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MAJOR HONEY BEE FLORA OF KODAGU DISTRICT AND ITS MEDICINAL IMPORTANCE - A SURVEY

Life Sciences

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ABSTRACT

Honey bees are social insect forage several flowers for nectar and pollen, in turn pollinate many crops and wild plants in natural habitats to conserve biodiversity. Bee flora are crucial to initiate beekeeping industry and plants around the beehive is a primary source of bee product, which are potential sources of nutrition, food additive and as a natural therapy. Bee flora with medicinal property is important to harvest a good quality and yield of bee products. The awareness of plant type, flowering time and duration, and their medicinal importance is supportive to establish and manage beekeeping. Based on this, plants with forage importance, their habit, flowering time and duration, medicinal importance and floral status was listed for the study area. In the present study, 85 bee flora of plants were identified, of which 12 species were included in the IUCN Red list. These plants which are of high forage value, as a source of nectar, pollen or both. Conservation of these species is useful for sustaining medicinal diversity and also to improve quality of bee products.

KEYWORDS

Bee flora, Honey bee, Biodiversity, Forage, Beekeeping

INTRODUCTION

Honey bees are an integral part of human food chain. It has a significant role in maintaining biodiversity and the environment, in terms of ecological stability and floral diversity in addition to pollination of agricultural and forest plants (Hung, et.al., 2018). Honey bees initiate foraging activity to gather pollen and nectar which help to increase the production of honey with the effectiveness of pollination services and ecosystem conservation. India has a rich diversity of bee forage plants which have enhanced the quality and productivity of crops, and bee products. Forests are the treasure house of biodiversity and have a significant influence on the economy and environment of Kodagu district, which has approximately 80% of its geographical area under tree cover, making it one of the reservoirs of forests in Karnataka State. The local communities of this district are depending on forest resources in several ways for their livelihood (Zorondo, et.al., 2014). The different types of forests like wet evergreen, semi-evergreen, moist-deciduous and dry-deciduous are found in this district, which has created a natural harmony between the land and its environment (Ravishankar and Nagaraja, 2021).

Plants plays a significant role in beekeeping as a source of pollen and nectar. Medicinal plants can bring out an excellent bee products such as honey, pollen, royal jelly, and propolis with effective therapeutic benefits (Alessandra, et.al., 2021). Beekeepers prefer plants with biological properties having an efficiency to alleviate different types of diseases. Depending on climate and topography, blooming period, bee flora differ from place to place. The medicinal potential of bee flora has been evaluated and reported by various researchers (Smith, et.al., 2015, Shailaja, et. al., 2016) . Study of bee flora with medicinally important species would encourage to conserve the concerned species. In recent years, beekeeping has become a professional activity because of the bee products used extensively in nutrition and medicine (Peter, et.al., 2020). Farmers manage the indigenous honey bees Apis cerana in bee hives and protect wild bees Apis dorsata in the forest and harvest honey from their nests. Exotic honey bee, Apis mellifera was introduced in movable hives for commercial purpose. Bee hives provide a supportive environment for bees to establish foraging activity to gather pollen and nectar.

Kodagu is one of the leading honey producing centers in Karnataka State, where the floral diversity of this area is an exceptional resource for beekeeping industry. Kodagu is known as a region for Coffea species conservation, which provides surplus nectar and pollen to foraging bees in addition to agricultural and horticultural crops. Hence, the area is found to be potential for commercial beekeeping. Apart from its natural forest, district is also a hotspot for agro forestry with a lot of major bee flora including spices. A beekeeper must have a data on flora visited by honey bees, their economic and medical importance in the vicinity of the apiary to enhance the productivity of hive products and sustainable management of beekeeping (Dalio, 2013). Earlier, Suryanarayana (1966) reported on the flora of Coorg with emphasis on bee forage plants. Recently, honey plant resources in Coorg district were detailed by mellissopalynological study (Shubharani, et. al., 2012). The objective of the present study, is to document medicinal plants that could serve as bee flora and their medicinal importance in Kodagu district. Likewise, factors such as blooming period and duration, information about their RET status required to conserve for quality honey production in this district were also discussed.

