Melissopalynological analysis of apiary (*Apis mellifera*) honey from Guntur District, Andhra Pradesh

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ABSTRACT

The paper reports pollen analysis of twenty-four honey samples of *Apis mellifera* during winter season of 2007-2009 from Guntur District, Andhra Pradesh, South India. Ten honey samples were found to be unifloral. Grass pollen grains were dominant in four samples and the remaining six samples show dominance of *Mimosa pudica* pollen. Thirty-six pollen types belonging to twenty families were recorded in these honey samples. *Mimosa pudica* is identified as a major nectar producing taxon for honey bees for this study area.

Key-words: Melissopalynology, Apiary, Guntur District.

INTRODUCTION

Melissopalynology, one of the branches of palynology, is significant in Apiculture. Quantitative and qualitative analyses of pollen grains from honey samples help in identifying bee-forage plants of an area that enables to assess the potentiality of that area for bee-keeping industry. The amount of honey that can be harvested from bee colonies primarily depends upon the abundance and extent of nectar yielding plants within the foraging range of the bees. Melissopalynological analysis of honeys has been carried out in South India (Raja et al. 2014), Andaman and Nicobar Islands (Singh & Kar 2011), Maharashtra (Harugade & Chaphalkar 2013), Western Ghats and Tamil Nadu (Suresh Kumar et al. 2012) and Visakhapatnam, Andhra Pradesh (Devender et al. 2014; Devender & Ramakrishna 2015). Apart from India, melissopalynological analysis also has been carried out in different parts of the world (Agwu et al. 2013; Valle et al. 2007; Adeonipekun 2012; Özler 2015; Omer Kilic et al. 2016). In the present study, an attempt has been made to identify the key plants preferred by honey bees in the Guntur district of Andhra Pradesh to study the potentiality of the area for apiary industry.

MATERIAL AND METHODS

Twenty-four apiary (*Apis mellifera*) honey samples (200 ml each) were collected (Table 1) during winter season of 2007-09 from Guntur District, Andhra Pradesh at (16°20' N : 80°27' E). These were processed for pollen recovery using Erdtman's (1960) acetolysis technique. Three slides were prepared from each sample for identification of pollen types up to species level with the help of reference pollen slides of local flora and relevant literature.

Three hundred pollen taxa per sample were counted to record the percentage of pollen types. Honey with a predominant pollen type (> 45%) was termed as unifloral and the rest as multifloral. Louveaux et al. (1978), recognises four frequency classes, viz. predominant ($P = >45\%$); secondary ($S = 16\text{-}45\%$); important minor ($I = 3\text{-}15\%$) and minor ($M = <3\%$).

In the present study, we adopted the methodology of Louveaux et al. (1978) and thus, the pollen analysis for each honey sample was recorded based on frequencies of the pollen types.

RESULTS

All the honey samples were palynologically scanned and recorded thirty six pollen taxa *viz., Hygrophila auriculata, Rungia repens, Asteracantha longifolia, Justicia procumbens, Celosia argentea, Amaranthus viridis, Cocos nucifera, Phoenix sylvestris, Borassus flabellifer, Ageratum conyzoides, Vernonia cinerea, Helianthus annuus, Tridax procumbens, Ceiba pentandra, Bombax ceiba, Tamarindus indica, Capparis grandis, Terminalia arjuna, Brassica nigra, Cucumis sativus, Coccinia grandis,* Grass pollen, *Lagerstroemia parviflora, Mimosa pudica, Prosopis juliflora, Albizia lebbeck, Psidium guajava, Syzygium cumini, Eucalyptus globulus, Sesamum indicum, Dodonaea viscosa, Cardiospermum halicacabum, Capsicum frutescens, Triumfetta rhomboidea, Coriandrum sativum* and *Tribulus terrestris* belong to twenty families (Plate 1 & 2, Table 2).

Frequency of different pollen grains in the honey samples from Guntur District, Andhra Pradesh:

Sample No. G-T-Ka-AM1: *P*-Grass Pollen (58.08%), *S-Ageratum conyzoides* (29.12%), *I-Celosia argentea* (11.26%), *M-Psidium guajava* (1.54%).

Sample No. G-T-Ka-AM2: *P-Mimosa pudica* (54.48%), *S*-Grass pollen (27.59%), *I-Cocos nucifera* (10.34%), *Tamarindus indica* (5.86%), *M-Terminalia arjuna* (1.73%).

