Chapter

Melissopalynological Analysis of Honeys from Paderu Forest Division of Visakhapatnam District in Andhra Pradesh, India

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Abstract

Palynological examination of 17 honey samples procured from 8 localities in Paderu forest division in Visakhapatnam district, Andhra Pradesh, India, produced assemblage of pollen in terms of quantity and diversity. According to melissopalynological assessment of the honey samples, 6 were unifloral, i.e., 3 from *Ageratum conyzoides* and 1 each from *Schleichera oleosa*, *Psidium guajava*, and *Mimosa pudica*, and 11 were multifloral. The dominant taxa include *Mimosa pudica*, *Syzygium cumini*, and *Centipeda minima*. The taxa such as *Terminalia arjuna*, *Dendrophthoe falcata*, *Lamiaceae*, *Asteraceae*, and *Phyllanthus emblica* were minor sources of nectar and bee forage, as indicated by low frequencies of their pollen. The numerous pollen types and their diversity show that bees travel considerable distance to collect the nectar for honey production.

Keywords: pollen analysis, honey, Paderu forest division, unifloral, multifloral

1. Introduction

Melissopalynology is a branch of plant sciences that studies pollen found in honey. Precision in interpreting pollen data recovered from the honey has always been a primary goal of those who study pollen and honey. We are using pollen count to determine the nectar source of a honey sample and recognize the types and percentage of recovered pollen in the honey. This study is the fact that honey bees utilize certain natural raw materials which are identifiable in honey. These natural raw materials include pollen and nectar [1]. The growth and development of honey bees depend on nectar as the source of carbohydrates and pollen as the source of proteins [2, 3]. Palynological analyses of honey and pollen loads are used to know about honey bee foraging ecology, habitat and vegetation [4–11]. Pollen of honey samples provides reliable information on floral resources of honeys along with the relative preferences of bees among the diverse assemblages of plant species flowering synchronously [12, 13].

The significant melissopalynological works have been reported from different sectors of this state, dealing with pollen analysis of honey [14–16]. Similar melissopalynological research work has been worked out in Karnataka [17–19],

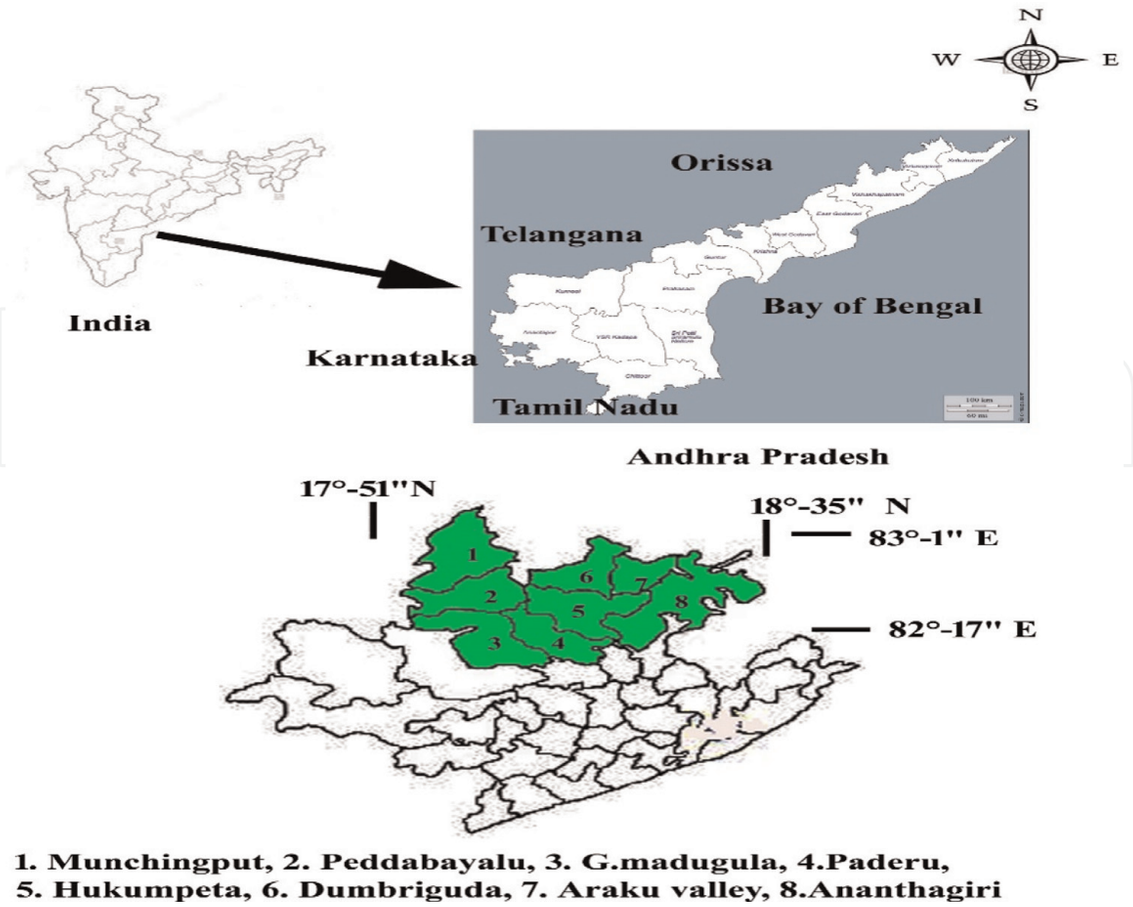

Figure 1.
Study area of Paderu forest division in Visakhapatnam district, Andhra Pradesh.

Bihar [20], Madhya Pradesh [21], Maharashtra [22], Uttarakhand [23–26], Uttar Pradesh [27, 28], and West Bengal [29–32], but the information is still rather sketchy. Qualitative and quantitative melissopalynological analyses in the east coast regions of India demonstrate that these regions are rich in bee plants with potential for producing adequate unifloral honeys, have an extended honey flow period, and thus can be utilized commercially for a moderate- to large-scale apiculture enterprises [33].