MATERIALS AND METHODS

Study area

Kodagu is located in the South Western part of Karnataka, India, bounded between latitudes 12°00'00"N and 12°30'00"N and longitudes 75°15'00E" and 75°45'00"E, with a total area of 4,102 Km^2. It is occupied by eastern and western slopes of Western Ghats and bordered by Dakshina Kannada district in the North, Mysore district in the East and Kasargod district of Kerala State of West and South. The district is divided into three administrative Taluks like Madikeri, Virajpet and Somvarpet. Kodagu has a temperate climate, medium humidity and heavy rainfall with an average of 2,692 mm per annum (Ashitha and Prasad, 2021). Certain part of the area receive rainfall even during post monsoon (Sachin, et. al., 2012). The highest and lowest temperatures recorded at Kodagu is 39°C and 10°C respectively, and March is the hottest month of the year.

Assessment of the areas for study

A comprehensive survey was conducted in 12 different beekeeping places of Kodagu like Talakaveri, Baghamandala, Napoklu, Madkeri, Somavarpet, Kutta, Kushalnagara, Sahanivarsanthe, Ponnampet, Shanthalli, Virajpet and Nagarahole during Jan 2019 to Dec 2020 (Figure 1). Bees foraging medicinal plants were collected in their natural habitats and were identified using local names and scientific references. The unidentified plants were collected and identified with the help of a taxonomist and compared with published literature. The study included observation of bee's visit on flowers of different plant species, their foraging behavior, flowering period and duration, habit and also interviews with local beekeepers and traditional medicinal healers to gather information regarding their medicinal importance.

Figure 1: Places selected for the study

RESULT AND DISCUSSION

The beekeepers have an intensive knowledge of plants growing in surroundings of their apiary. Honey bees pollinate various wild and cultivated plants, as they forage for pollen and nectar (Pande and Ramkrushna, 2018). In the present study, 85 plant species with foraging behavior and medicinal importance were identified and listed from the study region (Table 1).

Documentation of pollen and nectar yielding plants and their flower duration was also prepared in order to ensure continuous honey flow for sustainable beekeeping in the study area. The study revealed that February to May and September to October months are suitable for beekeeping development due to the abundance blooming of nectar and pollen yielding plants. The floral calendar is the time that indicates the approximate time and duration of flowering period of bee flora in the area (Table 2). Preparation of floral calendar for a specific area requires the complete observation of the agro ecosystem of the area and also seasonal changes. The survey was done by observation in the vicinity of apiaries and within the flight range of bees, to record the plant species, that the bees visit. Many forest trees with medicinal importance are good sources of bee forage. The detailed list of scientific names of bee flora, family, type of vegetation, its medicinal importance, period of flowering, and availability of nectar and pollen is given in Table-1.