Sample No. G-T-Ch-AM3: *P-Nil, S*-Grass pollen (32.27%), *Cocos nucifera* (18.69%), *I-Mimosa pudica* (12.46%), *Cucumis sativus.* (12.46%), *Brassica nigra* (8.72%), *Syzygium cumini* (5.61%), *Albizia lebbeck* (4.67%), *Coriandrum sativum* (3.12%), M-*Vernonia cinerea* (2%).

Sample No. G-T-Ko-AM4: *P-Mimosa pudica* (45.9%), *S-Borassus flabellifer* (22.39%), *I-Helianthus annuus* (14.63%), *Cocos nucifera* (9.76%), *Hygrophila auriculata* (7.32%), M-Nil.

Sample No. G-T-Ka-AM5: *P-Mimosa pudica* (47.27%), *S-Lagerstroemia parviflora* (29.09%), *I*-Grass pollen (12.73%), *Tridax procumbens* (10.91%), *M - Nil.*

Sample No. G-T-Ka-AM6: *P-Nil, S*-Grass pollen (40.74%), *Rungia repens* (25.92%), *Mimosa pudica* (22.22%), *I-Tridax procumbens* (6.66%), *M-Ceiba pentandra* (2.59%), *Brassica nigra* (1.87%).

Sample No. G-T-Ko-AM7: *P-Nil, S*-Grass pollen (44.31%), *I-Psidium guajava* (15.57%), *Amaranthus viridis.* (14.28%), *Brassica nigra* (12.28%), *Ceiba pentandra* (10.63%), *M-Tridax procumbens* (2.93%).

Sample No. G-T-An-AM8: *P-Nil, S*-Grass pollen (26.31%), *Borassus flabellifer* (19.75%), *Psidium guajava* (16.48%), *I-Albizia lebbeck* (11.18%), *Tridax procumbens* (7.89%), *Amaranthus viridis* (6.57%), *Bombax ceiba* (5.26%), *Ceiba pentandra* (3.28%), *Asteracantha longifolia* (3.28%), *M–Nil.*

Sample No. G-T-Kp-AM9: *P-Nil, S-Amaranthus viridis* (40.83%), Grass pollen (40.55%), *I-Psidium guajava* (15.64%), M-*Hygrophila auriculata* (2.98%).

Sample No. G-T-Gu-AM10: *P-Nil, S*-Grass pollen *(20.72%), Sesamum indicum (20.4%), I-Borassus flabellifer* (13%), *Lagerstroemia parviflora* (9.09%), *Psidium guajava* (9.09%), *Amaranthus viridis* (6.81%), *Albizia lebbeck* (6.81%), *Brassica nigra* (4.54%), *Ceiba pentandra* (6.81%), *M-Dodonaea viscosa* (2.73%).

Sample No. G-M-M-AM11: *P-Mimosa pudica* (60%), *S*-Grass pollen (24%), *I-Cucumis sativus* (8%), *Psidium guajava* (8%), *M-Nil.*

Sample No. G-M-R-AM12: *P-Nil, S-Helianthus annuus* (37.26%), *Justicia procumbens* (24.02%), *I-Brassica nigra* (15.25%), *Celosia argentea* (9.92%), Grass pollen (10.32%), M-*Hygrophila auriculata* (1.31%), *Capsicum frutescens* (1.92%).

Sample No. G-M-M-AM13: *P-Nil, S-Mimosa pudica* (38.23%), *Capparis grandis* (21.72%),

Psidium guajava (16.35%), I-*Cucumis sativus* (10.09%), *Phoenix sylvestris* (11.23%), M-*Helianthus annuus* (1.42%), *Cardiospermum halicacabum* (0.96%).

Sample No. G-D-E-AM14: P-*Mimosa pudica* (55.54%), S-Grass pollen (27.78%), I-*Cucumis sativus* (5.56%), *Lagerstroemia parviflora* (5.56%), *Justicia procumbens* (5.56%), M-Nil.

Sample No. G-D-E-AM15: P-*Mimosa pudica* (55.17%), S-Grass pollen (27.58%), I-*Tridax procumbens* (6.89%), *Rungia repens* (5.74%), M-*Cucumis sativus* (2.29%), *Albizia lebbeck* (1.14%), *Brassica nigra* (1.19%).

Sample No. G-D-E-AM16: P-Grass pollen (49.18%), S-Nil, I-*Cucumis sativus* (12.56%), *Psidium guajava* (10.92%), *Brassica nigra* (8.19%), *Amaranthus viridis* (8.19%), *Albizia lebbeck* (5.46%), M-*Asteracantha longifolia* (2.77%), *Tribulus terrestris* (2.73%).

