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Full Length Research Paper

Studies on the impact of anthropogenic interference on wild honeybees in Mysore District, Karnataka, India

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The field investigations were carried out to record the wild honeybee populations at different agro-ecosystems of Mysore District in Karnataka during 2006 - 2008. Data revealed the distribution of *Apis dorsata*, *Apis florea* and *Trigona iridipennis*, and their colony decline at natural and man-made ecosystems. The colony density, abundance and nesting sites of these species varied significantly between different habitats. Though wild honeybees share common food plants, but their nesting niche is different. However, due to intensive man-made activities at different nesting habitats and on the foraging plants, the small honey bees namely *A. florea* and *T. iridipennis* population is declining at various agro-ecosystems. Since, the foraging range of *A. florea* and *T. iridipennis* is small; they nest at lower elevations on small to medium sized trees or shrubs compared to *A. dorsata*. As a result, *A. florea* and *T. iridipennis* becomes easily victim to man-made activities. Therefore, there is a dire need to conserve these species at different agro-ecosystems.

Key words: Wild honeybee species, human interference, colony decline, Karnataka.

INTRODUCTION

India is a tropical country bestowed with highly diversified ecosystems inhabited by a variety of bee species. The varied ecological conditions with diversified flora have provided favorable habitat for various honeybee species in India. Several honeybee species *viz*., giant honeybee (*A. dorsata* F.), Indian bee (*Apis cerana* F.), dwarf bee (*A. florea* F.), and stingless bees (*Trigona* sp. and *Melipona* sp.), were widely distributed across the plains, hills and foothills of both urban and rural areas of Karnataka (Anonymous, 2005, 2007; Basavarajappa, 1998, 2004; Reddy and Reddy, 1989). These species pollinate various plants (Bright et al., 1998), and produce hive products such as honey, wax, pollen, etc. which are useful to mankind (Shukla and Upadhyay, 2007). While *A. dorsata* and *A. florea* (Hymenoptera: Apidae : Apini) show the strong tendency of migration from place to place (Basavarajappa, 2004; Neupane, 2004; Oldroyd et al., 2000; Paar et al., 2000), *Trigona iridipennis* (Hymenoptera : Apidae : Meliponini), a perennial species, rarely undertakes migration (Basavarajappa, 2006; Inoue et al., 1984; Solomon Raju et al., 2009). During emigration and immigration, these bees stay at various human built structures (Basavarajappa, 2008; Manjunath and Basavarajappa, 2008), and in the ground, hollow tree trunks, and branches (Solomon Raju et al., 2009). They share common foraging niche in human inhabited ecosystem, agricultural lands, and scrubby vegetation. During their foraging/ nesting at various ecosystems, wild honeybees encounter severe threat by man made activities (Basavarajappa, 1998) which is not understood properly. The present investigation, therefore, was undertaken to record the wild honeybee colony decline as influenced by man-made activities.

MATERIALS AND METHODS

The Mysore district lies in between $12^{\circ}18^{1}26^{11}$N and $76^{\circ}38^{1}59^{11}$E and located at an elevation of 739 m above msl in the Southern part of Karnataka (Figure 1). The district is beset with rich floral source and known for its high degree of biological activity (Anonymous, 2007; Kamath, 2001). The survey was conducted by employing variable width line transect method (Burnham et al., 1980) at different habitats namely scrubby vegetation, rocky areas, agricultural lands, avenue trees, trees in the cultivable lands, natural ecosystem, and buildings at residential area to estimate colony density of *A. dorsata*, *A. florea*, and *T. iridipennis* during 2006 - 2008. In each sampling site, several line transects of various size (that is, 1 km length for *A. dorsata* and *A. florea*, 100 m length for *T. iridipennis*) were selected where the observer walks through a fixed path and counting the honeybee colonies seen on both sides of the path.

