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Melittopalynological Study of Squeezed Summer Honeys Collected from Forest Area of Sindewahi Tahsil of Chandrapur District, (Maharashtra state)

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Abstract: ***The paper incorporates a qualitative and quantitative analysis of pollen contents in Six squeezed honey samples of Apisdorsata hives collected from forest area of Sindewahi tahsil of Chandrapur district. Terminaliasp. represents the predominant pollen type in five samples ranged from (47.13% to 75.47%) are designated as Terminaliahoney. The other significant pollen types recorded include Pongamiapinnata, Delonixregia, Mangiferaindica, Sapindusemarginatus, Syzygiumcumini, Azadirachtaindica. The pollen counts ranged from 161, 000/g to 456, 000/g. The data reflects the floral situation of the place where particular honey was produced and the identification of geographical origin based on the presence of a combination of pollen types of that particular area.***

Keywords: Pollen, Honey, *Apisdorsata,* Forest area, Sindewahi tahsil

1. Introduction

Melittopalynology is an applied branch of palynology dealing with the study of pollen grains in honey samples and its application in Apiculture. Plant produces nectar and pollen both of which are avidly sought after by the bees to provide nutrition to the colony. Melittopalynology is concerned with the identification of pollen in honeys. Evaluation of plants for their utility as sources of bee forage provides the information needed to assess the potential for bee keeping in an area.

Melittopalynological studies are thus helpful in bee management and in promoting the beekeeping development. Laboratory studies using Melittopaloynological methods have been made to evaluate sources of pollen and nectar for honey bees in different parts of the country namely Maharashtra (Bhusari *et al*., 2005; Phadke, 1962; Kumar and Jagtap, 1988; Kalkar and Shende, 2009, 2010; Mate, 2013), Andra Pradesh (Ramanujam and Khatija, 1991, Kalpana and Ramanujam, 1991, Moses, 1987, Karnataka (Yoganarasimhan, 1982; Agashe and Ranjaswami, 1997; Sheshagri, 1985; Bhargava *et al.*, 2009), Lucknow (Suryanarayana, 1976) and Indian honeys (Sen and Banarjee, 1956; Nair, 1964; Seethalakshmi, 1993). Present investigation incorporates a quanlitative and quantitative pollen analysis of Six honey sample from forest area of Sindewahi tahsil of Chandrapur District. In order to identify the chief bee foraging plants recognize the uni and multifloral honeys and identify areas suitable for bee-keeping industry in this area. It is further investigated that a study of this nature would also highlight the geographical source of the honey samples.

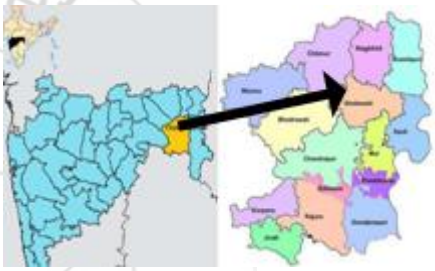

Figure 1: Map of Maharashtra Showing Chandrapur District & Sindewahi Tahsil

2. Literature Survey

"Melittopalynology, one of the branches of palynology finds a very significant application in the field of apiculture. It deals with a critical microscopic study involving qualitative and quantitative analysis of the myriad pollen contents of honeys and pollen loads of bees and bee hives at diverse floristic and geographical regions, (Ramanujam, 1991). Palynological studies also help to detect pollen from poisonous plants which are often toxic not only to bees but also to human beings (Deodikar and Thakar, 1954; Deodikar*et.al*., 1958; Deodikar, 1960). It is rather surprising that most of the poisonous plants in the hilly regions of Mahabaleshwar, flower during January-February which represents the dearth period with acute shortage of nectar and pollen from normal sources. Bees, therefore visit these poisonous plants due to sheer starvation (Chaubal and Deodikar, 1963)

3. Materials and Methods

Six honey samples viz., CHN-SIN-Naw, CHN-SIN-Gad, CHN-SIN-Was, CHN-SIN-Shi, CHN-SIN-Kag, CHN-SIN-Del were collected during the period 03 May 2012 to 12 Jun 2013 from Nawargaon, Gadbori, Wasera, Shirkhada, Kargata, Delanwahi respectively. All the samples represent squeezed honey collected from the natural *Apisdorsata* hives (Map).

