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# Research Article
# How Serious Is the Threat of Diseases and Pests to the Red Dwarf Honey Bee (*Apis florea* F.)?

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## Abstract

**Background and Objective:** The red dwarf honey bee (*Apis florea* F.) is one of the important pollinators of the semi-arid to tropical environments of several parts of Asia and some parts of Africa. This honey bee is facing severe decline in its colony numbers and foraging population in the semi-arid environment of northwest India. The probable causes of such losses are needed to be investigated. This article examines whether the diseases and pests are the causative agents for such a situation in this honey bee. **Materials and Methods:** This study was made from 1984-2012 at the main campus of CCS Haryana Agricultural University, Hisar (India). Year round survey of 58 managed colonies (two colonies in each year) and 145 wild colonies (five colonies in each year) of the red dwarf honey bee (*Apis florea* F.) was done and their diseases, pests, predators and enemies were studied in the live and deserted combs, on the colony sites as well as in the laboratory following standard methods. **Results:** No viral, bacterial, fungal and protozoan diseases were found to annihilate the colonies of the red dwarf honey bee. Likewise, the predators, nest destroyers and other vertebrate enemies too were not causing any damage to the colonies or foraging bees of this honey bee. However, an ectoparasitic mite (*Euvarroa sinhai* Delfinado and Baker) and a wax moth (*Galleria mellonella* L.) were the two pests of this honey bee causing serious damages to the colonies of this honey bee. More than 30% of the over wintered colonies of this honey bee were infested with an ectoparasitic mite (*Euvarroa sinhai*) and 100% of the over wintered colonies with the wax moth pest (*Galleria mellonella*). However, none of these pests were found to kill the infested colonies. Therefore, diseases, pests, predators and enemies were not the causes of colony declines in the red dwarf honey bee; some other factor (s) should be responsible for the colony losses of the red dwarf honey bee. **Conclusion:** In a pursuit to investigate the causative agents for the colony losses and declines of red dwarf honey bee in the semi-arid environment of northwest India, this study was made. Diseases and pests are not the real causes of colony declines/losses of the red dwarf honey bee. Other reasons of colony losses are needed to be investigated.

Key words: Red dwarf honey bee, *Apis florea*, colony, diseases, pests

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Competing Interest: The author has declared that no competing interest exists.

Data Availability: All relevant data are within the paper and its supporting information files.

## INTRODUCTION

Honey bees are pollinators of several crops and play an important role in their fruit/seed production[1,2]. They are also very important for the conservation of floral diversity[3]. Three species of honey bees are indigenous in India. These are, the giant honey bee (*Apis dorsata* F.), the red dwarf honey bee (*Apis florea* F.) and the Indian hive bee (*Apis cerana indica* F.). Before 1980, *Apis cerana* was the main species used for beekeeping in India, the exotic honey bee (*Apis mellifera* L.) was introduced in 1962 in the State of Himachal Pradesh and remained confined to parts of Himachal and Punjab states only. However, *Apis cerana* suffered massive losses due to the outbreak of a deadly Thai Sac Brood Virus, now the number of colonies of this honey bee in India is exceptionally low. Recent report reveals that the colonies of the giant honey bee (*Apis dorsata*) too are declining[4] and serious efforts are underway for its conservation[5].

The red dwarf honey bee (*Apis florea* F.) is distributed in a wide variety of habitats, for example, semi-deserts, steppes, savannas and rainforests and likewise diverse climates viz., semi-arid, sub-tropical and tropical. Its distribution ranges from southeast Asia to the Far East[6-9]; extending to Pakistan, Afghanistan, Iran[10], coastal areas of southern Iraq, Oman, Yemen, Sudan[11], Central Saudi Arabia[7], around Aqaba in Jordan[9,12-14]. In its natural abode, this honey bee visits several kinds of local crop plants for pollen and nectar. Earlier reports authenticate this perception revealing that *Apis florea* is the most abundant visitor and an important pollinator of many crop plants, for example, many oil seed, vegetable and condiment crop plants[15-17], pigeon pea, (*Cajanus cajan*)[18], sunflower (*Helianthus annuus* L.)[19], cauliflower (*Brassica oleracea* var. botrytis)[20], carrot (*Daucus carota* L.)[21,22], coriander (*Corriandrum sativum* L.)[23], fennel (*Foeniculum vulgare* L.)[24], Cucumber (*Cucumis sativus* L.)[25], Pracitrullus (*Pracitrullus fistulosus*)[26], wanga (*Cucumis melo* ssp. melo)[27], Onion (*Allium cepa* L.)[28], sarpagandha (*Rauvolfia serpentina*)[29] and European plum (*Prunus domestica* L.)[30]. Viewing the importance of this honey bee as a natural wild pollinator of several crops, study on its ecology gains importance.

