

Pollen analysis of apiary honeys from East Godavari district, AP

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Abstract

Pollen contents of 13 apiary honeys (5 of winter and 8 of summer) collected during November 1990–May 1991 from Kakinada and its adjoining areas and Diwancheruvu near Rajahmundry in the East Godavari district, AP, were analysed. On the basis of absolute pollen counts the honeys are referable to Groups II to IV.

The study highlights *Sapindus emarginatus* and *Eucalyptus globulus* during winter and *Borassus flabellifer* and *Syzygium cumini* during summer as the major sources of nectar for the Indian hive bee, *Apis cerana*, along the coastal belt of East Godavari district.

Key words: Pollen analysis, apiary honeys, East Godavari district.

1. Introduction

Pollen analysis of honey samples provides information on the plants visited by honey bees for nectar collection. Analysis of the pollen loads helps us to evaluate the sources of pollen to the bees. The pollen contents of honeys and pollen loads further reflect upon the local floristic composition and concomitantly their geographical origin and collection period. A critical screening of bee plants supplying nectar and pollen during different seasons and their numerical preponderance is essential to make any meaningful suggestions regarding the suitability of an area for bee-keeping (apiary) industry leading to commercial production of honey.

Melittopalynological studies of honeys of *Apis cerana*, *A. dorsata* and *A. florea* in Andhra Pradesh, notwithstanding their vast potential, have been few and far between to date. Seethalakshmi's pioneering study¹ on two honey samples from Guntur district brought to light *Phyla nodiflora*, *Hygrophila* sp., *Borassus flabellifer* and *Justicia* sp. as significant nectar suppliers. Jhansi and Ramanujam²⁻⁴ analysed honeys from Guntur, East Godavari, Karimnagar, Hyderabad, Visakhapatnam and Nalgonda districts and documented unifloral honeys of *Asteracantha* sp., *Borassus flabellifer*, *Psidium*

guajava, *Gardenia* sp. and *Leea* sp. Further studies on honeys and pollen loads highlighted the importance of *Mangifera indica*, *Tridax procumbens*, *Phoenix sylvestris*, *Helianthus annuus*, *Syzygium cumini* (in the Hyderabad urban complex); *Carum copiticum*, *Guizotia abyssinica*, *Prosopis juliflora*, *Ailanthus excelsa*, *Phoenix sylvestris* (in the agricultural tracts of Ranga Reddy district) and *Mimosa pudica*, *Sapindus emarginatus*, *Capsicum frutescens* and *Prosopis juliflora* (in the agricultural tracts of Guntur district) as significant bee plants⁵⁻¹⁰. Jhansi *et al*¹¹ encountered *Cassia fistula*, *Terminalia alata*, *Lagerstroemia parviflora*, etc., as reliable nectar sources for *Apis dorsata* bees in the deciduous forests of Prakasam district.

The present study records a critical qualitative and quantitative analysis of the pollen contents of 13 apiary honey samples collected essentially from the coastal belt of the East Godavari district of Andhra Pradesh and brings to light the key bee plants supplying nectar to the honey bees during winter and summer seasons.

2. Materials and methods

Thirteen honey samples from the apiary colonies of *Apis cerana* var. *indica* were collected from Kakinada and its adjoining villages and from Diwancheruvu near Rajahmundry in the East Godavari district of Andhra Pradesh during the period November 1990–May 1991. Of these, five samples represent winter honeys collected during Nov. 1990–Jan. 1991 and eight, summer honeys obtained during March–May 1991 (Table I).

