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Pollen analysis in honey samples from the two main producing regions in the Brazilian northeast

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ABSTRACT

Knowledge about the botanical source of honey is very important for the beekeeper while it indicates adequate and abundant supply sources of nectar and pollen for the bees, thus contributing toward improved yield. The present study means to identify the pollen types occurring in 58 samples of honey produced in two states of the northeastern region of Brazil, Piauí (38 samples) and Ceará (20 samples), and to verify the potential of the honey plants during the months of February to August. The samples were obtained directly from beekeepers in each state and analyzed at the Apiculture Laboratory of the Entomology Section of Escola Superior de Agricultura "Luiz de Queiroz", USP, Piracicaba, State of São Paulo, Brazil. The pollen analysis was performed using the acetolysis method. The samples were submitted to both a qualitative and a quantitative analysis. The dominant pollen in the State of Ceará is from *Mimosa caesalpiniaefolia, M. verrucosa, Borreria verticillata, Serjania* sp., and a Fabaceae pollen type, while in the State of Piauí it is from *Piptadenia* sp., *M. caesalpiniaefolia, M. verrucosa, Croton urucurana* and *Tibouchina* sp.

Key words: pollen type, honey, *Apis mellifera*, bee plant, Ceará, Piauí.

INTRODUCTION

The identification of plants used by honeybees assumes great importance, since it provides beekeepers with indications about adequate and abundant nectar and pollen supply sources (Howes 1953), especially considering that beekeeping in Brazil is targeted at an improved use of the richness offered spontaneously by the natural vegetation.

Knowledge about the pollen morphology of honey plants is important in the identification of plant species which contribute toward composition of honey. Preserving and multiplying those plants is also necessary, aiding in the establishment of a sustainable apiculture (M.C. Santos Júnior and F.A.R. Santos, personal communication). The pollen involuntarily collected by bees at nectar collection time is an important indicator of its botanical and especially geographical origin (Barth 1989, E.M.A.F. Bastos, personal communication).

The qualitative and quantitative palynological survey of a honey sample constitutes its pollen spectrum. This spectrum relates to nectar-producing plants, non-nectar-producing plants, contaminations, tainted honey, and mixtures (Barth 1989). Pollen qualitative analysis can provide important data, especially for honey characterization with reference to its geographic origin, occurrence of nectariferous plants, collection season, and at a later time with regard to honey determination from

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an unknown or questionable origin (Barth 1989). By means of quantitative pollen grain analysis, the honey makeup can be established, and the nectariferous botanical species which gave origin to it can be determined (Iwama and Melhem 1979). Studies developed by Santos (1963, 1978), Barth (1969, 1970 a,b,c, 1971a, 1989, 1990, 2004), Cortopassi-Laurino and Gelli (1991), B.M. Freitas (personal communication), Aires and Freitas (2001), Sodré et al. (2001), Arruda et al. (2005), and Persano-Oddo et al. (2004) demonstrated the importance of pollen found in honeys in furnishing knowledge about the botanical and geographic origin of the resource-providing plants, thus increasing the use of these trophic resources.

The present study means to identify the pollen types occurring in 58 samples of honey produced in two states of the northeastern region of Brazil, Piauí (38 samples) and Ceará (20 samples), and to verify the potential of honey plants during certain seasons of the year.

MATERIALS AND METHODS

Fifty-eight samples of honey produced by Apis mellifera L., 1758 (Hymenoptera: Apidae) were collected in the period from February to August 2002, directly from beekeepers at different cities in the states of Ceará (Araripe sample number 1; Santana do Cariri sample number 2; Asoré sample number 3; Iguatu sample numbers 4, 5, 6, 9, 14, 15, 16, and 17; Crato sample numbers 7, 10, 11, and 12; Missão Velha sample numbers 8 and 13; Pracajús sample numbers 18, 19, and 20), and Piauí (Pimenteiras sample numbers 21 and 22; Picos samples numbers 23, 24, 25, 26, 27, 28, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, and 58; Socorro sample number 29). The pollen analyses of honey were performed at the Useful Insects Laboratory of Departamento de Entomologia, Fitopatologia e Zoologia Agrícola of Escola Superior de Agricultura "Luiz de Queiroz", Piracicaba Campus, Universidade de São Paulo.

