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Influence of Changing Cultural Practices on Nesting behaviour of *Apis florea* Fabricius

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Abstract:

The dwarf honey bee *Apis florea* F. is generally found in areas with hot climate. In order to study the nesting behaviour of this species, investigations were carried out at altitude ranging from 365 to 1100 meter (m) above mean sea level. Survey was conducted during four seasons for complete three years surveying 4-6 villages in each region. It was observed that change in cultural practices by human society has led to overall decline in dwarf honey bee colonies in hilly areas. Plain areas were observed to be choice habitat for these bees. Important attracting factors for nesting were rich forage sources, bovine dung, uninterrupted agricultural practices, traditional animal husbandry, safe nesting site and less predator infestation in plains. Animal husbandry farms proved to be safe zone for colony habitation.

Keywords: dwarf honey bees, *A. florea*, cultural practices, safe habitat, traditional animal husbandry, predators

1. Introduction:

Honey bees are social insects that belong to the genus *Apis* (Hymenoptera: Apidae). These insects play pivotal role in nature and are beneficial to man in many respects. The genus *Apis* comprises mainly four species: *Apis florea* F. the dwarf honey bee; *Apis dorsata* F. the giant honey bee; *Apis cerana* F. the eastern honey bee and *Apis mellifera* L. the western honey bee. All the four species of honey bees are found in India. *A. andreniformes* S. is the counterpart species of *A. florea* F., *A. koschevnikovi* E is the sister species of *A. cerana* F. and *A. laboriosa* S. is the high altitude version of *A. dorsata*. These species are considered to be in advanced stage of speciation as they show greater physical variations than the other subspecies. The title dwarf honey bee is shared by two species of genus *Apis,* first species is *A. florea* F., the red dwarf honey bee and the second is *A. andreniformes* S. the black dwarf honey bee. Ruttner (1988) obtained three morphoclusters for *A. florea*: (1) S. India and Sri Lanka, (2) Thailand and (3) Oman, Pakistan and Iran. Mogga and Ruttner (1988) also reported three morphoclusters of *A. florea*. Based upon morphology *A. andreniformes* is the smallest honey bee and has recently been reconfirmed to be a separate species from the sympatric species, *A. florea* (Wu and Kuang, 1987).

A. florea builds single comb, nests in the open and in low bushes. Like other tropical honeybees they are prone to migration, at times over considerable distances. These migrations may be seasonal or in some cases may be a defence against predators and parasites. Till date, this species is unsuitable for apicultural use although it makes considerable contribution in crop pollination, supply of honey and wax. Honey hunting is practiced with this bee species and usually involves destruction of the nest and brood. In some areas, however collection of honey is practiced without destruction of the nest, and some honey gatherers even provide nest sites to which they transfer the whole colony. *A. florea* is well known for its quality honey which is considered to be of medicinal value by farmers. The most comprehensive studies on biogeography and distributional databases for *A. florea* are those of Maa (1953), Ruttner (1988), Wongsiri *et al.* (1990), Rinderer *et al*. (2002), Tahmasebi *et al.* (2002), Hepburn *et al.* (2005), Hepburn (2006) and Hepburn and Radloff (2011). Mossadegh and Birjandi (1986), Mossadegh (1990) and Deowanish *et al.* (2001) reported that *A. florea* absconds in response to temperature and heat while in Iran Tirgari *et al.* (1969) and Tirgari (1971) observed that *A. florea* migrated to areas with maximum exposure to sun light in autumn and in spring returned to dense foliage with less exposure of sun to the comb.

The present research was designed to understand the factors influencing geographic distribution of *A. florea* and was primarily focussed on studying (1) importance of natural nesting habitat (2) cultural importance of the species in relation to environment (3) the application of cultural practices towards attracting these honey bees for nesting thus maintaining biodiversity. As reports on the extent of colony decline and colony status in this region are not available, this necessitated survey and studies on the nesting behaviour of *A. florea.*

2. Materials and Methods

2.1 Study area

Dwarf honey bee colonies were surveyed in Chandigarh plains and six regions of Himachal Pradesh in India (Table 1) taking various environmental and cultural factors into account. Parameters like choice of habitat, food and defence from predators were chosen for the study. The study extended over three years (*i.e.* 2010 - 2012) and the regions covered were as described below (Table 4 and 5 and Fig. e).