Table I
Inventory of the honey samples and APC groupings

Honey sample	Locality	Date of collection	Colour	Absolute pollen counts/10g and groupings	
EG-KP-1	Kakinada	Nov. 1990	Amber	740,000	G-IV
EG-KP-2	Kakinada	Dec. 12, 1990	Pale yellow	200,000	G-III
EG-KP-3	Kakinada	Dec. 24, 1990	Pale yellow	220,000	G-III
EG-KP-4	Kakinada	Dec. 26, 1990	Pale yellow	280,000	G-III
EG-D-5	Diwancheruvu	March, 1991	Yellowish brown	880,000	G-IV
EG-D-6	Diwancheruvu	April 18, 1991	Amber	630,000	G-IV
EG-KP-7	Kakinada	April, 1991	Yellowish brown	470,000	G-III
EG-S-8	Sarparam	April, 1991	Amber	60,000	G-II
EG-S-9	Sarparam	May 8, 1991	Amber	50,000	G-II
EG-S-10	Sarparam	May 8, 1991	Amber	120,000	G-III
EG-KP-11	Kakinada	Jan. 1991	Yellowish brown	290,000	G-III
EG-G-12	Gigalpadu	May 8, 1991	Amber	310,000	G-III
EG-G-13	Gigalpadu	May 8, 1991	Amber	230,000	G-III

The technique of Louveaux *et al*¹² was employed in the recovery of pollen contents of the honeys and their slide preparation. Three pollen slides were prepared for each sample and scanned critically for their pollen contents. The pollen types recovered were identified with the help of reference slides and relevant literature. The pollen contents were analysed qualitatively and quantitatively by the method recommended by Louveaux *et al* (International Commission for Bee Botany)¹². Depending upon whether a honey sample was obtained from a single or multiple species, it was designated as uni- or multifloral. Based upon the frequencies of the pollen types, pollen spectra of the honey samples were prepared.

The ratio of honeydew elements (HDE) to total number of pollen grains of melliferous taxa in each sample was obtained by the study of unacetolysed honeys¹². The absolute pollen count (APC) of the honey samples was calculated using haemocytometer¹³, and the honey samples were categorized under various groups in accordance with the grading parameter provided by the International Commission for Bee Botany.

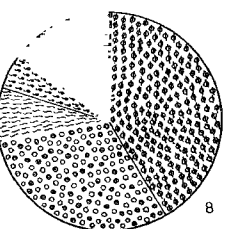
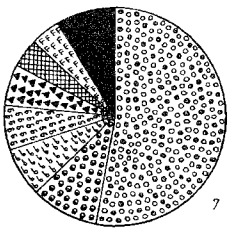
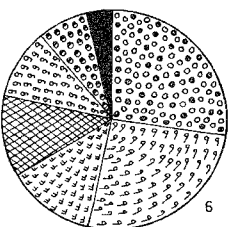
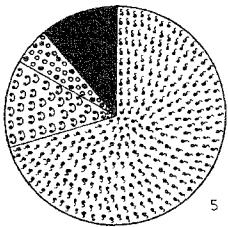
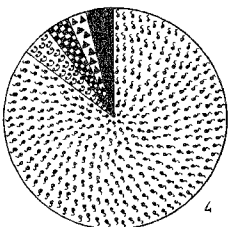
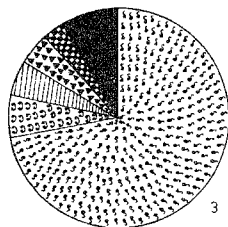
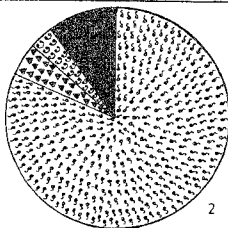
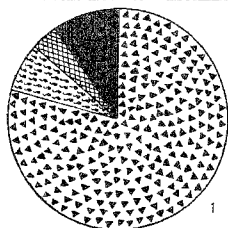
3. Observations

