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Floral Diversity for Foraging of the Asiatic Honey Bee, *Apis cerana indica* (Hymenoptera: Apidae) in Madurai District of Tamil Nadu, India

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A B S T R A C T

The Asiatic honey bee, *Apis cerana indica* harvests pollen and nectar from the flowers and helps in pollination process. Bee pasturage in the location is essential for better management of the hives and improving the yield. Floral diversity in the Madurai region was studied which revealed that the flora was belonging to 76 families. Among them family Fabaceae contributed a maximum of 31 species (12.25%) followed by Asteraceae 6.72% with 17 flora, Caesalpiniaceae (5.53%) and Cucurbitaceae (4.74%). The grouping of bee pasturage revealed that 41 were nectar yielders, 30 were pollen yielders and 182 of both nectar and pollen yielders.

Introduction

Honey bees harvest pollen and nectar from the flowers and help in pollination process (Dalio, 2015 and Kumar and Sharma 2016). One third of the crops rely exclusively on insect pollination only. It is estimated that one third of human food supply depends on insect pollination (Jivan, 2013; Said *et al.*, 2015). Indian bee, *Apis cerana indica* Fabricius is an economically important, domesticated honey bee species in southern part of India (I'anson Price and Gruter, 2015). It has been distributed in China, Japan, India, Bangladesh, Nepal, Papua New Guinea and Malaysia (Egelie *et al.*, 2015; Theisen-Jones and Bienefeld, 2016). Pollen and nectar from

plants are the prime food for bees. Bee bread, which is the mixture of pollen and honey is given to young ones with royal jelly. Bee pasturage in the location is essential for better management of the hive and improving the yield (Sodre *et al.,* 2007). With this concept investigations were carried out to identify the floral diversity in the southern part of Tamil Nadu.

Materials and Methods

The study area was the Agricultural College and Research Institute, Madurai of Tamil Nadu, India, which was located at the latitude of 9°55'25.79" N, longitude of 78°05'27.00" E and altitude of 331 feet mean sea level. The study area was surrounded by agricultural, horticultural crops and natural vegetation of foot hills of Yanaimalai rock. Indian honey bee, *A. cerana indica* colonies in 25 Newton hives were maintained in the above said location. All the colonies were with eight frames (13 x 21 cm) in brood chamber and eight frames in (6.5 x 21 cm) super chamber having approximate of 10000 -12000 bees. The study was conducted during 2016 to 2017.

Foraging flora was studied regularly once in a week during the entire study period. Observations were taken from 6.00 to 18.00 hr by recording different flowering plant species on which the bee performs foraging. Bee foraging plants were confirmed by the visit of bees and successful foraging of at least three bees within 10 minutes period of observation as described by Bhalchandra *et al.*, 2014.

The identified flora was further grouped into nectar, pollen and both nectar and pollen supplying plants. Nectar source was determined by extension of proboscis by the bee into the flower for nectar collection and pollen source was determined by the presence of pollen in the hind legs of bees. The plants were identified by the help of published reports, experts and online services.

