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Melissopalynology studies on the Indian honey bee (*Apis cerana indica* Fab.) in southern Kerala

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ABSTRACT: Melissopalynology studies of the Indian honey bee (*Apis cerana indica* Fab.) in southern Kerala was undertaken to study the potential pollen and nectar sources of Indian honey bee across the seasons in southern Kerala. A detailed characterization of all the honey and pollen samples showed the presence of 69 different pollen types; of which twenty four pollen types were identified up to species level. They were distributed among 19 families of these, the pollen types from the families of Arecaceae (3) and Asteraceae (3) were best represented in honey and pollen load samples. Honey bees were found to collect pollen from the tall trees (*Cocos nucifera*) as well as the small plants (*Mimosa pudica)* irrespective of their height.

Key words: Melissopalynology, *Apis cerana indica*, *Cocos nucifera, Mimosa pudica*

INTRODUCTION

Beekeeping is an agro based enterprise where honey bees are utilized to harvest nectar and pollen from the plant sources to produce honey and other hive products. Though most plants in the ecosystem produce nectar and pollen, all of them do not form the honey source. Hence, recognition and initial screening of various bee plants representing potential sources of nectar and pollen for honey bees throughout the year is an important prerequisite for launching apiary industry in any locality (Kalpana and Ramanujam, 1997). Melissopalynology is one of the applied branch of palynology that deals with the microscopic analysis of the pollen contents of honey and pollen loads of a location. It provides reliable information regarding the different flora which will help the bee keepers to frame proper management practices

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during dearth periods (Ramanujam and Khatija, 1991). Moreover, pollen analysis in honey can provide information on geographical and botanical origin of honey to a certain extent.

Melissopalynological studies, thus aids the beekeepers to formulate their seasonal bee management schedules particularly for migration of colonies to different floral sources by identifying the floral diversity of that specified area. This can enhance the honey production and also the quality of honey. Honey obtained from Kerala represents a large array of diversified flora but scientific information about this bee flora is limited. Since such knowledge depends on local vegetation, location wise scientific knowledge on pollen and nectar sources are highly indispensable. However, the location based study conducted in Kerala state has limited information on the seasonal variation (Nair, 2007). So the present investigation is aimed to find out the bee-forage sources for *A. cerana indica* by pollen analysis of honey and pollen samples.

MATERIALS AND METHODS

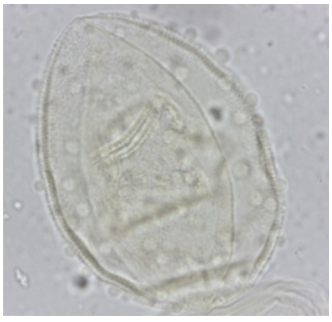
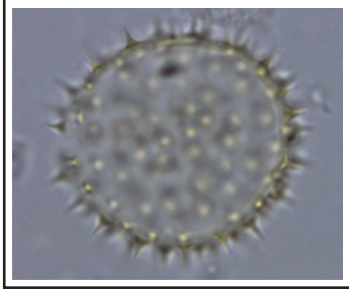
The study was conducted at AICRP on honey bees and pollinators, Department of Agricultural Entomology, College of Agriculture, Vellayani and at the Indian bee apiaries of Thiruvananthapuram and Kollam during 2011-13.