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The squeezing (pressing) of the honey combs was carried out under personal supervision and only honey bearing portion of the comb was used for this purpose. 1 ml of the honey sample was dissolved in 10 ml of distilled water & centrifuged. The sediment obtained was treated with 5 ml glacial acetic acid. The acetic acid was decanted and the material was subjected to acetolysis (Erdtman, 1960) for analysing the pollen content in honeys qualitatively & quantitatively, three pollen slides were prepared for each sample. The recorded pollen types were identified with the help of reference slides collection & relevant literature for quantification of pollen types recorded, a total of 300 pollen grains were counted at random from the three palynoslides prepared for each samples. Based on their frequencies, the pollen types encountered were placed under the pollen frequency classes recommended by the international commission for bee Botany Louveaux *et al;*(1978) viz., predominant pollen type (>45%), secondary pollen type (16-45%), important minor pollen types (3-15%), and minor pollen types (<3%).Non-melliferous (anemophilous) pollen types were excluded while determine the frequencies of melliferous pollen types (International Commission for Bee Botany Louveaux *et al. ;*1978). The absolute pollen count of each sample was determined in accordance with the method recommended by Suryanarayana *et al.* (1981). Unacetolysed samples of honey were examined for the study of honeydew elements (fungal spores, hyphal threads and algal filaments).

4. Results and Discussion

Of the 6 honey samples collected from Sindewahi tahsil, ***Terminaliasp.*** ranged from (47.13% to 75.47%) represented the predominant pollen type in five sample (CHN-SIN-Naw), (CHN-SIN-Gad), (CHN-SIN-Was), (CHN-SIN-Shi), (CHN-SIN-Del)i.e. Unifloral while 1 is multifloral (CHN-SIN-Kag). The other significant pollen types recorded includes (secondary to minor pollen) *Terminalia*sp., *Pongamiapinnata, Delonixregia, Syzygiumcumini, Mangiferaindica, Sapindusemarginatus, Pisidiumguajava, Asterecanthalongifolia, Leucaenaleucocephala, Rungiarepens, Azadirachtaindica* .

Table 1: Pollen frequency class & frequencies(%) in Apisdorsata summer honeys

Sample No.	Date of Collection	Type of Honey	Absolute pollen counts (APC) / g	HDE/P	*Pollen Type*
CHN-SIN-Naw	03-05-2012	Unifloral	205, 000/g	0.01	P - *Terminalia sp. (47.13)* S - *Pongamiapinnata(17.14)* *Delonixregia(16.81)* I - *Asteracanthalongifolia(4.10)* *Leucaenaleucocephala(4.06)* *Cucurbitaceae type (3.02)* *M - Sy(2.08), Eu(2.04), Bi(1.04), Br(1.02), All(0.98), Sap(0.68)* *NMP – Sorghum vulgare (0.18)*
CHN-SIN-Gad	08-05-2012	Unifloral	19, 000/g	0.03	P - *Terminalia sp.(61.35)* S - *Nil* I - *Syzygiumcumuni(13.83)* *Psidiumguajava(7.06)* *Mangiferaindica , Pongamiapinnata(each 4.02)* *Delonixregia(3.92)* M – *Ci(1.82), Son(1.04), Car, Cas(each 0.86), He(0.82),* *NMP – Sorghum vulgare(0.72)*
CHN-SIN-Was	09-05-2013	Unifloral	187, 000/g	0.01	P – *Terminalia sp.(66.67)* S - *Mangiferaindica(20.58)* I - *Azadirachtaindica(4.47)* *Pongamiapinnata(3.22)* M-*Ast.l(1.97), Bo(1.56),* *Cel(1.04),* *NMP – Sorghum vulgare(0.72)*
CHN-SIN-Shir	12-05-2013	Unifloral	456, 000/g	0.01	P - *Terminalia sp.(75.47)* S – *Sapindusemarginatus(17.43)* I - *Nil* M – *Ast.l(2.06), Bo, De(each 1.06), Ma(0.68), Caps(0.21), Car,* *May(each 0.33), Ju(0.86),* *NMP- Nil*
CHN-SIN-Kag	27-05-2013	Multifloral	161, 000/g	0.02	P - *Nil* S - *Terminalia sp.(31.75)* *Mangiferaindica (20.16)* *Delonixregia(17.06)* I -*Pongamiapinnata (14.15)* *Syzygiumcumuni (6.42)* M- *Cel(2.08), Ast.l, Ps(each 2.04), Bo(1.86), Car(1.06), May (1.04),* *Caps(0.43)* *NMP –Typhaangustata(11.58)* *Sorghum vulgare(4.16)*

