Diversity of *Apis* and non-*Apis* pollinators in University of Agricultural Sciences, Dharwad campus

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**Abstract**

The data on bee fauna included 34 bee species of *Apis* and non-*Apis*. Among them 14 species belongs to the family Apidae, 7 species halictidae, 7 species Megachilidae, 3 species Scoliidae and 3 species Vespidae. Among the different families recorded, Apidae constituted at higher per cent of 80.20 per cent followed by Halictidae 16.29 per cent, Scoliidae 1.6 per cent, Megachilidae 1.52 per cent and Vespidae 0.29 per cent. The highest Simpson index, Shannon-Wiener index and Margalef’s diversity index was observed during October month with 0.816, 2.023 and 2.815 respectively due to the availability of rich source of bee flora and favourable environmental conditions to the bees. Similarly highest evenness of 1 was observed during July month.

**Keywords:** *Apis*, Non-*Apis*, species, diversity

**Introduction**

Biodiversity is the foundation for all the services of natural ecosystem in which human beings and other organisms are living. Insect biodiversity contributes to large proportion among of all other biodiversity and are significant due to their role in ecology, agriculture, natural resources and human health. Among the insect pollinators, Lepidoptera is the most diversified group with more than 1,40,000 species followed by Coleoptera, Hymenoptera and Diptera (Ollerton et al., 2017) [6]. Pollinators contribute a lot to agriculture for better seed set and realising higher yield as compared to any other agricultural management. Crops like cherries, blueberries depend on honey bee for their pollination up to 90 per cent. Globally, pollinators support the 87 major crops in enhancing their production. Pollination independent crops are five times less important than those of the crops that require pollination (Belavadi and Ganeshaiah, 2013) [2]. Richness of plant species has positive effect on richness of solitary bees, bumble bees and other pollinators (Ebeling et al., 2008) [3]. Higher plant diversity is an indication of increased bee diversity (Schleuning et al., 2011) [8].

Pollination is necessary to increase better seed set and to maintain crop diversity. A total of 35 per cent of the world food production is contributed from the pollinator dependent crops. One out of every 3 bites of food we eat depends on pollinator service. Complete pollinator decline would lead to current consumption deficit of 6 per cent in vegetables and 12 per cent in fruits (Gallai et al., 2009) [4]. No pollinators no food. Pollinators utilization especially honeybees are considered as one of the eco-friendly and cheapest way in increasing the yield. The bee pollinators are considered as a major contributor for doubling the farmers income initiated by central government. In this context, the scientists and policy makers given the importance to the bee pollination in Agriculture. The research in this aspect would help in correlating abiotic and biotic factors which will be useful to plan a strategy in pollinator conservation. By considering these facts, investigations are planned to assess the diversity of *Apis* and non-*Apis* pollinators in University of Agricultural Sciences Dharwad, Campus.

**Materials and methods**

Bee fauna visiting the flowers were recorded by visually and sweep net collections. Survey was carried out during bright sunshine hours from 7 am to 12 noon according to the weather conditions at fortnight interval.
Visual scanning
Observations were recorded on the bee species of insects visiting the flowers to record the variation in species composition and their abundance. Observations were repeated on different days during flowering season.

Sweep net collection of flower visitors
After complete record of flower details and the pollinator visitation, the pollinators were collected for further identification and processed the specimens for identification with insect taxonomist. After collection using sweep net, the specimens were transferred to a poison tube and killed for identification purpose.

Killing, pinning and processing of specimens
Killing jar containing chloroform was used and the bottle was recharged as per the requirement during the survey period. After the collection and killing, the bees were pinned (insect pins no. 3) through the thorax and all the body parts such as legs, antennae, wings were stretched properly which are taxonomically important for quick and easy identification. The bees were dried properly, to remove the moisture that may obscure body hairs and other identification features, that are of taxonomically important. This process caused the hairs of the bees to stiffen and erect aiding for easier identification. Each specimens were labelled by providing the site, date and collector information. All specimens were kept in special insect boxes supplied with foam plates for pinning and paradichlorobenzene (PDB) to enable long storage to get rid off pest damage. All specimens were deposited in the department of Entomology, UAS, Dharwad for future reference. The collected specimens were identified by the taxonomist Dr. Yeshwanth, Department of Entomology, UAS, GKVK, Bengaluru.

Diversity of bee
The collected bee fauna was used to measure their richness and evenness which were computed month wise with the following formulas (Magurran, 1988) [3].

Diversity indices

a. Shannon-Wiener diversity
The Shannon diversity index is calculated by using the following equation:

\[ H' = -\sum p_i \ln p_i \]  Eq.1

where \( p_i \) is the proportion of individuals of the \( i \)th species found and

b. Simpson Index

\[ H' = 1 - \sum p_i^2 \]  Eq.2

c. Species richness models
Margalef’s diversity index

\[ D_{mg} = \frac{(S-1)}{\ln N} \]

Where, \( S \) is the number of species recorded and \( N \) is total number of individuals combined of all \( S \) species

d. Evenness
Relative abundance of each species in a particular habitat was calculated using the following formula

\[ E = \frac{H'}{\ln S} \]

Where \( H' \) the diversity index calculated from equation 1or/and 2, and ‘\( S \)’ is the total number of species present.

Results
Apis and non-Apis pollinators in UAS, Dharwad Campus
The study aimed of investigating the diversity of Apis and non-Apis bees in UAS, Dharwad, Campus. During the study, totally 34 species were identified by the taxonomist belong to different families, genera of Hymenoptera. It was recorded that 14 identified specimens belongs to the family Apidae, 7 species to the family Halictidae, 3 to the Scolidae, 7 to the Megachillidae and 3 to the Vespidae. It was not astonished to find the most dominant bee family Apidae, followed by Megachillidae and Halictidae, Scolidae and Vespidae. Among the non-Apis bees, Ceratina simillima, Ceratina lieftincki, Ceratina hieroglyphica, Ceratina binghami, Thyreus sp., Xylocopa nasalis, Xylocopa latipes, Xylocopa amethystina and Amegilla sp. belonging to the genus Apis were recorded (Table 1).