2.2. Method

All the colonies were counted through self observations and with the help of native people.
These observations were made every month dividing into four seasons of the year (Table 4).

Table 1. Localities, geographical coordinates and altitude of the study area

S. No.	Region	Latitude	Longitude	Altitude
1	Chandigarh	30°43'59.93"N	76°46'45.90"E	365 m
2	Gagret	31°39'37.88"N	76°3'35.09"E	439 m
3	Daulatpur	31°46'58.52"N	75°59'23.51"E	521 m
4	Parwanoo	30°50'17.02"N	76°57'30.60"E	672 m
5	Hamirpur	31°41'10.23"N	76°31'16.71"E	785 m
6	Chintpurni	31°48'34.53"N	76°7'27.90"E	975 m
7	Bangana	31°39'39.69" N	76°20'51.44"E	1100 m

Source: Google map

3. Results and Discussion:

From the seven surveyed regions, data generated revealed that the distribution of dwarf honey bee colonies in the villages of Chandigarh (Dhanas and Khuda Lahora) was highest and that of Chintpurni (H.P.) region was lowest. Other regions arranged in descending order *w.r.t.* number of colonies present were as Gagret, Daulatpur, Parwanoo, Hamirpur and Bangana. Height in metres above mean sea level i.e. altitude, temperature variations and forage availability affected the species population in these regions. Many aspects of biology especially ecology of *A. florea* have to be studied because better understanding of nesting of the species is needed. According to Whitecombe (1984) very less records of nesting ecology of dwarf honey bees are available and many inferences are made in reference to *A. mellifera* (Winston *et al.,* 1983). Akratanakul, (1977) made descriptive studies on the ecological aspect of *A. florea*. Reports of Oman flora and fauna provided essential information on physical, biotic and cultural environment of *A. florea* (Hawley, 1977; Gallagher and Woodcock, 1980; Whitecombe, 1984).

3.1. Dwarf honey bee Colonies

Although number of publications are available on morphometric studies of honey bee races (Rattanawannee *et al.,* 2010; Nedic *et al.,* 2011; Abou Shaara and Ghamdi 2012; Al Kahtani and Taha, 2014) there is lack of literature concerning geographic distribution and nesting interests of *A. florea* in India and world over.
Farmer's opinion supports that ten to fifteen year back approximate number of colonies located in Chandigarh region was 255 colonies per year. In foothills of Himachal Pradesh regions like Gagret, Daulatpur, Parwanoo, Hamirpur, Chintpurni and Bangana these numbers were 30, 28, 14, 29, 27 and 31 respectively. During the present study (Table:2) an average of 112.33 honey bee colonies were observed in Chandigarh region, 10, 6.66, 4.33, 6.66, 1, 6.66 were reported for Gagret, Daulatpur, Parwanoo, Hamirpur, Chintpurni and

Bangana respectively over the three year period of investigations (Fig. a). As per present research work abundance of *A. florea* colonies varied from season to season or yearly on the basis of environmental conditions supporting its survival (Table:4). Chintpurni is the region where no or least number of colonies has been reported during present work. This seems to be in accordance with the studies of Koeniger and Koeniger (1980) that swarming in *A. florea* extends long distances. Thakar and Tonapi (1962) reported that *A. florea* is a highly migratory species of honey bees and it periodically migrates between plains and adjacent low hills according to forage availability. Seasonal changes drive the colonies to other places for nesting. Mostly dwarf honey bee make local movements less than 500 m distance sometimes these movements are regarded as migrations (Tirgari *et al.*, 1969; Tirgari, 1971). Free, (1979) denied these movements as migration and described it as absconding due to lack of food supply, season changes and invasion by enemies.

3.2. Habitat/nesting preferences

Studies on *A. florea* for its habitat choice revealed that its preferences were different for plain and hilly areas (Fig. b). In plain areas 50% of the dwarf honey bee colonies preferably nested in bushes, 30% on small tree branches and 20 % in wooden heaps on ground. But in hilly areas heaped wood bundles on ground were choice of 60-80% of honey bee colonies with the remaining 40-20% of bees preferring to nest in bushes and none of the colony was observed to be nested on tree branches (Table: 3).