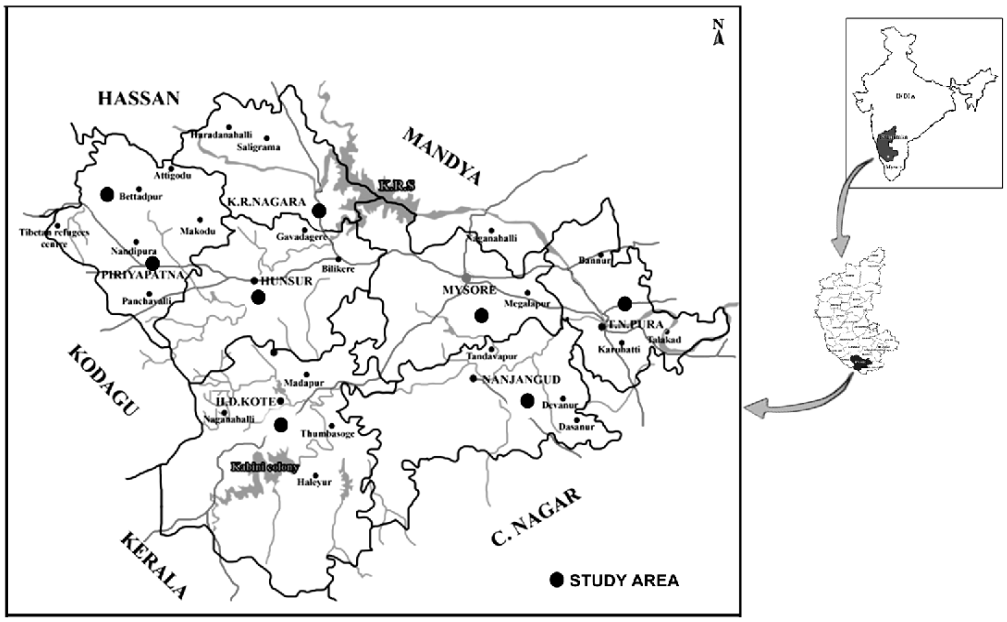

Figure 1. Map showing the study areas in Mysore district.

Where the nesting sites were not uniform and the vegetation distribution was also not similar in all the selected sampling sites, an all out search method was employed (Basavarajappa, 2008). Visits were made at quarterly intervals and altogether 72 observations were made by naked eyes as also using a binocular (10 x 50 X). *A. dorsata* colonies were recorded as per Basavarajappa (2006), Paar et al. (2000), and Reddy (2002). *A. florea* colonies were recorded after Basavarajappa (2008). *T. iridipennis* nests were observed by employing the method outlined by Solomon Raju et al. (2009) and Sheetal and Basavarajappa (2009). The recorded colonies were photographed with the help of Canon-power shot S21S, 8.0 Mega Pixels Digital Camera with 12 X optical zoom. The nesting elevation was measured by following the method of Krishnamurthy (2001). Further, the information on human interference at the vicinity of the wild honeybee colonies in nesting habitat on human built structures was collected with the help of questionnaire through personal interview of the local people. The distribution of wild honeybee colonies and their percentage was calculated by following standard methods. The percent decline in colonies was calculated by subtracting the second year (2007 - 2008) colony density in first year (2006 - 2007) colony density and multiplied by 100 (Basavarajappa, 2006; Thirumurthi et al., 1993). Moreover, the data was statistically analyzed by employing Friedman two way analysis of variance (X^2) and ANOVA ('F') ratio as per Saha (1992).

RESULTS

Occurrence of wild honeybee colonies

Altogether, 128 colonies were recorded during different months of 2006 - 2008 (Table 1), it is evident from the data that, the number of *T. iridipennis* colonies were higher (66.0) followed by *A. dorsata* (37.0), and *A. florea* (25.0). In comparison to the *A. dorsata* and *A. florea*, the abundance of *T. iridipennis* colonies was found more during most part of the year. The occurrence of the wild honeybee colonies during different months is depicted in Table 1. The data clearly indicated that, the colony density of the wild honeybees during different months differed significantly ($F = 4.31$; $P < 0.05$) from each other (Table 1). Percent occurrence of the wild honeybee colonies during different months of the years 2006 - 2008 is shown in Figure 2.

Distribution of the wild honeybee colonies at different habitats

Apis dorsata

The number of colonies were recorded at residential area (26) was far more than that observed on avenue trees (6.0) and non-residential area (5.0) (Table 2). On an average, 2.16 ± 1.64 colonies per km variable width line transect (VWLT) were recorded at residential area which included all the human built structures such as residential buildings, water tanks, hotels, water canals, etc. However, *A. dorsata* colonies were less in number in non-residential area, scrubby vegetation, agricultural lands, and forest plants located at different habitats. Hence, distribution of *A. dorsata* colonies at the three distinct habitats varied significantly ($F = 3.63$; $P < 0.05$) from each other (Table 2).