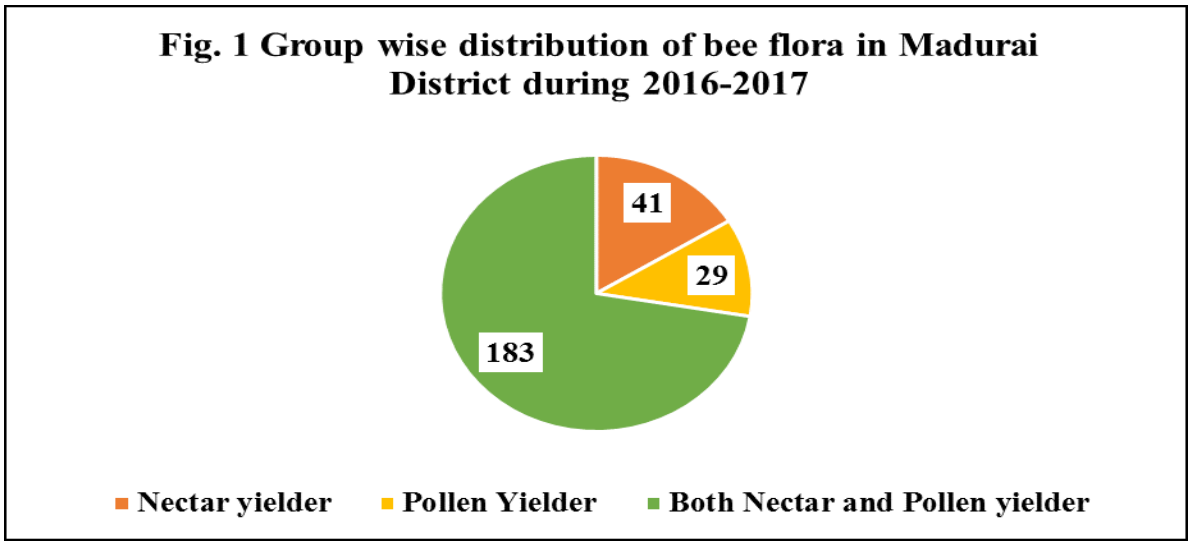
Results and Discussion

The identified plants of bee forage of 76 families were, Acanthaceae, Agavacea, Aizoaceae, Alliaceae, Amaranthaceae, Anacardiaceae, Annonaceae, Apiaceae, Apocynaceae, Aracaceae, Asclepidaceae, Asteraceae, Balsaminaceae, Bignoniaceae, Bombacaceae, Boraginaceae, Brassicaceae, Caesalpiniaceae, Cannaceae, Caricaceae, Chenopodiaceae, Cleomaceae, Clusiaceae, Combretaceae, Commelinaceae, Compositae, Convolvulaceae, Cucurbitaceae, Cyperaceae, Dioscoreaceae, Elaeocarpaceae, Euphorbiaceae, Fabaceae, Lamiaceae, Lecythidaceae, Leguminosae, Liliaceae, Lythraceae, Malvaceae, Martyniaceae, Meliaceae, Mimosaceae, Moraceae, Moringaceae, Musaceae, Myrtaceae, Nelumbonaceae, Nyctaginaceae, Oleaceae, Nymphaeaceae, Oxalidaceae, Papavarace, Pedaliaceae, Piperaceae, Poaceae, Polygonaceae, Portulacaceae, Punicaceae, Rhamnaceae, Rosaceae, Rubiaceae, Rutaceae, Sampigae, Santalaceae, Sapindaceae, Sapotaceae, Scorphulariaceae, Simaroubaceae, Solanaceae, Tiliaceae, Typhaceae, Ulmaceae, Urticaceae, Verbenaceae, Zingiberaceae and Zygophyllaceae (Table 1).

Among these 76 families Fabaceae contributes a maximum of 31 species (12.25%). Asteraceae (6.72%) contributing 17 species of bee foraging flora followed by Caesalpiniaceae (5.53%), Cucurbitaceae (4.74%) and 4.35% compositely contributed by Amaranthaceae, Euphorbiaceae and Lamiaceae (Table 1). The bee flora accounted in our study location was 253. Majority of them were Fabaceae, Asteraceae, Caesalpiniaceae, Cucurbitaceae, Euphorbiaceae, Amaranthaceae, Lamiaceae, Mimosaceae and Acanthaceae.