Table 1: Important bee forage plants of Kodagu

Sl. No.	Species	Family	Habit	Flowering Period	Medicinal Value	Floral Status
1	Abelmoschus angulosus	Malvaceae	Herb	Aug -Dec	Plant and seeds used in convulsion, snake bite and as cardiotonic.	Nectar & Pollen
2	Acacia catechu	Fabaceae	Tree	Jan - Dec	Bark extract used in cough, colitis, asthma, gastric trouble, blood pressure and oral diseases.	Nectar
3	Acacia concinna	Fabaceae	Shrub	Mar - Apr	Leaves can cure wounds and pods in purgative.	Pollen
4	Adathoda vasica	Acanthaceae	Shrub	May - Sep	Roots, flowers and leaves used to cure joint pain, eczema, malaria, venereal diseases and respiratory diseases.	Nectar
5	Aegel marmeloes	Rutaceae	Tree	Jan - May	Leaves and fruits used as expectorant, antioxidant and as anti inflammatory.	Nectar
6	Alstonia scholaris .	Apocynaceae	Tree	Jan- Mar	Bark decoction is used against jaundice, cancer, skin and gastrointestinal problems.	Nectar
7	Asparagus racemosus	Liliaceae	Climber	Jan- Sep	Plant used in diabetes, syphilis and gonorrhea.	Pollen
8	Azadirachta indica	Meliaceae	Tree	Mar - Sep	Leaf decoction used in reducing blood sugar, toothache and heal ulcers in digestive tract.	Nectar & Pollen
9	Bacopa monieri	Scrophulariaceae	Herb	Jan - Dec	Plant protect brain from alzheimer, memory loss and anxiety.	Nectar & Pollen
10	Bischofia javanica	Euphorbiaceae	Tree	Mar - Dec	Bark used in tuberculosis, stomach ulcer and mouth ulcer	Pollen
11	Borreria articularis	Rubiaceae	Herb	Jan - Dec	Plant used in treating fever, skin diseases, urinary and respiratory infections, eye and gum inflammation.	Nectar & Pollen
12	Butea monosperma	Fabaceae	Tree	Jan- Jul	Bart extract has wound healing, purgative and anthelmintic properties.	Nectar
13	Cadaba fruticosa	Capparaceae	Shrub	Nov - Mar	Plant used as anti inflammatory, antithelmitic, antibacterial and antioxidant.	Nectar & Pollen
14	Caesalpinia decapitate	Fabaceae	Climber	Oct - May	Leaves used in cancer, inflammation and liver disorder.	Pollen
15	Calophyllum apetalum	Clusiaceae	Tree	Mar - Dec	Root, bark and leaf are used in ulcers, boils, psoriasis and eye infection.	Nectar
16	Canthium dicoccum	Rubiaceae	Shrub	Apr - Dec	Plant used to cure fever, diarrhea and rheumatic pain.	Nectar & Pollen
17	Capparis zeylanica.	Capparaceae	Climber	Feb - Apr	Leaves used in chicken pox, boils, Snake bite and Paralysis.	Nectar & Pollen
18	Cipadessa baccifera	Meliaceae	Shrub	Mar - Nov	Leaf cure swelling and bleeding gum.	Pollen
19	Colebrookea oppositifolia	Lamiaceae	Shrub	Jan - Apr	Plant used in ulcers, hepatitis, dysentery and epilepsy.	Pollen
20	Commelina attenuata	Commelinaceae	Herb	Jul - Dec	Plant used as anti-inflammatory and diuretic.	Pollen
21	Costus speciosus	Costaceae	Herb	July - Jan	Rhizomes are purgative, expectorant, improve digestion and cure urinary disorders.	Nectar & Pollen
22	Digitalis purpurea	Scrophulariaceae	Herb	May - Oct	Plant used in spasm, heart diseases and tuberculosis.	Nectar & Pollen
23	Diospyros malabarica	Ebanaceae	Tree	Mar - Oct	Fruit in treating dysentery, blood diseases, gonorrhea and leprosy.	Nectar
24	Dipterocarpus indicus	Dipterocarpaceae	Tree	Jan - Jul	Bark and leaves used to treat ulcers and skin diseases	Nectar & Pollen
25	Eleocarpus marsupium	Elaeocarpaceae	Tree	Sep - Apr	Heart wood has antibacterial properties and used in skin diseases.	Nectar & Pollen
26	Erythrina stricta	Fabaceae	Tree	Mar - Jun	Bark used skin infection, pain and asthma.	Nectar
27	Eschscholzia californica	Papaveraceae	Shrub	Feb - Jun	Leaves used in tdepression, stress, pain and promoting sleep.	Nectar & Pollen