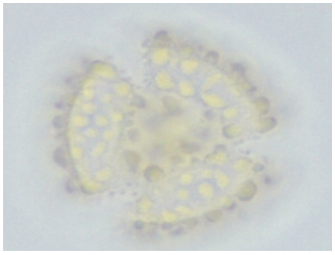
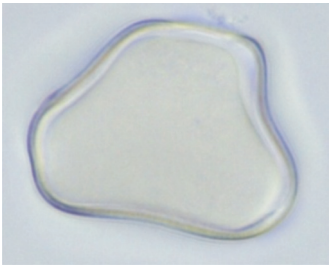
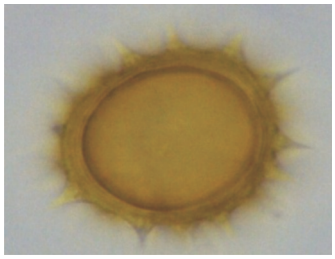
Three samples each of honey and pollen load were collected randomly from three hives of the selected apiaries during three seasons *viz*; honey flow season (January to April), dearth season (June to September) and brood rearing season (October to December) which is prevalent under Kerala conditions. The honey sample (3 ml) was collected directly from the comb cells with the aid of gradated filler to glass vials having 5 ml capacity. Pollen loads were collected from the pollen storage cells of brood chamber with the help of sterilized forceps. The collected pollen samples were fixed in 70 per cent ethyl alcohol. The samples were stored in room temperature and were subjected to pollen analysis (acetolysis and pollen slide preparation). Acetolysis was done mainly to remove the fine cellulose materials present in pollen grains thus providing better visibility for palynomorphs based on the procedures of Erdtman (1960). The pollen grains of different types obtained from each sample were identified based on the reference slides from Environmental Resource Research Centre (ERRC), Ambalamukku, Thiruvananthapuram and characters were described based on the terminology used in 'the glossary of spore terminology'.

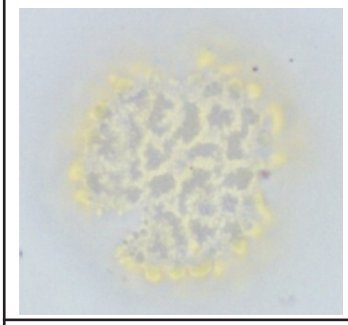
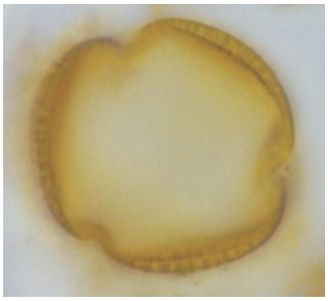
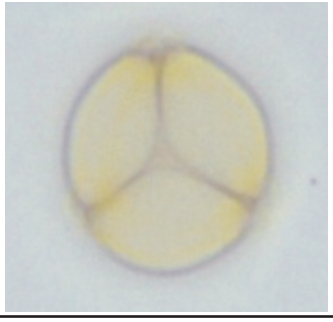
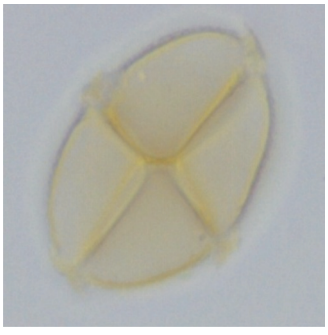
RESULTS AND DISCUSSION

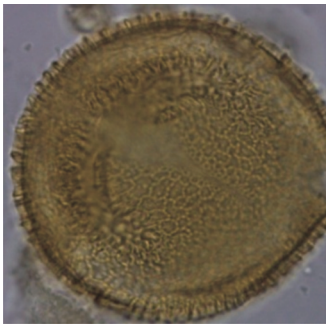
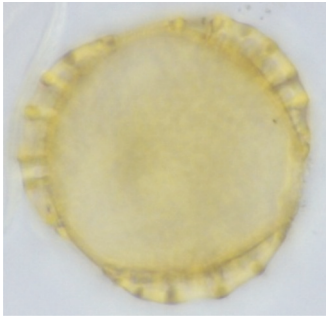
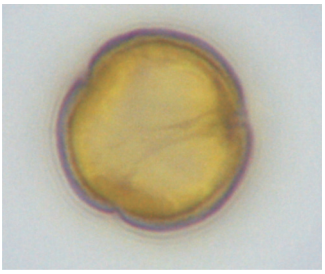
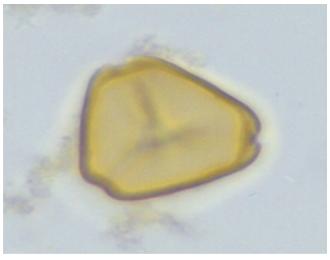
A detailed characterization of all the honey and pollen samples from fifteen locations of southern Kerala over the three seasons showed the presence of 69 different pollen types. Out of these 69 pollen types, twenty four pollen types were identified up to species level. The morphological description of the pollen types along with their microscopic view (1000 X) is given in Table 1.