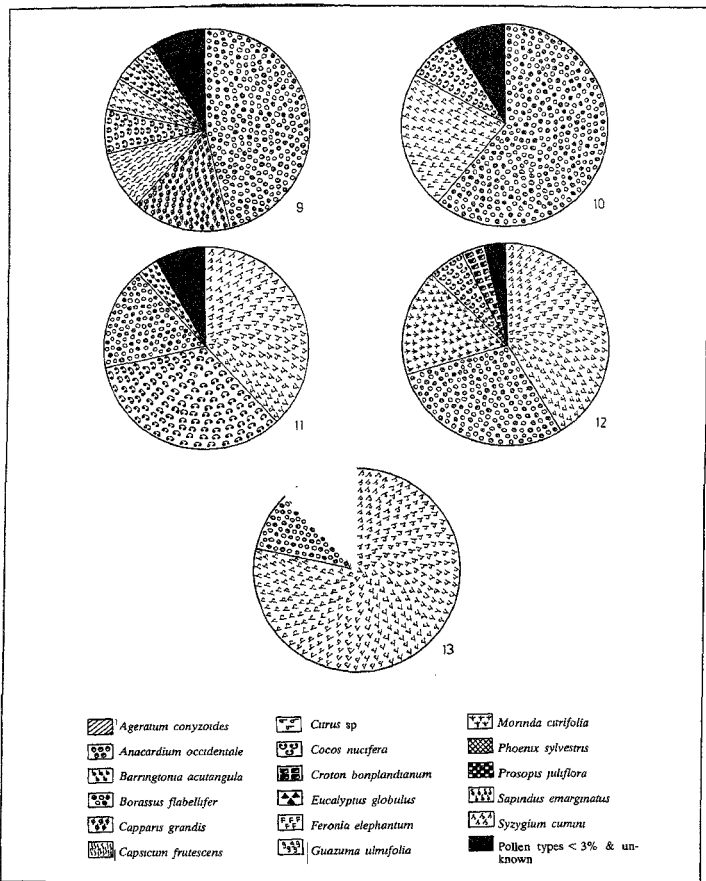
All the five winter honeys were found to be unifloral. *Sapindus emarginatus* (70.33–85.33 per cent) in four samples and *Eucalyptus globulus* (79.33 per cent) in one sample constitute the predominant pollen types; these may be designated as soapnut and eucalyptus honeys. The other noteworthy pollen types (up to important minor) include *Cocos nucifera*, *Phoenix sylvestris*, *Prosopis juliflora*, *Borassus flabellifer* and *Ageratum conyzoides*. A total of 36 pollen types (34 of melliferous and 2 of non-melliferous taxa) were recorded from the winter honeys. Samples KP-3 and KP-11 showed the maximum (19) and minimum (12) number of pollen types, respectively.

Four of the summer honey samples were found to be unifloral and the rest multifloral. *Borassus flabellifer* (46–62 per cent) in three samples and *Syzygium cumini* (78.33 per cent) in one sample represent the predominant pollen types; these may be designated as borassus and jamun honeys. The other noteworthy pollen types (up to important minor) recorded are *Citrus* sp., *Feronia elephantum*, *Phoenix sylvestris*, *Guazuma ulmifolia*, *Anacardium occidentale*, *Eucalyptus globulus*, *Capparis grandis*, *Capsicum frutescens*, *Sapindus emarginatus*, *Cocos nucifera*, *Barringtonia acutangula*, *Morinda citrifolia* and *Croton bonplandianum*. Forty-seven pollen types (43 of melliferous and 4 of non-melliferous taxa) were recorded from the summer honeys. Samples S-8 and D-5 showed the maximum (24) and minimum (11) number of pollen types, respectively.

Table II provides the details of the frequencies (%) and frequency classes of the pollen types recorded in the winter and summer honeys. Figures 1–5 are the pollen spectra of winter honeys and Figures 6–13 are of summer honeys, respectively. Figures 14–44 are the photomicrographs of some of the significant pollen types encountered in the study.

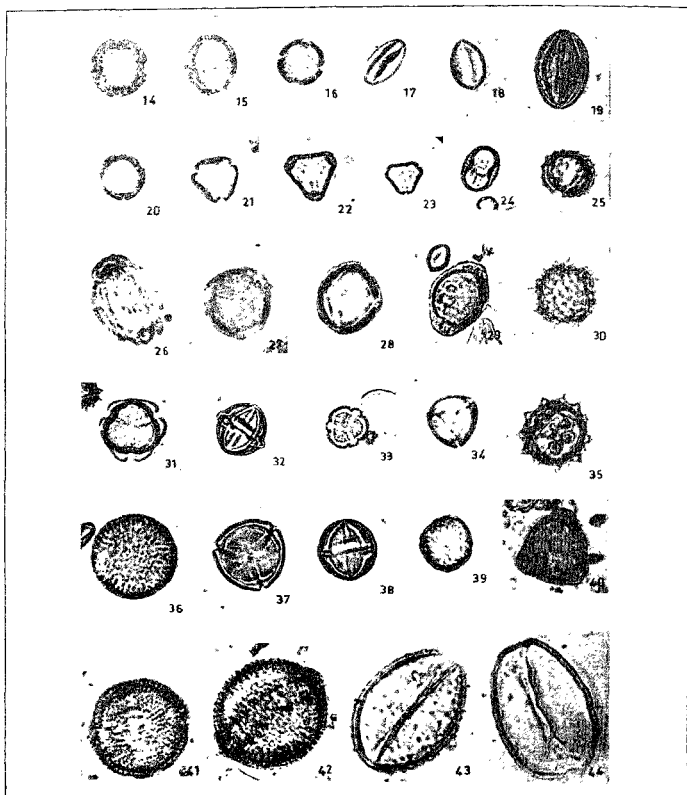
Amaranthus/Achyranthes sp., Poaceae pollen, *Cyperus rotundus* and *Holoptelea integrifolia* represent the pollen of anemophilous and non-melliferous plants recorded