28	Eucalyptus globulus	Myrtaceae	Tree	Sep - Dec	Oil can relieve cough, cold and joint pain.	Nectar & Pollen
29	Euphorbia milli	Euphorbiaceae	Herb	Feb - Jun	Plant has antifungal property, used to cure hay fever and breathing disorder.	Nectar
30	Euphorbia pulcherrima	Euphorbiaceae	Shrub	Sep - Dec	Leaves can cause abortion and stimulate breast milk.	Nectar & Pollen
31	Evolvulus alsinoides	Convolvulaceae	Herb	Sep - Dec	Plant used in nerve weakness and loss of memory.	Nectar & Pollen
32	Fagonia indica	Zygophyllaceae	Shrub	Jan -Dec	Leaves are antioxidant, anticancerous, laxative and gastroprotective property.	Nectar & Pollen
33	Ficus amplissima	Moraceae	Tree	Sep - Mar	Bark decoction reduce blood sugar level.	Pollen
34	Ficus benghalensis	Moraceae	Tree	Jan - Dec	Leaves used in treatment of wound, skin and eye disease.	Pollen
35	Ficus hispida	Moraceae	Shrub	Feb - Nov	Plant useful in treating convulsion, piles, anemia, and vitiligo.	Nectar & Pollen
36	Flacourtia indica	Flacourtiaceae	Shrub	Sep - Dec	Leaf and bark is effective in snake bite, arthritis and throat infection.	Pollen & Nectar
37	Garcinia gummi-gutta	Clusiaceae	Tree	Jan - Aug	Fruit reduce body weight and blood sugar.	Nectar & Pollen
38	Gardenia gummifera	Rubiaceae	Tree	Jan - Aug	Leaf and fruit cure fever, skin diseases and indigestion.	Nectar & Pollen
39	Gliricidia sepium	Fabaceae	Tree	Mar - May	Leaves used in dermatitis, burns, scabies and protozoal infection.	Nectar & Pollen
40	Glycine pentaphylla	Fabaceae	Climber	Sep - Feb	Plant used in ulcers and some metabolic diseases.	Nectar & Pollen
41	Gymnema sylvestre .	Apocynaceae	Climber	Mar - Jun	Leaves help to treat diabetics.	Nectar
42	Haldina cordifolia	Rubiaceae	Tree	Oct - Jun	Leaves used in treatment of intestinal worms.	Nectar
43	Helicteres isora	Sterculiaceae	Shrub	Jun - Oct	Plant used in treating snake bite and constipation.	Nectar
44	Hemidesmus indicus	Asclepiadaceae	Climber	Feb - Mar	Root extract used in leprosy, rheumatism, impotency and infections.	Nectar & Pollen
45	Holarrhena antidysenterica	Apocynaceae	Tree	Apr - Jul	Leaves normally used in diarrhea and constipation.	Pollen
46	Hopea wightiana.	Dipterocarpaceae	Tree	Apr – May	Bark is anti-inflammatory and astringent.	Nectar & Pollen
47	Hyptis suaveolens	Lamiaceae	Shrub	Sep - Dec	Leaves used to treat gastric ulcers and inflammation.	Nectar & Pollen
48	Indigifera cordifolia	Fabaceae	Herb	Jul – Dec	Plant is effective in skin, liver, kidney and spleen diseases.	Pollen
49	Lagerstroemia lanceolata	Lythraceae	Tree	Jun – Dec	Leaves relieve cold, cough, bronchitis and asthma.	Nectar
50	Lagerstroemia speciosa	Lythraceae	Tree	Jan - Dec	Leaves are antidiabetic.	Nectar
51	Lannea coromandelica	Anacardiaceae	Tree	Jan –Jul	Leaf used to treat hepatitis, dysentery and heart disease.	Nectar & Pollen
52	Leucas aspera	Lamiaceae	Herb	Jan – Dec	Leaves are antifungal, antioxidant and antinociceptive.	Nectar & Pollen
53	Madhuca indica	Sapotaceae	Tree	Mar - May	Leaf cure headache, inflammation and emetic problem.	Nectar
54	Mallotus philippensis	Euphorbiaceae	Tree	Jan - Dec	Leaves and roots are anthelmintic, anti spasmodic and antimicrobial	Nectar & Pollen
55	Manilkara hexandra	Sapotaceae	Tree	Jan - Dec	Leaves used in treatment of ulcers, fever, jaundice and arthritis.	Nectar & Pollen
56	Mesua ferrea	Clusiaceae	Tree	Mar -Oct	Flower is expectorant and used in burning feet.	Nectar & Pollen
57	Morinda pubescens	Rubiaceae	Shrub	Mar - Nov	Leaves in curing eczema, venereal and rheumatic disorders.	Nectar & Pollen
58	Naringi crenulata	Rutaceae	Shrub	Mar -Dec	Root and bark used in body pain, rheumatism, stomach ache and ulcers.	Pollen & Nectar
59	Nothopegia beddomei	Anacardiaceae	Shrub	Jan - Dec	Leaves remove toxins from human body.	Nectar & Pollen
60	Ocimum gratissimum	Lamiaceae	Herb	Jan - Dec	Leaf used in treatment of cancer, pain, anemia and infections.	Nectar
61	Oxalis corniculata	Oxalidaceae	Climber	Aug - Dec	Plant has wound healing property.	Nectar & Pollen
62	Pavonia odorata	Malvaceae	Shrub	Aug - Nov	Leaves cure fever and inflammation.	Nectar & Pollen
63	Pongamia pinnata	Fabaceae	Tree	Apr - Dec	Leaf paste applied in ulcers and skin diseases.	Nectar & Pollen
64	Prunus ceylanica	Rosaceae	Tree	Jan - Dec	Bark used in treatment of prostate cancer.	Nectar & Pollen
65	Randia dumetorum	Rubiaceae	Tree	Mar - Oct	Bark used as astringent, anti-inflammatory, antibacterial and analgesic.	Nectar & Pollen
66	Rubia cordifolia	Rubiaceae	Climber	Aug – Feb	Plant is used in skin diseases.	Nectar
67	Rubia tinctoria	Rubiaceae	Climber	Jan – Dec	Leaf decoction used to cure kidney and bladder stones.	Nectar & Pollen
68	Salvia leucantha	Lamiaceae	Herb	Jan – Dec	Plant has antioxidant activity, used in treatment of diabetes and obesity.	Nectar & Pollen

