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POLLEN MORPHOLOGY OF SELECTED BEE FORAGE PLANTS

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ABSTRACT
Pollen taxonomy is the prerequisite to compare the pollen present in honey samples with special reference to melissopalynological investigation. There is a scope to prepare pollen reference slides of flowering plants visited by honeybees of different ecological regions. The present study was undertaken during March 2010 to June 2012 in Western Ghats of Karnataka. Sixty eight flowering plants visited by honeybees were collected from Western Ghats of Karnataka and pollen morphological studies have been carried out. Species belonging to family Astraceae pollen are spinolous spherical in shape. The different species in families Fabaceae has a great morphological diversity. They also have variation in symmetry, position and distribution of apertures, exine structure and sculpture of the pollen wall. The pollen grain of plants belonging to family Malvaceae is echinate. Species of family Myrtaceae pollen are colporate and prolate.

KEY WORDS: Pollen morphology, Bee plants, pollen wall, exine structure, spinolous, echinate.

INTRODUCTION

Honeybees and flowering plants have been considered as an example for co-evolution and mutualism. Honeybees need flowering plants for nectar and pollen as source of food and flowering plants need honeybees for pollination. Beekeeping is entirely depending on the types of flowering plants available in any given area. There is a need to understand honeybee plant relationship to study food preferences of honeybees and pollination requirement. Pollen of various plants representing potential source of nectar and pollen for the honeybees is an important pre-requisite for the developing apiary (Kalpana and Ramanujam 1997). Pollen from the different flowers has specific shape, size and ornamentation. Microscopical analysis of pollen of plants forged by bees is an established method to determine the source of honey in the area. Earlier several studies on pollen morphology have been done worldwide (Raj 1969, Sowunmi 1973, Tomb et. al., 1974, Nair and Kapoor 1974, Gill and Chinnappa, 1982). Kral (1992) has made palynological investigation of forest trees in relation to forest history and natural mixture of tree species on the basis of their pollen profile. Noor et al., (2004) has done the palynological studies of cultivated plants of Rawalpindi, Pakistan. Adekanmbi and Ogundipe (2006) described the pollen morphological of 20 cultivated plants of Nigeria. Perveen and Qaiser, 2009 and 2010) conducted the pollen studies of the family Moringaceae and Berberidaceae. Several taxonomists identify the plant species on the basis of phenotypic character of plant. But now the pollen morphological studies can provide a basis for the identification of plant species. An interest in pollen morphology has increased its full application in systematic, paleobotany and allergy has been recognized (Noor et al., (2004). Pollen study has significant application in recognition of bee plants.

Western Ghats of Karnataka has a great diversity of flowering plants and has good potential for commercial beekeeping. The area fall under Western Ghats in Karnataka are Chamarajanagara, Mysore, Kodagu, Chikamaglur, Shimoga, Hassan, Dakshina kannada, Uttara kannada, Dharwad and Belgaum. It has geographical area of 44,870 sq meter and lies between $12^0.80'$ and $16^0.14'$ North latitude and $74^0.08'$ and $76^0.19'$ East longitude (Sivaram, 1995). This region was selected for maximum utilization of flora by beekeepers and recognizes the major pollen and nectar source to honeybees. The information on bee plants, pollen morphology and types of pollen in this region is limited. The purpose of this study is to provide the reference information on nectar and pollen source for honeybees and to evaluate the morphological difference in pollen grains of selected bee forage plants.

MATERIALS AND METHODS

Field studies

In the present investigation, the pollen morphology of 68 plant species from 39 families of apiculture importance has been identified and studied during March 2010 to June 2012. A field survey in different places in Western Ghats of Karnataka was conducted in order to identify the potential zones for the beekeeping. The sample of ripe pollen grains were collected from mature flower buds directly from the field after the plant has been confirmed as bee plant by visual observation that bees are foraging on plant either for nectar or for pollen or both. The mature pollen grains of the identified bee plant species are collected and preserved in 70% alcohol for further investigation.