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CHN-SIN-Del	12-06-2013	Unifloral	209, 000/g	0.02	P -*Terminalia sp. (50.26)* S - *Syzygiumcumuni (34.91)* I -*Asteracanthalongifolia (4.11)* *Rungiarepens(3.84)* M –*De(2.84), Tri(1.84), Son(1.64), Pr(1.06)* *NMP – Sorghum vulgare(0.72)*

Table 2: Showing pollen morphology of Melliferous taxa

Sr. No.	Pollen types	Pollen Size, Shape and Symmetry	Aperture pattern	Pollen wall (Sporoderm) Structure and sculpture
01	Allium cepa Linn.	14-28× 32-48µm, ellipsoidal, Bilaterally symmetrical	Monosulcate, sulcus tenuimarginate	Exine 1.5 µm thick, subtectate, surface faintly reticulate
02	Asteracanthalongifolia (Linn.) Nees.	56-59µm , Amb spheroidal or quadrangular; 50-55× 52-59µm, oblate spheroidal; Radially symmetrical	Tetracolporate, colpi long, ends tapering, tips acute, colpi alternating with 4 streak like pseudocolpi, ora more or less circular.	Exine 3.3µm thick, subtectate , surface reticulate, homobrochate, lumina polygonal and psilate.
03	AzadirachtaindicaA.juss	50-54µm, Ambsquarish, sides convex; 47-54 38-47µm, subprolate, poles smoothly rounded; Radially symmetrical	Tetracolporate, colpi long, ends tapering, tips acute, oralalongate	Exine 3 µm thick, tectate, surface psilate to locally granular
04	Brassica sp.(Linn) Koch	30-33 µm , Amb rounded triangular to almost spheroidal; 27-31× 24-27 µm, prolate spheroidal; radially symmetrical	Tricolplate , colpal ends tapering, tips acute	Exine 2.5 µm thick, sub tectate, surface reticulate, heterobrochate, meshes narrow at mesocolpial regions giving a striate look , lumina polygonal.
05	Bombaxceiba Linn	51 µm (49.5×52.5) µm, peroblate, isopolar, Radially symmetrical	Tricolprate, col. length 12 (10.5-13.5) µm	Exine thick 3 µm, coarsely reticulate, mesh 4.1 µm (3-4.5 µm) in the major part except at the angles showing medium reticulations 1-8 µm (1.5 -3 µm), greater number of baculae are found in the lumen. Murisimplibaculate, faint LO pattern.
06	Bidenapilosa Linn.	25-29 µm Amb spheroidal; 23-25× 27-30 µm, sub-oblate; Radially symmetrical	Tricolporate, colpi long, ends tapering, tips acute, oralalongate	Exine 1.5 µm thick, tectate, surface echinate, spines 6.8 µm long, base 2µm broad
07	CareyaarboreaRoxb.	52.1× 40.1 µm (48-54× 37.5 - 43.5) µm, subprolate, isopolar, radially symmetrical	Hexacolpate, syncolpate with crassimarginatecolpi, col. Length 43.5 (42-46.5) µm	Exinethick , 3 µm, undulating, considerable thick at the poles sexine-nexine not differentiated medium reticulate, more coarse at the poles. Mesh 1.5-3 µm, clear LO pattern
08	Citrus sp.	27-29 µm, Ambsquarish, 26-30 ×25-27 µm, prolate spheroidal radially symmetrical	Tetracolporate, colpi linear, tips acute, oralalongate	Exine 2 µm thick subtectate, surface Reticulate. Heterobrochate, meshes smaller near the apertural regions and larger elsewhere, luminahexa to pentagonal or irregular, psilate, murisimpli to locally duplibaculate
09	CasearíaellipticaWilld	29-37µm, Amb spheroidal ; 28-36 ×27-33 µm subprolate radially symmetrical	Tricolporate , colpi with tapering ends, ora lalongate	Exine 1.5 µm thick, tectate, surface psilate
10	Capsicum annuum Linn.	29-34 µm, Amb spheroidal; 29-35× 26-30 µm, subprolate; radially symmetrical	Tricolporate , colpi constricted at oral region, ends tapering, tips acute, ora prominently lalongate	Exine 1.5 µm thick, tectate, surface faintly granular to almost psilate
11	Celosia argentea Linn	30-35 µm spheroidal radially symmetrical	Pantoporate, pore No. 15-20, circular. Diam; 4-5 µm, pore membrance flecked with granules, interporal distance 8-11 µm	Exine 2 µm thick, tectate, interporal space coarsely granular
12	Clerodendrum sp.	43-48 µm , Amb spheroidal, 41-44 ×37-40 µm , prolate spheroidal ; Radially symmetrical	Tricolporate, colpi fairly long, tips acute, colpal margins broken	Exine 1.5 µm thick (excluding spinules), tectate surface spinulate, spinules 0.6-1 µm long, interspinular space finely granular
13	Cucurbitaceae type	50-63 µm, subprolate, isopolar, Radially symmetrical	Tricolporate, col. Length 48.7 (48-49.5) µm	Exine 4.5 µm thick, sexine - nexine not discernible, rather coarsely reticulate, mesh 3.4 (3 – 4.5) µm, baculae distinct, clear LO pattern
14	Delonixregia (Boj. ex. Hoof.) Ref.	59.62 µm, Amb more or less spheroidal to subtriangular; 53-56× 57-60 µm, oblate to suboblate; Radially symmetrical	Tricolporate, colpi long with blunt ends, ora faint, more or less rounded	Exine 5.2 µm thick, subtectate, surface coarsely reticulate. Heterobrochate, meshes smaller near the apertural regions & larger elsewhere , lumina poly to hexagonal with a number of