Figs. 1-13. Pollen spectra of honey samples.

1. EG-KP-1, 2. EG-KP-2, 3. EG-KP-3, 4. EG-KP-4, 5. EG-KP-11 (Winter), 6. EG-D-5, 7. EG-D-6, 8. EG-KP-7, 9. EG-S-8, 10. EG-S-9, 11. EG-S-10, 12. EG-G-12, 13. EG-G-13 (Summer).



FIGS. 14-44. Photomicrographs of significant pollen types recorded (all figs $\times 500$)

14 and 15. *Citrus* sp., 16. *Feronia elephantum*, 17. *Capparis grandis*, 18. *Phoenix sylvestris*, 19. *Prosopis juliflora*, 20. *Guazuma ulmifolia*, 21. *Sapindus emarginatus*, 22. *Eucalyptus globulus*, 23. *Syzygium cumini*, 24. *Justicia procumbens*, 25. *Ageratum conyzoides*, 26. *Barringtonia acutangula*, 27 and 28. *Anacardium occidentale*, 29. *Lagerstroemia flos-reginae*, 30. *Tridax procumbens*, 31 and 32. *Capsicum frutescens*, 33. *Tinospora cordifolia*, 34. *Schleichera oleosa*, 35. Compositae type, 36. *Croton bonplandianum*, 37 and 38. *Ricinus communis*, 39. *Holoptelea integrifolia*, 40. *Casuarina equisetifolia*, 41. *Morinda citrifolia*, 42. *Borreria hispida*, 43. *Borassus flabellifer*, 44. *Cocos nucifera*.