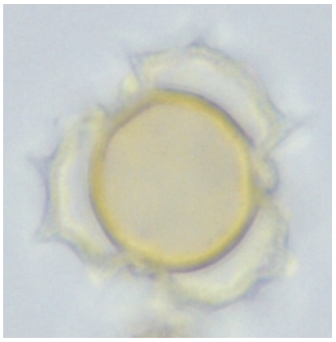
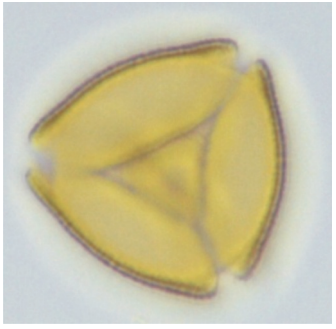
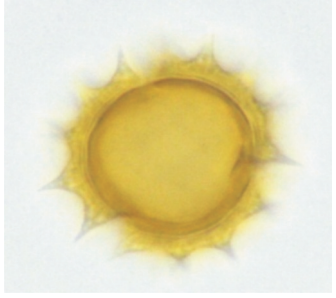
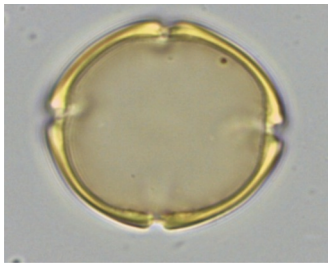
Table 1. Morphological description of individual palynomorphs

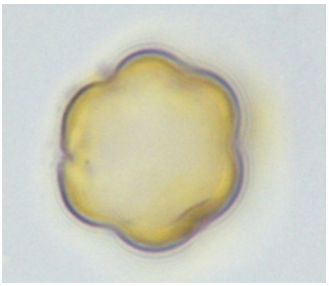
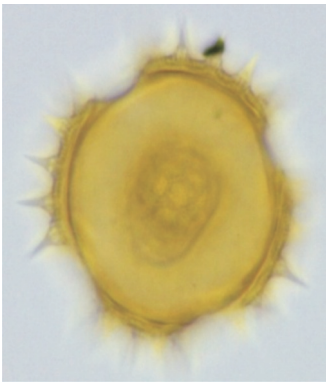
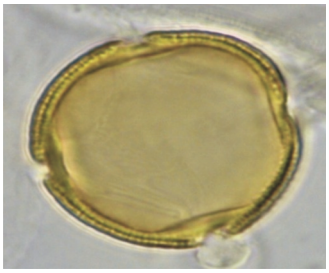
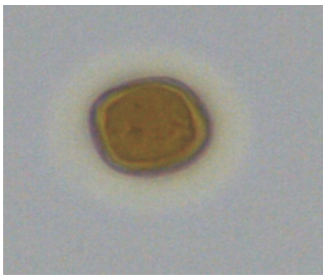
Pollen type	Pollen morphology
	*Acacia auriculiformis* A. Cunn. (Australian wattle) Family - Fabaceae Pollen grains in polyads, polyads 12-celled, spherical, polar outline circular, equatorial outline elliptic-obtuse-plane, polypantoporate, pori circular. Ektexine psilate.
	*Borassus flabellifer* L. (Palmyra palm) Family - Arecaceae Pollen grains in monads**,** tricolpate pollen grain. Ektexine foveolate and puntum were present in between and ektexine almost as thick as endexine.
	*Cocos nucifera* L. (Coconut) ; Family - Arecaceae Pollen grains in monads, pollen monocolpate, colpus with rounded ends. Ektexine faintly reticulate ektexine is almost as thick as endexine, endexine smooth.
	*Colocasia esculenta* L. (Taro)Family - Araceae Pollen grains in monads. Spheroidal in equatorial and polar view. Ektexine echinate, spines tapering at the tips.