The study area includes the Paderu forest division of Visakhapatnam district, Andhra Pradesh. This division is the higher altitude zone in the hilly tracts of Eastern Ghats of Andhra Pradesh. It has the second highest tribal population in Andhra Pradesh. Paderu forest division (**Figure 1**) lies in between latitudes of 17°-51″ and 18°-35″ north and longitude of 82°-17″ and 83°-1″ east with a total geographical area of 3,24,965 ha, out of which the forest area under the control of the division is 104811.91 ha. The division comprises of a series of hills with an average annual rainfall of 2800 mm and a rich diversity of plant wealth.

2. Materials and methods

The materials for the present study are 17 honey samples (50 ml each) that were procured from 8 different blocks of Paderu forest division during 2011–2013, i.e., 3 samples from Ananthagiri (Af-13, Af-34, and Af-57), 4 from Paderu (Af-10, Af-40,

Af-44, and Af-64), 2 from Munchingiputtu (Af-14 and Af-54), 2 from G.Madugula (Af-3 and Af-48), 3 from Peddabayalu (Af-11, Af-53, and Af-65), and one each from Araku Valley (Af-37), Dumbriguda (Af-9), and Hukumpeta (Af-51). For palynological assessment, the honey samples were chemically processed using the acetolysis method, i.e., 1 ml of honey sample was dissolved in 10 ml of distilled water and centrifuged. The supernatant liquid was drawn out. The resultant sediment was treated with 5 ml of glacial acetic acid and centrifuged. After decanting acetic acid, the sediment was treated with acetolysis mixture (5 ml). It was prepared by nine parts of acetic anhydride and one part of con. sulfuric acid and then heated under water bath until the liquid turned chestnut-brown color. After cooling it was again centrifuged and the supernatant liquid was decanted. The sediment then treated with glacial acetic acid, later centrifuged, and the supernatant liquid was decanted off. And the sediment was washed with distilled water, and 50% aqueous glycerin (5 ml) was added and centrifuged for 10 min. The supernatant liquid was decanted off, and the tubes were inverted upside down on a filter paper for a few minutes [34].

The pollen sediment was taken on a pellet of glycerin jelly and transferred to the center of the slide. After being warmed slightly, the melted jelly with pollen sediment was covered by cover slip. Cover glass was later sealed with paraffin wax and labeled with their respective codes. Three slides were prepared for each sample and studied critically for their pollen contents.

Identification of pollen recovered from honey samples were carried out through the consultation of reference pollen slides available in Paleobotany and Palynology lab, UCS, Saifabad, OU. Quantitative pollen analysis was based on the method recommended by the International Commission for Bee Botany [6]. Pollen contents were taken at random, covering the maximum mounted area to avoid repletion. Once identified and counted, the pollen grains were placed into one of following pollen frequency classes-predominant pollen types (>45%), secondary pollen types (16–45%), important minor pollen types (3–15%), and minor pollen types (<3%). Honey samples containing more than 45% of a single type of pollen were considered as unifloral honey. The pollen types were placed into arboreal and non-arboreal taxa for making honey pollen spectra (**Figure 2**). A detailed list which included sample number, locality, nature and type of honey, collection season, and frequency of pollen types recovered is given in **Table 1**.

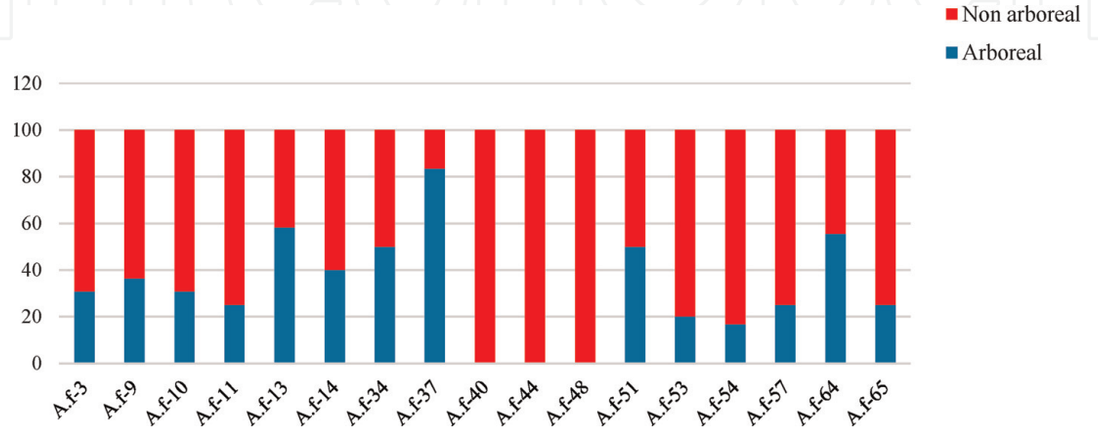

Figure 2.
Pollen spectra showing frequency of non-arboreal and arboreal taxa from different honeys of Paderu forest division.