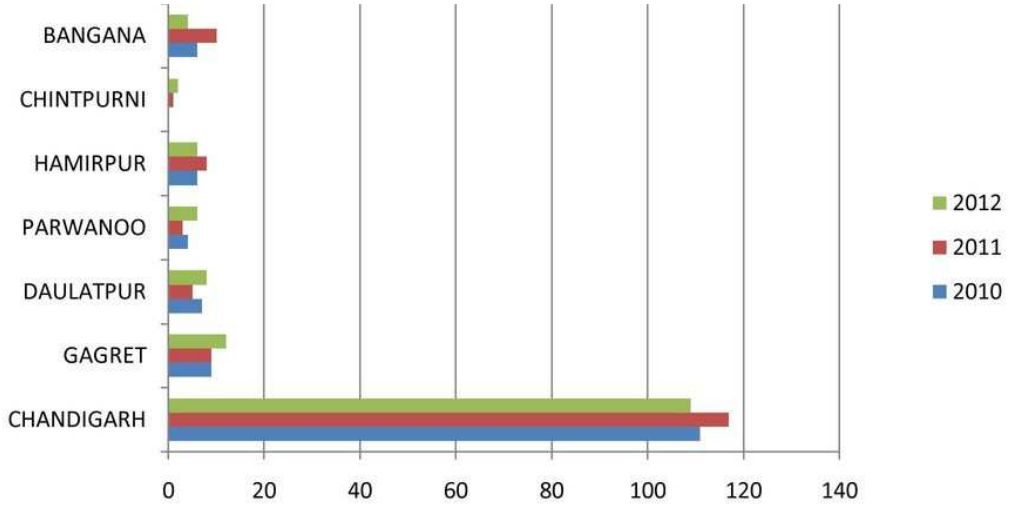

Fig. a. Number of dwarf honey bee colonies nested per year in different geographic regions of Chandigarh and Himachal Pradesh.

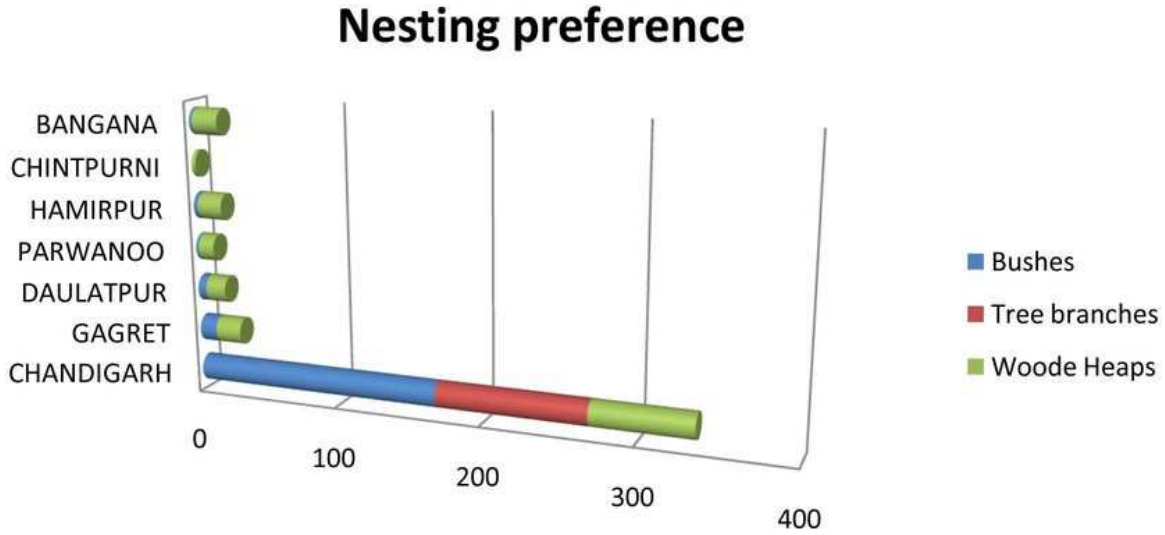

Fig. b. Nesting preference of *A. florea* in foothills of Chandigarh and foothills of Himachal Pradesh

3.3. Bee predation

In hilly terrains hornet nests (Fig c-D) were commonly found and they competed with dwarf honey bees for forage. The foraging timings of both were same and therefore bees fell easy prey to the hornets. Maximum hornet predation was observed in Hamirpur region and was more than 78% as per nest count method. Chintpurni was the second most hornet troubled region with 75% predation. Bangana suffered 68% hornet predation. In Gagret, Daulatpur and Parwanoo hornet predation was 60%. The least hornet troubled region was Chandigarh where this predation was 2%. This is supported by the opinion of Seeley (1983) who described ecological adaptations of four species of honey bees and stressed on the importance of predation in developing the nesting and defensive behaviour of three Asian species. The defensive strategy of *A. florea* has been published in Thailand (Seeley *et al.,* 1982), Oman (Whitecombe, 1984). Honey bees form a curtain of workers the primary function of this curtain is to defend the colony, brood and honey from predators (Seeley *et al.,* 1982) but role in thermoregulation cannot be ruled out (Whitecombe, 1984).