All honey samples were prepared using the acetolysis method (Erdtman 1952) and then submitted to both a qualitative and a quantitative analysis.

QUALITATIVE ANALYSIS

The qualitative analysis, referring to the pollen types present in the samples, was determined by comparison with a reference slide collection (600 species) and the descriptions of pollen grains obtained from the specialized literature (Barth 1970 a,b,c, 1971a,b, 1989, 1990).

QUANTITATIVE ANALYSIS

The quantitative analysis was performed by consecutively counting 300 pollen grains/replicate/sample. Percentages and classes of occurrence were determined. According to Louveaux et al. (1978) these are the dominant pollen (> 45% of total grains) (Dp), accessory pollen (16 to 45%) (Ap), important isolated pollen (3 to 15%) (Iip), and occasional isolated pollen (< 3%) (Oip). The results presented here correspond to the average of two counts.

For some plant species, the term "pollen type" was assigned, due to the little knowledge available about the honey species in the study region. We resorted to pollen type, which comprises all species that have equal or similar pollen grains, either belonging or not to a species in the same genus (Barth 1970b).

RESULTS AND DISCUSSION

The pollen analysis results are shown in Tables I and II and Figures 1 and 2.

Figures 1 and 2 allow the visualization of the dominant pollen types occurring in honey samples from the states of Ceará and Piauí analyzed.

The qualitative pollen analysis of the 58 honey samples showed a great variety of pollen grain types. Forty-one pollen types were found, distributed through 17 botanical families in the State of Ceará, while 39 pollen types, distributed through 19 botanical families, were found in the State of Piauí (Tables I and II). This information may contribute toward the characterization of honeys from these states with regard to their botanical origin.

The quantitative pollen analysis detected five different pollen types occurring as **dominant pollen** in the 20 samples of the State of Ceará that were analyzed: *Mimosa caesalpiniaefolia* (Mimosaceae) (50.0%), *M. verrucosa* (Mimosaceae) (5.0%), *Borreria verticillata* (Rubiaceae) (10.0%), *Serjania* sp. (Sapindaceae) (5.0%), and Fabaceae type (Fabaceae) (5.0%) (Table I). Five

TABLE I

Pollen spectrum of 20 *Apis mellifera* honey samples from different municipalities in the State of Ceará.

Plant family	Pollen types	Samples																			
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Amaranthaceae	*Alternanthera ficoidea*		Oip		Oip	Oip	Iip							Iip	Iip	Oip	Iip	Oip			
	Gomphrena sp.													Oip	Iip						
Apocynaceae	Apocynaceae type									Oip	Oip										
Arecaceae	*Astrocaryum* sp.			Oip							Oip										
Asteraceae	*Bidens* sp.								**Ap**										Oip		Oip
	Emília sp.			Oip			Oip	Oip	Iip												
	Mikania sp.				Oip		Oip														
	Asteraceae type			Oip																	
Brassicaceae	Brassicaceae type					Oip		Oip	Oip												
Chenopodiaceae	*Chenopodium* sp.			Oip						Iip	**Ap**	Iip	Iip								
	Chenopodiaceae type																	Oip			
Compositae	*Vernonia cognata*	Oip	Oip								Oip							Oip		Oip	
	Vernonia sp			Oip											Oip						
Euphorbiaceae	*Croton urucurana*			Iip	**Ap**		Oip		**Ap**	Oip					Oip	Oip	Oip	Oip			
	Croton sp.										Oip										
Fabaceae	*Bauhinia* sp.								Iip												
	Schrankia sp	Oip																	Oip		
	Fabaceae type			**Dp**	Iip		Oip			Iip			Iip					Iip			Oip
Lamiaceae	*Hyptis eriophylla*	Iip			Oip			Oip		Iip		Oip	Iip							Oip	
	Salvia sp													Oip	Oip	Oip		Oip			
Malvaceae	*Malvastrum* sp			Oip																	
	Sida sp.											IIP								Oip	Oip
Mimosaceae	*Acacia* sp			Oip				Oip													
	Leucaena leucocephala											Oip					Oip				
	Mimosa caesalpinifolia	**Dp**			**Dp**	**Dp**	**Dp**	**Dp**	Iip	**Dp**	**Ap**	**Dp**	**Ap**	**Ap**	**Dp**	**Ap**	**Dp**	**Dp**	**Ap**	**Ap**	**Ap**
	Mimosa scabrella	Oip						Oip			Iip	Oip		Oip							
	Mimosa verrucosa		Iip	Iip		Iip	**Ap**			Oip	Iip		**Dp**	Iip	Iip	**Ap**	Oip	Iip	Iip	Iip	Iip
	Piptadenia sp	Oip	Oip	Oip						Iip	Iip	Oip				Iip		Oip			
Myrtaceae	*Eucalyptus* sp.		Oip																	Iip	
	Myrcia type			Oip			Oip								Oip	Oip		Oip			
Poaceae	*Brachiaria decumbens*			Oip						Oip											
	Paspalum notatum										Oip										
Rubiaceae	*Borreria verticillata*	**Ap**	Iip		Oip		Iip		Oip				Iip	Iip	Iip	Iip	Oip		**Dp**	**Ap**	**Dp**
	Borreria sp.														Oip						
	Richardia sp												Oip			Oip					
Sapindaceae	*Serjania* sp.		**Dp**						Iip												
	Sapindaceae 1 type					Oip			Oip												
	Sapindaceae 2 type		Iip															Oip		Oip	
Solanaceae	Solanaceae 1 type						Iip		Oip	Oip											
	Solanaceae 2 type										IIP	Oip	IIP		Oip						
	No identified															Oip					