Table.1 Family wise distribution of bee flora in Madurai district during 2016 – 2017

S. No.	Family	No. of species	Percent contribution (%)	S. No.	Family	No. of species	Percent contribution (%)
1	Fabaceae	31	12.25	39	Boraginaceae	1	0.40
2	Asteraceae	17	6.72	40	Cannaceae	1	0.40
3	Caesalpiniaceae	14	5.53	41	Caricaceae	1	0.40
4	Cucurbitaceae	12	4.74	42	Chenopodiaceae	1	0.40
5	Amaranthaceae	11	4.35	43	Cleomaceae	1	0.40
6	Euphorbiaceae	11	4.35	44	Clusiaceae	1	0.40
7	Lamiaceae	11	4.35	45	Combretaceae	1	0.40
8	Mimosaceae	10	3.95	46	Cyperaceae	1	0.40
9	Acanthaceae	9	3.56	47	Dioscoreaceae	1	0.40
10	Malvaceae	8	3.16	48	*Elaeocarpaceae*	1	0.40
11	Aracaceae	6	2.37	49	Lecythidaceae	1	0.40
12	Convolvulaceae	6	2.37	50	Liliaceae	1	0.40
13	Poaceae	6	2.37	51	Lythraceae	1	0.40
14	Rubiaceae	6	2.37	52	Martyniaceae	1	0.40
15	Solanaceae	6	2.37	53	Moraceae	1	0.40
16	Myrtaceae	5	1.98	54	Moringaceae	1	0.40
17	Rutaceae	4	1.58	55	Musaceae	1	0.40
18	Verbenaceae	4	1.58	56	*nelumbonaceae*	1	0.40
19	Apiaceae	3	1.19	57	Nyctaginaceae	1	0.40
20	Bignoniaceae	3	1.19	58	*Nymphaeaceae*	1	0.40
21	*Commelinaceae*	3	1.19	59	Oleaceae	1	0.40
22	Sapotaceae	3	1.19	60	Oxalidaceae	1	0.40
23	Anacardiaceae	2	0.79	61	Papavarace	1	0.40
24	*Annonaceae*	2	0.79	62	Pedaliaceae	1	0.40
25	Apocynaceae	2	0.79	63	Piperaceae	1	0.40
26	Brassicaceae	2	0.79	64	Portulacaceae	1	0.40
27	Compositae	2	0.79	65	Punicaceae	1	0.40
28	Leguminosae	2	0.79	66	Rhamnaceae	1	0.40
29	Meliaceae	2	0.79	67	Sampigae	1	0.40
30	Polygonaceae	2	0.79	68	Santalaceae	1	0.40
31	Rosaceae	2	0.79	69	Sapindaceae	1	0.40
32	Tiliaceae	2	0.79	70	Scorphulariaceae	1	0.40
33	Agavaceae	1	0.40	71	Simaroubaceae	1	0.40
34	Aizoaceae	1	0.40	72	Typhaceae	1	0.40
35	Alliaceae	1	0.40	73	Ulmaceae	1	0.40
36	Asclepidaceae	1	0.40	74	Urticaceae	1	0.40
37	Balsaminaceae	1	0.40	75	Zingiberaceae	1	0.40
38	Bombacaceae	1	0.40	76	Zygophyllaceae	1	0.40



Similar flora for *A. mellifera* has been reported by Almeida-Muradian *et al.*, (2005) and (Kumar *et al.*, 2015). In west Bengal, melissopalynological study on Acanthaceae family revealed 70 genera and 340 species (Ghosh and Karmakar, 2012). The availability of bee foraging flora in a region decides the strength of the hive, (Bhalchandra *et al.*, 2014) and occur according to the location and season (Ponnuchamy *et al.*, 2014).

In the present study, grouping of bee pasturage revealed 41 nectar yielders, 29 pollen yielders and 183 of both nectar and pollen yielders (Fig. 1). This was in accordance with the study conducted in the part of Paithan Taluk of Aurangabad region which showed 63 bee flora, including 41 wild and 22 agro-horticultural plants. Similarly in agro-horticultural crops of 6 nectar yielding, 5 pollen yielding and 11 nectar and pollen yielding plants were observed (Waykar and Baviskar, 2015). The seasonal flora availability could be correlated with the observations of Behera *et al.*, (2014). During July to August (dearth period) the *A. cerana* and *Apis mellifera* foraged on 25 different shrubs, herbs, climbers and tree species in part of south Gujarat as (Kumar *et al.*, 2015) observed 20 different medicinal plant species belonging to thirteen families and eleven tree species, six herb species and three shrub species.

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