S. no	Sample code	Locality	Nature of honey	Type of honey	Season collected	Predominant pollen type (>45%)	Secondary pollen types (16–45%)	Important minor pollen types (3–15%)	Minor pollen types (1–3%)	Pollen present (0.5–<1%)
1	V-P-GM-Bp-AF-3	G.Madugula	Multifloral	Squeezed	Spring	—	*Carum copticum* (21.74%)	Urticaceae type (15.02%), *Eucalyptus globulus* (13.22%), *Syzygium cumini* (12.78%), *Psidium guajava* (9.40%), *Tridax procumbens* (6.05%), *Blumea oxyodonta* (4.70%), *Bombax ceiba* (4.03%), *Brassica nigra* (3.81%), *Vernonia cinerea* (3.65%)	*Spilanthes calva* (2.69%), *Hakea laurina* (1.79%), *Saccharum officinarum* (1.12%)	—
2	V-P-DG-Vb-AF-9	Dumbriguda	Multifloral	Squeezed	Spring	—	*Mimosa pudica* (28.62%)	*Crotalaria juncea* (13.01%), *Tridax procumbens* (8.57%), *Psidium guajava* (8.55%), *Andrographis echioides* (8.17%), *Terminalia arjuna* (7.94%), *Schleichera oleosa* (7.06%), *Commelina suffruticosa* (5.57%), *Ageratum conyzoides* (5.20%)	*Dendrophthoe falcata* (2.60%), *Acacia chundra* (2.48%), *Pedalium murex* (2.23%)	—
3	V-P-P-Sa-AF-10	Paderu	Unifloral	Squeezed	Spring	*Ageratum conyzoides* (68.25%)	—	*Schleichera oleosa* (7.93%), *Parkinsonia aculeata* (6.03%), *Citrullus lanatus* (3.17%)	*Peltophorum pterocarpum* (2.22%), *Crotalaria juncea* (2.22%), *Ocimum basilicum* (2.53%), *Tridax procumbens* (1.90%), *Mimosa pudica* (1.58%), *Terminalia arjuna* (1.58%)	*Cyperus rotundus* (0.95%), *Acacia chundra* (0.95%), *Pedalium murex* (0.69%)
4	V-P-PB-PB-AF-11	Peddabayalu	Multifloral	Squeezed	Autumn	—	—	*Coriandrum sativum* (15.90%), *Mimosa pudica* (15.19%), *Syzygium cumini* (12.36%), *Ageratum conyzoides* (11.30%),	*Vicoa indica* (2.47%), *Amaranthus spinosus* (2.47%), *Pedalium murex* (2.47%),	—

S. no	Sample code	Locality	Nature of honey	Type of honey	Season collected	Predominant pollen type (>45%)	Secondary pollen types (16–45%)	Important minor pollen types (3–15%)	Minor pollen types (1–3%)	Pollen present (0.5–<1%)
								Ocimum sanctum (6.00%), *Schleichera oleosa* (5.30%), *Eucalyptus globulus* (4.94%), *Polygonum barbatum* (3.53%), *Blumea oxyodonta* (3.53%), *Casuarina equisetifolia* (3.18%)	*Vernonia cinerea* (2.12%), *Cajanus cajan* (2.12%), *Solanum nigrum* (1.76%), *Celosia argentea* (1.41%), *Lagerstroemia parviflora* (1.06%), *Commelina suffruticosa* (1.41%), *Xanthium strumarium* (1.48%)	
5	V-P-AG-Ch-AF-13	Ananthagiri	Unifloral	Squeezed	Autumn	*Schleichera oleosa* (55.00%)	—	*Mimosa pudica* (13.07%), *Eucalyptus globulus* (8.65%), *Phyllanthus emblica* (6.92%), *Dendrophthoe falcata* (3.07%), *Leucas aspera* (3.69%)	*Manilkara zapota* (2.88%), *Psidium guajava* (1.73%), *Careya arborea* (1.69%), *Vicoa indica* (1.50%), *Dillenia pentagyna* (1.34%)	*Clerodendrum inerme* (0.46%)
6	V-P-MUN-L-AF-14	Munchingiputtu	Multifloral	Squeezed	Autumn	—	—	*Eucalyptus globulus* (13.46%), *Tridax procumbens* (8.77%), *Centipeda minima* (8.32%), *Ageratum conyzoides* (7.41%), *Terminalia arjuna* (6.80%), *Psidium guajava* (6.80%), *Crotalaria juncea* (6.95%), *Syzygium cumini* (6.95%), *Commelina suffruticosa* (6.95%), *Sapindus emarginatus* (4.84%), *Erythrina variegata* (3.02%), *Leucas aspera* (3.78%)	*Datura stramonium* (2.26%), *Cassia occidentalis* (2.42%), *Vernonia cinerea* (2.11%), *Citrullus lanatus* (2.11%), *Albizia lebbeck* (1.96%), *Conyza stricta* (1.96%), *Lannea coromandelica* (1.66%), *Lantana camara* (1.47%)	—

S. no	Sample code	Locality	Nature of honey	Type of honey	Season collected	Predominant pollen type (>45%)	Secondary pollen types (16–45%)	Important minor pollen types (3–15%)	Minor pollen types (1–3%)	Pollen present (0.5–<1%)
7	V-P-AG-Gb-AF-34	Ananthagiri	Unifloral	Squeezed	Spring	*Ageratum conyzoides* (81.03%)	—	*Phyllanthus emblica* (12.06%), *Madhuca indica* (5.86%)	*Saccharum officinarum* (1.05%)	—
8	V-P-AR-Me-AF-37	Araku Valley	Unifloral	Squeezed	Spring	*Psidium guajava* (55.03%)	*Mimosa pudica* (24.59%)	*Terminalia arjuna* (10.53%), *Delonix regia* (5.85%)	*Acacia chundra* (2.34%), *Gardenia lucida* (1.66%)	—
9	V-P-P-Sp-AF-40	Paderu	Unifloral	Squeezed	Spring	*Ageratum conyzoides* (92.83%)	—	*Dendrophthoe falcata* (4.98%)	*Tridax procumbens* (2.19%)	—
10	V-P-P-Vm-AF-44	Paderu	Unifloral	Squeezed	Spring	*Mimosa pudica* (69.57%)	—	*Hyptis suaveolens* (14.56%), *Conyza stricta* (13.59%)	*Tridax procumbens* (1.26%), *Cardiospermum halicacabum* (1.02%)	—
11	V-P-GM-Ak-AF-48	G.Madugula	Multifloral	Squeezed	Spring	—	*Mimosa pudica* (32.91%), *Conyza stricta* (28.30%), *Tridax procumbens* (17.81%).	*Pedalium murex* (5.24%), *Hyptis suaveolens* (3.56%), *Saccharum officinarum* (3.18%), *Sida acuta* (3.14%), *Ageratum conyzoides* (3.14%)	*Tribulus terrestris* (2.72%)	—
12	V-P-HP-R-AF-51	Hukumpeta	Multifloral	Squeezed	Spring	—	*Eucalyptus globulus* (35.48%), *Mimosa pudica* (17.41%).	*Hygrophila auriculata* (14.83%), *Cocos nucifera* (11.61%), *Borassus flabellifer* (10.96%), *Cucumis sativus* (9.71%).	—	—
13	V-P-PB-L-AF-53	Peddabayalu	Multifloral	Squeezed	Spring	—	*Syzygium cumini* (41.82%), *Centipeda minima* (18.87%)	*Mimosa pudica* (14.59%), *Vernonia cinerea* (11.08%), Urticaceae type (6.80%)	*Caesalpinia bonduc* (1.36%), *Bombax ceiba* (2.33%), *Dendrophthoe falcata* (1.36%)	*Sida acuta* (0.97%), *S. cordata* (0.82%)