Apis florea

The abundance pattern of colony distribution recorded was as follows: non-residential area (16), avenue trees (6.0), and residential area (3.0) (Table 2). On an average,

Table 1. Wild honeybee colonies recorded during the year 2006 - 2008 in Mysore district.

S/ No.	Month	No. of wild honeybee colonies			Total
		A. dorsata	*A. florea*	*T. iridipennis*	
1.	January	1.0	-	3.0	4.0
2.	February	4.0	2.0	4.0	10.0
3.	March	5.0	2.0	8.0	15.0
4.	April	8.0	4.0	10.0	22.0
5.	May	7.0	4.0	9.0	20.0
6.	June	3.0	3.0	6.0	12.0
7.	July	2.0	3.0	7.0	12.0
8.	August	3.0	4.0	6.0	13.0
9.	September	2.0	1.0	5.0	8.0
10.	October	2.0	2.0	3.0	7.0
11.	November	-	-	3.0	3.0
12.	December	-	-	2.0	2.0
Total		37.0	25.0	66.0	128.0
Mean ± SD		3.08 ± 2.54	2.08 ± 1.56	5.50 ± 2.61	10.66 ± 6.34
'F' value			4.31*		

Note: Each value is a mean of 72 observations. P < 0.05; *Significant.

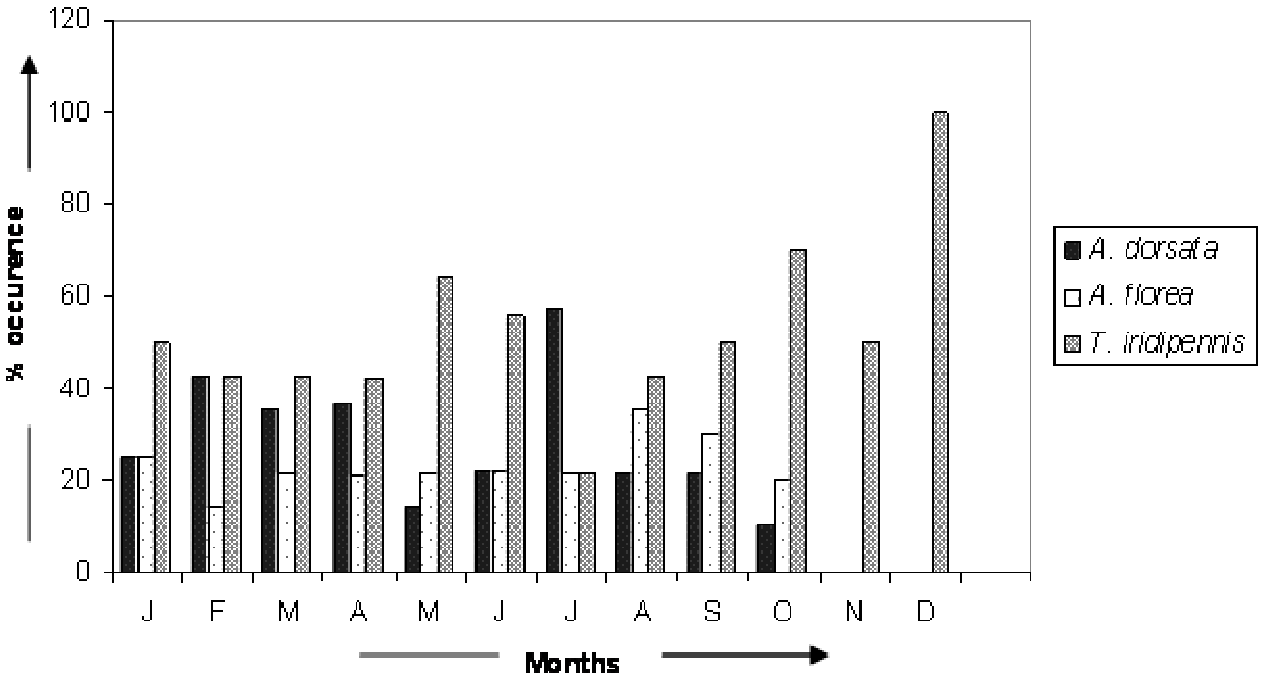

Figure 2. Occurrence of wild honeybee colonies during different months in Mysore district.