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				free bacules, muri thick, sinuous, simpli to locally duplibaculate
15	Eucalyptus sp.	23-27 µm, Amb triangular, sides concave to almost flat; 15-18 × 25-29 µm , oblate, Radially symmetrical	Tricolporate, syncolpate, parasyncolpate, oralalongate, margins incrasste	Exine 1.5 µm thick, much thickened at angles, tectate, surface psilate
16	Helianthus annuus Linn.	40-44 µm, Amb spheroidal, 37-39× 40-42 µm, oblate spheroidal; Radially symmetrical	Tricolporate , colpal ends tapering, oralalongate	Exine 3 µm thick (without spines), tectate, surface densely echinate, spines 7-8 µm long, base 2.4 µm wide, tip pointed.
17	Justiciaprocumbens Linn.	24-28× 16-18 µm, onlong; Bilaterally symmetrical	Dicolporate, colpi faint, narrow, streak like, oralalongate	Exine 1 µm thick at poles, 2.5 µm thick at equator, tectum undulating, circular to irregular are poles (2-4 µm) aligned linearly are seen on either side of the colpi, rest of the wall finely reticulate
18	Leucaenaleucocephala (Lam.) de Wit	52-59 µm, Amb spheroidal : 47-49×51-58 µm, sub oblate: Radially symmetical	Tricolporatecolpilong, tips acute, oralalongate	Exine 4 µm thick, subtectate surface microreticulate, homobrochate
19	Mangiferaindica Linn.	27-31 µm, Ambsubtriangular; 29-32 ×26-28 µm , subprolate; Radially symmetrical	Tricolporatecolpi long, tips acute ora prominently lanlongate	Exine 2.5 µm thick, subtectate, surface striatoreticulae, striations more or less parallel in equatorial view, lumen generally elongated in polar direction, murisimplibaculate
20	Maytenusemarginata Wild.	Oblate, 45-49 µm, Amb, rounded triangular to almost spheroidal , isopalar, Radially symmetrical	Tricoloporate, colpi length 9.4 µm, (9-10.5) µm, oralalongate	Exine thick 3 µm, sexine thicker than nexine, reticulate size of mesh 2.4 (1.5-3)µm, distinct LO pattern.
21	Pongamiapinnata (Linn) Pierre.	29-31 µm, Ambsubtriangular: 27-31× 25-28 µm, subprolate; Radially symmetrical	Tricolporate, colpi linear to narrowly elliptic tips acute, oralalongate	Exine 1.5 µm thick, subtectate, surface granular to locally faintly microrecticulate
22	Prosopisjuliflora (Sw.) DC	36-39 µm, Amb rounded triangular; 38-42× 30-35 µm, prolate to subprolate; Radially symmetrical	Tricolllporate, occasionally syncolpate, colpi tapering towards poles, tips acute, oralalongate	Exine 3.2 µm thick, tectate surface faintly reticulate
23	Pisidiumguajava Linn.	24-25 µm, Ambsubtriangular; 13-16× 26-28 µm, oblate; Radially symmetrical	Tricolporate, syncolpate, parasyncolpate, oralalongate	Exine 1.5 µm thick , tectate surface granular to pailate
24	Sonchusoleraceuslinn.	39-44 µm, Amb more or less hexagonal with rounded corners, sides straight to slightly convex; 37-47x 40-45 µm oblate spheroidal , Radially symmetrical	Tricolporate, colpi faint due to heavy sculpture, oralalongate	Exineupto 12 µm thick, tectate, sexine much thicker than nexine at ridges, surface echinolophate), spines of different sizes, upto 3 µm long, fenestralluminaupto 21, polygonal to irregular, psilate, 6-8 prominent ridges are soon along the equator which join the equatorial lacuna of both the hemispherrrrres
25	Sapindusemarginatusvahi	24-26 µm, Amb triangular, sides straight or even slightly concave; 18-20×26-29 µm, oblate (occasionally suboblate); Radially symmetrical	Tricolporate, colpi narrowly elliptic long, tips acute, oralOlongate	Exine 2 µm thick on mesocolpia, 1-1.5 µm thick near apertures, surface psilate
26	Rungiarepens(Linn.) Nees.	40-44 ×25-26 µm, oblong; Bilaterally symmetrical	Diporate, pores circular, 2.5 µm, in diam, margin of the pores densely beset with small processes	Exine 3 µm thick at poles, 4.6 µm at equaltor, subtectate, tectum undulating, distinct rounded to irregular areolae (2-4 µm) linearly aligned in the vicinity of apertures, rest of the wall microreticulate
27	Syzygiumcumini (Linn.). Skeels.	16-18 µm, Amb triangular to rarely quadrangular, sides slightly concave; 10.5-12x17-20 µm, oblate; Radially symmetrical	Tricolporate, rarely tetra colporate, syncolpate, parasyncolpate, oralalongate	Exine 1.25 µm thick, tectae, surface granular to smooth
28	Terminalia sp.	19-22 µm, Amb spheroidal; 21-24 x20-22 µm, subprolate; Radially symmetrical	Tricolporate, colpi alternating with pseudocolpicolpi linear, tips acute pseudocolpi almost equal the size of colpi, ora more of less circular	Exine 1.5 µm thick, tectae, surface psilate to locally finely granular
29	Tridaxprocumbens Linn.	31-38 µm, Amb rounded triangular to squarish; 30-35x 32-38 µm, oblate spheroidal; Radially symmetrical	Tri to tetra colporate, colpi linear, sharply tapering, ora faint, circular	Exine 5 µm (without spines) thick, tectate, surface echinate, spines 6 µm long, 2.5 µm in diam, at base