S. no	Sample code	Locality	Nature of honey	Type of honey	Season collected	Predominant pollen type (>45%)	Secondary pollen types (16–45%)	Important minor pollen types (3–15%)	Minor pollen types (1–3%)	Pollen present (0.5–<1%)
14	V-P-MUN-Sk-AF-54	Munchingiputtu	Multifloral	Squeezed	Autumn	—	*Syzygium cumini* (37.63%), *Centipeda minima* (18.70%), *Mimosa pudica* (18.27%)	Urticaceae type (11.82%), *Vernonia cinerea* (7.74%), *Tridax procumbens* (5.84%)	—	—
15	V-P-AG-Mt-AF-57	Ananthagiri	Multifloral	Squeezed	Autumn	—	*Syzygium cumini* (26.97%)	*Spilanthes calva* (13.40%), *Mimosa pudica* (13.24%), *Centipeda minima* (12.43%), *Cyathocline purpurea* (12.76%), *Leucaena leucocephala* (10.10%), *Tridax procumbens* (5.71%), *Vernonia cinerea* (5.39%)	—	—
16	V-P-P-Rb-AF-64	Paderu	Multifloral	Squeezed	Autumn	—	*Tridax procumbens* (27.95%), *Schleichera oleosa* (19.88%), *Erythrina variegata* (16.42%)	*Eucalyptus globulus* (12.96%), *Leucaena leucocephala* (6.34%), Urticaceae type (5.47%), *Cocos nucifera* (4.32%), *Amaranthus spinosus* (3.45%), *Dendrophthoe falcata* (3.21%)	—	—
17	V-P-PB-L-AF-65	Peddabayalu	Multifloral	Squeezed	Autumn	—	*Mimosa pudica* (41.0%), *Schleichera oleosa* (26.61%), *Dendrophthoe falcata* (19.42%)	*Hakea laurina* (12.97%)	—	—

Table 1.
Pollen content in honey samples of Paderu forest division in Visakhapatnam district.

3. Palynological results

The qualitative and quantitative analyses of 17 squeezed honey samples procured from different blocks of Paderu forest division in Visakhapatnam district of Andhra Pradesh were conducted. The pollen results provide new insights into the pollen composition of these honey samples. A total of 69 pollen morphotypes (**Figures 3–5**) in 35 families were identified, including 65 entomophilous pollen