Colonies of the red dwarf honey bee are steeply declining in the semi-arid environment of northwest India (unpublished observations) and reasons of such declines are not known. Earlier reports documented the status and severity of damages caused by the diseases and pests to the European honey bee (*Apis mellifera*)[31] and the giant honey bee (*Apis dorsata*)[4,32] in the semi-arid environment of northwestern region of India. However, such information on the red dwarf honey bee is completely lacking. The main aim of this study is to investigate the extent of threat of diseases and pests to the colony survival of the red dwarf honey bee (*Apis florea*).

## MATERIALS AND METHODS

**Study site and the colonies:** This study was carried out from 1984-2012 on 58 managed colonies (two colonies each year) and 145 wild colonies (five colonies in each year) at the main campus (in an area of about 9 $km^2$) of CCS Haryana Agricultural University, Hisar (Haryana, India) where the red dwarf honey bee makes nests in the hedges and bushes (Fig. 1) and visits flowers of locally grown plants (Fig. 2-4). The managed colonies were kept in the artificial wooden boxes fabricated for manual manipulations and the wild colonies made nests in their natural abode which were within the approach for manipulations and/or recording of observations

Fig. 1: A colony of the red dwarf honey bee (*Apis florea* F.)
Source: https://www.google.co.in/search?hl=en&tbm=isch&source=hp&biw=1074&bih=494&ei=81dwW_KkN4z6vgT6jraoBg&q=apis+florea+images&oq=Apis+florea&gs_l=img.1.1.0l10.5283.10168.0.19578.11.8.0.3.3.0.299.1725.0j3j5.8.0....0...1ac.1.64.img..0.11.1745....0.MZToeVluwcs

Fig. 2: Red dwarf honey bee visiting the flower of lemon (*Citrus limon* L.)

Fig. 3: Red dwarf honey bee visiting the flowers of fennel (*Foeniclum vulgare* L.)

Fig. 4: Red dwarf honey bee visiting the flowers of carrot (*Daucus carota* L.)

on the brood condition and live bees. For the survey of honeybee diseases and pests, live colonies (n = 58; nested in the artificial wooden boxes) and the deserted combs (n = 145; these colonies nested in their natural abode) were examined for the presence/absence of diseases, pests, predators and enemies, the extent of damages caused to the colonies and their symptoms. Live colonies nesting in the wooden boxes were individually handled frequently. The bees in the colony were gently removed with a finger or fly flapper to observe the brood condition in the colony.

**Vertebrate and invertebrate enemies and predators of the red dwarf honey bee:** The bird and wasp predators and other enemies (ants, spiders and vertebrates) preying upon or causing harm to this honeybee were recorded on the foraging sites of this honey bee and several times every week near the managed colonies too.

**Wax moth pest of the red dwarf honey bee:** Observations on the wax moth infestation were recorded by examining the live as well as the deserted combs just with the naked eyes as did for the giant honey bee[32]. The type and the extent of damage caused to the adult bees and the brood was also evaluated.

**Acarine diseases and pests of the red dwarf honey bee:** For the survey of acarine disease, a sample of about 50 adult bees was drawn from each of the approachable colonies every year during early April (58 managed colonies) using Sihag Bee Sampler[33]. The sampled bees were washed in the soap water, sieved through the fine muslin cloth and rewashed the supernatant in fresh water in a Petri-plate. The presence of any ectoparasitic mite in the sample was confirmed under the light microscope. The type and the extent of damage caused to the adult bees and the brood was also evaluated.

**Fungal diseases of the red dwarf honey bee:** Likewise, presence/absence of chalk/stone brood disease was ascertained on the basis of presence or absence of the symptoms of these diseases in the brood[34]. The type and the extent of damage caused to the adult bees and the brood was also evaluated.

**Protozoan diseases of the red dwarf honey bee:** To know the causes of adult bee mortality at the colony site, the dead adult bees lying on the floor below the colony/nest were collected, brought to the laboratory, counted and examined for the presence of diseases[34]. Every year, several such bees were dissected under light microscope in the laboratory and the color and phenotypic condition of their ventriculus and the water smear of the latter was examined for the presence/absence of nosemosis fungal disease[35].