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Table 3: Showing pollen morphology of Non-melliferous taxa

Sr. No.	Pollen types	Pollen Size, Shape and Symmetry	Aperture pattern	Pollen wall (Sporoderm) Structure and sculpture
01	Sorghum vulagare Pers.	51-55 µm, spheroidal; Radially symmetrical	Monoporate, pore circular provided with annulus, pore diam with annulus 4.1 µm without annulus 3.3 µm	Exine 1 µm thick, tectate , surface faintly granular to almost psilate
02	Typhaangustata Bory. et Chaub	28-35 µm, ellipsoidal, triangular or spheroidal; Radially symmetrical	Monoporate pore more or less circular 4-5 µm in diam, margin wavy, pore membrane densely granular	Exine 2.5 µm thick, subtectate, surface reticulate in places retipilate, reticulum homobrochate, lumina polygonal to circular, psilate, murisimplibaculate

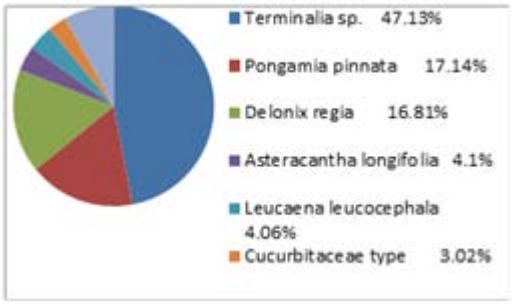

Figure 1.1: Palynograph of Nawargaon

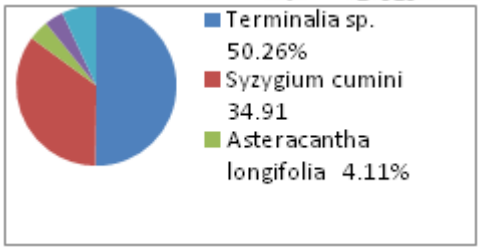

Figure 1.2: Palynograph of Delanwadi

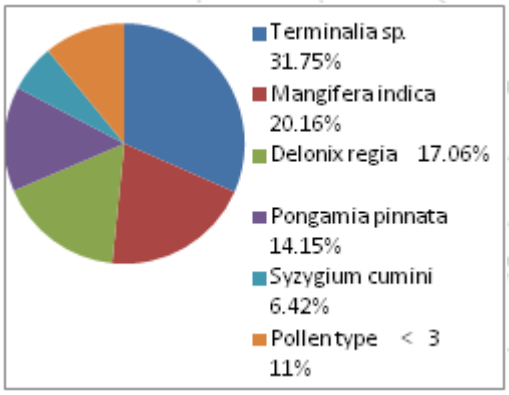

Figure 1.3: Palynograph of Kargata

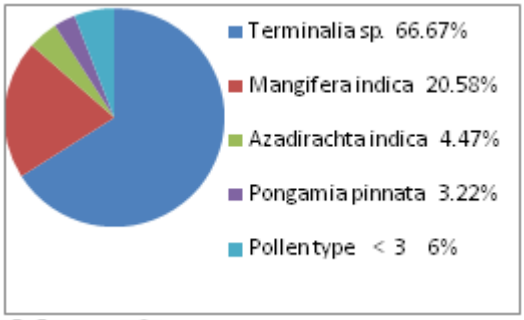

Figure 1.4: Palynograph of Wasera

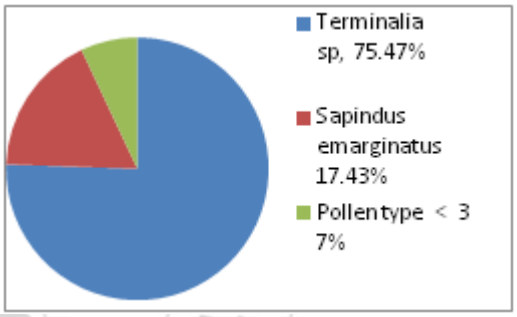

Figure 1.5: Palynograph of Shirkada

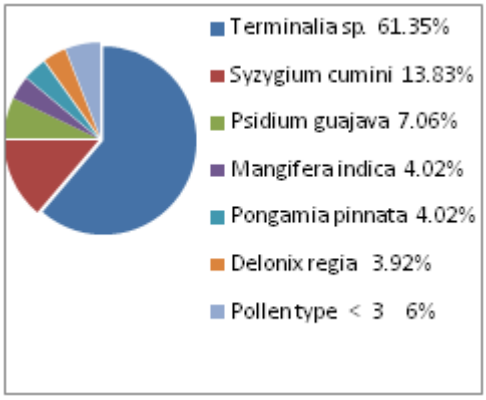

Figure 1.6: Palynograph of Gadbori

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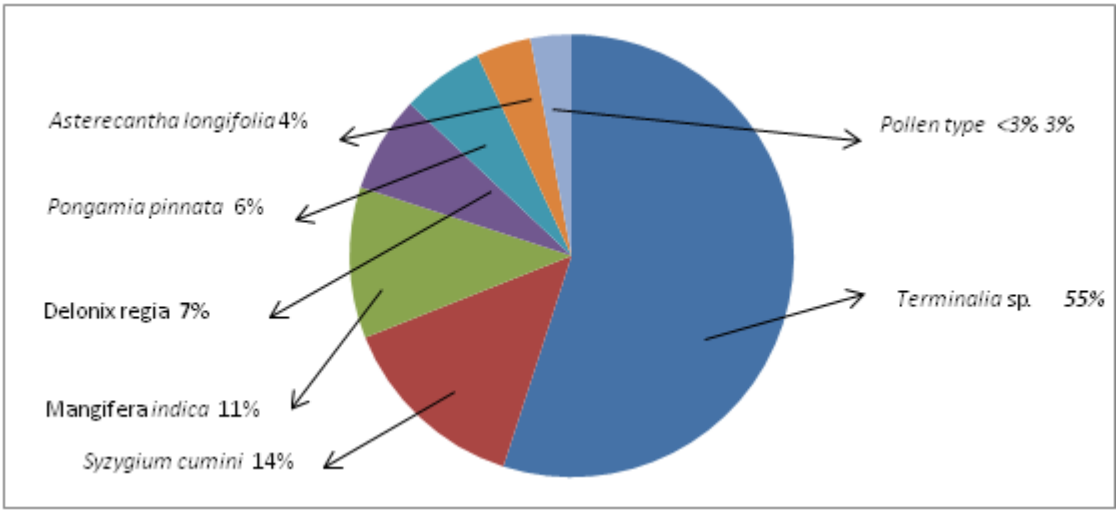