Sample No. G-D-Kz-AM17: P-Nil, S-*Lagerstroemia parviflora* (30.04%), Grass pollen (21%), I-*Amaranthus viridis* (13.03%), *Ceiba pentandra* (12.02%), *Borassus flabellifer* (9.03%), *Sesamum indicum* (6.02%), *Brassica nigra* (6.01%), M-*Tridax procumbens* (2.85%).

Sample No. G-Ts-Va-AM18: P-Nil, S-*Celosia argentea* (41.04%), *Coccinia grandis* (30.26%), I-*Borassus flabellifer* (14.04%), *Helianthus annuus* (12.32%), M-Grass pollen (2.34%).

Sample No. G-Ts-Va-AM19: P-Nil, S-*Coccinia grandis* (37.23%), *Borassus flabellifer* (26.63%), I-*Mimosa pudica* (13.02%), Grass pollen (1'.75%), *Eucalyptus globulus* (9.43%), M-*Celosia argentea* (1.94%).

Sample No. G-Ts-Ts-AM20: P-Nil, S-*Prosopis juliflora* (30%), Grass pollen (16.1%), I-*Mimosa pudica* (12.93%), *Psidium guajava* (11.42%), *Eucalyptus globulus* (15.57%), *Borassus flabellifer* (5.71%), *Triumfettar homboidea* (5.71%), M-*Amaranthus viridis* (2.56%).

Sample No. G-C-C-AM21: P-Grass pollen (60.03%), S-*Ageratum conyzoides* (17.42%), *Celosia argentea* (15.25%), I-*Psidium guajava* (5.28%), M-*Helianthus annuus* (2.02%).

Sample No. G-C-C-AM22: P-Grass pollen (61.44%), S-*Ageratum conyzoides* (25.07%), I-*Tridax procumbens* (9.12%), M-*Cucumis sativus* (2.24%), *Coriandrum sativum* (2.13%)

Sample No. G-V-Pv-AM23: P-Nil, S-*Mimosa pudica* (44.31%), Grass pollen (17.72%), I-*Lagerstroemia parviflora* (13.78%), *Psidium guajava* (13.78%), *Syzygium cumini* (7.69%), M-*Terminalia arjuna* (2.72%).

Sample No. G-V-Pv-AM24: P-Nil, S-*Mimosa pudica* (36.32%), *Cocos nucifera* (34.21%), Grass pollen (22.02%), I-*Prosopis juliflora* (5.72%), M-*Lagerstroemia parviflora* (1.73%).

DISCUSSION

Amongst the twenty four honey samples collected from the study area, ten samples were found unifloral and fourteen were multifloral. The unifloral samples were represented with predominant pollen types of *Mimosa pudica* in six samples *viz.*, 54.48% in Sample No. G-T-Ka-Am2, 45.9% in Sample No. G-T-Ko-Am4, 47.27% in Sample No. G-T-Ka-Am5, 60.00% in Sample No. G-M-M-Am11, 55.54% in Sample No. G-D-E-Am14 and 55.17% in Sample No. G-D-E-Am15, and Grass pollen in four samples *viz.*, 58.08% in Sample No. G-T-Ka-Am1, 49.18% in Sample No. G-D-E-Am16, 60.03% in Sample No. G-C-C-Am21 and 61.44% in Sample No. G-C-C-Am22 (Table 3).

Pollen of *Mimosa pudica* and grass pollen were recorded as "very frequent" class. The class "frequent" was represented by the pollen of *Amaranthus viridis*, *Borassus flabellifer*, *Brassica nigra*, *Cucumis sativus*, *Lagerstroemia parviflora*, *Tridax procumbens*, *Albizia lebbeck*, *Ceiba pentandra*, *Celosia argentea* and *Helianthus annuus*. The "Infrequent" class was represented by *Ageratum conyzoides*, *Cocos nucifera* and *Hygrophila auriculata*. The pollen taxa *viz.*, *Asteracantha longifolia*, *Bombax ceiba*, *Capsicum frutescens*, *Capparis grandis*, *Cardiospermum halicacabum*, *Coccinia grandis*, *Coriandrum sativum*, *Dodonaea viscosa*, *Eucalyptus globulus*, *Justicia procumbens*, *Phoenix sylvestris*, *Prosopis juliflora*, *Psidium guajava*, *Rungia repens*, *Sesamum indicum*,

Table 1: Inventory of the honey samples of *Apis mellifera* during winter season.

