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Population Dynamics of Varroa Mites and Bee Lice in Honey Bees Colonies

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Abstract: ***This study was designed to evaluate the population dynamics of Varroa mites and bee lice in naturally infested honey bee colonies Apis mellifera Varroa destructor* and *Braula coeca infestation rate on both adult bees and sealed brood was estimated, in addition of the estimation of falling parasites trapped by using anti-varroa bottom boards. The results showed that mean infestation rate of V. destructor on adults and brood was 2 % on January, increased rapidly on June to reach the maximum of 40% , then decreased again to the season minimum rate in Dec 2014. The infestation rate of B. coeca began to increase rapidly in May, reaching the season's maximum rate of 2.1 %, for A. mellifera in December of 2014. We conclude both of the honey bee parasites were found in the apiary with the most common parasite being the Varroa mite. In spite of hosting few pathogens, yet most parasites, A. m. colonies appeared to be healthy.***

Keywords: Population dynamic, *Varroa destructor*, *Braula coeca, Libya*

1. Introduction

Honey bees, *Apis mellifera*, colonies infected with many pathogens, parasites and pests which endangering their health and life [1]. The majority of pathogens and parasites affecting honey bees have an almost worldwide distribution [2]. However, the health status of honey bees in Africa is poorly characterized [3].

The introduced ecto-parasitic mite, *Varroa destructor* Anderson & Trueman, is considered as one of the most serious threats to honey bee health, by feeding on hemolymph of adult and developing bees, spreading disease, and reducing their lifespan [4]. Honey bee colonies commonly die from *V. destructor* infestation within a few years if were not treated [5]. The population dynamics and negative effects of *V. destructor* have been well documented in Europe and the USA [1].

The bee lice, *Braula coeca* Nitzsch (Braulidae: Diptra) is a cosmopolitan inhabitant of honey bee and generally considered to bee minor pest [6]. This ecto-parasite particularly prefers the queen, followed by nursing bees; only rarely do they live on drones [7]. The bee louse causes little or no harm to bee colonies, but if it is present in a large number, it certainly incommodes its host [8]. The most serious injury caused by this pest is that the developing B. *coeca* instars within the honey cells can cause physical damage to honey combs when they tunnel the wax capping [9]. It has been suggested that severe infections may decrease the efficiency of queens [10], cause the queen to be superseded [11] and reduce honey production [12].

Lately, several Libyan beekeepers raised concerns about the important reduction of honey production, the collapse of honey bee colonies and their adverse effects of agriculture and food production (per. Com.). In that respect, investigations on the importance of parasitism on honey bees by *V. destructor* and *B. coeca* were very seldom carried out. We report here the first survey, covering one year period, of the seasonal variations of *V. destructor* and *B. coeca* in bee colonies based on sampling of adult worker bees and brood on different seasons.

2. Materials and Methods

The experiment was conducted at the Research and Experiments Stations at Faculty of Agriculture- University of Tripoli (UOT) (32°54'N / 13°11'E), form January to December 2014. Apiary consisted of twenty-one honey bee colonies naturally infested with bee parasites. These colonies occupied hives with 2 Dadant chambers. Standard management practices were used throughout the year. Parasite population was monitored on adult bees, brood, and the naturally falling parasite for a comprehensive evaluation to the building up trends during the year.

2.1 Seasonal prevalence of ecto-parasites in honey bee colonies

2.1.1 Infestation rate of adult worker bees

Alcohol wash technique was used [13] for sampling varroa mites infestation on worker bees, worker bees were brushed directly from the combs of the hives into a jar (Approximately 300 bees/colony). In the lab, containers (bees in 100 ml 70% alcohol) were vigorously placed for 30 min on the shaker, to dislodge parasites. Content was pour over sieve (mesh width 3 mm) to separate the parasites from the bees and second sieve (mesh width 1 mm) placed below to collect them. Finally, parasites were examined under a stereomicroscope at 40X magnification to differentiate between the bee louse and Varroa mites because of their resembles on their appearances; however, being an insect, *B.coeca* has six legs that extend to the side. Total number of both parasites and number of bees in each sample was recorded then percentage (i.e. number of mites per 100 bees) was calculated. Data was taken every 8 weeks.