**Bacterial and viral diseases of the red dwarf honey bee:** Presence or absence of the bacterial and viral brood diseases was confirmed on the basis of respective presence or absence of their symptoms in the brood[35]. The observations were initiated after a week of the settlement of the manually

immigrated colonies and were repeated at 21 days interval till the desertion of the combs. The deserted combs were examined only after the local migration of the colonies.

## RESULTS

**Vertebrate and invertebrate enemies and predators of the red dwarf honey bee:** During this study, no predatory bird or wasp was found to attack this honey bee on the nesting or the foraging sites. Likewise, other enemies like ants, spiders, toads and other vertebrates were also not seen attacking the colony or destroying the nests or preying upon the adult bees (Table 1). Therefore, the vertebrate and invertebrate predators did not seem to be the cause of decline in colony numbers of the red dwarf honey bee in the semi-arid environment of northwest India.

**Acarine disease and wax moth pest of the red dwarf honey bee:** This honeybee was found to be infested with two pests, namely, an ectoparasitic mite (*Euvarroa sinhai*) (Fig. 5) and a wax moth (*Galleria mellonella*) (Fig. 6). About 32% of the colonies (65 out of 203 colonies) were infested with ectoparasitic mite (*Euvarroa sinhai*). All the 58 old over wintered colonies (n = 58) and only 7 (out of 145) new colonies were found to be infested with this mite.

The ectoparasitic mite (*Euvarroa sinhai*) was found to parasitize the drone brood of the red dwarf honey bee. Though the intensity of the mite infestation in the brood could not be fully ascertained, all the infested colonies survived successfully till their desertion of the nest/local migration. The number of phoretic mites, however, remained low and variable (range = 0-3, Mean$\pm$SD = 0.7$\pm$0.02, n = 1025). No bees with deformed wings or legs were ever observed crawling on the bottom board of the hiving box and none of the infested colonies was ever found to be completely destroyed by this mite.

On the other hand, invariably, all the overwintered colonies were found to be infested with the wax moth pest, as the wax moth infestation could be seen in all the deserted combs. This pest was found to completely devour the comb (Fig. 6). The wax moth disturbance seemed to cause nest desertion/absconding in this honey bee. Nevertheless, all the queens and their worker forces survived the infestation of the wax moth, none of the bee forces were completely annihilated. All the new colonies established in March-April, however, were free from this pest. These observations indicate that the ectoparasitic mite (*Euvarroa sinhai*) (Fig. 5) may be a cause of drone destruction and the wax moth

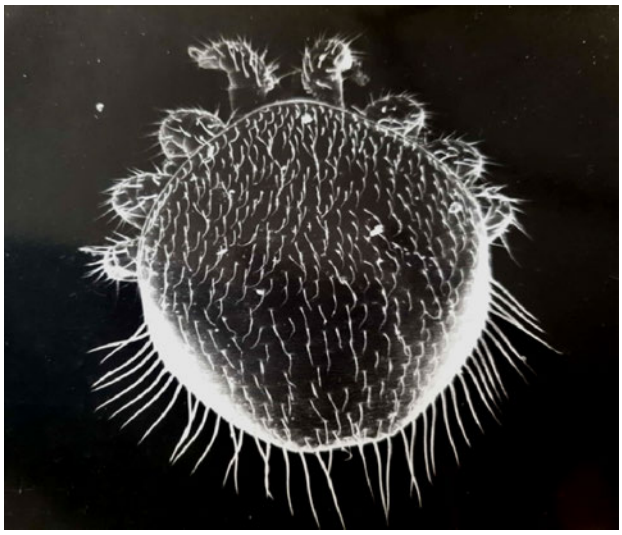

Fig. 5: *Euvarroa sinhai* (female), an ectoparasite of red dwarf honey bee (*Apis florea*)
(x50 magnification) (Photo: Kamal Aggarwal)

Fig. 6: A comb of red dwarf honey bee (*Apis florea*) devoured by the wax moth (*Galleria mellonella*)

(*Galleria mellonella*) (Fig. 6) may be a cause of the devouring of the colony nest resulting in nest desertion/absconding in this honey bee. However, none of these two pests were ever found to completely kill the colony of the red dwarf honey bee.