Per cent contribution of bee families
The per cent contribution of bee families present in Table 2. Among the different families recorded, Apidae constituted at higher per cent of 80.20 per cent followed by Halictidae 16.29 per cent, Scolidae 1.6 per cent, Megachillidae 1.52 per cent and Vespidae 0.29 per cent.

Diversity indices of bees observed during survey at UAS, Dharwad campus from July 2019-2020
The dominance of species was observed by, Simpson index which recorded highest value during the October month of 0.816 followed by November month (0.778) and lowest during August month (0.701). The Shannon diversity index (2.023) and Margalef’s index (2.815) registered highest values during fourth month of my research work (October) and least during January (1.514) and December (1.206). Evenness highest value 0.875 observed during July month followed by December and least during March month of 0.646 (Table 3).

### Table 1: *Apis* and non-*Apis* pollinators recorded at UAS, Dharwad, July 2019 to March 2020

| Sl. No. | Common name            | Scientific name            | Family       |
|--------|------------------------|----------------------------|--------------|
| 1      | Rock bee               | *Apis dorsata*             | Apidae       |
| 2      | Indian bee             | *Apis cerana indica*       | Apidae       |
| 3      | Little bee             | *Apis florea*              | Apidae       |
| 4      | Stingless bee          | *Melipona iridipennis*     | Apidae       |
| 5      | Small carpenter bee    | *Ceratina simillima*       | Apidae       |
| 6      | Small carpenter bee    | *Ceratina lieftincki*      | Apidae       |
| 7      | Small carpenter bee    | *Ceratina hieroglyphica*   | Apidae       |
| 8      | Small carpenter bee    | *Ceratina binghami*        | Apidae       |
Table 2: Per cent contribution of bee families

| Bee family | Per cent contribution |
|------------|-----------------------|
| Apidae     | 80.20                 |
| Halictidae | 16.29                 |
| Scolidae   | 1.6                   |
| Megachilidae | 1.52              |
| Vespidae   | 0.29                  |
| Total      | 100                   |

Table 3: Diversity indices of Bees observed during survey at UAS, Dharwad campus, July 2019 to March 2020

| Months | Simpson index | Shannon diversity index | Margalef's diversity index | Evenness |
|--------|---------------|-------------------------|---------------------------|----------|
| July   | 0.762         | 1.569                   | 1.189                     | 0.875    |
| August | 0.701         | 1.543                   | 1.731                     | 0.793    |
| September | 0.766     | 1.87                    | 2.808                     | 0.674    |
| October | 0.816        | 2.023                   | 2.815                     | 0.729    |
| November | 0.778      | 1.733                   | 1.726                     | 0.788    |
| December | 0.787       | 1.686                   | 1.206                     | 0.857    |
| January | 0.704        | 1.514                   | 1.429                     | 0.727    |
| February | 0.707       | 1.561                   | 1.938                     | 0.678    |
| March   | 0.739        | 1.75                    | 2.509                     | 0.646    |
| Total   | 0.816        | 2.053                   | 4.34                      | 0.592    |

Discussion
During the study period, totally 34 bee species were identified with the help of the taxonomist. The identified bees were belongs to different families, genera of Hymenoptera. It was recorded that 14 species belongs to the family Apidae, 7 species to the family halictidae, 3 species to the Scolidae, 7 species to the Megachilidae and 3 species to the Vespidae. It was not astonished to find the most dominant bee family as Apidae, followed by Megachilidae and Halictidae, Scolidae and Vespidae. These findings were supported by Arati (2010), who grouped collected bees into three families, 20 genera, 65 species. The recorded families included Apidae, Megachilidae, Halictidae under the Apoidea super family. It was recorded that 16 species belong to the Megachilidae family in 5 genera, 22 species to the Halictidae in 8 genera and 27 species to the Apidae in 7 genera. Yogeshkumar (2012) [10] also reported the diversity of pollinators with 49 species of insect pollinators in and around Pantnagar. Satyanarayana and Seetharam (1982) [7] also reported the diversity of pollinators in sunflower capitulum and observed Honey bees (Apis dorsata, Apis cerana indica, Apis florea) contributed 85 per cent of the total flower visitors.
Including all the floral groups of field crops, horticultural crops, ornamental flowers, trees and weeds, the dominance of species i.e., Simpson index (0.816) recorded highest value during the October month, Shannon diversity index and Margalef’s index registered with 2.023 and 2.815 respectively, also during the October month, Evenness highest value of 0.875 observed during July month. The findings corroborate with the results of Arati (2010) [1] in medicinal and Aromatic plant which reported the highest value of Simpson index, Shannon index, Margalef’s diversity index during the November month and evenness during the November and June months. Similarly Siregar et al. (2016) [9] reported highest Shannon diversity index and evenness in rubber plantation of 2.28 and 0.73 followed by palm oil plantation of 2.25, 0.66 and least in jungle-rubber forest of 0.88, 2.28.

Conclusion
Totally 34 specimens were identified by the taxonomist which included both Apis and non-Apis bees in UAS, Dharwad, Campus belonging to different families of hymenoptera. It was recorded that 14 species belongs to the family Apidae, 7 species to the family Halictidae, 3 species to the Scolidae, 7 species to the Megachilidae and 3 species to the Vespidae. 80.20 per cent contribution from the family Apidae. Dominance of a species, richness of a species and Shannon diversity index found highest during October month and evenness found maximum during July month.

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