In the same way these helpless creatures i.e. dwarf honey bees find a safe place to nest in bushes nearby dung heaps. As per the present survey nests of dwarf honey bee in vicinity of the dung heaps were present even when hornet nests were there (Fig. d-A & D). As observed in village areas of Chandigarh region these bee colonies were in abundance and the reason behind this abundance was odour of the decaying dung which deterred pests ad predators. In Chandigarh rural areas like Dhanas and Khuda Lahora huge heaps of dung were found and these dwarf honey bees nested in nearby bushes or wood bundles that offered protection and camouflage.

Table: 2. Year wise distribution of number of *Apis florea* colonies in different regions of Himachal Pradesh and Chandigarh Plains

Region	2010	2011	2012	Mean
Chandigarh	111	117	109	337
Gagret	9	9	12	30
Daulatpur	7	5	8	20
Parwanoo	4	3	6	13
Hamirpur	6	8	6	20
Chintpurni	0	1	2	3
Bangana	6	10	4	20

Table: 3. Number of colonies nested in different structures collectively in three years

Region	Bushes	Tree branches	Wooden Heaps	Total colonies nested
Chandigarh	168.5	101.1	67.4	337
Gagret	12	0	18	30
Daulatpur	6	0	14	20
Parwanoo	1.95	0	11.05	13
Hamirpur	3	0	17	20
Chintpurni	0	0	3	3
Bangana	2	0	18	20

Table: 4. Season specific distribution pattern of *Apis florea* colonies number (n) in seven study regions

Region	Jan-April	May-june	July-Sept	Oct-Dec	Total
Chandigarh	8±1.73	35.66±3.05	48.66±2.08	19.66±1.52	112.33±4.16
Gagret	-	3.66±0.57	6±1	0.66±0.577	10.33±1.52
Daulatpur	-	2±1	4.33±0.57	-	6.66±1.51
Parwanoo	-	3.33±2.51	1±1.73	3±3	7.33±4.16

Hamirpur	-	4±3.6	2.66±2.88	4.66±4.16	11.33±5.03
Chintpurni	-	1±1	-	-	1±1
Bangana	-	2.33±2.081	2±2.64	3±1.73	7.33±1.15

Table: 5. Nesting trend of *Apis florea* colonies in India during four different seasons of the year

Year	Region	Jan-April	May-june	July-Sept	Oct-Dec	Total
2010	Chandigarh	9	35	47	20	111
2011	Chandigarh	6	39	51	21	117
2012	Chandigarh	9	33	48	18	109
2010	Gagret	0	3	6	0	9
2011	Gagret	0	4	5	1	10
2012	Gagret	0	4	7	1	12
2010	Daulatpur	0	2	5	0	7
2011	Daulatpur	0	1	4	0	5
2012	Daulatpur	0	3	4	0	8
2010	Parwanoo	0	1	3	0	4
2011	Parwanoo	0	3	0	3	6
2012	Parwanoo	0	6	0	6	12
2010	Hamirpur	0	0	6	0	6
2011	Hamirpur	0	7	1	8	16
2012	Hamirpur	0	5	1	6	12
2010	Chintpurni	0	0	0	0	0
2011	Chintpurni	0	1	0	0	1
2012	Chintpurni	0	2	0	0	2
2010	Bangana	0	0	5	1	6
2011	Bangana	0	3	1	4	8
2012	Bangana	0	4	0	4	8