Dp = dominant pollen greater than 45% of total pollen grains, Ap = accessory pollen from 16 to 45%, Iip = important isolated pollen from 3 to 15%, and Oip = occasional isolated pollen smaller than 3%.

TABLE II

Pollen spectrum of 38 *Apis mellifera* honey samples from different municipalities in the State of Piauí.

Plant family	Pollen types	Samples																			
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Amaranthaceae	*Alternanthera ficoidea*		Oip			Oip															
Anarcadiaceae	Anarcadiaceae type		Oip																		
Arecaceae	Arecaceae type															Iip					
Asteraceae	*Bidens* sp.	Iip	Iip									Iip					Oip		Oip	Oip	
	Emilia sp.												Oip					Oip			
	Mikania sp.			Iip				Oip			Oip					Iip					
Caesalpiniaceae	Caesalpiniaceae tupe			Oip									Iip								
Chenopodiaceae	*Chenopodium* sp.						Oip		Oip	Oip	Iip	Iip	**Ap**	Oip	Oip	Iip	Oip		Oip	Iip	Iip
Compositae	*Vernonia cognata*	Iip	Oip																	Iip	Oip
	Vernonia sp																Oip				
Euphorbiaceae	*Croton urucurana*												**Ap**		Oip	Iip					Oip
	Croton sp.	Iip	Iip								Oip										
Fabaceae	*Bauhinia* sp.												Iip			Iip					
	Schrankia sp	Oip																			
	Fabaceae type									Oip			Iip			Oip				Iip	
Lamiacea	*Hyptis eriophylla*	Oip	Oip			Oip														Iip	Oip
	Salvia sp											Iip									
Malvaceae	*Sida* sp.					Oip		Oip				Iip	**Ap**		Iip						
	Malvaceae type																				
Melastomaraceae	*Tibouchina* sp.			**Ap**		Iip	Iip	Oip	Oip	Oip			**Ap**	Oip	Iip	**Ap**	Oip	Iip	Iip	Oip	**Ap**
Mimosaceae	*Mimosa caesalpinifolia*			Iip	Oip					**Dp**		**Dp**	Iip							Iip	Iip
	Mimosa scabrella		Oip											Oip		Oip		Oip	Oip		Oip
	Mimosa verrucosa	**Dp**	**Dp**	Oip		Oip	Oip		Oip	**Ap**	Iip	**Ap**	Oip		Oip					Iip	**Dp**
	Piptadenia sp	Oip		Dp	Dp	Dp	Dp	Dp	Dp	Oip	Dp	Oip	Iip	Dp	Dp	Dp	Dp	Dp	Dp	Ap	
Myrtaceae	*Eucalyptus* sp.			Oip																	
	Myrcia type	Iip							Oip										Oip		
Rubiaceae	*Borreria verticillata*					Iip	Oip	Oip		Iip	Iip	Iip	Iip		Iip	Iip				**Ap**	
	Borreria sp.										Iip	Iip								Iip	
	Richardia sp.												Iip			Iip					Oip
	Rubiaceae type																				
Rutaceae	*Citrus* sp.																			Oip	
Sapindaceae	*Serjania* sp.					Oip	Oip	Oip				Oip							Oip		
	Sapindaceae 1 type		Oip																		
	Sapindaceae 2 type																				
Solanaceae	Solanaceae type					Oip		Oip													
	No identified						Oip												Oip		

