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Summer Pollen Sources to *Apis dorsata* honeybees collected from Chimur tahsil forest area of Chandrapur District of Maharashtra State (India)

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Abstract The pollen loads from 137 honeycombs of *Apis dorsata* (Rock Bee) were examined. These honeycombs were collected from the Chimur forest area (Allizanza, Jamni Borgaon of Chandrapur District of Maharashtra State) during the period between May 13 and May 23, 2013. It was determined that 25 loads (18.24%) were unifloral, 23 loads (16.78%) were biforal, and 89 loads (64.96%) were multifloral. Unifloral pollen loads contained pollen from *Terminalia sp.* In fact, *Terminalia sp.* pollen was present in 111 loads (81.02%) of the total pollen samples examined. This study establishes that *Terminalia sp.* (Combretaceae) constitutes the primary source of pollen for honey bees during the summer, with *Mangifera indica* (Anacardeaceae), *Citrus sp.* (Rutaceae), *Blumea sp.* (Asteraceae), and *Delonix regia* (Caesalpineaceae) following as significant sources.

Keywords: pollen source, honeybee, chimur tahsil, forest.

1. Introduction

Flower blossoms are visited by honey bees for the collection of nectar and pollen. The protein necessary for new cell formation is primarily derived from nectar, which typically contains a small amount of glucose and pollen grains (Rahman Khan 1941). During their developmental stages, young bees are naturally drawn to the sweetest nectar available, much like their preference for nutrient-rich and flavorful pollen, as observed in previous studies (Ramanujam 1991). Through melittopalynological investigations utilizing honey samples and pollen loads, the specific flower types preferred by honey bees in their foraging regions can be accurately identified. Since 1994 (Ramanujam), the loyalty of bees to particular plants within any floristic community has been discerned by studying bee pollen loads. This method involves highlighting the percentage of various pollen types in each shipment. Quantifying this information allows for the determination of the relative significance of different pollen sources in a particular area, a finding supported by Chaudhari's research in 1978.

While honey studies have been more prevalent, only a handful have delved into pollen loads in India. Sharma (1970a, 1970b, 1972) and Chaturvedi (1973) examined the pollen loads of the Indian hive bee, *Apiscerena*, in Kangra, Himachal Pradesh, and Banthara, near Lucknow. Seethalakshmi and Perey (1980) identified *Borassus flabellifer* as an exceptional pollen source in Tamilnadu, analyzing 900 pollen loads of *Apiscerena* in Vijayarai, West Godavari District, Andra Pradesh, thereby highlighting the region's apiculture potential. Further studies by Kalpana et al (1990) and Ramanujam and Kalpana (1990) described the pollen resources of *Apis florea* and *Apiscerena* honey bees in Hyderabad and Ranga Reddy Districts. In recent research, Borkar Laxmikant and Mate Devendra (2014) successfully identified the origin of *Apis dorsata* pollen. Cherian et al (2011) discussed pollen sources for *Apiscerena* honey bees in Nagpur District of Maharashtra, as well as in the Bramhapuri forest in Chandrapur District. This study aims to identify the primary and tertiary pollen sources for *Apis dorsata* bees in these forests during summer, achieved by analyzing the composition and quantity of pollen in various honeycombs.

2. Materials and Methods

2.1. Material

 Received: July 8, 2023 | Accepted: September 7, 2023

Three honeycombs were gathered from the Allizanza, JamniBorgaon forest region in the Chimur Tahsil of the Chandrapur District of Maharashtra State (Figure 1) between May 13 and 23, 2013, yielding a total of 137 pollen loads (Comb loads) of *Apis dorsata*. (CHN-CHI-ALL), "CHN-CHI-JAM," "CHN-CHI-BOR," etc.