Preparation of pollen slides

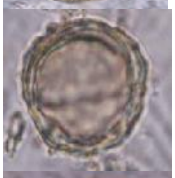
The preserved material was prepared by acetolysis method according to Erdtman (1960) for light microscope, which involves the introduction of acetolysed mixture comprising acetic anhydride mixed with concentrated sulphuric acid in the ratio 9:1. The tubes were immersed in boiling water bath for 3-5 min, centrifuged and the supernatant decanted. The residue was washed water and decanted, about few drops of glycerin was added and mounted on slide. The prepared slides were studied under

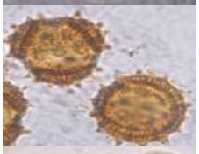
light microscope for morphological studies and photomicrograph of pollen grains was taken.

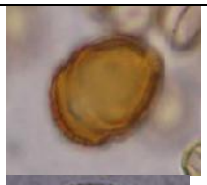
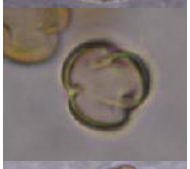
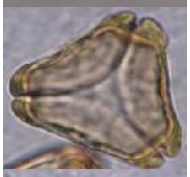
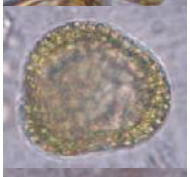
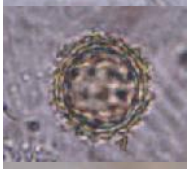
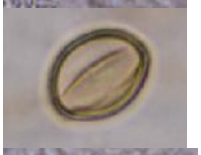
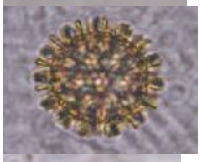
RESULTS AND DISCUSSION

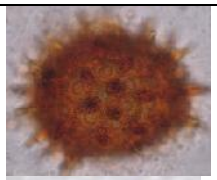
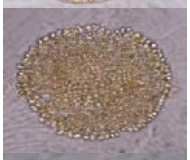
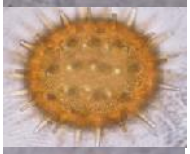
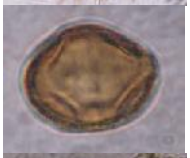
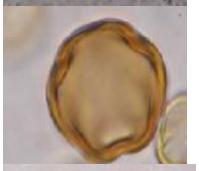
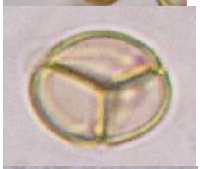
Data collected during the study is presented on Table 1. The information incorporates 68 species belonging to 39 families, useful as source of forage to honeybees. Information of flowering period and their economic importance is also given. The forage source includes 39.7% are tree species, 32.3% are shrubs and 26.4% species are herbs and 1 aquatic plant. The pollen morphology varies among different plant species; occur in varying shapes and forms. They also show variation in symmetry, exine structure and sculpture. *Cassia* sp., *Euphorbia* sp., *Terminalia* sp., *Melastoma* sp. and *Pongamia pinnata* pollen are spherical, pollen of family Malvaceae are echinate. Pollen of *Anthurium* sp., *Adhatoda vasica, Antigonon leptopus*, *Jasminum* sp. and *Punica granatum* are oblate in shape.