4.1 How traditional animal husbandry was associated with the safety of dwarf honey bees.

Few years back animals were knot tied to a wooden pole and were provided with a soft bedding cushion of waste and raw grass (Fig d-A). The animal faecal castings were crushed to a layer with their hooves and over covered by waste grass, urine and dung. Daily addition of urine and dung led to decomposition of crushed dung and grass resulting in release of a smell. This smell repelled most of the parasitic and predatory insects like mosquitoes, wasps and hornets. Wall and floors of the houses in these hilly areas were lined with bovine dung to prevent the attacks of harmful insects. This dung smell provided a safe zone to the dwarf honey bees for nesting and bees nested in nearby dry wood bundles or covered bushes. But in recent time people have decreased labour in animal husbandry and replaced this old practice of cushioned platform for animals to a plane slanting cemented floor from where fresh dung is cleared regularly and urine gets drained and dried (Fig c-A). The bovines are fed with chopped grass without any wastage. So in the absence of accumulation of dung, urine and waste grass a thick bedding sheet is not formed and dung smell is too less to repel the predatory insects. This condition has led to increase in the number of predatory insects. These predatory insects compete for forage as well attack the bees to kill and eat them.

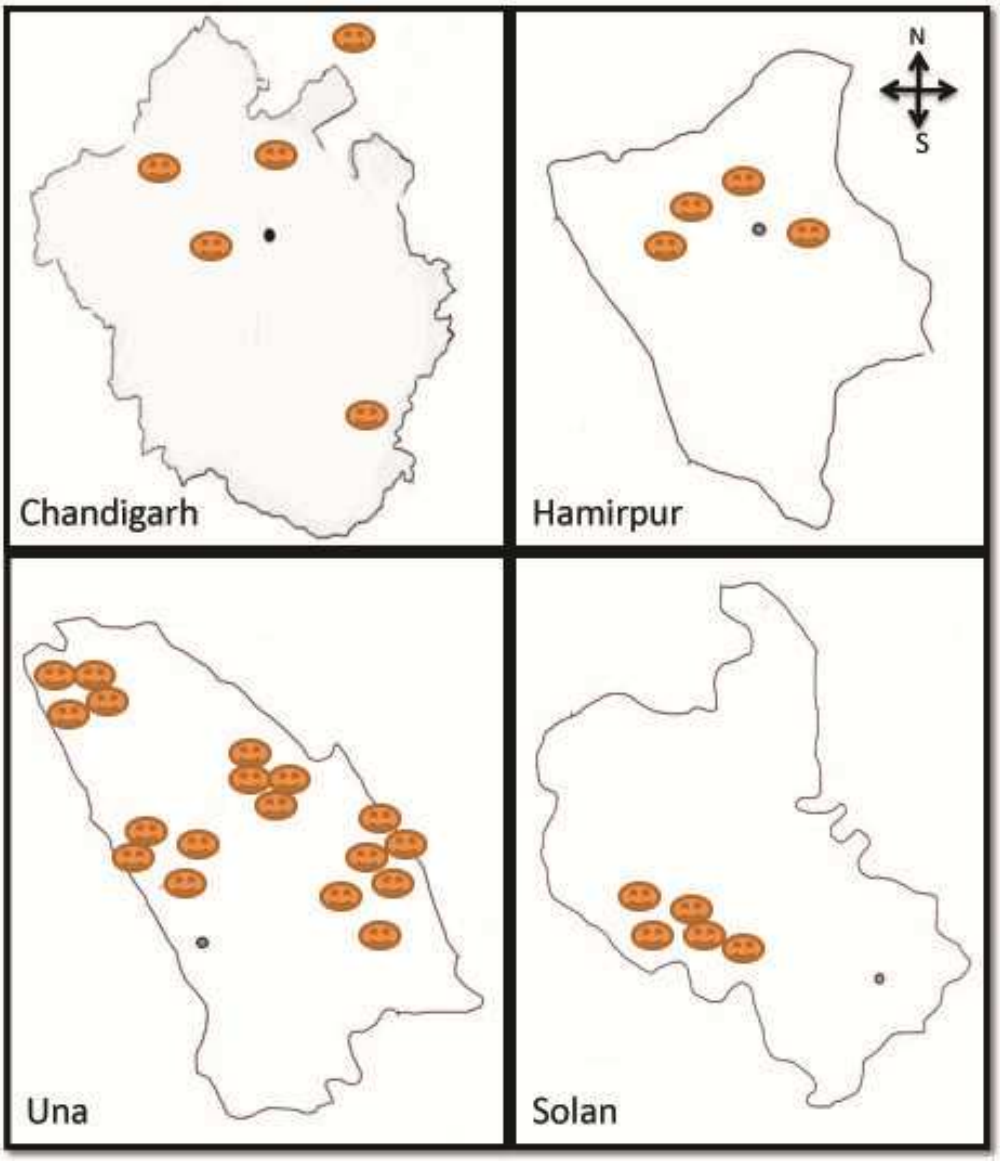

Fig. e. In the Table smile icons represents the number of localities surveyed for *Apis florea* from different regions of Chandigarh plains (Khuda Lahora, Dhanas, Syunk, Manimajra and Panjab University) and foothills regions of Himachal Pradesh Hamirpur , Una (Bangana, Chintpurni, Gagret and Daulatpur) and Solan (Parwanoo) study area.