1.33 ± 1.23 colonies per km VWLT were noticed at non-residential area which included bushes, scrubby jungles, and small to medium sized trees. This clearly indicated that the *A. florea* colonies at different sites fluctuated significantly (F = 116.51; P < 0.05) from each other (Table 2).

Trigona iridipennis

Maximum number of nests (52) was documented at residential area as opposed to non-residential area (10) and avenue trees (4.0) (Table 2). On an average, 4.33 ± 0.75 colonies per 100 m VWLT were recorded at

Table 2. Distribution of wild honeybee colonies at different habitats in Mysore district.

S/No.	Month	*A. dorsata*			*A. florea*			*T. iridipennis*		
		Avenue trees	Residential area	Non-residential area	Avenue trees	Residential area	Non-residential area	Avenue trees	Residential area	Non-residential area
1.	January	-	1.0	-	-	-	-	-	3.0	-
2.	February	-	3.0	1.0	-	-	2.0	-	3.0	1.0
3.	March	1.0	4.0	-	-	-	2.0	1.0	6.0	1.0
4.	April	1.0	5.0	2.0	1.0	-	3.0	2.0	5.0	3.0
5.	May	2.0	4.0	1.0	1.0	1.0	2.0	1.0	7.0	1.0
6.	June	-	3.0	-	1.0	-	2.0	-	6.0	-
7.	July	-	2.0	-	1.0	-	2.0	-	5.0	2.0
8.	August	-	2.0	1.0	1.0	-	3.0	-	4.0	2.0
9.	September	1.0	1.0	-	-	1.0	-	-	5.0	-
10.	October	1.0	1.0	-	1.0	1.0	-	-	3.0	-
11.	November	-	-	-	-	-	-	-	3.3	-
12.	December	-	-	-	-	-	-	-	2.0	-
Total		6.0	26.0	5.0	6.0	3.0	16.0	4.0	52	10.0
Mean ± SD		0.50 ± 0.67	2.16 ± 1.64	0.41 ± 0.66	0.50 ± 0.67	0.25 ± 0.45	1.33 ± 1.23	0.33 ± 0.65	4.33 ± 0.75	0.83 ± 1.03
'F' value			3.63*			116.51*			14.25*	

Note: Each value is a mean of 72 observations.
$P < 0.05$; *Significant.

residential area comprising residential buildings, and office buildings at human inhabited ecosystem. However, the number of *T. iridipennis* nests were small (0.83 ± 1.03 and 0.33 ± 0.65) at non-residential area as well as on avenue trees. As such, there was a significant variation ($F = 14.25$; $P < 0.05$) among the different habitats with respect to the distribution of *T. iridipennis* colonies (Table 2).

Nesting elevation

The results on nesting elevation of wild honeybees are furnished in Table 3. *A. dorsata* was found to select higher elevation ranging from 20 to 70 ft with a mean value of 45 ft to nest on human built structures and on trees. As against, *A. florea* chosen to nest at lower elevation (2 to 35 ft) with a mean height of 18.5 ft in bushes, scrubby vegetation and on small to medium sized trees. However, *T. iridipennis* nested on the ground and also at a height of 25 ft in hollow tree trunks and branches, rock crevices, and building wall cavities. The places selected by wild honeybees for their nesting was differed significantly ($X^2 = 21.5$; $P < 0.05$) from each other (Table 3). Selection of a suitable nesting niche is reported to be a species specific strategy (Neupane, 2004; Oldroyd et al., 2000; Paar et al., 2000;) and the same nesting behaviour has been observed in the wild honeybees in question.

Percent decline of wild honeybee colonies

The results on the decline of the wild honeybee colonies during 2006 - 2007 and 2007 - 2008 are shown in Figures 3 and 4. The data indicated that, greatest decline in colonies was recorded during July followed by October with respect to *A. dorsata* colonies during 2006 - 2007 (Figure 3). In

Table 3. Nesting elevation of wild honeybee colonies recorded in Mysore district (n = 72).