S. No.	Sample code	District	Mandal	Village	Date of collection
1	G-T-Ka-Am1	Guntur	Tenali	Katevaram	12-10-2007
2	G-T-Ka-Am2	Guntur	Tenali	Katevaram	11-10-2008
3	G-T-Ch-Am3	Guntur	Tenali	Chinaravuru	14-10-2008
4	G-T-Ko-Am4	Guntur	Tenali	Kolakaluru	16-10-2008
5	G-T-Ka-Am5	Guntur	Tenali	Katevaram	20-10-2008
6	G-T-Ka-Am6	Guntur	Tenali	Katevaram	12-11-2008
7	G-T-Ko-Am7	Guntur	Tenali	Kolakaluru	09-12-2008
8	G-T-An-Am8	Guntur	Tenali	Angalakuduru	13-12-2008
9	G-T-Kp-Am9	Guntur	Tenali	Kopalle	14-01-2009
10	G-T-Gu-Am10	Guntur	Tenali	Gudivada	25-02-2009
11	G-M-M-Am11	Guntur	Mangalagiri	Mangalagiri	05-11-2008
12	G-M-R-Am12	Guntur	Mangalagiri	Ramachandrapuram	18-12-2008
13	G-M-M-Am13	Guntur	Mangalagiri	Mangalagiri	26-12-2008
14	G-D-E-Am14	Guntur	Duggirala	Emani	10-11-2008
15	G-D-E-Am15	Guntur	Duggirala	Emani	15-11-2008
16	G-D-E-Am16	Guntur	Duggirala	Emani	02-12-2008
17	G-D-E-Am17	Guntur	Duggirala	Emani	06-02-2009
18	G-Ts-Va-Am18	Guntur	Tsundur	Valiveru	03-10-2007
19	G-Ts-Va-Am19	Guntur	Tsundur	Valiveru	24-01-2009
20	G-Ts-Ts-Am20	Guntur	Tsundur	Tsundur	18-02-2009
21	G-C-C-Am21	Guntur	Chebrolu	Chebrolu	15-11-2007
22	G-C-C-Am22	Guntur	Chebrolu	Chebrolu	25-11-2007
23	G-V-Pv-Am23	Guntur	Vemuru	Peravalipalem	02-11-2008
24	G-V-Pv-Am24	Guntur	Vemuru	Peravalipalem	04-11-2008

Table 2: Representation of pollen types in various families in winter honeys of *Apismellifera*.

S.No.	Name of the Family	Pollen Types
1	Acanthaceae	*Hygrophila auriculata, Rungia repens , Asteracantha longifolia, Justicia procumbens*
2	Amaranthaceae	*Celosia argentea, Amaranthus viridis*
3	Arecaceae	*Cocos nucifera, Phoenix sylvestris, Borassus flabellifer*
4	Asteraceae	*Ageratum conyzoides, Vernonia cinerea, Helianthus annuus, Tridax procumbens*
5	Bombacaceae	*Ceiba pentandra, Bombax ceiba*
6	Caesalpiniaceae	*Tamarindus indica*
7	Capparidaceae	*Capparis grandis*
8	Combretaceae	*Terminalia arjuna*
9	Brassicaceae	*Brassica nigra*
10	Cucurbitaceae	*Cucumis sativus, Coccinia grandis*
11	Poaceae	Grass pollen
12	Lythraceae	*Lagerstroemia parviflora*
13	Mimosaceae	*Mimosa pudica, Prosopis juliflora, Albizia lebbeck*
14	Myrtaceae	*Psidium guajava, Syzygium cumini, Eucalyptus globulus*
15	Pedaliaceae	*Sesamum indicum*
16	Sapindaceae	*Dodonaea viscosa, Cardiospermum halicacabum*
17	Solonaceae	*Capsicum frutescens*
18	Tiliaceae	*Triumfetta rhomboidea*
19	Apiaceae	*Coriandrum sativum*
20	Zygophyllaceae	*Tribulus terrestris*

Table 3: Frequency of predominant pollen types in unifloral winter honey samples of *Apis mellifera*

S. No	Sample Code	Predominant Types (S)
1	G-C-C-Am22	Grass pollen *(61.44%)*
2	G-C-CAm21	Grass pollen *(60.03%)*
3	G-T-Ka-Am1	Grass pollen *(58.08%)*
4	G-D-E-Am16	Grass pollen *(49.18%)*
5	G-M-M-Am11	*Mimosa pudica (60%)*
6	G-M-E-Am14	*Mimosa pudica (55.54%)*
7	G-D-E-Am15	*Mimosa pudica (55.17%)*
8	G-T-Ka-Am2	*Mimosa pudica (54.48%)*
9	G-T-Ka-Am5	*Mimosa pudica (47.27%)*
10	G-T-Ko-Am4	*Mimosa pudica (45.9%)*

Syzygium cumini, Tamarindus indica, Tribulus terrestris, Terminalia arjuna, Triumfetta rhomboidea and *Vernonia cinerea* were recorded as "rare" class type (Text Figure 1).