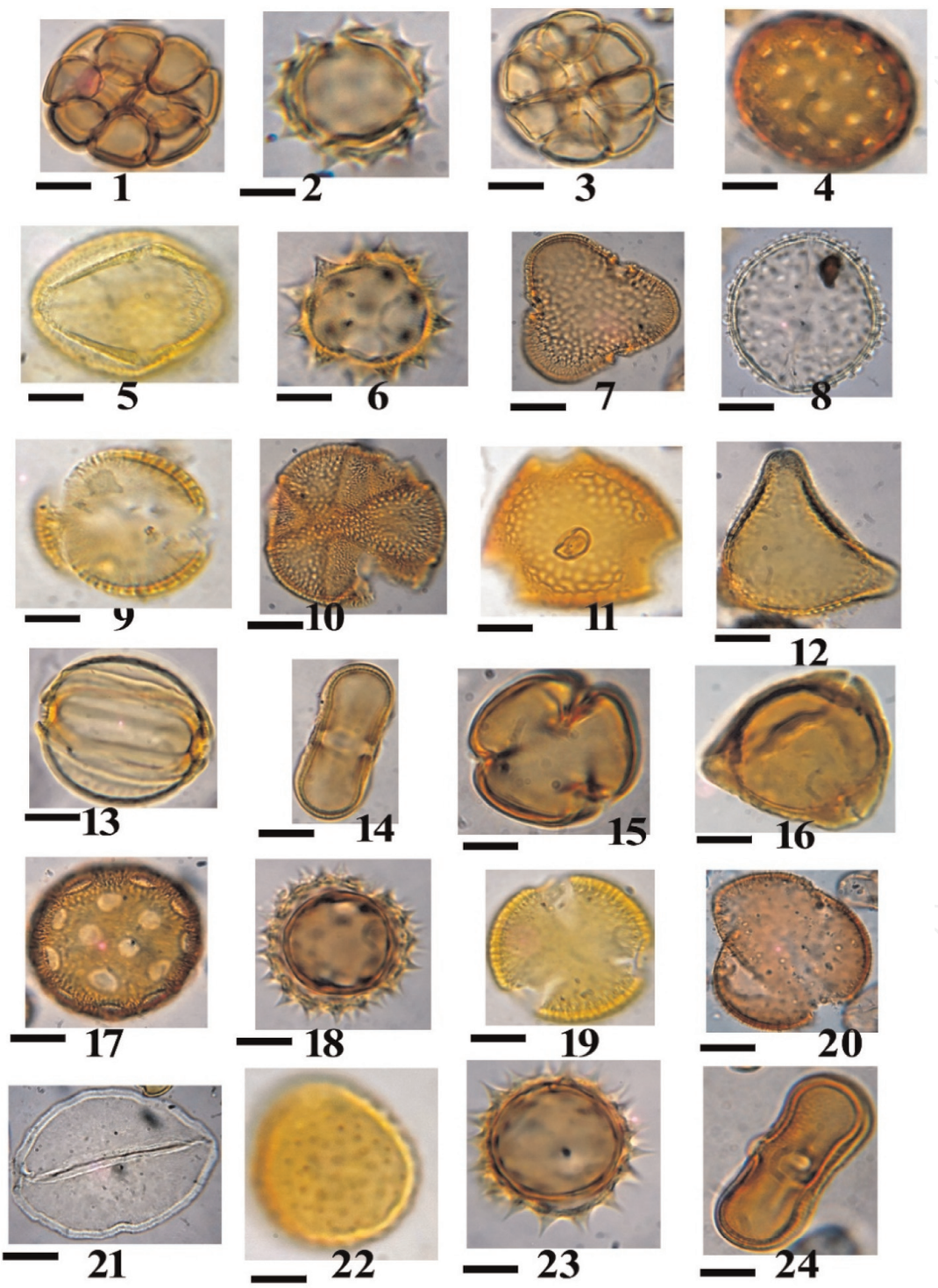

Figure 3.
(1) Acacia chundra, (2) Ageratum conyzoides, (3) Albizia lebbeck, (4) Amaranthus spinosus, (5) Andrographis echioides, (6) Blumea oxyodonta, (7) Bombax ceiba, (8) Borassus flabellifer, (9) Brassica nigra, (10) Caesalpinia bonduc, (11) Cajanus cajan, (12) Cardiospermum halicacabum, (13) Careya arborea, (14) Carum copticum, (15) Cassia occidentalis, (16) Casuarina equisetifolia, (17) Celosia argentea, (18) Centipeda minima, (19) Citrullus lanatus, (20) Clerodendrum inerme, (21) Cocos nucifera, (22) Commelina suffruticosa, (23) Conyza stricta, and (24) Coriandrum sativum. Scale bar: 10 μm.

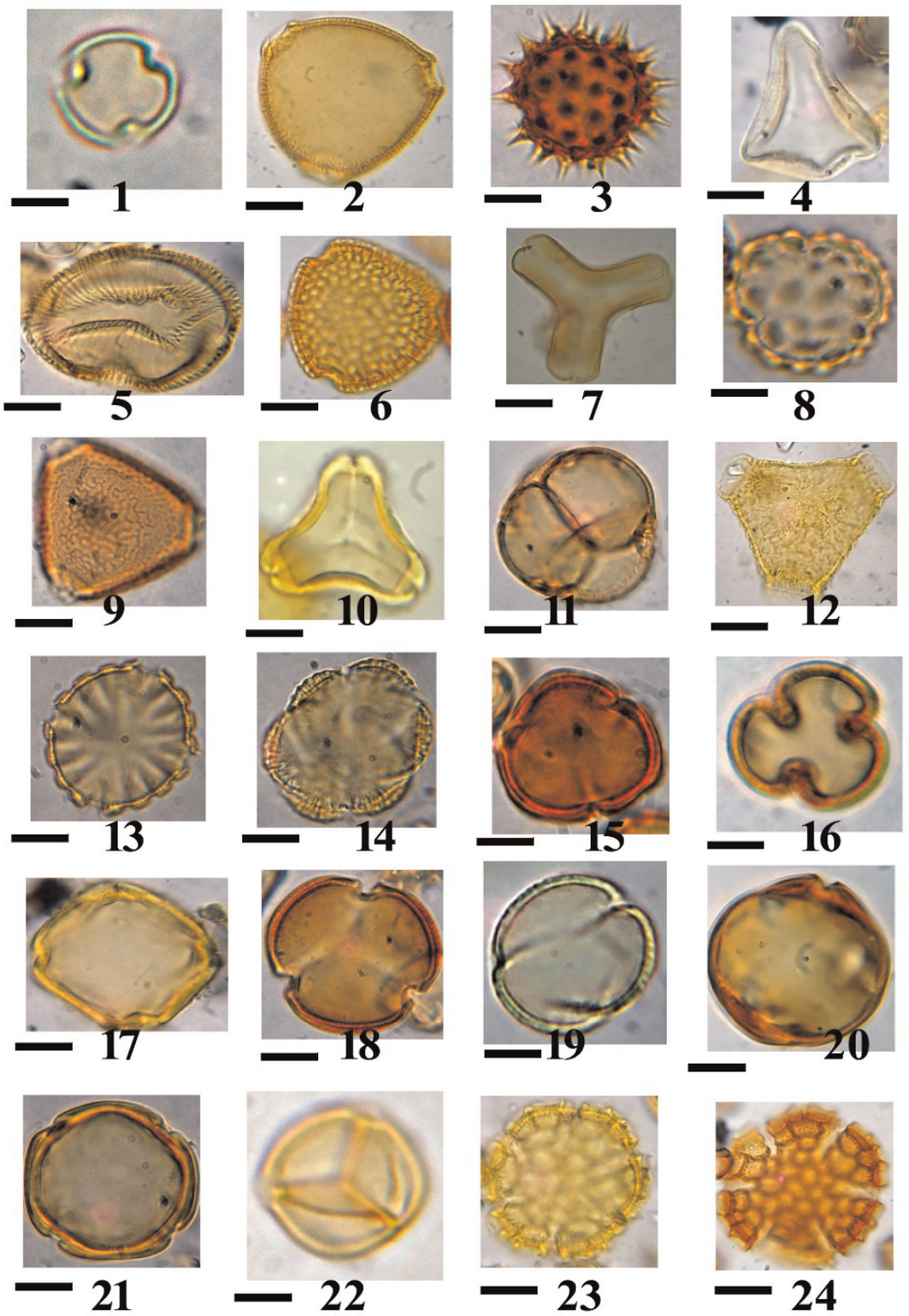

Figure 4.
(1) Crotalaria juncea, (2) Cucumis sativus, (3) Cyathocline purpurea, (4) Cyperus rotundus, (5) Datura stramonium, (6) Delonix regia, (7) Dendrophthoe falcata, (8) Dillenia pentagyna, (9) Erythrina variegata, (10) Eucalyptus globulus, (11) Gardenia lucida, (12) Hakea laurina, (13) Hygrophila auriculata, (14) Hyptis suaveolens, (15) Lagerstroemia parviflora, (16) Lannea coromandelica, (17) Lantana camara, (18) Leucaena leucocephala, (19) Leucas aspera, (20) Madhuca indica, (21) Manilkara zapota, (22) Mimosa pudica, (23) Ocimum basilicum, and (24) Ocimum sanctum. Scale bar: ▬ *10 μm.*