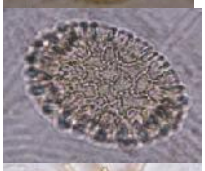
TABLE-1: Pollen type and its morphology

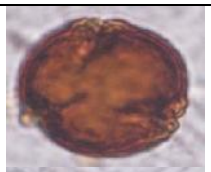
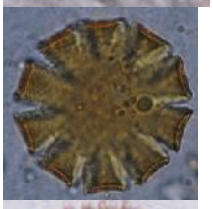
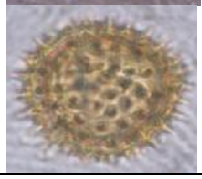
Sr. No.	Pollen type	Plant name and Family name	Morphology	Flowering period	Forage source
1.		*Acacia* sp. ***(Fabaceae)***	*Polyad type, individual cell sub-globose, in periphery and square in centre, polyads not in the form of pollinia, (grains group of 16)*	*9-12*	*Tree*
2.		*Adhatoda vasica* (**Acanthaceae)**	Monoporate, oblate, radial symmetry	1-12	Shrub
3.		*Agava* sp. (**Agavaceae)**	Colpate, striate surface, bilateral symmetry	1-12	Shrub
4.		*Ageratum conyzoides* **(Asteraceae)**	Prolate, spinolous, radial symmetry	1-12	Herb
5.		*Anthurium* sp. **(Araceae)**	Oblate, colpate, prolate, oralolongate, brevicolpi. bilateral symmetry	1-12	Herb
6.		*Antigonon leptopus* **(Polygonaceae**)	Striated surface, exine reticulate, oblate shape, bilateral symmetry	1-12	Shrub
7.		*Bauhinia purpurea* **(Fabaceae)**	Tri-periporate, prolate-spheroid, reticulate , ora- lolongate, bilateral symmetry	2-4	Tree
8.		*Bombax malabaricum* **(Bombacaceae)**	Colporate, prolate, per-oblate, bilateral symmetry	1-3	Tree
9.		*Butea monosperma* **(Fabaceae)**	Colporate,prolate, oblate-spheroid, obscure pattern, bilateral symmetry	1-5	Tree

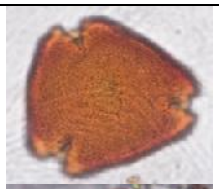
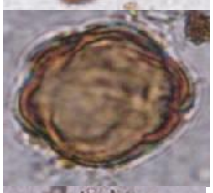
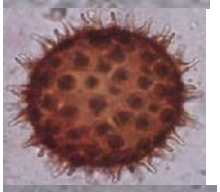
10.		*Caesalpinia pulcherrima* **(Fabaceae)**	3-colporate, sub-oblate shape, bilateral symmetry	3-6	Tree
11.		*Calliandra portoricensis* **(Fabaceae)**	Polyad type, individual cell globose , prolate shape	4-6	Tree
12.		*Callistemon linearis* (**Myrtaceae)**	Colporate, prolate, oblate-spheroid, obscure pattern, bilateral symmetry	2-5	Tree
13.		*Cassia fistula* **(Fabaceae)**	Colporate, prolate, prolate-spheroid, punctitegillate, bilateral symmetry	3-8	Shrub
14.		*Chrysanthemum* sp. **(Asteraceae)**	Exine reticulate, porate, spheroid, spinolous, radial symmetry	1-12	Herb
15.		*Cocos nucifera* **(Arecaceae)**	1-Sulcate, is reticulate type, monad, bilateral symmetry	1-12	Tree
16.		*Coffea* sp. **(Rubiaceae)**	3-colporate,oblate, exine forming a ring, bilateral symmetry	3-4	Shrub
17.		*Commelina diffusa* **(Commelinaceae)**	Shape elliptical, narrow furrow on one (convex) side, bilateral symmetry	7-10	Herb
18.		*Coriandrum sativum* **(Apiaceae)**	3-Colporate, prolate, per-prolate, bilateral symmetry	6-8	Herb
19.		*Croton* sp. **(Euphorbiaceae)**	Inaperturate, retipilate, radial symmetry, clavateexine	1-12	Shrub
20.		*Cucurbita pepo* **(Cucurbitaceae)**	Porate, exine is reticulate,or retipilate, radial symmetry	8-10	Shrub