In total, thirty six pollen taxa belonging to twenty families were identified from winter honey samples of *Apis mellifera*. Of the thirty six pollen taxa, four belong to Asteraceae and Acanthaceae, three belong to Myrtaceae, Arecaceae and Mimosaceae, two taxa are referable to Amaranthaceae, Cucurbitaceae, Bombacaceae and Sapindaceae and one each referable to Poaceae, Caesalpiniaceae, Combretaceae, Brassicaceae, Apiaceae, Lythraceae, Pedaliaceae, Solanaceae, Capparidaceae, Zygrophyllaceae and Tiliaceae (Table 2).

The present study clearly indicates that the honey samples of Guntur District have strong palynological similarity with the Adilabad, Medak, Visakhapatnam, Karnool, Mahaboobnagar and Nizamabad districts of Andhra Pradesh and Telengana states (Ramakrishna & Swathi 2013; Chaya & Varma 2004; Devender et al. 2014; Devender & Ramakrishna 2015; Ramanujam & Khatija 1995; Ramakrishna & Bushan 2004).

The pollen grains in the honey samples of Guntur District *viz.*, *Ageratum conyzoides, Tridax procumbens, Eucalyptus globulus, Psidium guajava, Celosia argentea, Brassica nigra,* Grass pollen, *Bombex ceiba, Hygrophila auriculata, Borassus flabellifer, Cadriospermum helicacabum, Rungia repens, Vernonia cinerea, Coriandrum sativum* and *Sesamum indicum* are commonly
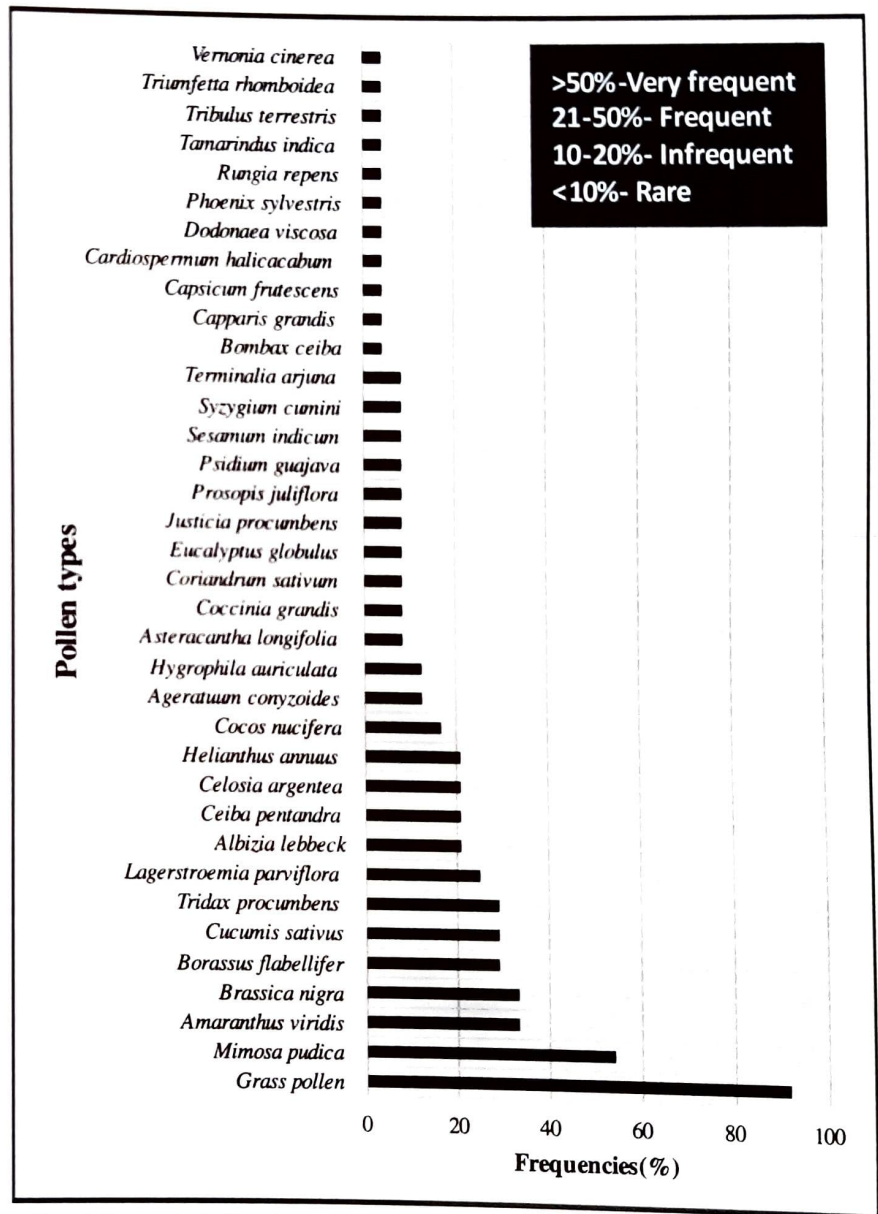
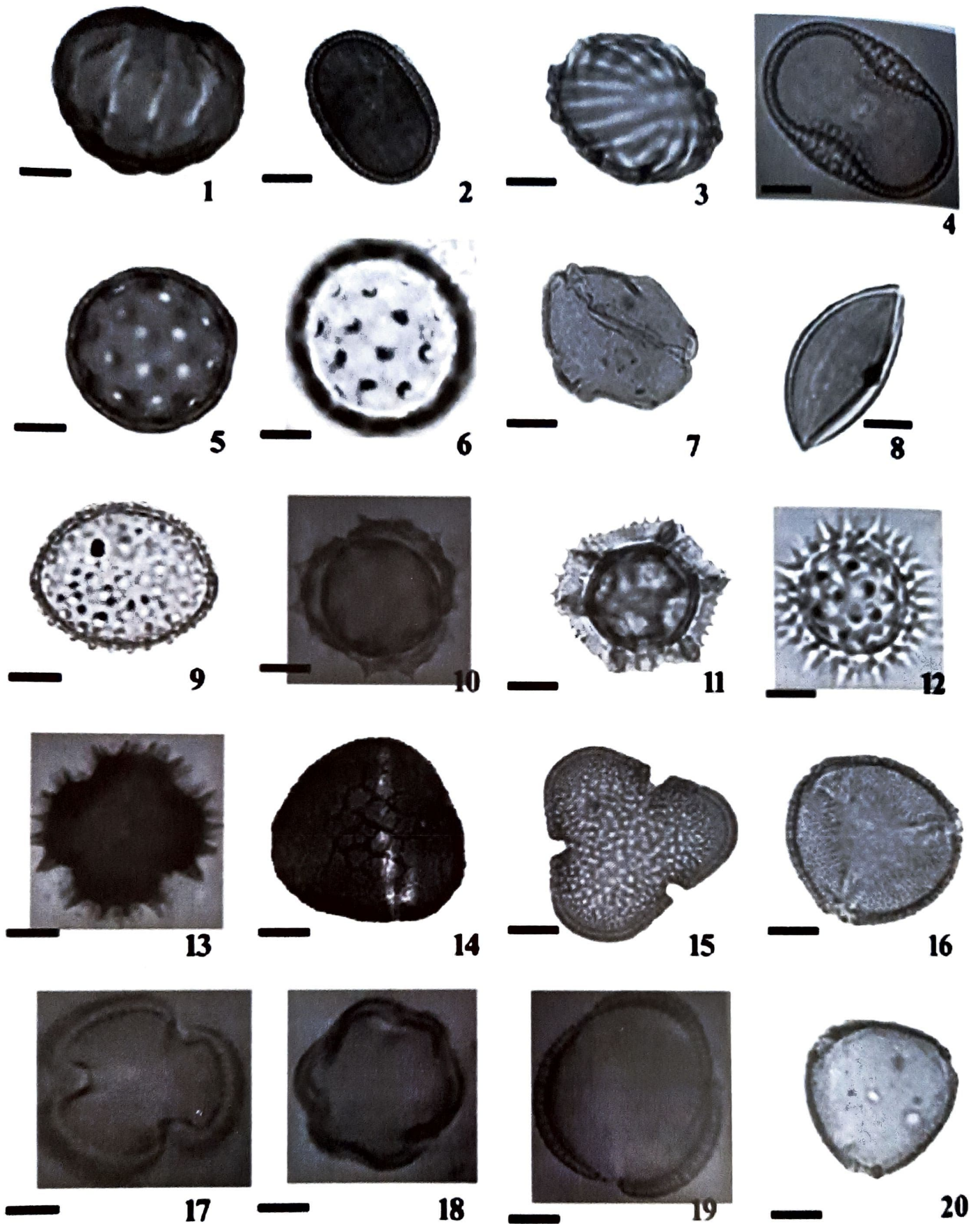**Text Figure 1:** Pollen frequency distribution in winter honeys of Apismellifera