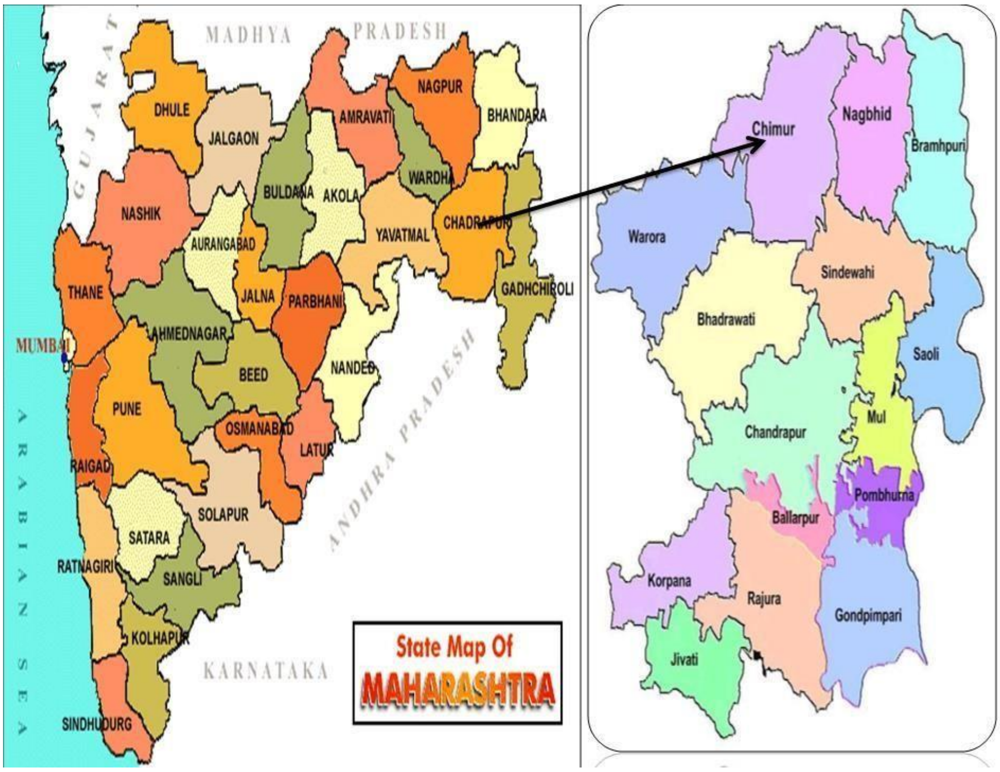

Figure 1 Map showing Chimur Tahsil of Chandrapur district from which the pollen loads were collected.

2.2. Methodology

According to Erdtman (1960), the process of catalyzing pollen grains from each pollen load needed a total volume of one millilitre of glacial acetic acid. For each pollen sample of different sizes, separate microscope slides were created to be viewed under the microscope. According to Sharma (1970a), there are three different types of pollen loads: unifloral, bifloral, and multifloral. These classifications are based on the amount of various types of pollen that are present. Forensic palynoslide references and other related information were utilized in the process of positively identifying pollen samples. We determined the pollen production of the important taxonomic groups using a hemocytometer.

3. Results and Discussion

Only 25 (18.24%) of the 137 pollen loads that were obtained from three combs were found to be unifloral, 23 (16.78%) were found to be bifloral, and 89 (64.96%) were found to be multifloral. The pollen loads were gathered from honeybee hives. There were a total of 25 unifloral loads, 18 of which carried the pollen of Terminalia species and 7 of which contained the pollen of *Mangifera indica*.

There are 17 different forms of pollen, which can be categorized into 15 different groups. After the study was finished, it was found that 25 (18.24%) of the loads were unifloral, 23 (16.78%) of the loads were bifloral, and 89 (64.96%) of the loads were multifloral (Tables 1 and 2). This information may be found in the tables. Pollen grains collected from twenty-five different plant species collectively constituted fifteen different plant families. These include the woody shrubs and trees found in the forest, such as Terminalia spp. (Combrataceace), *Mangifera indica* (Anacardeaceae), Blumea spp. (Asteraceae), and *Delonix regia* (Caesalpiniaceae), as well as the herbaceous weeds that are present in the understory, such as Blumea spp.

The 25 unifloral pollen loads include pollen from 18 different species of Terminalia (72 percent), 7 different species of *Mangifera indica* (28 percent) (Figure 2), and Bifloral (five percent). There are nine distinct species of Terminalia and seven distinct species of *Mangifera indica* among the 23 total species, accounting for 16.78% of the total. In addition, there was a mixture of Blumea species, as well as one *Delonix regia* plant, three Prosopis juliflora plants, and two Terminalia plants. The multifloral loads analyzed in this study contained a variety of pollen types, including *Terminalia sp., Mangifera indica, Blumea sp., Citrus sp., Delonix regia, Pongamia pinnata, Catharanthus tinctorius, Asteracantha longifolia, Capparis grandis, Azadirachta indica, Clerodendrum sp.,* and *Allium cepa* (Figure 3).

Table 1 Pollen morphological characteristics of the taxa recorded.