S/ No.	Bee species	Nesting elevation (ft)		
		Min.	Max.	Mean
1.	*A. dorsata*	20.0	70.0	45.0
2.	*A. florea*	2.0	35.0	18.5
3.	*T. iridipennis*	0.5	25.0	12.75
$X^2 = 21.5$*				

Note: P < 0.05; *Significant.

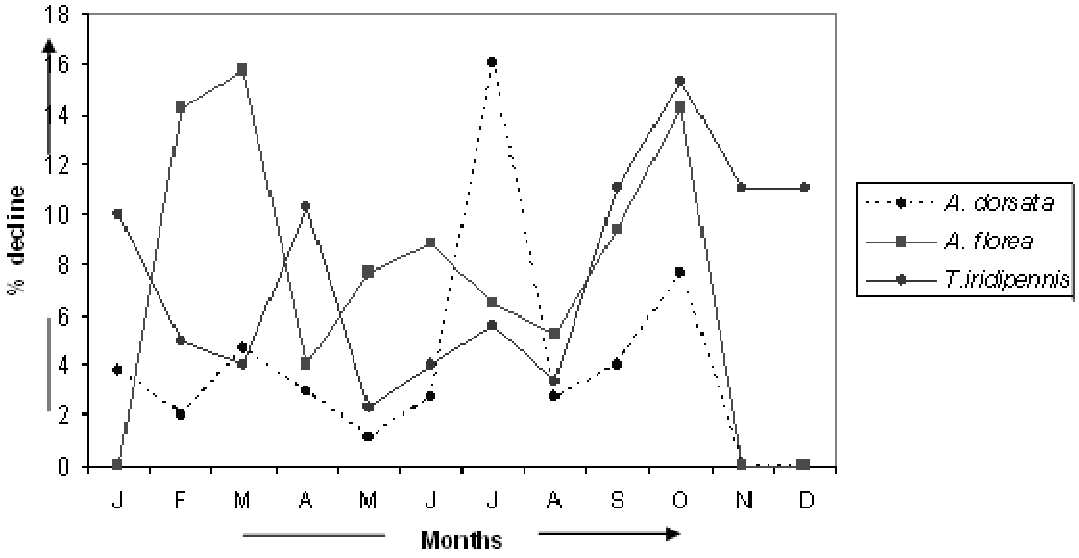

Figure 3. Month-wise decline of wild honeybee colonies in Mysore District during 2006 - 2007.

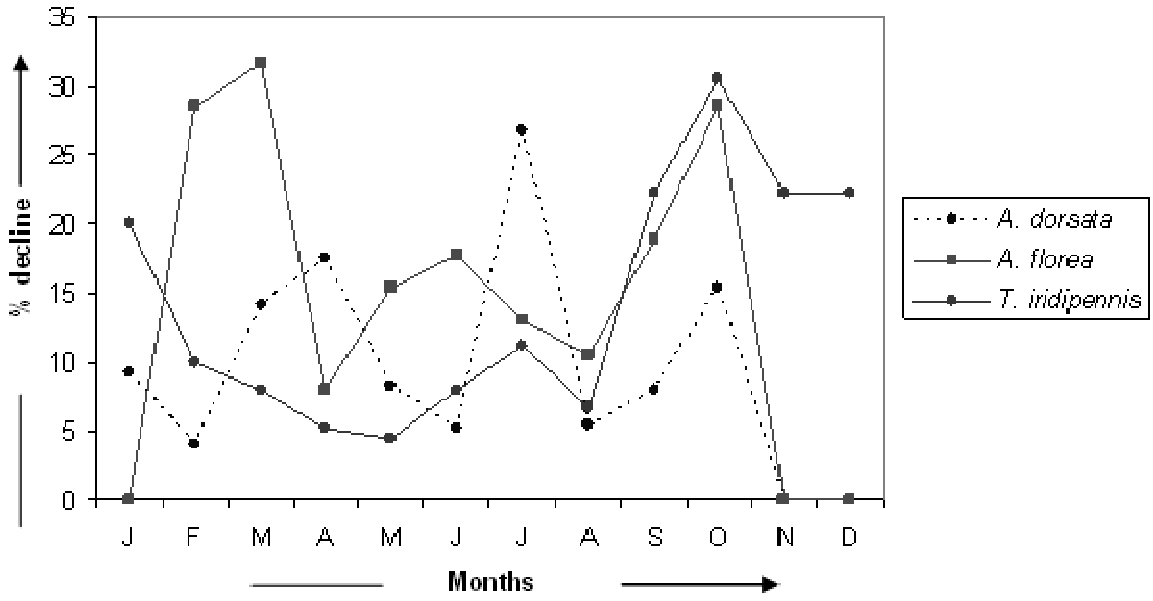

Figure 4. Month-wise decline of wild honeybee colonies in Mysore District during 2007 - 2008.