Figure 1.7: Composite palynograph of summer honeys from Sindewahi tahsil

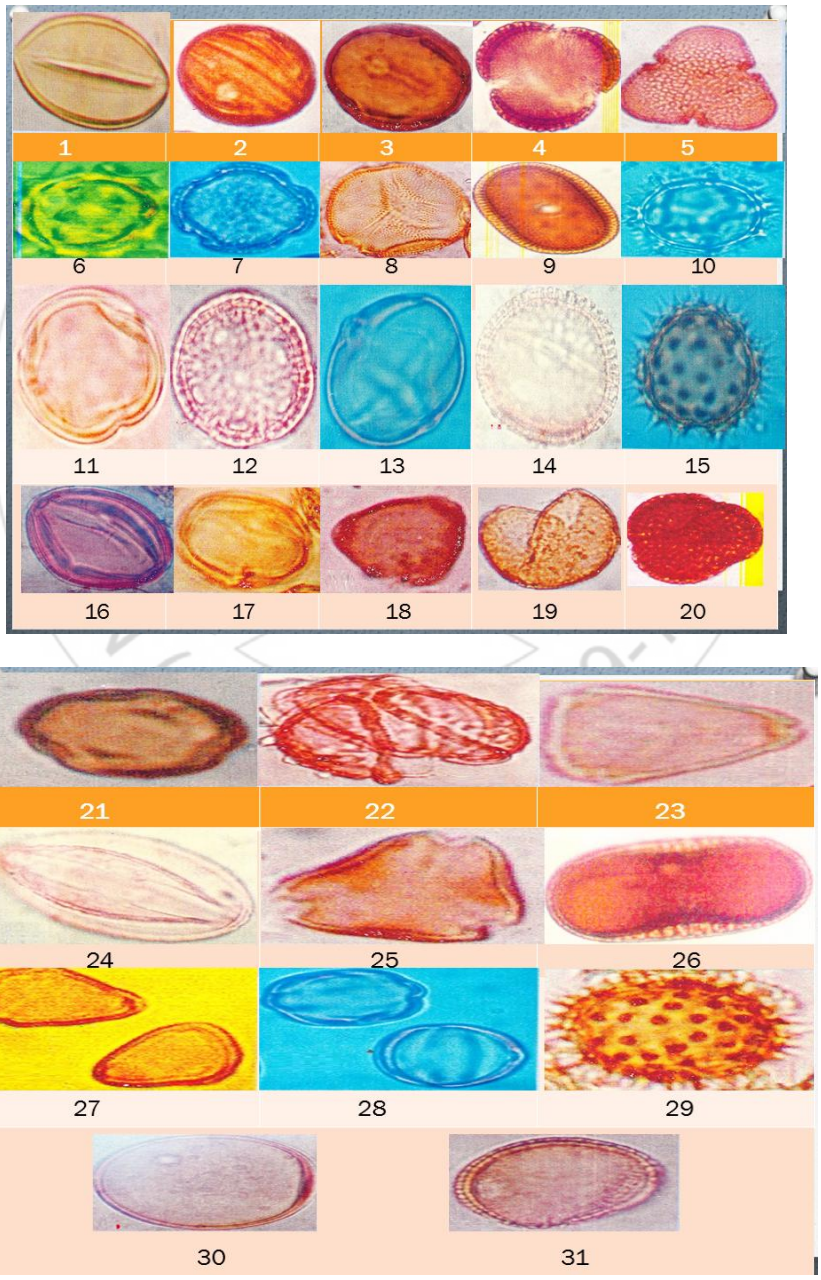

Figure 2: Microscopic photograph of pollen grains found in honey sample

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1) Allium cepa 2)Asteracanthalongifolia
3) Azadirachtaindica 4) Brassicasp.
5) Bombaxceiba 6) Bidenspilosa
7) Citrussp. 8) Cucurbitaceae type
9) Rungiarepens 10) Sonchusoleraceus
11) Casearіaelliptica 12) Celosia argentea
13) Capsicumannuum 14) Delonixregia
15)Helianthusannuus 16) Leucaenaleucocephala
17) Mangiferaindica 18) Eucalyptus sp.
19) Clerodendrumsp. 20) Maytenusemarginata
21) Pongamiapinnata 22) Careyaarborea
23)Pisidiumguajava 24)Prosopisjuliflora
25) Sapindusemarginatus 26) Justiciaprocumbens
27) Syzygiumcumini 28) Terminalia sp.
29) Tridaxprocumbens 30) Sorghum vulgare
31) Typhaangustata

All together 31 pollen types (29 of melliferous and 2 of non-melliferous taxa) referable to 23 families have been recorded from these samples (Photoplate). The sample (CHN-SIN-Naw) showed the maximum number of pollen type (13) and the sample (CHN-SIN-Was), the minimum number (8).