Type of Pollen	Shape Size, ans Symmetry	Pattern of Aperture	sculpture & Pollen Wall (sporoderm) structure
Combretaceae			
01 *Terminalia* sp.	Amb spheroidal, 19-22 µm in diameter; subprolate, 21-24 µm by 20-22 µm in size; radially symmetrical	Tricolporate; colpi and pseudocolpi alternate; colpi are linear with acutely pointed extremities; pseudocolpi are nearly as large as colpi; ora are about round.	Exine and tectae are 1.5 µm thick; they range in texture from psilate to coarsely granular at the surface as well as in some regions.
Anacardiaceae			
02 *Mangiferaindica*Linn.	Amb subtriangular 27-31 µm; 29-32 ×26-28 µm , subprolate; Radially symmetrical	Prominently elongate and tricolporatecolpi with sharply pointed points	Prominently elongate and tricolporatecolpi with sharply pointed points
Asteraceae			
03 *Blumea* sp.	Amb spheroidal, isopolar 21-24 µm, Radially	21-24 µm, spheroidal, isopolar, Radially	Four spines are in the interspaces; the exine is 3 micrometers thick and echinate on the surface.
04 *Carthamustinctorius*Linn.	Amb spheroidal 59-65 µm: subprolate, radially symmetrical 58-62× 66-73 µm,	Tricolporate, oralalongata, colpi with truncate tips.	Spinoid processes and other exine structures. Columella single or branching, sharply wavy with supratectal solid, pointy, robust sinule-like processes.
Caesalpiniaceae			
05 *Delonix regia* (Boj. ex. Hoof.) Ref.	53-56 57-60 µm, oblate to suboblate; Amb roughly spheroidal to subtriangular (59.62 m); Circular in shape	Tricolporate; colpi long and rounded; ora small and oblong.	Exine thickness of 5.2 µm, subtectate, coarsely reticulate surface. Muri is thick, sinuous, and simple to locally duplibaculate, apertural regions have smaller meshes than the rest of the brain, and lumina ranges from polyhedral to hexagonal with plenty of free bacules.
Mimosaceae			
06 *Albizia lebbeck* (Linn) Benth	Spheroidal or biconvex disc, 72-74 µm in diameter, each cell of the polyad 17-19 µm in diameter, Amb of every cell squarish; 16-celled polyad, radially symmetrical, with core eight cells of two stacked groups of four cells each, and periphery eight cells (4+4+8 condition).	Trimorphic pollen, dilated pores	Exine thickness of 1.6 µm, weakly reticulate tectate surface.
07 *Prosopisjuliflora*(Sw.) DC	Amb rounded triangular 36-39 µm; prolate to subprolate;38-42× 30-35 µm, Radially symmetrical	Sharp, pointed, and triangular are characteristics shared by the oralalongata, tricolllporate, and syncolpate.	Exine thickness of 3.2 µm, weakly reticulate tectate surface.

Lecythidaceae				
08	*Careyaarborea*Roxb.	subprolate, isopolar, radially symmetrical 52.1× 40.1 µm (48-54× 37.5 -43.5) µm,	Hexacolpate, syncolpate with crassimarginatecolpi, col. Length 43.5 (42-46.5) µm	Medium reticulate, more coarse toward the poles; sexine-nexine is not distinguished; exine is thick, undulating, and rather thick at the poles. Medium reticulate, more coarse toward the poles; sexine-nexine is not distinguished.
Fabaceae				
09	*Pongamia pinnata* (Linn) Pierre.	Ambsubtriangular 29-31 µm,: subprolate; Radially symmetrical 27-31× 25-28 µm,	It is orally elongated and has three colpi that are regular to narrowly elliptic at the tips.	Granular to faintly microrecticulate 1.5 µm thick subtectate exine.
Cleomaceae				
10	*Cleome gynandra* Linn	Amb spheroidal 19-21 µm, , prolate spheroidal; radially symmetrical 18-22 ×14-16 µm,	Tricolporate, with narrowing colpi and no strong ora; in an elongated shape.	Exine thickness of 1 micrometres; subtectate surface with fine reticulation; homobrochate morphology; polygonal, smooth, murisimplibaculate light sources;
Rutaceae				
11	*Citrus*sp.	Ambsquarish 27-29 µm, prolate spheroidal radially symmetrical 26-30 ×25-27 µm,	Tetracolporate, colpi linear, tips acute, oralalongate	Exine Subtectate layer 2 µm thick, Reticulate on the surface.
Capparidaceae				
12	*Capparis grandis* Linn.	Amb spheroidal 10-12 µm; µm prolate to subprolate Radially symmetrical 14-16 ×9-12;	Tricolporate; colpi elongated to oblong; apices sharp; ora elongated but hardly visible;	The surface of the exine is barely granular to virtually psilate, and it is 1 µm thick and tectate.
Acanthaceae				
13	*Asteracantha longifolia* (Linn.) Nees.	Amb spheroidal or quadrangular, 56-59 µm; oblate spheroidal 50-55× 52-59 µm; Radially symmetrical	Tetracolporate in shape with long, tapering colpi that taper to acute tips; colpi alternate with four pseudocolpi that resemble streaks; ora are roughly round.	Subtectate, reticulate, homobrochate, psilate, polygonal, and 3.3 µm thick exine with polygonal and psilate lumina.
Meliaceae				
14	*Azadirachta indica* A.juss	Ambsquarish, sides convex 50-54 µm; subprolate 47-54 38-47 µm, poles smoothly rounded; Radially symmetrical	oral elongation and tapering pointed ends	Surface psilate to locally granular, 3 µm thick tectate exine
Verbenaceae				
15	*Clerodendrum*sp.	Amb spheroidal 43-48 µm, 41-44 ×37-40 µm, prolate spheroidal; Radially symmetrical	Tricolporate; colpi moderately long; colpi's apexes sharp; colpi's margins fractured	Exine 1.5 µm in thickness (not including spinules), spinulate tectate surface, spinules of 0.6-1 µm in length, and a coarsely granular interspinular