Table II
Frequency classes* and frequencies (%)** of pollen types

Honey sample	Pollen types
WINTER	
EG-KP-1	P — <i>Eucalyptus globulus</i> (79.33) S — Nil I — <i>Sapindus emarginatus</i> (7.33), <i>Phoenix sylvestris</i> (3.67) M — <i>Borassus flabellifer</i> (2.67), <i>Croton bonplandianum</i> , <i>Caesalpinia</i> sp. (each 1.0), As, Ci, Borr, Co, Lo, Ju, Coc, Si (each < 1.0), UN (1.33) NMP — Poaceae type (0.33); HDE/P = 0.01
EG-KP-2	P — <i>Sapindus emarginatus</i> (81.33) S — Nil I — <i>Eucalyptus globulus</i> (4.67), <i>Cocos nucifera</i> (3.67) M — <i>Borassus flabellifer</i> (2.0), <i>Prosopis juliflora</i> , Solanaceae (each 1.33), <i>Ageratum conyzoides</i> (1.0), Mo, Ev, Gr, Borr, Ca, La, Tr, Ch, Ti (each < 1.0), UN (0.67) NMP — Poaceae type, <i>Amaranthus/Achyranthes</i> sp. (each 0.33); HDE/P = 0.02
EG-KP-3	P — <i>Sapindus emarginatus</i> (72.0) S — Nil I — <i>Cocos nucifera</i> (6.33), <i>Ageratum conyzoides</i> (5.33), <i>Eucalyptus globulus</i> (5.0), <i>Prosopis juliflora</i> (3.0) M — <i>Borassus flabellifer</i> (2.0), Solanaceae (1.67), Mo, Cr, Hy, Tr, All, Borr, Ti, Le, Ev, Ri, Pe (each < 1.0), UN (0.33) NMP — Poaceae type (0.33); HDE/P = 0.02
EG-KP-4	P — <i>Sapindus emarginatus</i> (85.33) S — Nil I — <i>Cocos nucifera</i> (4.33), <i>Prosopis juliflora</i> (3.33), <i>Eucalyptus globulus</i> (3.0) M — Cr, Mo, Hi, Bor, Co, Cas, Tr, Le, Sp, Borr, Ca (each < 1.0) NMP — Poaceae type (0.33); HDE/P = 0.01
EG-KP-11	P — <i>Sapindus emarginatus</i> (70.33) S — Nil I — <i>Cocos nucifera</i> (12.67), <i>Borassus flabellifer</i> (5.67) M — <i>Prosopis juliflora</i> (2.67), <i>Citrus</i> sp., <i>Eucalyptus globulus</i> (each 2.0), <i>Borreria hispida</i> (1.67), <i>Casuarina equisetifolia</i> (1.0), Com, Cr, Ag, Ph (each < 1.0), UN (0.33) HDE/P = 0.01
SUMMER	
EG-D-5	P — Nil S — <i>Borassus flabellifer</i> (27.33), <i>Citrus</i> sp. (25.67) I — <i>Feronia elephantum</i> (13.0), <i>Phoenix sylvestris</i> (12.33), <i>Guazuma ulmifolia</i> (10.67), <i>Anacardium occidentale</i> (7.33) M — Urticaceae (1.33), Coc, Az, Sa, Li (each < 1.0), UN (0.33) HDE/P = 0.01
EG-D-6	P — <i>Borassus flabellifer</i> (53.0) S — Nil I — <i>Anacardium occidentale</i> (9.67), <i>Citrus</i> sp. (7.33), <i>Guazuma ulmifolia</i> (6.67), <i>Eucalyptus globulus</i> (6.0), <i>Phoenix sylvestris</i> (4.67), <i>Feronia elephantum</i> (4.0) M — <i>Lannea coromandelica</i> (2.0), <i>Schleichera oleosa</i> (1.67), <i>Syzygium cumini</i> (1.33), <i>Lagerstroemia flos-reginae</i> (1.0), Te, Sa, Az, Bo, Coc (each < 1.0), UN (0.33) NMP — <i>Holoptelea integrifolia</i> (1.0); HDE/P = 0.01

Table II (contd)