2.1.2 Infestation rate of sealed brood

For sampling mites on worker brood cells, two frames with recently sealed brood were selected from each colony. Then one- hundred sealed brood cells were randomly selected. Each cell was uncapped, and the pre-pupa or pupa inside

was carefully examined for mites' infestation, any detected mites were counted. The removed caps and the cells were also examined as the mite frequently hides there [14]. Total number of inspected cells and number of adult mites was recorded and percentage of infestation of sealed brood was calculated. Data were taken on 8-weeks intervals basis for the entire investigation period.

2.1.3 Naturally falling rate of parasites

Fourteen colonies were equipped with screened bottom boards operated with the drawer (closed bottom) underneath covered with paper smeared with a thin layer of Vaseline oil to capture the fallen ecto-parasites. The anti-varroa screened bottom board promotes the natural grooming behavior of honey bees. Numbers of fallen mites and louses after three days of Vaseline sheet installation were recorded (i.e. mite per day). Data were taken on 4-weeks intervals basis for the entire investigation period.

3. Results and Discussion

3.1 Seasonal prevalence of V. destructor in honey bee colonies

A total of 1289 mites were separated from 23207 adult worker bees sampled during this study, with overall mean infestation rate of 5.55 mite/ 100 bees, infestation rates ranged from 0.17 to 16.20 individuals per 100 worker bees. Results showed that *A. mellifera* colonies were infested with *V. destructor* during all seasons, growth rate of mites population increased gradually during spring perhaps responding to extended brood area, but the highest rates were recorded during June 2014, with 16 mites/ 100 adult bees (Fig. 1). Later, population of phortic mites dropped gradually to reach the lowest level during winter, with 2 mite/ 100 adult bees. Similarly, population of mites on sealed brood had the same trend with a much higher growing rate, with 40 mite/ 100 brood cells during its peak. Different factors contribute to the population growth of mites, which eventually can lead to colony collapse [15]. Although larval stages of the honey bee must be available for mite reproduction, this is only one factor that influences mite population growth [16].

The development time of worker brood, the hygienic behavior, the grooming behavior and the reproductive ability are characteristics long associated with varroa tolerance. Furthermore, regional differences in weather conditions and mite genotypes make it difficult to characterize the mite reproductive ability and the varroa population dynamics over a wide-spread area [23]

Varroa mite population dynamics vary according to bees genotype, mites genotype, geographical location, and climatic conditions [17]. The average infestation rates of untreated *A. m. scutellata* colonies measured during autumn and winter of 1999 were 7.7 and 1.0 mites per 100 adult honey bees, respectively [18]. Another study reported that highest rates were recorded during winter 2014, with 3.6 mites per 100 bees [19]. In *A. m. capensis*, the neighbouring subspecies, *V. destructor* infestation rates also differed between the winter of 1999 (3.5 mites per 100 adult honey bees) and 2000 (7.5 mites per 100 adult honey bees) [18].

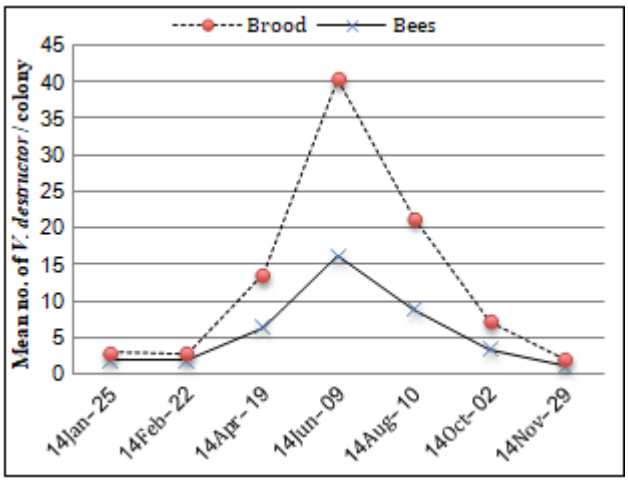

Figure 1: Infestation rate of *V. destructor* on 100 adult bees, and on 100 sealed brood cells.