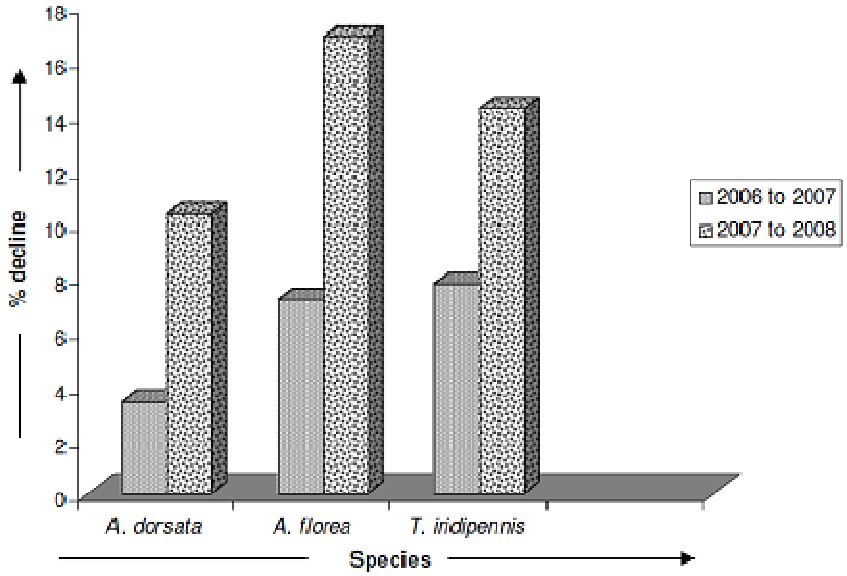

Figure 5. Decline of wild honeybee colonies in Mysore District.

addition to April, similar trend was observed during 2007 - 2008 also (Figure 4). However, decline *A. florea* colonies was more in February, March, May, June, September and October during 2006 - 2007 (Figure 3). Similar trend was recorded during 2007 - 2008 also (Figure 4). As opposed, *T. iridipennis* colonies declined more in January, April, July, September, October, November and December during 2006 - 2007 (Figure 3). The trend was similar even during 2007 - 2008 also (Figure 4). Thus, there was a considerable fluctuation in the abundance of wild honeybee colonies during both 2006 - 2007 and 2007 - 2008.

The total per cent decline in wild honeybee population is shown in Figure 5. Initially, the decline in *A. dorsata* colonies was 4% only during 2006 - 2007 and it was in excess of 10% during 2007 - 2008. However, *A. florea* colonies showed 7% reduction during 2006 - 2007 and it was 16% during 2007 - 2008. Similarly, *T. iridipennis* had a decline of 8% of its nests during 2006 - 2007 and it was rose to 15% during 2007 - 2008 (Figure 5). Thus, there was a consistent decline in the colonies of wild honeybees in general and *A. florea* and *T. iridipennis* in excess of 7% compared to *A. dorsata* in particular (Figure 5).