Honey sample		Pollen types	
EG-KP-7	P — Nil	S — <i>Capparis grandis</i> (41.33), <i>Borassus flabellifer</i> (30.67)	I — <i>Cappaicum frutescens</i> (7.33), <i>Sapindus emarginatus</i> (5.33)
	M — <i>Eucalyptus globulus</i> (2.67), <i>Croton bonplandianum</i> , <i>Hygrophila auriculata</i> (each 2.0), <i>Ploerix sylvstris</i> (1.67), <i>Justicia procumbens</i> (1.33), <i>Cocos nucifera</i> , <i>Oleandria umbellata</i> , <i>Ricinus communis</i> (each 1.0), <i>Ag. Ce</i> , <i>Pr</i> , <i>Bv</i> , <i>Al</i> , <i>Borr</i> , <i>De</i> (each < 1.0)	NMP — <i>Amaranthus/Achyranthes</i> sp., Poaceae type (each 0.33); HDE/P = 0.02	
EG-S-8	P — <i>Borassus flabellifer</i> (46)	S — <i>Capparis grandis</i> (16.33)	I — <i>Cappaicum frutescens</i> (9.33), <i>Cocos nucifera</i> (7.33), <i>Syzygium cumini</i> (5.0), <i>Barringtonia acutangula</i> (4.0), <i>Sapindus emarginatus</i> (3.0)
	M — <i>Guzmania umbellata</i> (2.0), <i>Moa</i> , <i>Pr</i> , <i>Pe</i> , <i>Ev</i> , <i>Ag</i> , <i>Sc</i> (each < 1.0), <i>LN</i> (0.33), <i>Ph</i> , <i>Ri</i> , <i>Ct</i> , <i>Ht</i> , <i>Ju</i> , <i>Mo</i> , <i>Pr</i> , <i>Pe</i> , <i>Ev</i> , <i>Ag</i> , <i>Sc</i> (each < 1.0), <i>LN</i> (0.33)	NMP — <i>Amaranthus/Achyranthes</i> sp. (0.67), Poaceae type, <i>Cyperus rotundus</i> (each 0.33); HDE/P = 0.01	
EG-S-9	P — <i>Borassus flabellifer</i> (62.0)	S — <i>Syzygium cumini</i> (21.67)	I — <i>Cocos nucifera</i> (8.0)
	M — <i>Barringtonia acutangula</i> (2.33), <i>Morinda citrifolia</i> (2.0), <i>Cap</i> , <i>Cr</i> , <i>Ev</i> , <i>Pr</i> , <i>Eu</i> , <i>Caps</i> , <i>Tr</i> , <i>Le</i> , <i>Te</i> , <i>Al</i> , <i>Sc</i> (each < 1.0)	NMP — <i>Amaranthus/Achyranthes</i> sp. (4.0); HDE/P = 0.01	
EG-S-10	P — Nil	S — <i>Syzygium cumini</i> (38.33), <i>Cocos nucifera</i> (34.0), <i>Borassus flabellifer</i> (16.33)	I — <i>Barringtonia acutangula</i> (3.33)
	M — <i>Evolvulus asinoides</i> (2.67), <i>Croton bonplandianum</i> (2.0), <i>Morinda citrifolia</i> (1.33), <i>Le</i> , <i>Cap</i> , <i>Pr</i> , <i>Law</i> , <i>Cas</i> (each < 1.0)	NMP — <i>Amaranthus/Achyranthes</i> sp. (5.0); HDE/P = 0.01	
EG-G-12	P — Nil	S — <i>Syzygium cumini</i> (41.0), <i>Borassus flabellifer</i> (29.67), <i>Morinda citrifolia</i> (16.67)	I — <i>Cocos nucifera</i> (5.33), <i>Croton bonplandianum</i> (3.67)
	M — <i>Barringtonia acutangula</i> , <i>Sapindus emarginatus</i> (each 1.0), <i>De</i> , <i>Mi</i> , <i>Tr</i> , <i>Pr</i> , <i>Pe</i> (each < 1.0)	HDE/P = 0.01	
EG-G-13	P — <i>Syzygium cumini</i> (78.33)	S — Nil	I — <i>Borassus flabellifer</i> (9.33)
	M — <i>Cocos nucifera</i> , <i>Eucalyptus globulus</i> (each 2.33), <i>Morinda citrifolia</i> (2.0), <i>Pr</i> , <i>Ba</i> , <i>Cr</i> , <i>Sa</i> , <i>Mi</i> , <i>Law</i> , <i>De</i> , <i>Ag</i> , <i>Tr</i> , <i>Ci</i> , <i>Al</i> , <i>Ch</i> (each < 1.0)	NMP — Poaceae type (0.33); HDE/P = 0.01	

* 300 pollen grains per sample were counted at random for determining the frequency classes (P, S, I, M).
 ** 1200 pollen grains per sample were counted at random for calculating the frequencies (%) of the pollen types.
 P: Predominant pollen types (> 45 %); S: Secondary pollen types (16–45 %); I: Important minor pollen types (3–15 %); M: Minor pollen types (< 3 %); LN: Unknown pollen types; NMP: Pollen types of

Table II (contd)

non-melliferous taxa; HDE/P: Ratio of honeydew elements versus total number of pollen grains of melliferous taxa.

Abbreviations for pollen types constituting less than 1 per cent of the sample.