21.		*Cyperus* sp. **(Cyperaceae)**	Aperture indistinct, pear shaped,3-4 aperturoid areas, bilateral symmetry,	8-1	Herb
22.		*Datura arborea* **(Solanaceae)**	Colporate, prolate, oblate-spheroid, oralolongate, brevicolpi. radial symmetry	1-12	Shrub
23.		*Elaeocarpus angustifolius* **(Elaeocarpaceae)**	3-colporate, prolate to prolate-spheroid exine obscure, bilateral symmetry	7-10	Tree
24.		*Eucalyptus globus* **(Myrtaceae)**	Colporate, prolate, oblate-spheroid, obscure pattern,parasyncoplate, bilateral symmetry	1-8	Tree
25.		*Euphorbia pulcherrima* **(Euphorbiaceae)**	3- Colporate, spheroid shape, furrows indistinct, reticulate, bilateral symmetry.	11-1	Shrub
26.		*Eupatorium purpureum* (**Asteraceae)**	Porate, spheroid shape, spinolousexine, radial symmetry,	9-3	Herb
27.		*Gliricida sepium* **(Fabaceae)**	Monocolpate, exine obscure, sub-oblate, bilateral symmetry	1-12	Tree
28.		*Gomphrena globosa* **(Amaranthacae)**	Pantoporae, spheroid, exinepunctitegillate with supratectal processes, radial symmetry	6-9	Tree
29.		*Hamelia patens* **(Rubiaceae)**	Perprolate, exin epsilate, radial symmetry	1-12	Shrub
30.		*Hibiscus* sp. **(Malvaceae)**	Pantoporate, pores 32, echinate, radial symmetry	1-12	Shrub
31.		*Holmskioldia sanguinea* **(Verbinaceae)**	3-Colpate,oblate- spheroid shape,psilate surface, furrows are complex with 2 pseudocolpi bilateral symmetry	1-12	Shrub

32.		*Ipomoea indica.* **(Convolvulaceae)**	Pantoporate, pores 70-75,Echinate, radial symmetry	1-12	Shrub
33.		*Ixora coccinea* **(Rubiaceae)**	Colpate-Prolate, oralalongate, radial symmetry	1-12	Shrub
34.		*Jasminum* sp. **(Oleaceae)**	Sub oblate, or oblate spherical, furrows short, reticulate, radial symmetry	1-12	Shrub
35.		*Jatropha curcus* **(Euphorbiaceae)**	Inaperturate, reticulate, gemmate exine, crotonoid pattern surface, radial symmetry	1-12	Shrub
36.		*Cimbopogon citratus* **(Poaceae)**	Monolete, Monoporate, inaperturate, exine psilate, radial symmetry	1-12	Herb
37.		*Malva sylvestris* **(Malvaceae)**	Pantoporate, echinate, spheroid, radial symmetry	4-7	Herb
38.		*Mangifera indica* **(Anacardiaceae)**	Colporate, prolate, striato-reticulate, bilateral symmetry	2-5	Tree
39.		*Manilkara zapota* **(Sapotaceae)**	Colporate, psilateexine, radial symmetry	5-8	Tree
40.		*Melastoma* sp. (**Melastomaceae)**	3-colporate, prolate, spheroid, radial symmetry	1-12	Tree
41.		*Mimosa pudica* **(Fabaceae)**	Tetrad, tetragonal, Psilate, radial symmetry	7-10	Herb
42.		*Moringa oleifera* **(Moringaceae)**	Ptychotreme, psilateexine, oncus, Periporate, radial symmetry	1-4	Tree

43.		*Mussaenda* sp. **(Rubiaceae)**	4-5 colporate, obscure pattern, punctitegillate, oblate-spheroid, bilateral symmetry	1-12	Tree
44.		*Nelumbo nucifera* **(Nymphaceae)**	Sub globose, radial symmetry	4-6	Aquatic plant
45.		*Ocimum* sp. **(Lamiaceae)**	6-colpate,sub-oblate, reticulate. hexatreme, radial symmetry	1-12	Herb
46.		*Passiflora foetida* **(Passifloraceae)**	Reticulate surface, oblate shape, bilateral symmetry	4-7	Herb
47.		*Pavonia* sp. **(Malvaceae)**	Pantoporate, spheroid exineechinate, spinolous, radial symmetry	6-8	Herb
48.		*Peltophorum pterocarpum* **(Fabaceae)**	Colporate, prolate-spherical, exine reticulate, bilateral symmetry,	4-6	Tree
49.		*Plumbago zeylanica* **(Plumbaginaceae)**	3-colpate, reticulate, prolate-sub prolate, furrows are long, bilateral symmetry	9-11	Shrub
50.		*Pongamia pinnata* **(Fabaceae)**	Prolate to prolate-spheroid pores indistinct, colporate, punctitegillate, bilateral symmetry	3-7	Tree
51.		*Psidium guajava* **(Myrtaceae)**	Triangular spore wall, smooth, prolate, oblate-spheroid, oralalongate, bilateral symmetry	4-9	Tree
52.		*Punica granatum*. **(Punicaceae)**	Colpate, oblate , radial symmetry	4-6	Tree
53.		*Ricinus communis* **(Euphorbiaceae)**	3- Colporate, prolate-spheroid, finely reticulate, bilateral symmetry	1-4	Shrub