Plate 1

1. *Hygrophila auriculata,* 2. *Rungia repens,* 3. *Asteracantha longifolia,* 4. *Justicia procumbens,* 5. *Celosia argentea,* 6. *Amaranthus viridis,* 7. *Cocos nucifera,* 8. *Phoenix sylvestris,* 9. *Borassus flabellifer,* 10. *Ageratum conyzoides,* 11. *Vernonia cinerea,* 12. *Helianthus annuus,* 13. *Tridax procumbens,* 14. *Ceiba pentandra,* 15. *Bombax ceiba,* 16. *Tamarindus indica,* 17. *Capparis grandis,* 18. *Terminalia arjuna,* 19. *Brassica nigra,* 20. *Cucumis sativus* (Scale bar: 10μm).
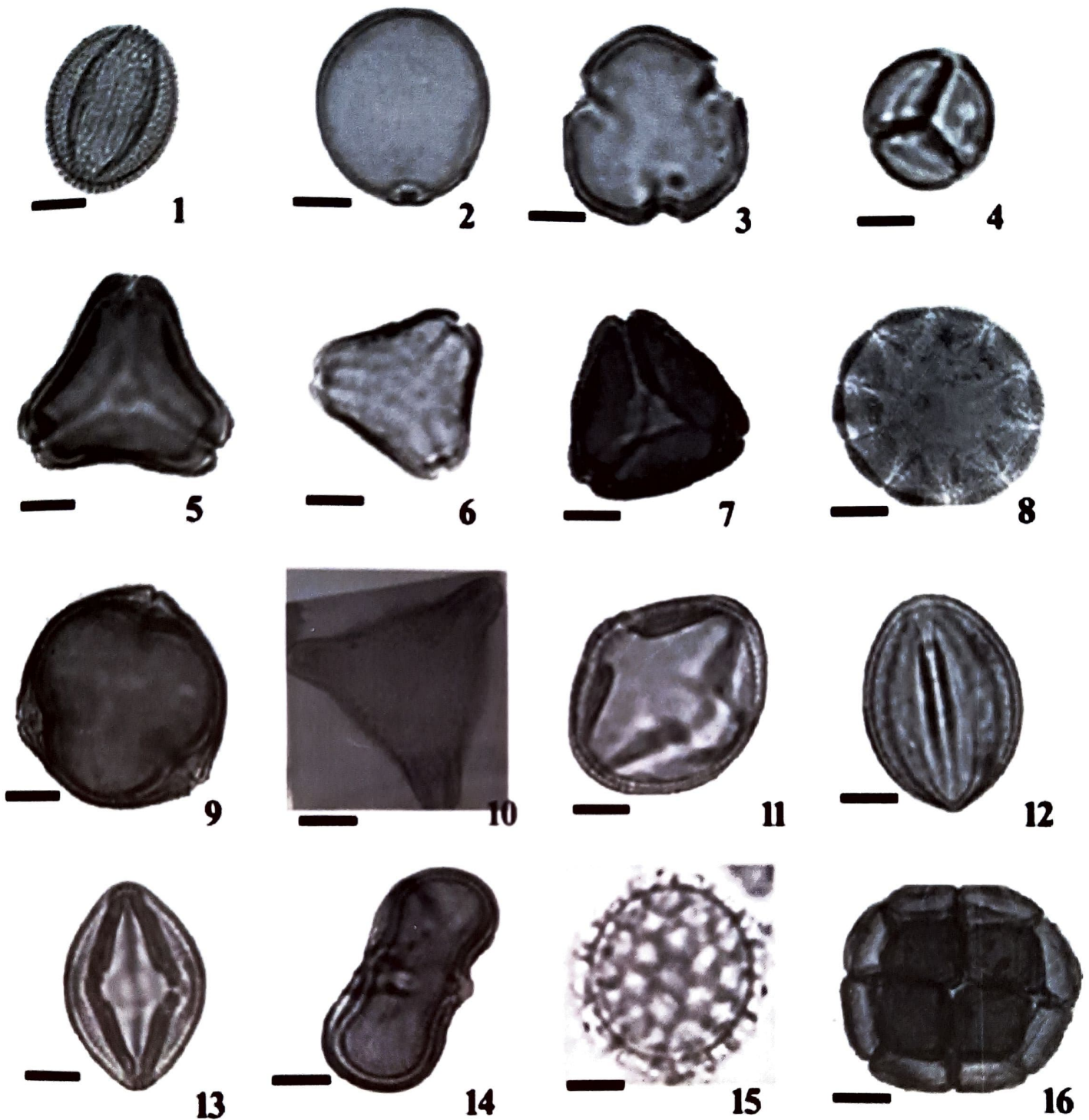
Plate 2