TABLE II (continuation)

Plant family	Pollen types	Samples																	
		21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38
Asteraceae	*Bidens* sp.						Oip												Oip
Chenopodiaceae	*Chenopodium* sp.	Oip		Oip			Oip	Oip	Oip	Oip	Oip	Oip		Oip	Oip		Oip	Oip	Oip
	Chenopodiaceae type																		
Euphorbiaceae	*Croton urucurana*				Iip	**Dp**	Oip	Oip		Iip	Oip			Oip	Oip			Oip	Iip
	Croton sp.								Iip										
Fabaceae	*Schrankia* sp								Iip	Oip						Oip			
	Fabaceae type	Oip								Iip	Iip								
Lamiaceae	*Hyptis eriophylla*	Oip												Oip		Oip			
	Salvia sp								Oip										
Malvaceae	*Sida* sp.	Oip						Oip	Oip	Iip		Oip	Oip		Oip				Oip
Melastomataceae	*Tibouchina* sp.	**Ap**	**Ap**		Oip	Iip	Oip	**Ap**	**Ap**	**Ap**	Dp	**Ap**	Iip	Iip	**Ap**	Oip	**Ap**	Oip	
Mimosaceae	*Leucaena leucocephala*									Oip									
	Mimosa caesalpinifolia		Iip	Oip					**Ap**	Iip		Oip	Oip	Oip	Oip	**Ap**	Oip		
	Mimosa verrucosa	Iip					Oip			Iip		Oip							
	Piptadenia sp	**Dp**	**Ap**	Dp	Dp	**Ap**	**Dp**	**Dp**	Iip	Iip	Iip	**Dp**	**Dp**	**Dp**	**Dp**	**Dp**	**Dp**	**Dp**	**Dp**
Poaceae	*Brachiaria decumbens*										Iip								
	Paspalum notatum									Oip									
	Zea mays							Oip											
Rubiaceae	*Borreria verticillata*	Oip		Iip	Oip				Iip			Oip	Oip	Oip		Oip			Oip
	Borreria sp.	Oip			Oip					Iip	Iip	Oip			Iip				
	Richardia sp		**Ap**		Oip				Iip	Iip	Oip		Oip	Oip					
	Rubiaceae type												Oip						

Dp = dominant pollen greater than 45% of total pollen grains, Ap = accessory pollen from 16 to 45%, Iip = important isolated pollen from 3 to 15%, and Oip = occasional isolated pollen smaller than 3%.

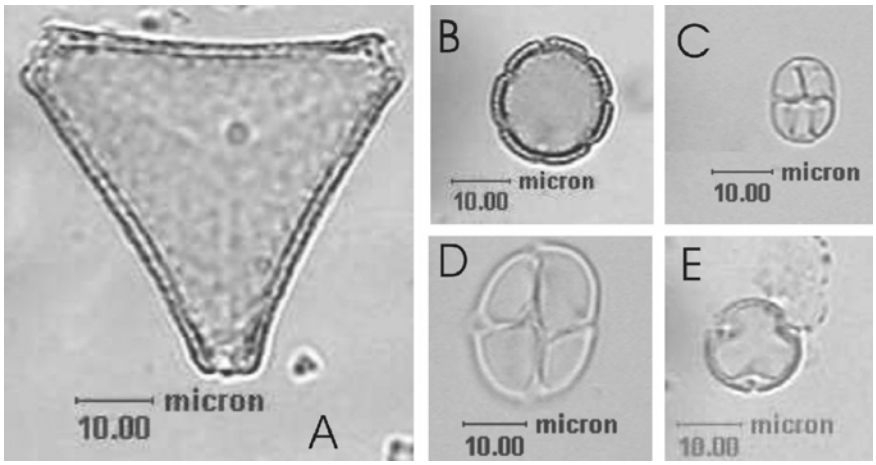

Fig. 1 – Dominant pollen types found in 20 *Apis mellifera* honey samples from the State of Ceará. A – *Serjania* sp. (Sapindaceae); B – *Borreria verticillata* (Rubiaceae); C – *Mimosa caesalpiniaefolia* (Mimosaceae); D – *M verrucosa* (Mimosaceae); E – Fabaceae Type (Fabaceae).