				gap.
Liliaceae				
16	*Allium cepa* Linn.	ellipsoidal 14-28× 32-48 µm, Bilaterally symmetrical	Single sulcus with a thin border	1.5 micrometre thick exine; subtectate; mildly reticulate surface
Cucurbitaceae				
17	*Cucurbitaceae type*	subprolate,50-63 µm, Radially symmetrical, and isopolar	Colored tricolporate, measuring 48.7 µm in length	Baculae are apparent, and there is a distinct LO pattern throughout the exine, which is thick at 4.5 µm and indistinguishable from the nexine at 3.4 (3 - 4.5) µm.

Table 2 Analysis of pollen loads from honeycomb.

Chimur Tahsil							
Comb	Total Po	Unifloral Loads		Bifloral Loads		Multifloral Loads	
	Pollen Loads	Number	Composition	Number	Composition	Number	Composition
CHN-CHI-Jam-30	37	01	1- Te	NIL	-	36	12-Te(46,48), De(17,32), Bl(5,11), Cl(4,5), Ma(15,17) 8-Car(16,76), Te(3,15),Alb(8,61) 6-Pon(60,72), Te(22,32), Bl(6,8) 5-Pr(24,26), Ast.l(27,28), Ma(35,40), De(7,13) 2-Bl(37,41), Ca(27,30), Az(19,20), All(10,16) 1-Ma(18), Bl(30), Te(52) 1-Car(24), Ma(28), Bl(48) 1-Cle(6), Ma(72), Pr(22)Bl(8,13),
CHN-CHI-Bor-31	48	14	13- Te 1- Ma	06	3-Pr(15-66), Te(34-85) 1-Te(82), Ca(18) 1-Ma(64), Te(36) 1-Ma(72), Pr(28)	28	12-Te(35,40), De(27,28), Ma(24,26), Bl(7,13) 8-Ma(18,63), Te(11,43), De(10,36), Alb(3,16) 4-Pon(3,83), Bl(4,85),

							De(12,13) 2-Te(20,86), Ca(10,78), Un(2,4) 1-Te(81), Cu(14), Bl(5) 1-Ma(45), Te(34), Un(21)
CHN-CHI-All-29	52	10	6-Ma 4- Te	17	8-Ma(24,47), Te(53,76) 7-Bl(22,33), Te(67,78) 2-Te(27,31), De(69,73)	25	10-Bl(30,41), Te(27,30), Ma(19,20), De(17,16) 8-Te(60,72), Ma(22,32), Ci(6,8) 3-Car(27,28), Te(35,40), Ma(24,26), De(7,13) 2-Cart(16-76), Pon(8-61), Te(8-10), Car(7-15) 1-Ca(3), Bl(4), Ci(32), Ma(61) 1-Te(56), Ma(33), Pon(6), Car(5)
Total	137	25 (18.24%)		23 (16.78%)		89 (64.95%)	

Abbreviations for pollen types recorded from pollen loads: Te- *Terminalia* sp. Ma- *Mangifera indica.* Bl- *Blumea* sp. Ci- *Citrus* sp. Car- *Careya arborea.* Pon-*Pongamia pinnata.* Cl- *Cleome gynandra.* Cart- *Carthamus tinctorius.* Ast-l- *Asteracantha longifólia.* Az-*Azadirachta índia.* All- *Allium cepa.* Cu- *Cucurbitaceae type.* De- *Delonix regia.* Ca- *Capparis grandis.* Pr-*Prosopis juliflora.* Cle- *Cleodendrum.* Alb- *Albizia lebbeck.*