69	Saraca asoca	Fabaceae	Tree	Mar – Oct	Leaf decoction used in pain, fever and reproductive disorders.	Nectar & Pollen
70	Schefflera sp.	Araliaceae	Tree	Nov – Apr	Leaf and root decoction used in treating pains, asthma and arthritis.	Nectar & Pollen
71	Scolopia crenata	Flacourtiaceae	Tree	Apr – Dec	Leaves have antioxidant and analgesic property.	Nectar
72	Semecarpus auriculata	Anacardiaceae	Tree	Nov –Mar	Leaves used to treat leprosy, ulcer, throat problem and dysentery.	Nectar
73	Shorea roxburghii	Dipterocarpacece	Tree	Feb – May	Bark & flower decoction used in dysentery, fever and heart disorder.	Nectar
74	Sida rhombifolia	Malvaceae	Herb	July – Dec	Plant is used in fever, asthma and inflammation.	Nectar & Pollen
75	Silybum marianum	Asteraceae	Herb	Mar –May	Plant is used in age related brain and liver disorder.	Nectar
76	Symplocos cochinhinensis	Symplocaceae	Tree	Oct – May	Leaves are effective in eye diseases and snake bite.	Nectar & Pollen
77	Terminalia bellirica	Combretaceae	Tree	Mar –Dec	Bark and leaves used in liver and respiratory problems.	Nectar & Pollen
78	Thespesia populnea	Malvaceae	Tree	Jan – Dec	Leaf, bark and root used in skin, liver and gall bladder problems.	Pollen
79	Thevetia peruviana	Apocynaceae	Tree	Jan – Dec	Leaves used in wound healing and cardiovascular diseases.	Nectar & Pollen
80	Tinospora cordifolia	Minispermaceae	Shrub	Jan – Dec	Plant used in treating jaundice, skin, eye disorder and bone fracture	Pollen
81	Toddalia asiatica	Rutaceae	Shrub	Nov –Jan	Root used to treat malaria.	Nectar & Pollen
82	Toona ciliata	Meliaceae	Tree	Mar –Oct	Leaf infusion use as cardiotonic and in menstrual disorder.	Nectar & Pollen
83	Trichodesma zeylanicum	Boraginaceae	Shrub	Jan - Dec	Leaves and roots used in pains, tuberculosis and rheumatism.	Nectar & Pollen
84	Vernonia albicans	Asteraceae	Herb	Jan -Dec	Plant used in eye infection.	Nectar & Pollen
85	Vitex negundo	Verbenaceae	Tree	Apr - Dec	Leaves are used to improve motility of sperms and menstrual cycle.	Nectar

Among 85 plants assessed during survey shows that the plants belong to 38 families. Fabaceae was identified as a major family with 10 species (11.76%), followed by Rubiaceae (8) and Lamiaceae (5) with 9.41% and 5.88% respectively. Apocynaceae, Euphorbiaceae and Malvaceae were found with 4 species each (4.70%), whereas Anacardiaceae, Clusiaceae, Dipterocarpaceae, Meliaceae, Moraceae and Rutaceae comprised of 3 species each (3.52%). The families such as Asteraceae, Capparaceae, Flacourtiaceae, Lythraceae, Sapandaceae and Scrophulariaceae were comprised of 2 species (2.32%) and nearly 20 families (23.25%) were found with a single species (Table 1). The identified 85 bee flora of Kodagu district confirmed the trees (42 %) as dominant habit, followed by shrubs (20 %), herb (15 %), and climbers (9 %) as shown in Figure 2.