In Africanised honey bees that are also tolerant to the parasitic mite, comparable infestation rates of 3.5 mites per 100 adult honey bees were recorded [20]. These figures (<3.5 mites per 100 adult honey bees) correspond to those for European honey bees that survive in the presence of *V. destructor* after acaricides treatment [21, 22] and therefore seem to be at a level where several of the honey bee subspecies can tolerate the parasite.

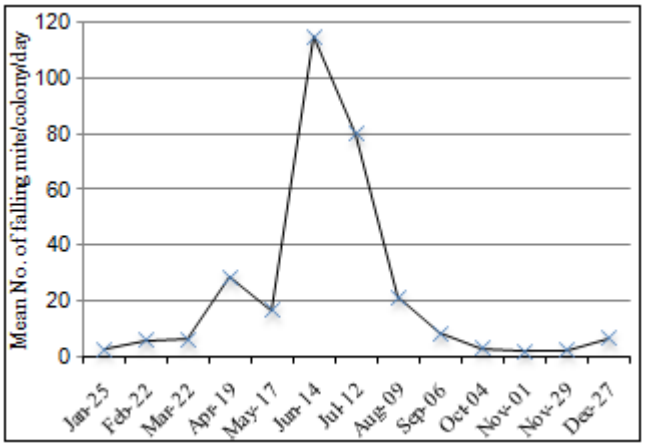

Figure 2: Mean number of naturally falling mites per colony for 3-days trapping period.

The milder winter conditions in Mediterranean climates and the availability of food during a considerable part of the winter account for this difference in the brood-rearing cycle, which, in turn, is relevant to the intrinsic growth rate of *V. destructor*.

A total of 8417 mites were trapped on Vaseline sheets from 14 colonies during 40 days (on 3-day sampled/ 4weeks), falling mites ranged from 2.44 to 114.9 individuals per day per colony. Results showed that *A. mellifera* colonies were infested with *V. destructor* during all seasons. Mean number of falling mites was very low during winter, with 2.7 mite per day per colony, increased gradually to reach peak during June 2014, with 116 mites per colony per day. Then number of falling mites dropped gradually to reach the lowest level during winter (Fig. 3). Clearly, falling mites rate had the same trend of growing population of mites on both adult bees and sealed brood with summer peak (Fig. 1).

Hygienic behaviour is the dominant natural defence against *V. destructor* mites infesting brood cells, while grooming minimize mites infesting adult bees [24]. This honey bees' behavioral resistance may influence colony defence, which would directly contribute in slowing varroa buildup population.

Depending on season and the amount of brood, a natural downfall of 0.5-10 mites on the bottom boards is regarded to be the threshold for a basic necessity of treatment [25]. This corresponds to an absolute mite population of 2000-3000 mites, which is considered as an economic threshold [26]. In general, feasible diagnostic tools are an essential component of integrated pest management [27].

3.2 Seasonal prevalence of *B. coeca* in honey bee colonies

A total of 69 mites were separated from 23207 adult worker bees sampled during this study, with infestation rate of 0.29 louse/ 100 bees. Results showed that some of *A. mellifera* colonies were infested with *B. coeca* during all seasons, infestation rates ranged from 0.10 to 1.19 individuals per 100 worker bees. Our results were similar to recent study in Libya with mean rates of parasitism of bee lice did not exceed 0.5% in experimental colonies during Jan, Jun and Oct 2015 [28].