In the sample (CHN-SIN-Kag) however the pollen of *Typhaangustata* were found to be good number (11.58%). The absolute pollen counts ranged from 161, 000/g to 456, 000/g and the HDE/P ratio ranged from 0.01 to 0.03 and represented by fungal spores (Table 1).

The details of the pollen analysis of the 6 honey samples (melliferous/non-melliferous) are represented in table 2. Similarly individual palynograph (Pollen spectra) of each honey sample and composite palynograph was also given to show the pollen contents of the samples of Sindewahi tahsil. The distinguishing morphological features of the pollen types encountered in the present study are given below. The bee plants of Sindewahi tahsil are referable to 3 categories:

1) **Crop plants**:, *Allium cepa, Brassica sp., Capsicum annuum*and *Helianthus annuus**Sorghum vulgare.*
2) **Arborescent taxa/shrub**: *Terminalia sp.,* Pongamiapinnata, Delonixregia**,** *Syzygiumcumini, Rungiarepens, Eucalyptus* sp., *Prosopisjuliflora, Pisidiumguajava,* Bombaxceiba, *Cucurbitaceae* type, Mangiferaindica, Casearіaelliptica, *Sonchusoleraceu, Justicaprocumbens, Clerodendrum, Careyaarboreya, Mayeteneousemarginal, Leucaenaleucocephala, Sapindusemarginatus.*
3) **Herbaceous weeds:** Asteracanthalongifolia, Tridaxprocumbens, Sapindusemarginatus, Celosia argentea, Bidenspilosa.Of these three categories the arborersent plants *Terminalia sp.* constitute the chief bee forage plants in this tahsil during summer season. Besides the other arborersent plants *Delonixregia, Pongamiapinnata, Azadirachtaindica*represents most preferred nectar sources for the honey bees. Our observation indicates that *Terminalia sp.* represent abundant nectar and pollen sources to *Apisdorsata*.

The region selected for the present study has good potential for sustaining bee keeping ventures because of the diversity of nectar and pollen taxa. Since *Terminalia sp.* are member of combretaceae is major sources of forage for honey bees therefore efforts should be made to increase it's cultivation. The other plant encountered in these honey samples are the member of families like Acanthaceace, Anacardeaceace, Mimoscae, Caesalpiniaceace, Celastraceace, Myrtaceace, Samydaceae, Menisphermaceace, Liliaceace, Capparidaceae, Amaranthaceae, Cleomaceae, Solanaceae, Papillionaceae and Sapindaceae in this area.

To improve the bee-keeping industry a proper understanding and mutualism between bees and available plant taxa in the region and in a particular season is necessary. The identified taxa were not only the economic crops but also play an important role in the development of bee-keeping in this region.

This data reflects the floral situation of the place where particular honey was produced and the identification of geographical origin based on the presence of a combination of pollen types of that particular area.

5. Conclusion

The present melittopalynological concepts based on 06 honey samples and ***Apisdorsata*** from seasons clearly brought to light that SINDEWAHI tahsils of Chandrapur district with large forest area in which ***Terminalia*sp.** with extensive plantations of ***Prosopisjuliflora, Delonixregia***and ***Leucaenaleucocephala***not only provide the bulk of giant bee honey, but also have the potential for attracting bee-keeping industry involving colonies of the Indian Hive Bee, ***Apiscerena***on modest commercial scale.

Adequate primary sources of nectar and pollen, augmented by secondary or alternate source when required for prolonged periods, availability unpolluted water resources and suitable soil types with enough moisture are prerequisites of paramount importance for successful operation for bee-keeping ventures in any area. A consideration of all these parameters clear by indicates that the forest area of Sindewahi, in particular merit serious attention for establishing bee-keeping enterprises for commercial honey production in Chandrapur district. Maintenance of apiaries in the vicinity of agricultural crops, in additional providing enough harvest of honey, also results in enhanced crop yield as a consequence of higher degree of pollination. Summer represents the honey flow season period with adequate sources of bee forage in the forest area with agricultural tracts; successful operation of apicultural activities necessitates migration of apiary colonies to nearby deciduous forest areas during summer months, for uninterrupted production of commercial honey.

6. Future Scope

The chief aim of this study is to exploit the methodology of melittopalynology for recognizing the major bee forage plants and make suitable recommendations and meaningful suggestions for promoting the cause of bee-keeping (apiary) industry and honey production in some specific areas of Chandrapur district. This would incidentally facilitate in realizing an additional source of income to all such farmers, who would take up beekeeping ventures on commercial scale. This will create interest in the present circumstances of non-employment.

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