**Fungal diseases of the red dwarf honey bee:** There were no symptoms of chalk or stone brood diseases in the brood of 203 colonies observed in this study. The aqueous smear of

Table 1: Incidence of diseases, pests, predators and enemies of the red dwarf honey bee (*Apis florea*) in the semiarid environment of northwest India

| Diseases, pests, predators and enemies | Description of the pathogen/pest/enemy | | | | | |
|---|---|---|---|---|---|---|
| | Symptoms | Causal organism present/absent | Month of incidence/ infestation | Colonies affected (%) | Kind of damage to the colony | Gravity of damage to the colony |
| Viral disease | Absent | Absent | - | - | - | - |
| Bacterial disease | Absent | Absent | - | - | - | - |
| Fungal disease | Absent | Absent | - | - | - | - |
| Protozoan disease | Absent | Absent | - | - | - | - |
| Acarine disease | Perforated drone brood/Phoretic mite | *Euvarroa sinhai* (present) | February-March | 100% of the over wintering colonies (n = 65, N = 65), 4.8% of the new colonies (n =7, N = 65) | Not sure | Not sure |
| Wax moth infestation | Several silken tunnels in the midrib of the comb | *Galleria mellonella* (present) | March-April | 100% of over wintered colonies, none of the new colonies | Destroy and devour the combs | Combs in badly damaged state |
| Predatory wasps/birds | Not seen | Absent | - | - | - | - |
| Other enemies | Not seen | Absent | - | - | - | - |

-: Incidence did not take place, N: Total number of colonies observed, n: Number of colonies showing the presence of mites

Table 2: Mortality of adult bees of the red dwarf honey bee (*Apis florea*) at the colony sites due to low ambient temperatures

| Ambient temperature range | Duration (days) range | Bee mortality (number of dead bees per day) | |
|---|---|---|---|
| | | Range | Mean* |
| <10°C | 10-15 | 20-45 | 32.6±9.2 |
| 10-15°C | 15-20 | 5-20 | 9.7±1.6 |
| 15-20°C | 25-30 | 3-4 | 3.7±0.5 |
| >20 | 300-315 | Scanty | Scanty |

*Mean±SD of 272 observations

ventriculus of the bees sampled from the dead pools of adult bees examined under light microscope too did not confirm the presence of spores of *Nosema* fungus. This indicated that in the semi-arid environment of northwest India, the dwarf honeybee did not face any threat of colony losses due to fungal diseases (Table 1).

**Protozoan disease of the red dwarf honey bee:** During the study period, no live bees trembling or crawling were ever seen on the floor below the colony nests. Likewise, no symptoms of bee dysentery were ever present and also, no black excreta of bees were ever observed on the floors below the colony nests. Therefore, chances of any protozoan disease in the red dwarf honey bee in the semi-arid environment of Northwest India were also excluded (Table 1).

**Bacterial and viral diseases of the red dwarf honey bee:** During the entire period of this study, no dead larvae were ever observed in the brood of 58 managed colonies nesting in the wooden boxes and also in the deserted combs of 145 wild colonies. Therefore, symptoms of sac brood or foul brood diseases, as found in *Apis mellifera* were absent in the red dwarf honeybee.

**Adult bee mortality near the colony of the red dwarf honey bee:** Some adult dead bees, however, were regularly observed during the extreme winters (Table 2). Every year in December/January, the ambient night temperature fell below 10°C which continued for 10-15 days (Table 2). During these days adult bee mortality ranging from 20-45 per day (Mean±SD = 32.6±9.2, n = 272). Before and after these chilling nights, when night temperature remained between 10-15°C, for 15-20 days, these bee deaths were small in number (range 5-20 per day, Mean±SD = 9.7±1.6, n = 272). In the nights with temperature above 15°C, the bee deaths decreased to very small numbers (range = 3-4 per day, Mean±SD = 3.7±0.5, n = 272) and bee deaths were very rare and scanty in the nights with temperature >20°C. These deaths seemed to be caused by the super cooling of the bees on the outer curtain of the bee blanket and not due to any of the major diseases mentioned above. This factor also did not completely kill any of the observed colonies of the red dwarf honey bee in the semi-arid environment of northwest India.

The foregoing account clearly reveals that, though two pests viz. an ectoparasitic mite (*Euvarroa sinhai*) (Fig. 5) and a wax moth (*Galleria mellonella*) (Fig. 6) do cause disturbances and some losses to the colonies of the red dwarf honey bee, yet none of the diseases, pests, predators and enemies are completely killing the colonies of this honey bee. Therefore, these agents cannot be held responsible for the decline in colony numbers and foraging populations of the red dwarf honey bee (*Apis florea*) in the semi-arid environment of northwest India.