4.2. Reduction or loss of mixed crop farming leading to less or no food choice for pollinators

People of hilly terrain used to sow mixed crops. Mixed crops pattern provided floral variety in the fields and attracted variety of insects for food and pollination (Fig d-C). Kharif crop with paddy, corn, cucurbits, legumes, sun flower etc and Ravi crop with wheat, mustard, peas, gram etc offered good floral rewards to bees. Sudden change in farming practice here has lead to mass reduction in population of dwarf honey bee and many other insect species. In Chintpurni where farmers have stopped farming (Fig c- C) in some parts due to increased stray animal prevalence and monkey menace there is drastic decline in dwarf honey bee population leading to its loss in the region. In rural areas of Chandigarh mixed crop farming is less but other forage sources are sufficiently available. Beekeepers are concerned about the reduction in colony size and strength (Frazer *et al.,* 2011) and pesticide exposure is a potential factor in this reduction. Bee attractants increases the pollination efficacy of crop plants with increased visitation of the honey bees (Anita *et al.,* 2012). Basavarajappa and Raghunandan (2013) emphasized the need of conservation of honey bee populations in its natural conditions in southern districts of Karnataka.

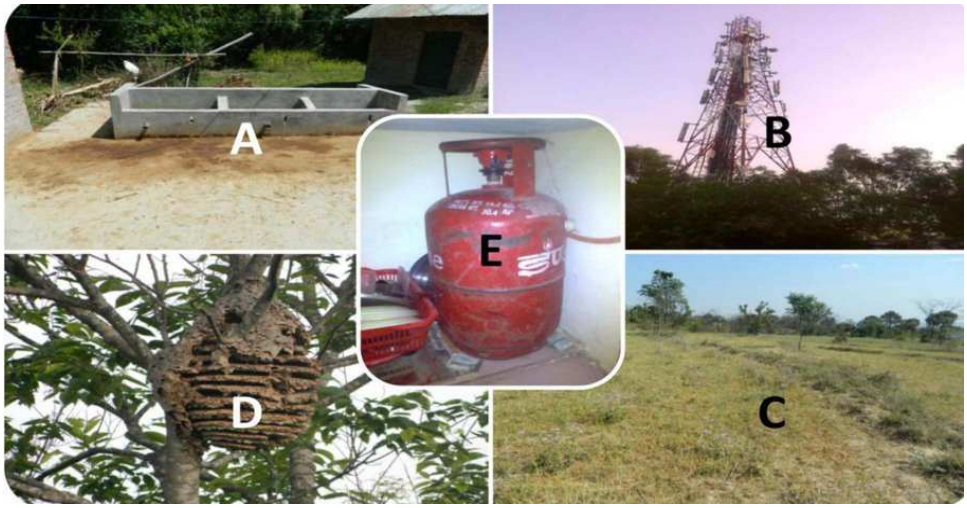

Fig. c. Unfavourable environmental factors behind the decline of dwarf honey bee species. (A) Changed animal husbandry practice (B) radiations from cell phone towers (C) reduction in agricultural practice (D) increase in number of predators (E) replacement of conventional cooking fuels.