Although some of the herbs including Bacopa monieri, Borreria articularis, Leucas aspera, Ocimum gratissimum, Salvia leucantha and Vernonia albicans bloom throughout the year and provide food for honey bees during dearth periods. Data regarding flowering period of bee forage plants during the survey indicated that 60% of Kodagu vegetation provides nectar and pollen to honey bees throughout the year (Table 2).

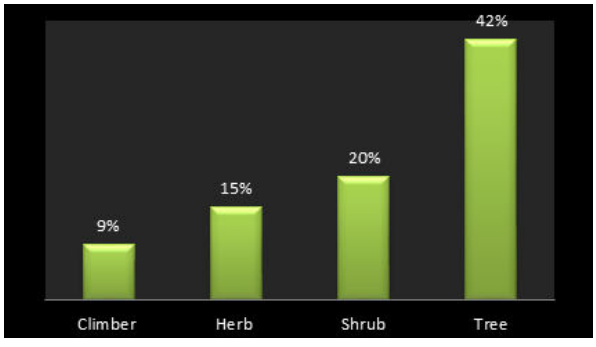
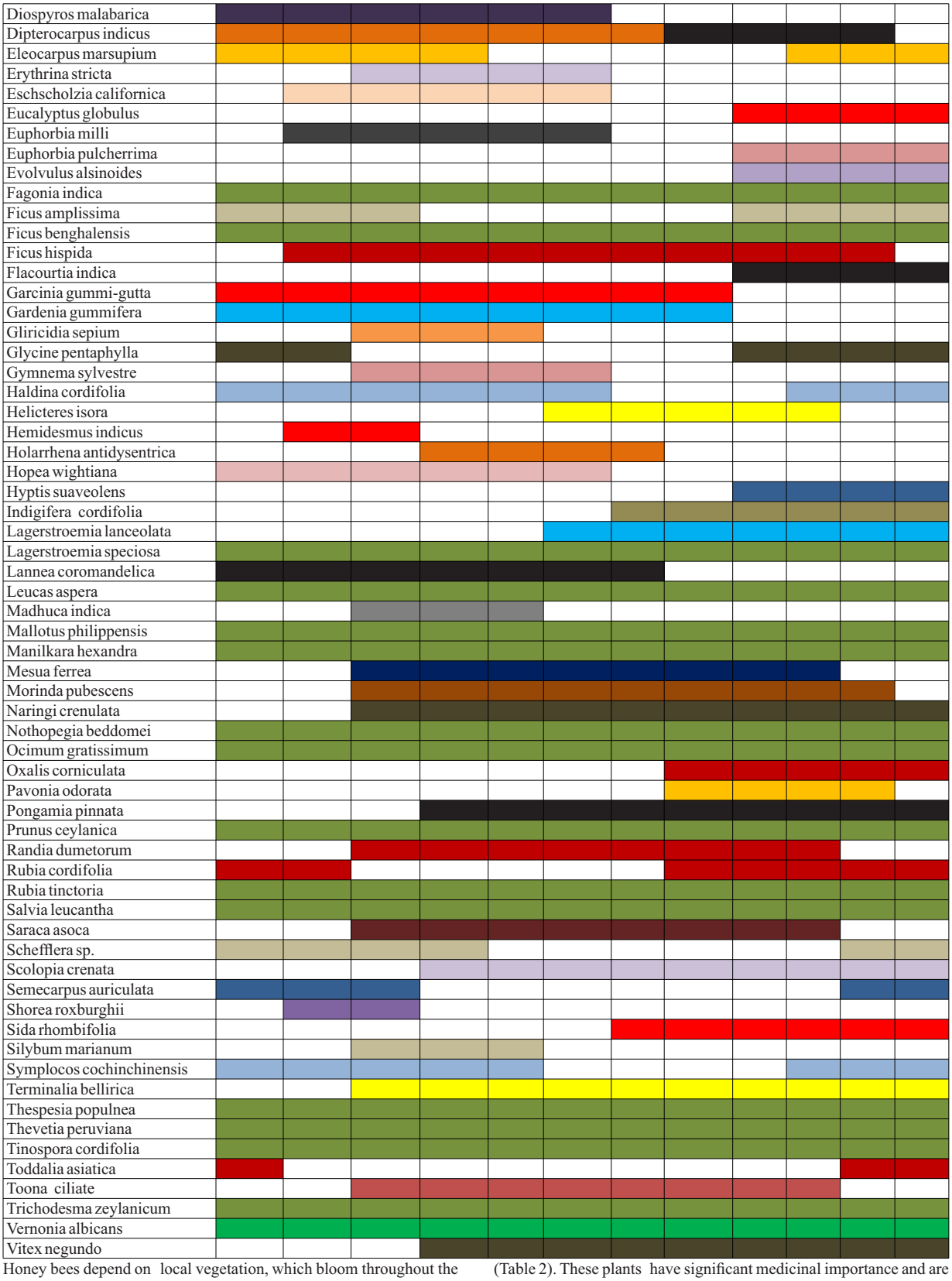