DISCUSSION

The colonies of *A. dorsata* did not exist during November - December as also *A. florea* (Tables 1 and 2; Figure 2). In Mysore district, November, December and January months correspond to winter season of the year (Kamath, 2001), which is characterized by dry cold conditions with sparse floral resource (Manjunath and Basavarajappa, 2008). While giant honeybee, *A. dorsata*, requiring more food, maintains a foraging range of about 800 m to support its large colony, the dwarf honeybee, *A. florea*, needing considerably small quantity of food, forages up to 500 m (Anonymous, 2005). If the flora is not adequate within the radius of 500 to 800 m, these honeybees will migrate to other places in search of food as they have great demand for energy to maintain warm conditions inside the comb. Dyer and Seeley (1994) have reported that honeybees resort to migrations whenever they face hostile conditions such as inclement weather conditions and scanty flora during winter months. Perhaps this could be the reason for their absence during winter months namely November and December. Interestingly, the *T. iridipennis* nests were found during all the months (Tables 1 and 2; Figure 2). It lives in perennial colonies without absconding easily during seasonal variations (Inoue et al., 1984; Roubik, 1979) and hence migrates rarely. Previously, Sheetal and Basavarajappa (2009) have observed that *T. iridipennis* could maintain nests even during winter months (Tables 1 and 2), despite the prevalence of dry cold conditions accompanied by sparse flora. *T. iridipennis* is a small bee, lives in small nests and has with less than 1000 individuals (Sheetal, 2009; Sheetal and Basavarajappa, 2009) and has thermo-regulatory mechanism(s) in the nest to maintain brood temperature (Sung et al., 2008). The bee depends much on the locally available flora and may not require more pollen and nectar to fulfill its small sized colony requirement even during the floral dearth in winter season. This could be one of the reasons for the occurrence of *T. iridipennis* during all the months (Tables 1 and 2; Figure 2). Hence, *T. iridipennis* colony density depended on the prevalence of suitable weather conditions in association with the availability of flora at their preferred nesting sites.