## DISCUSSION

In the semi-arid environment of northwest India the red dwarf honey bee exhibits decline in its colony numbers. This study was carried out to ascertain whether this decline in colony numbers is due to some diseases, pests, predators and enemies or some other factor(s). The results revealed that this honey bee is not seriously threatened by any vertebrate or invertebrate predator, any pest, enemy or diseases (Table 1). The green bee-eater (*Merops orientalis orientalis* Latham) and the yellow-banded brown wasp (*Vespa orientalis* L.) are two serious predators of *Apis mellifera* in this region[31,36-39]. At least, 58 of these colonies remained under the daily observations of the author during their entire stay there. These predators were never seen near the colonies or on the foraging site of the red dwarf honey bee even during the inclement weather conditions. Likewise, other enemies of honeybees (mainly ants, beetles and vertebrates) were also absent in this region.

However, as stated above, about 32% colonies of red dwarf honey bee were found to be infested with ectoparasitic mite pest (*Euvarroa sinhai*) and invariably all such colonies with the wax moth pest (*Galleria mellonella*). This mite in India was first observed by Delfinado and Baker in 1971 from the red dwarf honey bee[40]. However, the losses caused to the colonies due to this mite in the red dwarf honey bee could not be ascertained in this study. The absence of phoretic mites in the swarm colonies may be due to their excessive low number in the samples which could not be detected by the method used in this study. These two pests may, however, induce absconding in this honeybee.

Some earlier reports enlist the infestation of colonies of the red dwarf honey bee by the diseases and the pests[41]. However, none has evaluated the gravity of damages caused by these agents to the colonies of this honey bee. Like the giant honey bee (*Apis dorsata*)[4] and the European honey bee (*Apis mellifera*)[31,42], in the semi-arid environment of northwest India, the red dwarf honeybee was free from any viral, bacterial, fungal and protozoan disease (Table 1). However, in Iran, the red dwarf honey bee[41] and elsewhere *Apis mellifera*[42] was found to have all these diseases. In the absence of any larval mortality and symptoms, the presence of any viral, bacterial or fungal disease was completely excluded in the brood of the dwarf honey bee in the semi-arid environment of northwest India and no other tests were necessitated/ required.

Therefore, there were no viral, bacterial, fungal and protozoan diseases and the predators and other nest destroyers of the red dwarf honey bee (*Apis florea*) in the semi-arid environment of northwest India. However, this honey bee had two very significant pests which seemed to be some detrimental to the colonies. The actual role of wax moth was visible but the extent of damage caused to this honey bee by the ectoparasitic mite pest needs to be investigated. However, none of these pests and even the low ambient temperature was responsible for the decline of colony numbers and foraging populations of the red dwarf honey bee in the semi-arid environment of northwest region of India. Therefore, there is a need to further investigate the real cause(s) of the decline in the colony numbers and the foraging populations[43] of the red dwarf honey bee in the semi-arid environment of northwest India.

## CONCLUSION

The red dwarf honey bee is indigenous to southeast, south and western Asia and eastern part of Africa. This honey bee is an integral component of bee diversity in the agro-ecosystems of semi-arid environments of northwest, India. It is a useful pollinator of many crops in this region. In recent years this honey bee is facing severe decline in its colony numbers. Viewing the importance of this honey bee in the agro-ecosystems of its natural abode, the factors responsible for such decline needed to be investigated. An ectoparasitic mite (*Euvarroa sinhai*) and a wax moth (*Galleria mellonella*) were the two major pests/enemies of this honey bee in this region. However, none of these two pests were responsible to cause the colony declines in this honey bee. Therefore, further investigations on the factors responsible for the colony losses in this honey bee are needed to be carried out.

## SIGNIFICANCE STATEMENT

This study discovered that the red dwarf honey bee is free from the viral, bacterial, fungal and protozoan diseases. Invertebrate and vertebrate enemies too were not visible near the colonies or on the foraging sites. But, the colonies were infested with an ectoparasitic mite and a wax moth pest. However, these pests too were not responsible for the colony losses. This information will be useful in guiding the researchers to uncover the critical issue of colony losses and decline in the red dwarf honey bee. Thus far, the researchers have not explored this situation and the reasons for this situation in the red dwarf honey bee (*Apis florea*). Thus further new efforts are needed to be made to explore the causes of colony decline in this honey bee.

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