Ag: *Ageratum conyzoides*, Al: *Albizia lebbbeck*, All: *Allium cepa*, As: *Aspidoptery indica*, Az: *Azadirachta indica*, Ba: *Barringtonia acutangula*, Bo: *Bombax malabaricum*, Bor: *Borassus flabellifer*, Borr: *Borreria hispida*, Ca: *Caesalpinia* sp., Cap: *Capparis grandis*, Caps: *Capsicum frutescens*, Cas: *Casuarina equisetifolia*, Ce: *Ceiba pentandra*, Ch: *Chenopodium album*, Ci: *Citrus* sp., Co: *Coccinia grandis*, Coc: *Cocos nucifera*, Com: *Compositae*, Cr: *Croton bonplandianum*, De: *Delonix regia*, Eu: *Eucalyptus globulus*, Ev: *Evolvulus alsinoides*, Gr: *Grewia* sp., Hi: *Hibiscus* sp., Hy: *Hygrophila auriculata*, Ju: *Justicia procumbens*, La: *Lagersiroemia flos-reginae*, Law: *Lawsonia inermis*, Le: *Leucaena leucocephala*, Li: *Liliaceae*, Lo: *Loranthus longiflorus*, Mi: *Mimosa pudica*, Mo: *Momordica charantia*, Ol: *Oldenlandia umbellata*, Pe: *Peltophorum ferrugineum*, Ph: *Phoenix sylvestris*, Pr: *Prosopis juliflora*, Ri: *Ricinus communis*, Sa: *Sapindus emarginatus*, Sc: *Schleichera oleosa*, Si: *Sida acuta*, Sp: *Sphaeranthus indicus*, Te: *Terminalia alata*, Ti: *Tinospora cordifolia*, Tr: *Tridax procumbens*.

in minor percentages and their occurrence might be due to contamination of the honeys in the hives by the bees themselves.

The ratio of honeydew elements (represented by fungal spores, viz., *Drechslera*, *Curvularia* and *Nigrospora*, and fungal hyphae) to total number of pollen grains of melliferous taxa ranged from 0.01 to 0.02 and hence referable to the category, 'practically none' (Table II).

The absolute pollen counts (i.e., the number of pollen per 10 grams) of the honey samples ranged from 50,000 (S-9) to 880,000 (D-5) and the honeys are referable to Groups II, III and IV (Table I).

The colour of the honey samples ranged from pale yellow to amber (Table I).

The degree of similarity between a pair of unifloral honeys with the same predominant pollen type can be determined by using the formula $2c/a+b$, where a and b represent the total number of pollen types in the honey samples and c represents the number of pollen types common to both the samples⁶. An index value of more than 0.5 indicates a high degree of similarity between the samples and vice versa. The similarity index values between six possible pairs of soapnut honeys with *Sapindus emarginatus* as the predominant pollen type, and the three possible pairs of borassus honeys with *Borassus flabellifer* as the predominant pollen type are given in Table III. The Kakinada samples show high similarity index values ranging from 0.52 to 0.7, with the exception of KP-2 and KP-11 which had a value of 0.47. This could be attributable to the same period of collection (December) and a similar floristic composition. Likewise, although all the borassus honeys were obtained during summer, only the Sarparam samples (S-8 and S-9) showed high index value i.e., 0.59. The low index values between the Sarparam and Diwancheruvu borassus honeys could be due to the relative differences in the composition of local plant communities.

Table III
Similarity index values between (a) *Sapindus* (soapnut) honeys and (b) *Borassus* honeys

	KP-2	KP-3	KP-4	KP-11		D-6	S-8	S-9
KP-2	-				D-6	-		
KP-3	0.7	-			S-8	0.44	-	
KP-4	0.59	0.63	-		S-9	0.35	0.59	-
KP-11	0.47	0.52	0.57	-				
a					b			

4. Discussion

Among other things, melittopalynological studies facilitate recognition of relative importance of various plants as nectar and/or pollen sources for the honey bees in any particular locality. The present study encompassing qualitative and quantitative pollen analysis of 13 honey samples from the apiaries of Kakinada and its vicinity and Diwancheruvu near Rajahmundry in the East Godavari district has brought to light that *Sapindus emarginatus* and *Eucalyptus globulus* during winter and *Borassus flabellifer*, *Syzygium cumini*, *Cocos nucifera*, *Capparis grandis*, *Citrus* sp. and *Morinda citrifolia* during summer constitute significant sources of nectar for the honey bees of this region. *Borassus flabellifer*, seen locally in profusion, as indicated by the high frequencies of its pollen in summer honeys merits consideration as an important and reliable source of nectar. The recent melittopalynological studies of the apiary honeys of Tenali and Repalle taluks of Guntur district^{2,10} also highlighted *Sapindus emarginatus* and *Borassus flabellifer* as reliable and noteworthy bee plants.

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