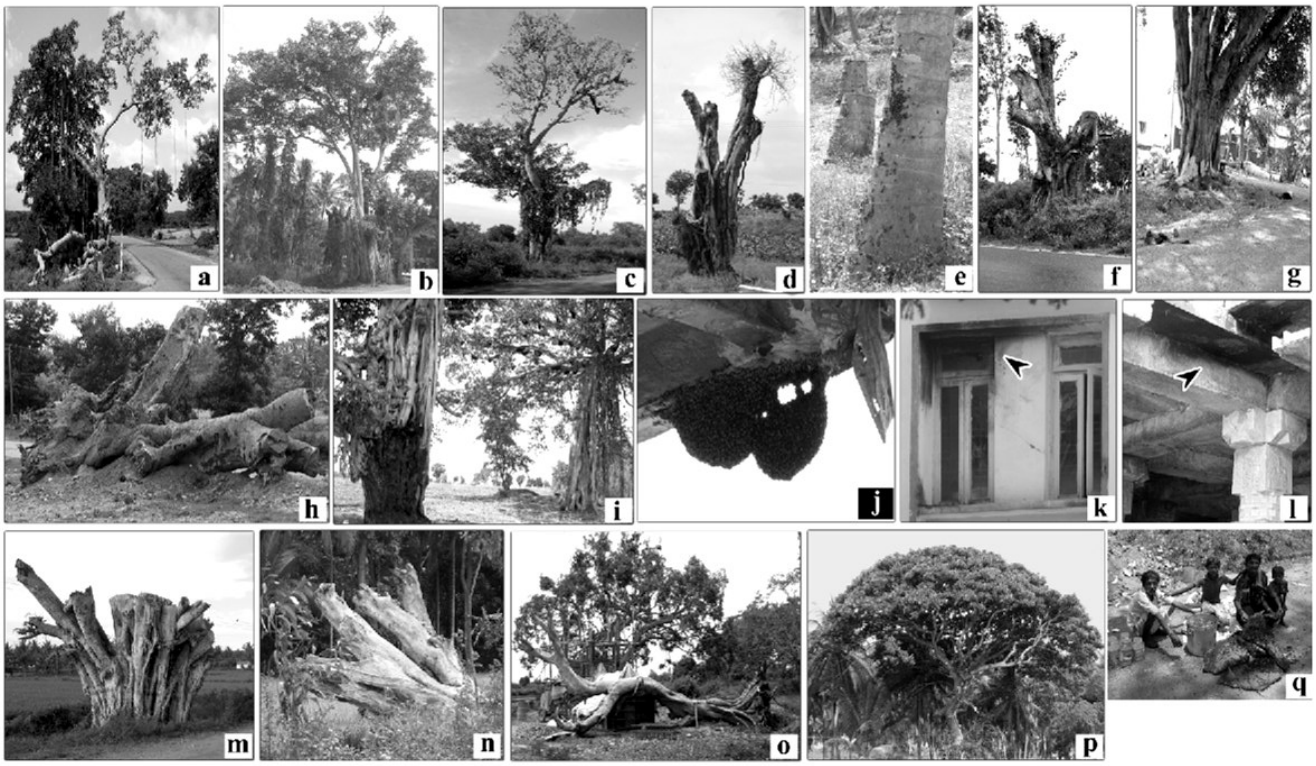

Figure 6. Man-made activities on various nesting sites of wild honeybees in Mysore District. a: Branches removed on *Ficus benghalensis* located on road side. b:Major limbs of *F. benghalensis* removed. c: Colonies of Apis *dorsata* on a few left out branches of *F. benghalensis*. D: Tree without canopy in the cultivable land. e: Coconut tree *(Cocus nucifera)* cut for expansion of cropping area. f: Tree without canopy on road side. g: Tamarind tree (*Tamarindus indica)* is in the process of being removed. h: Uprooted giant tree previously used by *A. dorsata* for colony establishment. I: Half burnt *F. benghalensis* tree in cultivable land. j: Colonies of *A. dorsata* teared apart on the eave of human built structures. k: Wild bee colonies burnt off on the eave of building. l: Crude oil applied on the nesting sites of wild honeybees. m: Tree trunk without canopy - once supported huge colonies of wild honeybees. n: Uprooted tree in agriculture land. o: Giant tree uprooted near by a village. p: Rain tree (*Samanea saman*) peripheral branches trimmed. q: Conventional honey hunting practiced by tribals.

Reasons for wild honeybee colonies decline:

Besides uprooting of trees on either side of avenues (Figures 6a, b, c, f, g and m) and at cultivable lands (Figures 6d, e, h, i and n), several man-made activities at nesting sites (Figures 6j, k, l, o, p and q) have contributed the depletion of wild honeybee colonies considerably. While *A. dorsata* prefers tall trees and human built structures (Basavarajappa, 1998, 2004; Reddy and Reddy, 1989; Manjunath and Basavarajappa, 2008; Basavarajappa et al., 2009), *A. florea* chose small to medium sized trees and bushy vegetation. However, *T. iridipennis* builds nests in the hollow tree trunks of trees, wooden logs, and wall crevices (Solomon Raju et al., 2009). Accordingly, the nesting elevation of these honeybees varied considerably (Table 4). The nesting sites (small to medium sized trees, scrubby vegetation, peripheral limbs/ branches of trees, bushy shrubs, and dead tree trunk as shown in Figure 6) of *A. florea* and *T. iridipennis* are more often destroyed by local people, landless farmers and shepherd and livestock care takers (Basavarajappa, 1998; Basavarajappa et al., 2009). Moreover, *A. florea* is weak in its defense and *T. iridipennis* does not defend due to its vestigial sting. It, therefore, becomes obvious that these bees suffer more destruction due to human activities compared to *A. dorsata* which is strong in its defense and selective nesting habit.

In some places, the nesting trees of *A. dorsata* are distributed sporadically (Figures 6d, i and n) in agri-horticultural ecosystems (Basavarajappa et al., 2009). Farmers uproot such trees to expand their cultivable lands (Figure 6). The harvesting of coconuts, periodic clearing of fronds and removal of withered leaves (Basavarajappa, 1998); trimming of limbs/ branches (Figure 6p) by shepard, tribes, and rural poor would further aggravate the problem in several ecosystems (Basavarajappa, 1998; Setty and Murali, 1998). Further, on most occasions, due to conventional practice of honey hunting *A. dorsata* colonies (Figure 6q) get declined rapidly (Basavarajappa, 1998; Manjunath, 2008). The honey hunters, hobbyists and farmers use fire torches to drive away the colony members or to burn off combs (Figures 6k and i) while harvesting the honey (Anonymous,

2005; Basavarajappa, 1998, 2004). Obviously, this causes severe destruction to giant and dwarf honeybee colonies. In addition, change of cropping pattern and application of pesticides in the cropping area (Jagadish et al., 2002) could have cumulative effect on bee colonies. Understandably, all these man-made activities at nesting sites in different ecosystem perhaps might have caused the dwindling of wild honeybee colonies. In view of all the aforementioned reasons, it is obvious that, there is a dire need to create awareness about the conservation of these bees as they are realized to play a pivotal role in the welfare of man as they contribute adequately to the pollination of various plants in the cultivated land as well as in the wild species.

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