The climatic differences between regions might explain the differences in *B. coeca* numbers. In Benin, Paraïso et al [29] observed higher infestation rates as in our study that ranged from 0.3 to 4.6 individuals per 100 *A. m. adansonii* workers. While in South Africa, Strauss et al [19] recorded the highest infestation rates during winter 2011. In contrast, *B. coeca* numbers in other regions of the world peaked at different seasons (spring and autumn in US [7]; summer and autumn in Jordan [30]). Indeed, varying climatic conditions not only between regions but also between years, could explain the differences in the infestation rates of both *V. destructor* and *B. coeca* in South Africa in the winters of 2010 and 2011[19]; with values during the first winter being lower and more comparable with the other seasons.

Similar studies conducted in Jordan reported that bee lice, *B. orientalis*, is quite common found in 64.3% of inspected apiaries and diagnosed in 45.4% of the hives [12]. It reported that prevalence of lice infestation recorded in adult bee of the three peasant associations of Wukro Woreda were 5- 6% [31]. A decrease in infestation rate was reported after December and during spring, reaching its lowest level in April, although bee lice were found inside the bee colonies throughout the year [12]. Another study showed rapid increase in the infestation rate of *B. coeca* to begin in May in the same country [30]. In South Africa low prevalence of *B. coeca* infestation was reported during November 2008 to March 2009 [19]. The recent identification of *B. coeca* in Florida, indicated its presence in colonies along the eastern shore of Maryland, USA for some time, whereas the large infestations reported from Spain [32].

Though no detrimental effects have been attributed to the presence of *B. coeca* on the honey bees in some earlier reports [33], however, a recent experimental study had shown bee lice to be an evident cause of reduction in the number of worker bees and honey production [12].

AL Ghzawi et al. [34] claimed that the beginning of the summer seasons is the best time in managing bee lice, they found that the colonies which treated with tobacco smoke produce higher quantities of honey. In Libya up to now bee lice are not considered a major pest threat, and due to the similar appearance, most beekeepers hardly differentiate between varroa mites and bee lice [28], so no proper control method was practiced.

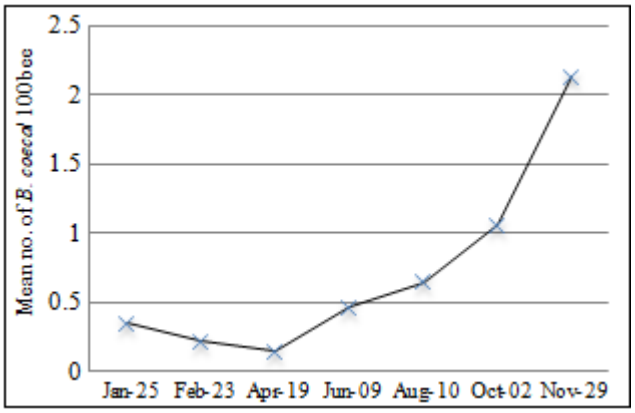

Figure 1: Infestation rate of *B. coeca* on 100 adult bees.

The lack of a significant correlation between the seasonal infestation rates of *V. destructor* and *B. coeca*, indicates that there is minimal or no direct competition between these pests. This becomes even more apparent when considering the life history of the two organisms; *B. coeca* larvae emerge from eggs laid on honey frames capping [35], and are not dependent on developing honey bee brood for survival during maturation. Conversely, *V. destructor* depends on sealed honey bee brood for their reproductive phase and their main food source is honey bee haemolymph and not honey, pollen or food secretions as the case with *B. coeca* [31].

Although the adults of both species spend a considerable time on adult honey bees, *V. destructor* prefers to attach itself to the abdomen to feed but can also be found between the head and thorax of adult honey bees [36], while *B. coeca* rests on the thorax and moves to the head of honey bees to feed directly from the mouth of the adult bee [31], this suggests that competition for space on adult honey bees or for food is unlikely.

In conclusion, this study, has shown the low *V. destructor* and *B. coeca* infestation rates, thus they do not have a significant effect on the health of the honey bees population. In addition, few honey bee viruses were detected in this region and this might explain why the Libyan honey bees population is able to survive in the presence of *V. destructor*, without treatment, at least for 5 years. It is recommended that, at this stage, further trials with different apiaries and different regions in Libya will lead to comprehensive assessment of both pests all over the country.

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