54.		*Rosa canina* **(Rosaceae)**	3-colporate, spherical shapeor prolate spheroid,exine is intectate, surface psilate, bilateral Symmetry	1-12	Shrub
55.		*Ruta graveolens* **(Rutaceae)**	Colporoidate, exinepsilate, bilateral symmetry	3-5	Herb
56.		*Samanea saman* **(Fabaceae)**	Polyad type, individual cells are sub-globose, group of cells are more than 16, bilateral symmetry	3-7	Tree
57.		*Santalum album* **(Santalaceae)**	Colporate, Prolate, psilate exine, radial symmetry	9-12	Tree
58.		*Sesamum indicum* **(Pediliaceae)**	Anamotreme, colpate, sub oblate shape, bilateral symmetry	5-9	Herb
59.		*Sida* sp. **(Malvaceae)**	Pantoporate, echinate, radial symmetry	7-12	Herb
60.		*Solanum melongena* **(Solanaceae)**	Prolate, sub-spheroid, punctitegillate, furrows long, exinepsilate and thin, bilateral symmetry	1-12	Shrub
61.		*Syzygium jambos* **(Myrtaceae)**	Sub triangular spore wall, smooth, psilateexine, colporate, prolate, oblate-spheroid, obscure pattern, parasyncoplate, bilateral symmetry	3-6	Tree
62.		*Tabebuia argentea* **(Bignoniaceae)**	Triangular aperture, 3-colpate, prolate-spheroid to sub prolate, clavate surface, bilateral symmetry	12-2	Tree
63.		*Tagetes erecta* **(Asteraceae)**	Pantopoarate, spinolous exine, radial symmetry	1-12	Shrub

64.		*Tecoma stans* **(Bignoniaceae)**	Tri- zonocolpate, bilateral symmetry	9-12	Tree
65.		*Terminalia* sp. **(Combrataceae)**	3-colporate, prolate, spheroid shape, radial symmetry	5-10	Tree
66.		*Thespesia populnea* **(Malvaceae)**	Pantoporate, exineechinate, spheroid, radial symmetry	1-12	Shrub
67.		*Thunbergia alata* **(Acanthaceae)**	Furrows are fused, sometimes forming spiral, radial symmetry	1-12	Herb
68.		*Tridax procumbens* **(Asteraceae)**	Porate, spinolous, spheroid shape. radial symmetry	1-12	Herb

The pollen of *Acacia* sp., *Calliandra portoricensis* and *Samanea saman* are sub globoes, where as *Commelina diffusa* pollen are elliptical in shape, *Cyperus* sp. has pear shaped pollen, and *Plumbago zeylanica* pollen grain is reticulate in shape. It has been established in this study, that the species belongs to family Asteraceae pollen type were spinolous and Malvaceae pollen types were echinate. But there is variability in the pollen type of the species belongs to family Fabaceae. Therefore, it is essential to examine a large number of pollen grains from one family in order to obtain a complete knowledge of different types within that family. Species belongs to the family Myrtaceae pollen grains are colporate and prolate. Pollen grains of species belong to family Euphorbiaceae are inaperturate and reticulate. Little variation can be seen in the pollen morphology of the plant species belongs to family Rubiaceae.

Identification of bee forage plants and their propagation helps in proving the bee forage which in turn improves the efficiency of beekeeping industry and commercial honey production. Karnataka is one of the leading states in India in beekeeping development. This study helps beekeepers in Karnataka to formulate this seasonal bee management schedule particularly for migrating of bee colonies to different floral sources. These studies will be useful for identifying the flora used by honeybees and improve the conservation status of economically important plants. The pollen morphology is also useful to identify various species and taxa in their respective families. It is useful to identify the pollen present in honey samples in order to know the botanical and geographical origin of honey.

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