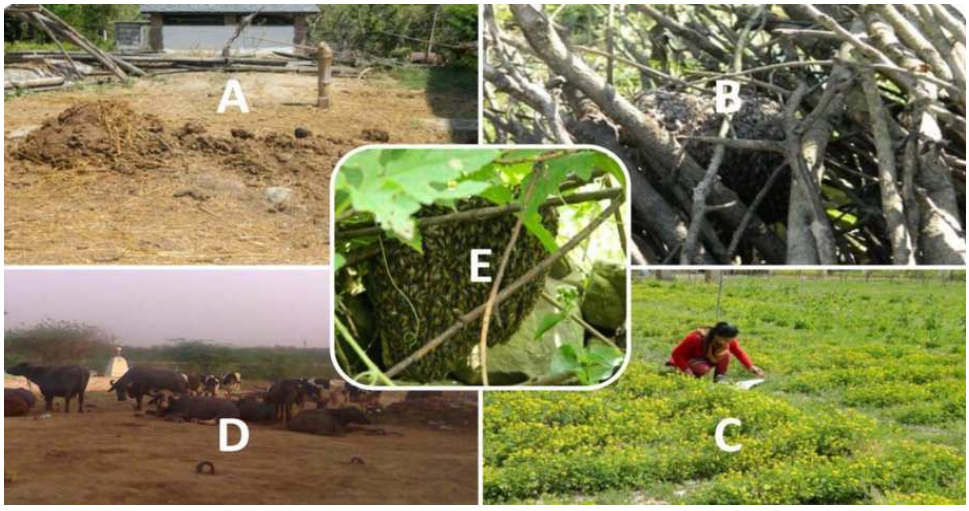

Fig. d. Favourable cultural practices supporting habitat selection of dwarf honey bees. (A) cushioned animal bedding (B) heaping of wood bundles for cooking purpose, a dwarf honey bee colony can be seen here (C) agriculture still in practice (D) bovine population in agriculture use (E) nest of *Apis florea*.

4.3. Heaps of traditional cooking fuel i.e. wood bundles in hilly terrains attracted dwarf honey bees to build nest.

Few years back villagers cooked their food on the wooden fuel collected from farms and forests. Farmers used to pile up these wood bundles nearby home. These heaps provided a suitable nesting site to dwarf honey bees (Fig d-B). Dwarf honey bees camouflaged in the wooden heaps. With the introduction of advanced cooking fuel sources like LPG village people have no interest in collecting wood and heaping it in their vicinity. This cultural change has affected nesting site of dwarf honey bees. But in areas like Chandigarh dwarf honey bee has more habitat choice and builds nest in waste wood bundles, flower bushes or on branches of small trees. Reason behind building nest in wood bundles may be that it provided more support to the hive with intertwining twigs through it. Another possibility may be for safety from predators.

4.4. Increased weed infestation replaced the choice flora of dwarf honey bees.

In recent years farmers have started giving up agricultural practices. These abandoned fields, pastures and grasslands provide a suitable place for the proliferation and growth of weeds (Fig c-C). The invasive weeds like *Parthenium hysterophorus* (White top weed), *Ageratum conyzoides* (Goat weed) and *Lantana camara* (Red sage) are adversely affecting the habitat of many native plant and animal species. They alter flora composition for survival of wildlife by reducing forage and territorial space. Regions with lowest distribution of *A. florea* were noticed to be

infested with white top weed due to construction related disturbances nearby. Previously these common grounds were meant for threshing crops and to heap wood bundles. Shady places where different types of herbs and grasses grew are now suffering from infestation of goat weed and weeds have occupied most of the space where herbal plants and bushes used to grow and so have replaced the choice flora of dwarf honey bees.

4.5. Honey bee Predators in large number

Increase in number of hornet nests is an indicator of reduction in honey bee colonies. These hornets and wasps are predatory on the honeybees as well and on other bees of the family Apidae. Defensive attempts like heat production are made by guard bees against attacking wasp predators (Tan *et al.*, 2010). Hawking of bees by the wasp, *Vespa velutina* is most frequent and highest in mid-summer (Tan *et al.*, 2007). The menace of different *Vespa* species causes greater loss to western honey bee, *A. mellifera* as compared to indigenous *A. cerana indica* (Kumar *et al.*, 1993). Hornets were the main predators of dwarf honey bees in all sites of the hilly area under study. As per the present reports there was approximately 56.07 % decline in number of dwarf honey bee colonies in Chandigarh plains and 65.21 % in foot hills of Himachal. Reports on invertebrate and vertebrate predators or parasites include 40 different species of birds (Morse and Laigo, 1969; Abrol, 2003; Nagaraja and Rajagopal, 2011).

4.0 Conclusion:

As per observations from present study *A. florea* is in struggling phase for its habitat in hilly areas due to life style, cultural and environmental changes. With the reduction in agricultural practices and animal husbandry in these areas, decline in honey bee colony density has taken place. Since it is preliminary study hence to validate data long term studies are required.

5. 0 Acknowledgements

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