types (i.e., *Acacia chundra*, *Ageratum conyzoides*, *Albizia lebbeck*, *Andrographis echioides*, *Blumea oxyodonta*, *Bombax ceiba*, *Borassus flabellifer*, *Brassica nigra*, *Caesalpinia bonduc*, *Cajanus cajan*, *Cardiospermum halicacabum*, *Careya arborea*, *Carum copticum*, *Cassia occidentalis*, *Casuarina equisetifolia*, *Centipeda minima*,

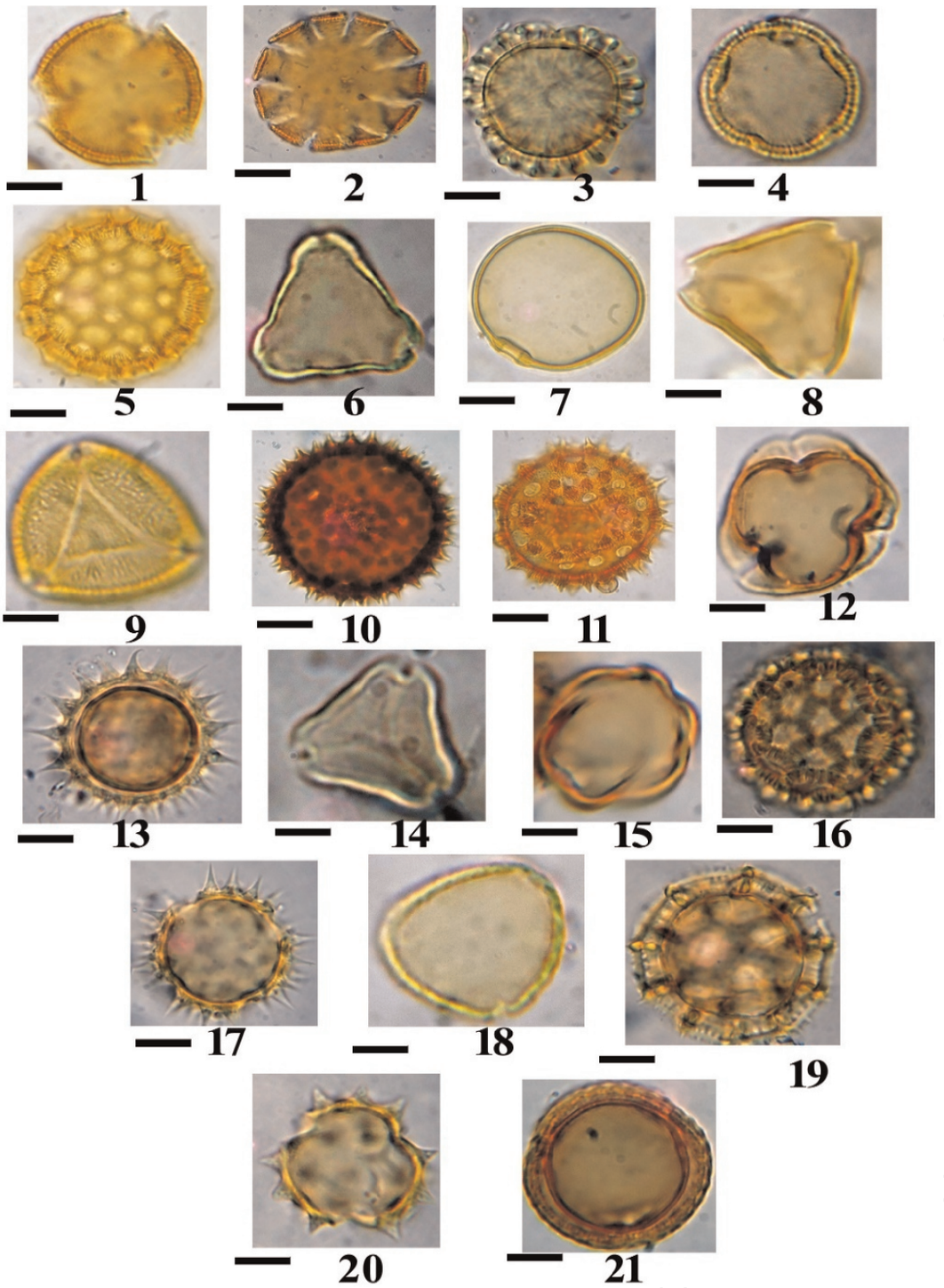

Figure 5.
(1) Parkinsonia aculeata, (2) Pedalium murex, (3) Peltophorum pterocarpum, (4) Phyllanthus emblica, (5) Polygonum barbatum, (6) Psidium guajava, (7) Saccharum officinarum, (8) Sapindus emarginatus, (9) Schleichera oleosa, (10) Sida acuta, (11) S. cordata, (12) Solanum nigrum, (13) Spilanthes calva, (14) Syzygium cumini, (15) Terminalia arjuna, (16) Tribulus terrestris, (17) Tridax procumbens, (18) Urticaceae type, (19) Vernonia cinerea, (20) Vicoa indica, and (21) Xanthium strumarium. Scale bar: 10 μm.

