whereas 81.2% and 71.4% of infested apiaries were recorded in the Southern and North Eastern regions, respectively. The North Western region had a higher number of colonies per apiary (8 colonies per apiary) than the Southern and North Eastern regions (4.5 colonies per apiary and 3 colonies per apiary, respectively).

The recorded infestation levels varied among locations within the regions (Table 2). Darna and Tobrog showed no infestation, while Morzik showed the highest infestation (15.7%).

Distribution of bee lice in Libya

The prevalence of the bee lice *B. coeca* infestation on honey bee colonies in the three regions of Libya revealed an overall prevalence of 0.11% in the adult honey bees (i.e., 44 louse per 38,657 bees). Our study revealed that the bee louse, *B. coeca*, is quite uncommon, having been found only in 7.5% of investigated apiaries and in 4.1% of inspected hives (Table 3).

All inspected apiaries in the Northeastern of Libya were lice-free, while only Sookna and Hoon in the Southern region were slightly infected compared to a higher infestation in bee colonies in Tripoli (Table 4).

Discussion

The sampling time (February to March) may have contributed to the low incidence of *Varroa* mites infestation that was reported in this study compared to previous reports in Libya. Keshlaf and AlFallah (2018) reported higher infestations of *Varroa* mites on adult worker bees in spring (6.3%) and summer (16.3%). *Varroa* mites generally increases after the peak of brood production because they reproduce well in brood cells (Alfallah and Mirwan, 2018). The recorded infestation levels seem to be apiary-dependent, rather than the regional factor, since good beekeeping practice might be the reason for the lower infestation rate. However, the low infestation in Darna and Tobrog might be attributed to low sampling, since only one apiary was used from each of these two locations. *Varroa* mites were the most common honey bee pest in Jordan, according to Al-Chzawi *et al.* (2009); they were reported in all apiaries, and 90% of the inspected colonies.

Similar infection by rates to those in our study. A study carried out in Jordan revealed that the bee louse, *Braula orientalis*, is quite frequently identified in 45.4% of the inspected colonies and 64.3% of the examined apiaries (Al-Chzawi *et al.*, 2009). The infestation rates varied from 0.3 to 4.6 individuals per 100 *Apis mellifera adansonii* workers were reported in Benin by Paraíso *et al.* (2012). Strauss *et al.* (2013) agreed with what we found, they reported that *Apis mellifera scutellata* colonies in South Africa were infested (2.1 to 2.3 individuals per 100). According to Gideyet *et al.* (2012), the infestation rates with louse among the adult worker bees were 5%–6% in Wukro Woreda, Ethiopia. Low infestation by *B. coeca* among investigated honey bees was reported in this study and may be related to the time of sampling (February to March). *Barulla coeca* populations typically increase after the honey crop, when they have favorable reproduction in honey cap wax (Keshlaf and Mirwan, 2019).

Despite bee lice being discovered inside bee colonies all year long, Al-Ghzawi *et al.* (2009) observed a decline in the infestation rate after December and during the spring, hitting its lowest level in April. Zaitoun and Al-Ghzawi (2008) reported that the infestation rate of *B. coeca* increased rapidly in May. In comparison, *B. coeca* populations peaked at various times in other

Table 1. Apiaries and colonies infested with *Varroa* mites *V. destructor* in adult worker bee samples from the three regions of Libya.

Region	Number of apiaries			Number of colonies		
	Examined	Infested	%	Examined	Infested	%
North western	13	13	100	113	65	60.19
Southern	32	26	81.25	108	72	63.72
North eastern	21	15	71.43	95	33	34.74
Total	66	54	81.82	316	170	53.80

Table 2. Detailed infestation rates *Varroa* mites *V. destructor* on adult worker bee samples from 316 selected colonies.

Region	Apiaries (Infested)	Colonies (Infested)	No. Worker	No. Varroa	% infestation	Range
Southern					5.0	
Sookna	2(2)	(5)6	796	111	13.9	0.3–1.8
Morzik	7(6)	(4)15	1,996	132	6.6	0.7–15.7
Obari	4(4)	(12)13	2,518	141	5.6	1.4–7.5
Sabha	3 (3)	(12)15	1,628	74	4.5	1.2–5.7
BrakEshatti	4(3)	(9) 16	2,177	57	2.6	0.0–8.3
Ghat	4(2)	(9) 18	2,343	61	2.6	0.6–4.1
Omlaraneb	3(3)	(7)12	2,209	52	2.3	0.4–4.6
Hoon	5(3)	(7)13	1503	27	1.8	0.0–3.7
North western					2.7	
Tripoli	12(12)	109(68)	15,122	611	4.0	0.3–12.7
Yefren	1(1)	4(4)	631	9	1.4	1.1–5.7
North eastern					0.9	
Sert	3 (3)	15 (9)	1,943	27	1.4	0.7–2.1
Bengazi	5 (3)	24 (4)	1,657	9	0.5	0.0–2.4
Zouitina	3 (3)	15 (5)	1,208	5	0.4	0.0–2.8
Shehat	5 (4)	16 (5)	1,181	22	1.9	0.0–8.2
Derna	1	5 (0)	252	0	0	-
Tobrog	1	5 (0)	242	0	0	-
Al Marg	1	5 (5)	399	6	1.5	-
Ejabel Al akder	2 (2)	10 (5)	852	11	1.3	0.2–2.0
Total	66 (54)	316(170)316 (170)	38,657	1,355	3.5	