Figure 2: Habit wise distribution of species

Table 2: Floral calendar of Kodagu

Species	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Abelmoschus angulosus												
Acacia catechu												
Acacia concinna												
Adathoda vasica												
Aegel marmeloes												
Alstonia scholaris												
Asparagus racemosus												
Azadirachta indica												
Bacopa monieri												
Bischofia javanica												
Borreria articularis												
Butea monosperma												
Cadaba fruticosa												
Caesalpinia decapitate												
Calophyllum apetalum												
Canthium dicoccum												
Capparis zeylanica												
Cipadessa baccifera												
Colebrookea oppositifolia												
Commelina attenuata												
Costus speciosus												
Digitalis purpurea												



Honey bees depend on local vegetation, which bloom throughout the year during dearth periods (Mangesh and Mahale, 2019). Acacia catechu, Bacopa monieri, Borreria articularis, Fagonia indica, Ficus amplissima, Ficus benghalensis, Lagerstroemia speciosa, Leucas aspera, Mallotus philippensis, Manilkara hexandra, Nothopegia beddomei, Ocimum gratissimum, Prunus ceylanica, Rubia tinctoria, Salvia leucantha, Thespesia populnea, Thevetia peruviana, Tinospora cordifolia and Trichodesma zeylanicum bloom throughout the year and provides pollen and nectar when seasonal plants were not in bloom (Table 2). These plants have significant medicinal importance and are mainly depending on pollinators (Waykar, et.al., 2014). Among 85 bee flora, 12 species, including Aegel marmeloes, Asparagus racemosus, Bacopa monieri, Dipterocarpus indicus, Garcinia gummi-gutta, Hopea wightiana, Rubia cordifolia, Saraca asoca, Semecarpus auriculata, Shorea roxburghii, Symplocos cochinchinensis and Tinospora cordifolia were identified as RET species and included in IUCN Red list. Bacopa monieri and Tinospora cordifolia are the main species provide food to honey bees throughout the year. The species

like Aegel marmeloes, Rubia cordifolia, Semecarpus auriculata and Shorea roxburghii are the main nectar source for bees. Dipterocarpus indicus, Garcinia gummi-gutta, Hopea wightiana, Saraca asoca and Symplocos cochinchinensis are tree species mainly attract wild bees. Overall, these plants which are of high forage value, provide the basis for future activities to promote conservation efforts and take measures to increase their population. The present study provides collective information of bee flora with medicinal potential for promotion and conservation of these plants to improve beekeeping in this district.

CONCLUSION

The quality of bee products depends on botanical sources existing near the apiary (Martinello and Mutinelli, 2021). Health benefits of these products are studied and reported by various researchers (Bartomeus, et. al., 2014, Jung et. al., 2018, Bakour, et. al., 2019). Honey bees pollinate many plants while foraging flowers for nectar and pollen, in turn, enhance diversity and density of medicinal plants (Khalifa, et. al., 2021). In apiculture, floral calendar is one of the most useful tools which requires complete observation of seasonal changes of the area, foraging behavior of bees, and interaction of honey bees with blossom surrounding bee hive (Ghosh, 2020). Furthermore, it has been found that the majority of plants are pollinated by honey bees, are valuable sources of medicine. Medicinal plants growing in and around the study area exhibited an acceptable foraging importance of bees as a source of food.

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