Citrullus lanatus, *Clerodendrum inerme*, *Cocos nucifera*, *Commelina suffruticosa*, *Conyza stricta*, *Coriandrum sativum*, *Crotalaria juncea*, *Cucumis sativus*, *Cyathocline purpurea*, *Datura stramonium*, *Delonix regia*, *Dendrophthoe falcata*, *Dillenia pentagyna*, *Erythrina variegata*, *Eucalyptus globulus*, *Gardenia lucida*, *Hakea laurina*, *Hygrophila auriculata*, *Hyptis suaveolens*, *Lagerstroemia parviflora*, *Lannea coromandelica*, *Lantana camara*, *Leucaena leucocephala*, *Leucas aspera*, *Madhuca indica*, *Manilkara zapota*, *Mimosa pudica*, *Ocimum basilicum*, *O. sanctum*,

Parkinsonia aculeata, *Pedalium murex*, *Peltophorum pterocarpum*, *Phyllanthus emblica*, *Polygonum barbatum*, *Psidium guajava*, *Sapindus emarginatus*, *Schleichera oleosa*, *Sida acuta*, *S. cordata*, *Solanum nigrum*, *Spilanthes calva*, *Syzygium cumini*, *Terminalia arjuna*, *Tribulus terrestris*, *Tridax procumbens*, Urticaceae type, *Vernonia cinerea*, *Vicoa indica*, *Xanthium strumarium*) and 4 anemophilous pollen types (i.e., *Amaranthus spinosus*, *Celosia argentea*, *Cyperus rotundus*, and *Saccharum officinarum*). Pollen analysis data of each sample is discussed below according to provenance of the samples.

G.Madugula (V-P-GM-Bp-AF-3, spring collection): the sample proved to be multifloral with secondary pollen taxa including *Carum copticum* (21.74%), followed by important minor pollen types, Urticaceae type (15.02%), *Eucalyptus globulus* (13.22%), *Syzygium cumini* (12.78%), *Psidium guajava* (9.40%), *Tridax procumbens* (6.05%), *Blumea oxyodonta* (4.70%), *Bombax ceiba* (4.03%), *Brassica nigra* (3.81%), and *Vernonia cinerea* (3.65%).

Dumbriguda (V-P-DG-Vb-AF-9, spring collection): the sample procured is productive and proved to be multifloral with secondary pollen taxa *Mimosa pudica* (28.62%). *Crotalaria juncea* (13.01%), *Tridax procumbens* (8.57%), *Psidium guajava* (8.55%), *Andrographis echioides* (8.17%), *Terminalia arjuna* (7.94%), *Schleichera oleosa* (7.06%), *Commelina suffruticosa* (5.57%), and *Ageratum conyzoides* (5.20%) are recorded as important minor pollen types.

Paderu (V-P-P-Sa-AF-10, spring collection): the sample proved as unifloral with one predominant pollen taxon, *Ageratum conyzoides* (68.25%), followed by *Schleichera oleosa* (7.93%), *Parkinsonia aculeata* (6.03%), and *Citrullus lanatus* (3.17%) as important minor pollen taxa.

Peddabayalu (V-P-PB-PB-AF-11, autumn collection): the sample procured is multifloral with pollen of *Coriandrum sativum* (15.90%), *Mimosa pudica* (15.19%), *Syzygium cumini* (12.36%), *Ageratum conyzoides* (11.30%), *Ocimum sanctum* (6.00%), *Schleichera oleosa* (5.30%), *Eucalyptus globulus* (4.94%), *Polygonum barbatum* (3.53%), *Blumea oxyodonta* (3.53%), and *Casuarina equisetifolia* (3.18%) as important minor pollen taxa.

Ananthagiri (V-P-AG-Ch-AF-13, autumn collection): the sample procured is productive and proved as unifloral as evidenced by the predominant pollen taxon *Schleichera oleosa* (55.00%), followed by the recovery of *Mimosa pudica* (13.07%), *Eucalyptus globulus* (8.65%), *Phyllanthus emblica* (6.92%), *Dendrophthoe falcata* (3.07%), and *Leucas aspera* (3.69%) as important minor pollen types.

Munchingiputtu (V-P-MUN-L-AF-14, autumn collection): the sample proved as multifloral with pollen of *Eucalyptus globulus* (13.46%), *Tridax procumbens* (8.77%), *Centipeda minima* (8.32%), *Ageratum conyzoides* (7.41%), *Terminalia arjuna* (6.80%), *Psidium guajava* (6.80%), *Crotalaria juncea* (6.95%), *Syzygium cumini* (6.95%), *Commelina suffruticosa* (6.95%), *Sapindus emarginatus* (4.84%), *Erythrina variegata* (3.02%), and *Leucas aspera* (3.78%) as important minor pollen types.

Ananthagiri (V-P-AG-Gb-AF-34, spring collection): the sample procured is unifloral as palynologically evidenced by a single predominant pollen taxon, *Ageratum conyzoides* (81.03%), followed by *Phyllanthus emblica* (12.06%) and *Madhuca indica* (5.86%) as important minor pollen types.

Araku Valley (V-P-AR-Me-AF-37, spring collection): the sample procured is productive and proved to be unifloral with predominant pollen taxon *Psidium guajava* (55.03%), followed by secondary pollen taxon *Mimosa pudica* (24.59%), *Terminalia arjuna* (10.53%), and *Delonix regia* (5.85%) pollen as important minor pollen types.

Paderu (V-P-P-Sp-AF-40, spring collection): the sample procured is productive like the AF-34 samples which is unifloral with predominant pollen taxon, *Ageratum conyzoides* (92.83%) followed by important minor pollen taxon, *Dendrophthoe falcata* (4.98%).

Paderu (V-P-P-Vm-AF-44, spring collection): the samples is palynologically productive and proved to be unifloral with single predominant pollen taxon, *Mimosa pudica* (69.57%), followed by the important minor pollen types like *Hyptis suaveolens* (14.56%) and *Conyza stricta* (13.59%).