Table 3. Apiaries infested with bee lice *B. coeca* in adult worker bee samples from the three regions of Libya.

Region	Number of apiaries			Number of colonies		
	Exam	Infest	%	Exam	Infest	%
North western	13	3	23.1	113	9	8.2
Southern	32	2	6.2	108	4	3.7
North eastern	21	0	0	95	0	0
Total	66	5	7.5	316	13	4.1

parts of the world, including the spring and fall seasons in Egypt (Hassanein and Abd El-Salam, 1962), and the USA (Smith Jr and Caron, 1984), and Jordan in summer and autumn (Zaitoun and Al-Ghzawi, 2008). The variations in *B. coeca* populations between these areas could be explained by environmental changes. Strauss *et al.* (2013) reported that the infection rates of *V. destructor* and *B. coeca* that in South Africa varied between the winters of 2010 and 2011. This might be explained by varying climatic circumstances between years and between areas.

A recent experimental study revealed bee louse to be an obvious cause of a decrease in the number of

Table 4. Detailed infestation rates of bee lice *B. coeca* on adult worker bee samples from 316 selected colonies.

Region	Apiaries (Infested)	Colonies (Infested)	No. Worker	No. Louse	% infestation	Range
Southern						
Sookna	2 (1)	(6) 3	466	8	1.7	1.4–3.1
Hoon	5 (1)	(1) 13	123	1	0.8	-
North western						
Tripoli	12 (12)	68 (9)	2225	35	1.6	0.4–6.4

worker bees and honey production (Al-Ghzawi *et al.*, 2009), despite some previous accounts not attributing any negative effects to the presence of *B. coeca* on the honey bees (Akratanakul, 1986).

It is unlikely that there would be a competition between *V. destructor* and *B. coeca* for space on adult honey bees or for food. They have different behaviors in regard to space occupied by honey bee workers and food consumed (Bowen-Walker *et al.*, 1997; Ellis, 2008). As well, the lack of a significant association between their seasonal infestation rates decreases the possibility of direct competition (Keshlaf and Mirwan, 2019).

By removing infected pupae, hygienic behavior has been described as a colony-level defense strategy against the parasitic mite *V. destructor* (Boecking and Drescher, 1992; Spivak and Downey, 1998).

In a preliminary study, Keshlaf and Alfallah (2019) reported that the hygienic behavior of Libyan honey bees was high and reduced the *Varroa* mites populations in the colony. However, their results indicated that this behavioral resistance was ineffective with bee lice. This is made even clearer when comparing the two creatures' life histories; bee lice *B. coeca* larvae emerge from eggs placed on honey caps and are not reliant on developing honey bee offspring to live through adulthood (Ellis, 2008). In contrast, honey bee larvae that have been sealed is required for the reproduction of *Varroa* mites *V. destructor*, and their primary food supply is honey bee hemolymph rather than the food of honey bees as is the case with bee lice *B. coeca* (Ellis, 2008; Rosenkranz *et al.*, 2010).

The migratory beekeeping encouraged the outcross distribution of *V. destructor* and *B. coeca*; as a consequence, multiple species may coexist in the same population (Crane, 1990).

Conclusion

According to the results and the low rates of both ecto parasites of this study *V. destructor* and *B. coeca*, considered that they have a minor threat to the health of the honey bee population under investigation. However, the numbers found can be regarded as high because *V. destructor* was significantly more prevalent in the examined populations. Moreover, despite being bee lice *B. coeca* present in west Libya, it is rarely observed there.

Throughout this investigation, integrated pest management is highly recommended to improve the beekeeping industry and pollination services.

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Conflict of interest

The authors have no conflict of interest to declare.

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Availability of data

Data available on request from the authors.

Authors' contributions

MK and TS: conception, design, and organization of the study; MK, TS, HM, SG and SM: conducted the study; MK, HM and SM: acquisition of data; MK, HM and TS: analysis and interpretation of data; MK, HM and TS: drafting of the manuscript and critiquing the output for important intellectual content. All authors discussed the results and commented on the manuscript.

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