1. *Coccinia grandis*, 2. Grass pollen, 3. *Lagerstroemia parviflora*, 4. *Mimosa pudica*, 5. *Psidium guajava*, 6. *Syzygium cumini*, 7. *Eucalyptus globulus*, 8. *Sesamum indicum*, 9. *Dodonaea viscosa*, 10. *Cardiospermum halicacabum*, 11. *Capsicum frutescens*, 12. *Triumfetta rhomboidea*, 13. *Prosopis juliflora*, 14. *Coriandrum sativum* 15. *Tribulus terrestris*, 16. *Albizia lebbeck* (Scale bar: 10µm).

encountered in the honeys of Adilabad district (Ramakrishna & Swathi 2013).

The commonly recorded pollen grains in honey samples of Medak and Guntur districts are *Asteracantha longifolia, Rungia repens, Celocia argentea, Phoenix sylvestris, Ageratum conyzoides,* *Helianthus annuus, Tridax procumbens, Brassica nigra, Eucalyptus globulus, Triumfetta rhomboidea* and *Coriandrurm sativum* (Chaya & Varma 2004).

The pollen grains of *Ageratum conyzoides, Albizia lebbeck, Eucalyptus globulus, Syzygium cumini, Psidium guajava, Mimosa pudica, Vernonia cinerea,*

Prosopis juloflora, Bombax ceiba, Ceiba pentandra, Cocos nucifera, Borassus flabellifer, Phoenix sylvestris, Justicia procumbens, Rungia repens, Terminalia arjuna, Brassica nigra and *Lagerstroemia parviflora* have been recorded in the honey samples of both Visakhapatnam and Guntur districts (Devender et al. 2014; Devender & Ramakrishna 2015). The pollen grains of *Terminalia arjuna, Lagerstroemia parviflora, Bombax ceiba, Helianthus annuus* and *Syzygium cumini* have been recorded in both the honey samples of Karnool and Guntur districts (Ramanujam & Khatija 1995).

The common pollen grains recorded in the honey samples of Mahaboobnagar and Guntur districts are *Terminalia arjuna, Lagerstroemia parviflora, Bombax ceiba, Ageratum conyzoides, Phoenix sylvestris, Syzygium cumini* and *Albizia lebbeck* (Ramanujam & Khatija 1995). The pollen grains in the honeys of Guntur District *viz., Helianthus annuus, Terminalia arjuna, Bombax ceiba, Lagerstroemia parviflora, Sesamum indicum*, grass pollen, *Phoenix sylvestris, Albizia lebbeck* and *Ageratum conyzoides* have been commonly encountered in the honey samples of Nizamabad District (Ramakrishna & Bushan 2004). The pollen grains in the honey samples of Guntur District *viz., Borassus* sp., *Cocos* sp., *Phoenix* sp., *Mimosa* sp. and Asteraceae types was common in the honey samples of southern India (Raja et al. 2014).

The present study also indicates that the honey samples of Guntur District possess strong palynological similarity with various other parts of the world. The commonly recorded forage families in Argentina are Apiaceae, Asteraceae, Brassicaceae, Cucurbitaceae, Myrtaceae, Poaceae, Zygophyllaceae and Solanaceae (Valle et al. 2007). The families Asteraceae, Brassicaceae, Poaceae, Apiaceae, Myrtaceae and Amaranthaceae are common bee forage families in Turkey (Kilic et al. 2015; Özler 2016). The families Acanthaceae, Amaranthaceae, Asteraceae, Myrtaceae, Arecaceae, Bombacaceae, Combretaceae, Caesalpiniaceae, Mimosaceae, Sapindaceae, Solanaceae and Poaceaea are common bee forage families in Nigeria (Adeonipekun 2012; Agwu et al. 2013). As revealed from the present analysis, the pollen grains of all the above mentioned families have been recovered from the honey samples of Guntur District, Andhra Pradesh.

Based on the foregoing account it can inferred that honey samples of apiary (*Apis mellifera*) from Guntur District empower us to recognize the bee foraging plants. These plants embody the essential nectar source to the bees in the winter. Hence, it denotes that the Guntur District is appropriate to develop apiary ventures and augment the honey production due to procurable of more bee foraging plants.

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