Pollen type	Pollen morphology
	*Cullenia exarillata* Robyns. (Wild durian) Family - Bombacaceae Pollen grains in monads, polar outline circular and equatorial outline elliptic. Tricolporate with very short ectoaperture. Ektexine thicker than endexine with granules scattered on the surface.
	*Dillenia pentagyna* Roxb. (Dillenia) Family - Dilleniaceae Pollen grains in monads, polar outline circular and equatorial outline elliptic. Trizonocolpate, colpi narrowly elliptic, wide at equator, sides tapering and tips acute. Ektexine verrucate.
	*Elaeis guineensis* Jacq. (Oil palm) Family - Arecaceae Pollen grains in monads, polar outline triangular-obtuse-concave and equatorial outline elliptic. Trizonoporate. Psilate pollen grain.
	*Hibiscus rosasinensis* Linn. (Shoe flower) Family - Malvaceae Pollen grains in monads, polar and equatorial outline circular. Pantoporate and echinate pollen type.

Pollen type	Pollen morphology
	*Hopea ponga* dennst. (Elapongu) Family - Dipterocarpaceae Pollen grains in monads, polar outline triangular; obtuse-convex and equatorial outline elliptic. Trizonocolpate with wide colpus, sides tapering towards apocolpia to acute tips. Ektexine reticulate.
	*Mangifera indica* L. (Mango) Family - Anacardiaceae Pollen grains in monads, prolate in equatorial view. Tricolporate grain. Ektexine reticulate and thicker than endexine.
	*Mimosa pudica* L. (Sensitive plant) Family - Mimosaceae Pollen grains in tetrads, tetrads spherical, polar outline circular, equatorial outline is quadrangular-obtuse-plane, tetrapantoporate, pori circular. Ektoexine psilate.
	*Mimosa invisa* (Giant sensitive plant) Family - Mimosaceae Pollen grains in tetrads, tetrads elliptic, prolate spheroidal, exine surface tuberculated, polar outline circular and equatorial outline quadrangular-obtuse-plane. Tetrapantoporate, pori circular, psilate pollen.

Pollen type	Pollen morphology
	*Passiflora foetida* (Passion fruit) Family - Passifloraceae Pollen grains in monads, polar outline triangular-obtuse-convex and equatorial outline elliptic. Trizonocolporate. Ektexine reticulate, reticulum lumen large.
	*Peltophorum pterocarpum* (Copper pod) Family - Caesalpiniaceae Pollen grains in monads, polar outline circular and equatorial outline circular to elliptic. Ektexine reticulate. Endexine smooth. Lumina irregularly polygonal to isodiametric.
	*Poeciloneuron pauciflorum* Bedd. Family - Clusiaceae Pollen grains in monads, polar and equatorial outline circular. Tricolporate pollen. Ektexine, microreticulate, ektexine thicker than endexine.
	*Psidium guajava* L. (Guava) Family - Myrtaceae Pollen grains in monads, triangular in polar view, oblate spheroidal in equatorial view. Trizonocolporate, oralalongate. Psilate pollen.

Pollen type	Pollen morphology
	*Spilanthus calva* D. C. (Tooth ache plant) Family - Asteraceae Pollen grains in monads, polar and equatorial outlines circular. Trizonocolporate with elliptic colpi, sides abruptly tapering towards the poles. Ektexine echinate.
	*Schleichera oleosa* (Lour.) Oken. (Lac tree) Family - Sapindaceae Pollen grains in monads, polar outline triangular-acute convex to circular, equatorial outline elliptic, trizono para syncolporoidate, parasyncolpia triangular acute-concave. Ektexine reticulate.
	*Tagetes erecta* L. (Big marigold) Family - Asteraceae Pollen grains in monads, equatorial outline circular, trizonocolporate. Ektexine echinate.
	*Tabernaemontana gamblei* (Crape jasmine) Family - Apocynaceae Pollen grains in monads, tetrazonocolporate, prolate in polar view and circular in equatorial view. Ektexine thicker and bulged outward on the four sides. Psilate pollen grain and endexine smooth.