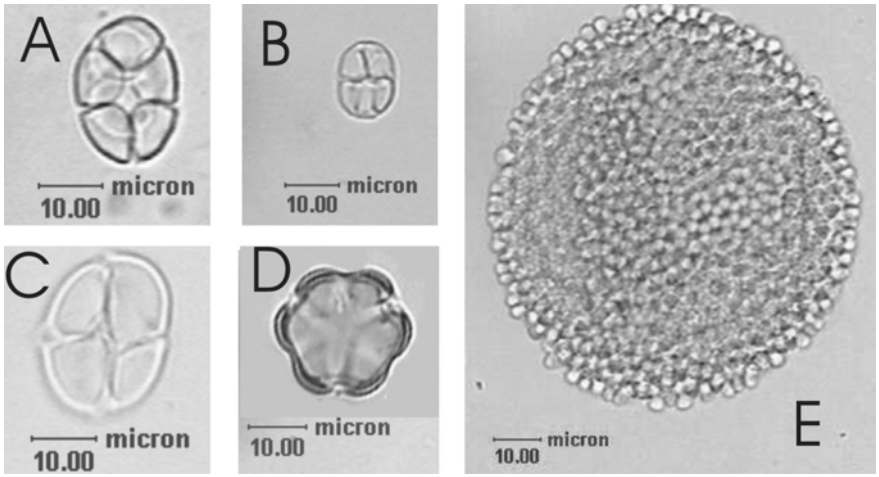

Fig. 2 – Dominant pollen types found in 38 *Apis mellifera* honey samples from the State of Piauí. A – *Piptadenia* sp. (Mimosaceae); B – *M. caesalpiniaefolia* (Mimosaceae); C – *Mimosa verrucosa* (Mimosaceae); D – *Tibouchina* sp. (Melastomataceae); E – *Croton urucurana* (Euphorbiaceae).

different pollen types were also identified as dominant pollen in the 38 samples of the State of Piauí: *Piptadenia* sp. (Mimosaceae) (68.4%), *M. caesalpiniaefolia* (Mimosaceae) (5.3%), *M. verrucosa* (Mimosaceae) (7.9%), *Croton urucurana* (Euphorbiaceae) (2.6%), and *Tibouchina* sp. (Melastomataceae) (2.6%) (Table II).

It can be seen that the samples in both states are quite similar with regard to their floral origins, as they were collected in the same season and at nearby geographic regions. The quantitative pollen analysis of the honeys demonstrated the important participation of *M. caesalpiniaefolia* in the makeup of honeys from the State of Ceará. In the State of Piauí, in addition, the strong participation of the genus *Piptadenia* sp. was detected. These two pollen types reiterate the beekeeping potential of these plants in the states under study.

Barth (1989) mentioned that the pollen from Mi-

mosaceae plants like *M. caesalpiniaefolia, M. verrucosa*, and *M. scabrella* types were frequently found in honey from the states of Ceará and Bahia, and that these pollen types cannot be used to discriminate between honeys produced in each state. In addition, pollen grains from the *Borreria verticillata* and *B. latifolia* types, found at high percentages in some samples, could indicate that a honey came from the State of Ceará. In the present work, the high frequency of the *M. caesalpiniaefolia* pollen type was observed in samples from the State of Ceará; this species was found in 10 samples as dominant pollen, followed by *Borreria verticillata* in two samples only. B.M. Freitas (personal communication) had previously verified the importance of *M. caesalpiniaefolia* as a honey plant in the State of Ceará, and this was later confirmed by Noronha (personal communication).

Aires and Freitas (2001), however, verified the occurrence of *Cocos nucifera, Alternanthera tenella*, and *Eucalyptus* sp. in monofloral honeys, and the predominance of family Mimosaceae in heterofloral honeys from the State of Ceará Arruda et al. (2005) analyzed honey samples from Chapada do Araripe, Ceará, and verified *Serjania* sp. and the *Cordia* pollen type as dominant during the months of November and December.