G. madugula (V-P-GM-Ak-AF-48, spring collection): the samples proved as multifloral as evidenced by secondary pollen types like *Mimosa pudica* (32.91%), *Conyza stricta* (28.30%), and *Tridax procumbens* (17.81%). The remaining taxa are represented as important minor pollen types like *Pedalium murex* (5.24%), *Hyptis suaveolens* (3.56%), *Saccharum officinarum* (3.18%), *Sida acuta* (3.14%), and *Ageratum conyzoides* (3.14%).

Hukumpeta (V-P-HP-R-AF-51, spring collection): the sample is palynologically proved to be multifloral as evidenced by secondary pollen types, *Eucalyptus globulus* (35.48%) and *Mimosa pudica* (17.41%), followed by important minor pollen types, *Hygrophila auriculata* (14.83%), *Cocos nucifera* (11.61%), *Borassus flabellifer* (10.96%), and *Cucumis sativus* (9.71%).

Peddabayalu (V-P-PB-L-AF-53, spring collection): the sample procured is productive and proved as multifloral with pollen of *Syzygium cumini* (41.82%), *Centipeda minima* (18.87%) recorded as secondary pollen types, followed by the pollen of *Mimosa pudica* (14.59%), *Vernonia cinerea* (11.08%), and Urticaceae type (6.80%) as important minor pollen types.

Munchingiputtu (V-P-MUN-Sk-AF-54, autumn collection): the sample proved as multifloral with evidenced of pollen of *Syzygium cumini* (37.63%), *Centipeda minima* (18.70%), and *Mimosa pudica* (18.27%) represented as secondary pollen types. The remaining taxa are represented as important minor pollen types like Urticaceae type (11.82%), *Vernonia cinerea* (7.74%), and *Tridax procumbens* (5.84%).

Ananthagiri (V-P-AG-Mt-AF-57, autumn collection): the sample procured is productive and proved as multifloral with pollen of *Syzygium cumini* (26.97%) represented as secondary pollen taxon, followed by the pollen of *Spilanthes calva* (13.40%), *Mimosa pudica* (13.24%), *Centipeda minima* (12.43%), *Cyathocline purpurea* (12.76%), *Leucaena leucocephala* (10.10%), *Tridax procumbens* (5.71%), and *Vernonia cinerea* (5.39%) as important minor pollen types.

Paderu (V-P-P-Rb-AF-64, autumn collection): the sample proved to be multifloral with evidenced by secondary pollen types like *Tridax procumbens* (27.95%), *Schleichera oleosa* (19.88%), and *Erythrina variegata* (16.42%). The remaining taxa are *Eucalyptus globules* (12.96%), *Leucaena leucocephala* (6.34%), Urticaceae type (5.47%), *Cocos nucifera* (4.32%), *Amaranthus spinosus* (3.45%), and *Dendrophthoe falcata* (3.21%) recollected as important minor pollen types.

Peddabayalu (V-P-PB-L-AF-65, autumn collection): the sample procured is productive and proved as multifloral with pollen of *Mimosa pudica* (41.0%), *Schleichera oleosa* (26.61%), and *Dendrophthoe falcata* (19.42%) identified as secondary pollen types, followed by single-pollen taxon *Hakea laurina* (12.97%) as important minor pollen taxon.

4. Discussion

The present Melissopalynological study provides new insights into the pollen composition of honey samples from Paderu forest division in Visakhapatnam district of Andhra Pradesh. A total of 69 pollen morphotypes from 17 honeys produced by *Apis florea* were identified. Six honeys were considered unifloral honeys because they contained a predominant pollen type (>45%). The dominant of unifloral honeys, without any toxic pollen grains and with scarce fungal elements, suggests that most of the honeys are of good quality and suitable for human consumption.

The results coincide with the melissopalynological investigation in the peninsular part of India where unifloral honeys are dominant [35]. The diverse flora of India is due to varied climatic conditions in different parts of India. The multifloral source of honeys may be generated by the absence of major ingredients of forest and invasion of secondary forest elements [36]. The Palynological analysis of Paderu forest division honeys reflects that the native flora may be used as a source of good quality honey. In our studied honey-pollen exploration, it is easy to perceive that the honey bee preferred mainly non-arboreal in spring honeys, with the exception of Af-37 as arboreal dominant; *Ageratum conyzoides* is a predominant pollen taxon in three spring samples, *Mimosa pudica*, *Tridax procumbens*, and *Conyza stricta* as secondary pollen taxa. In autumn season also, bees preferred mainly non-arboreal exception of Af-13 and -64 samples, in Af-13 sample as unifloral with *Schleichera oleosa* as predominant pollen taxa.

Based on the above study, bees are preferred mainly on non-arboreal to collect nectar and convert to honey due to the flowering time of the melliferous species; climatic condition and human activities (e.g., farming, reforestation, and forest fires) may be other factors to consider in understanding the presence or absence of some taxa in the pollen spectra of honeys. In recent years, many rural communities have taken up beekeeping as an alternative source of their livelihood strategies. Even the younger generation is showing interest because beekeeping is so easy and simple that anybody can take it as an enterprise. Thus, our melissopalynological investigation may contribute to and favor the possibilities of using rich flora of the studied area in order to develop beekeeping enterprises on a commercial basis, in which self-employment opportunities may be created for many rural communities and develop their livelihood strategies in this area.

5. Conclusions

The analysis of the pollen content of Paderu forest division in Visakhapatnam district of Andhra Pradesh honey samples indicates that the local flora may be used as a source of good quality honey. The overall preponderance of non-arboreal in most of the honeys reflects that the honey bees prefer to visits to collect nectar. The scarce appearance of pollen from nectar-less plants such as *Amaranthaceae*, *Cyperaceae*, and *Poaceae* indicates that they were trapped in the hive incidentally by wind or were inadvertently transported by honey bees. And apiculture may enhance honey production in floristically rich province of Paderu forest division in Visakhapatnam district of Andhra Pradesh and adjoining areas, when job opportunities may be created for many developing rural communities of this state.

Acknowledgements

The authors are thankful to the Principal, University College of Science, Saifabad, OU, and Head of the Department of Botany, Osmania University, for providing laboratory facilities and acknowledge to local beekeepers for sample collection.

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