Pollen type	Pollen morphology
	*Terminalia paniculata* Roth. (Maruthu) Family - Combretaceae Pollen grains in monads, polar outline triangular-obtuse-convex and equatorial outline elliptic. Trizonocolporate with pseudocolpi in between. Ektexine psilate, ektexine almost as thick as endexine.
	*Tridax procumbens* L. (Coat buttons) Family - Asteraceae Pollen grains in monads, polar and equatorial outlines circular. Tetrazonocolporate, colpi elliptic, sides abruptly tapering towards the poles and sides tapering to acute tips. Ektoexine echinate, echinae narrowly triangular in outline.
	*Trichilia connaroides* Wight & Arm. (Peelimaram) Family - Meliaceae Pollen grains in monad, circular in equatorial view and quadrungular in polar view. Tetrazonocolporate. Ektexine granulated with ektexine thicker than endexine and bulged.
	*Muntingia calabura* L. (Bird cherry) Family - Elaeocarpaceae Pollen grains in monads, triporate pollen, pores very small in size. Ektosexine granulated. Endosexine smooth.

The pollen types were distributed among 19 families - Fabaceae, Arecaceae, Araceae, Bombacaceae, Dilleniaceae, Malvaceae, Dipterocarpaceae, Anacardiaceae, Mimosaceae, Passifloraceae, Caesalpiniaceae, Clusiaceae, Myrtaceae, Asteraceae, Sapindaceae, Apocynaceae, Combretaceae, Meliacea and Elaeocarpaceae. Of these, the pollen types from the families of Arecaceae (3) and Asteraceae (3) were best represented in honey and pollen load samples followed by the family Mimosaceae (2). The remaining families had only one type of pollen. The pollen types coming under the family Arecaceae were of *B. flabellifer*, *C. nucifera* and *E. guineensis* while that of Asteraceae were *S. calva*, *T. erecta* and *T. procumbens*. The pollen types coming under the family Mimosaceae belong to the genus *Mimosa*, *M. pudica* and *M. invisa*. This indicates the preference of honey bees to these plants for nectar and pollen sources. Similar findings were also reported by Sharma, 1969; Chaubal, 1976; Garg, 1996 and Bhargava *et al*., 2009 where they reported that most of the pollen grains in honey belong to Asteraceae.

The identified pollen types in this study included local plants such as *C. nucifera, M. pudica, M. invisa, T. erecta, A. auriculiformis* etc. Along with them, the wild plant species such as *D. pentagyna*, *H. ponga, S. oleosa*, *C. exarillata* were also recorded which may be because of the nearness of apiaries to forested areas. Though most of the apiaries are concentrated around the rubber plantations, pollen of *Hevea brasiliensis* was not present in any of the sample collected during the three seasons. This finding was in line with that of Kumar and Jagtap (2005) who reported that *H. brasiliensis* will be under represented in the samples due to the production of the nectar in the extra floral nectaries on the petioles of newly emerging leaves.

In the present study, 24 pollen types were identified up to species level which comprised of 14 trees, four shrubs and six herbs. Of these, tree species was found to be dominant which included *A. auriculiformis, B. flabellifer, C. nucifera, C. exarillata, D. pentagyna, E. guineensis, H. ponga, M. indica, P. pterocarpum, P.* pauciflorum, *S. oleosa, T. paniculata*, *T. connaroides* and *M. calabura*. This is in accordance with Mishra (1995), Sharma (2011) and Shubharani *et al.* (2012) where they reported that bees highly prefer trees rather than shrubs and herbs. Apart from this, the height of the plant is also not a barrier to bees for collecting pollen and nectar as they are found to visit both the tall trees (*C. nucifera*) and small plants (*M. pudica*). Thus the bees satisfy their dietary requirements from the preferred sources in and around the apiary irrespective of the plant height.

Thus the palynological investigations of honey and pollen load samples collected from Indian bee apiaries of southern Kerala revealed the presence of 69 pollen types, of which 24 pollen types were identified up to species level, for their colonial sustenance and honey production.

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