Honey samples showing a predominance of the *Piptadenia moniliformis* pollen type, indicate that the honey is from the State of Piauí (Barth 1989). In our work, 26 samples (68.4% of all samples from Piauí) showed this genus as the dominant pollen.

Based upon the quantitative analysis of pollen grains, we were able to observe a great participation of **accessory pollen** in the samples, corresponding to 55.0% of the samples for the State of Ceará and 58% of the samples for Piauí. Barth (1970b) mentioned that honeys containing accessory pollen occur frequently, due to the fact that Brazilian beekeeping is carried out in a primitive manner with regard to bee pasture. The author highlighted the importance of accessory and dominant pollen with reference to the amount of nectar supplied. In the present work, we observed samples containing accessory pollen without the presence of dominant pollen for the State of Ceará in samples 8, 10, 13, 15, and 19 (25.0% of samples) (Table I), and for the State of Piauí in samples 11, 12, 19, 22, 28, and 29 (15.8%) (Table II).

The following plant species were observed as accessory pollen types: *Bidens* sp., *Chenopodium* sp., *C. urucurana, M. caesalpiniaefolia, M. verrucosa*, and *B. verticillata* for the State of Ceará, and *Chenopodium* sp., *C. urucurana, Sida* sp., *Tibouchina* sp., *M. caesalpiniaefolia, M. verrucosa, Piptadenia* sp., *B. verticillata*, and *Richardia* sp. for the State of Piauí.

According to A.F. Silva et al. (personal communication) the most important plants visited in the State of Piauí for the production of honey are "marmeleiro" (*Croton sonderianus*), "jitirana" (*Hyptis suaveolens*), "camaratiba" (*Cratylia mollis*), "silvestre" (*Serjania glabrata*), and "angico de bezerro" (*Piptadenia molinis*). In the present work, two genera were verified to fall into the dominant or accessory pollen percentage range: *Piptadenia* (29 samples), and *Croton* (2 samples). The presence of *Hyptis* and *Serjania* (Table II) was also verified in the isolated pollen category, indicating the existence of these plants in the area under study.

With regard to **important** or **occasional isolated pollen**, their presence was observed in almost all samples studied (Tables I and II). This pollen type has little importance with regard to the amount of nectar supplied; however, it provides information with regard to the source and geographic origin of the sample (Barth 1989).

CONCLUSIONS

Typical honeys from the State of Ceará contain mostly *M. caesalpiniaefolia* as dominant pollen; in turn, honeys from the State of Piauí contain *Piptadenia* sp., demonstrating the importance of these plants in those states during the months of February through August.

Species like *M. verrucosa, M. scabrella, Serjania* sp., *C. urucurana*, and two species in the genus *Borreria* were observed in both states studied and have potential as honey plants during certain seasons of the year.

RESUMO

O conhecimento da origem botânica do mel é de grande importância para o apicultor por indicar fontes adequadas e de abundante suprimento de néctar e pólen para as abelhas, contribuindo, desta forma, para uma melhor produção. O presente estudo teve como objetivo identificar os tipos polínicos em 58 amostras de méis produzidos em dois estados da região

nordeste do Brasil, Piauí (38 amostras) e Ceará (20 amostras), verificando o potencial das plantas apícolas durante os meses de fevereiro a agosto. As amostras foram obtidas diretamente de apicultores de cada Estado e analisadas no Laboratório de Apicultura do Setor de Entomologia da Escola Superior de Agricultura "Luiz de Queiroz", USP, Piracicaba, Estado de São Paulo. A análise polínica foi realizada utilizando-se o método da acetólise. As amostras foram submetidas às análises qualitativa e quantitativa. Constatou-se como pólen dominante no Estado do Ceará, *Mimosa caesalpiniaefolia, M. verrucosa, Borreria verticillata, Serjania* sp. e tipo polínico Fabaceae e para o Estado do Piauí, *Piptadenia* sp., *M. caesalpiniaefolia, M. verrucosa, Croton urucurana* e *Tibouchina* sp.

Palavras-chave: Tipo polínico, mel, *Apis mellifera*, planta apícola, Ceará, Piauí.

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