(a) (b)

Figure 2 Pollen types in unifloral pollen loads (a) *Terminalia* sp., (b) *Mangifera indica.*

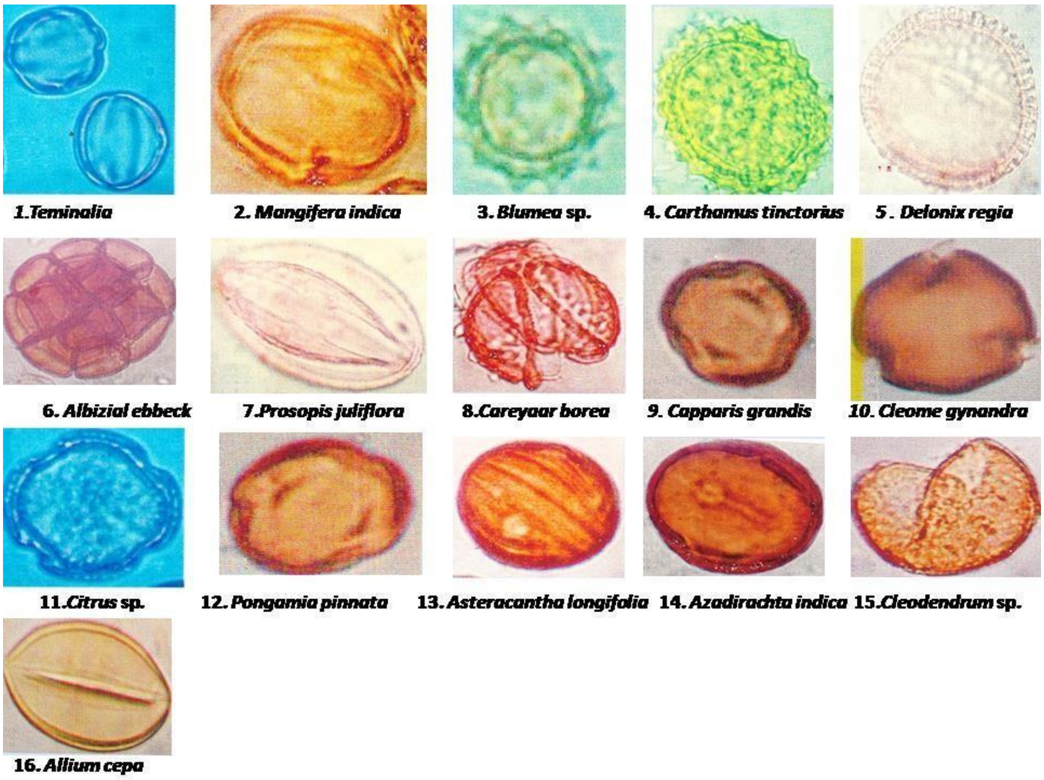

Figure 3 Light microscopic photograph of pollen grain in pollen loads.

When examining the distribution of different pollen types in the overall pollen loads analyzed, it was found that Terminalia sp. pollen was present in 111 loads (81.02%), followed by *Mangifera indica* pollen in 81 loads (59.12%), Blumea sp. pollen in 64 loads (46.71%), and *Delonix regia* pollen in 56 loads (40.81%), among others (Borkar et al., 2022). In the Chimur Tahsil forest zone of the Chandrapur District in the state of Maharashtra, pollen loads were gathered from Apis dorsata beehives. According to the findings of the study, the majority of the pollen loads were likely produced by a selection of the typical arborescent and shrubby species that are found in this region.

Some of the species that are known to inhabit this area include *Terminalia chebula*, *Mangifera indica*, *Delonix regia*, *Albizia liebbeck*, *Caryodendron arboreum*, *Pongamia pinnata*, and *Careya arborea*. All of these can be discovered in the region. Bees of the species Apis dorsata obtain a small amount of the pollen they need from herbaceous weeds such as *Carthamus tinctorius* and Blumea species. According to the numbers, Terminalia sp. pollen is the most frequent, accounting for 72 percent of the Unifloral loads and 81.02 percent of the total pollen loads that were investigated (Borkar et al 2022).

4. Conclusions

Therefore, Terminalia sp. is the primary flower from which honeybees collect pollen during the summer. *Mangifera indica* (59.12 percent), Delonix (40.87 percent), Blume (46.71 percent), Albizia (11.67 percent), and Careya (10.1 percent) are also important pollen sources for the honeybees in this region.

In the summer, these taxa provide a substantial amount of pollen to the honeybees in this forest.

Ethical considerations

Not applicable.

Conflict of Interest

The authors declare no conflicts of interest.

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