Botanical profile of bee pollen from the southern coastal region of Bahia, Brazil

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RESUMO – (Perfil botânico do pólen apícola proveniente do Litoral Sul da Bahia, Brasil). O presente trabalho teve por objetivo identificar a origem botânica das bolotas de pólen coletadas pelas abelhas *Apis mellifera* L. no município de Canavieiras, Bahia, gerando uma lista de plantas poliníferas pertencentes ao bioma Mata Atlântica e importantes para o desenvolvimento da apicultura regional. Foram analisadas palinologicamente 35 amostras de pólen apícola, utilizando-se o processo de acetólise para, em seguida, serem feitas análises qualitativas e quantitativas. Os resultados revelaram que os tipos polínicos *Elaeis* (23,99%), *Mimosa pudica* (22,78%) e *Cecropia* (13,68%) foram os mais abundantes no pólen apícola analisado. Estes tipos polínicos também apresentaram as maiores frequências relativas de todo o material estudado e representam importantes plantas fontes de pólen para as abelhas na área estudada.
Palavras-chave: apicultura, *Apis mellifera*, Mata Atlântica, melissopalinologia, tipo polínico

ABSTRACT – (Botanical profile of bee pollen from the southern coastal region of Bahia, Brazil). This paper aims to identify the botanical origin of pollen loads collected by *Apis mellifera* L. in Canavieiras municipality, Bahia state. It provides a list of polliniferous plant species from the Atlantic Forest biome that are important for the development of regional apiculture. Using the acetolysis method, 35 bee-pollen samples were analyzed qualitatively and quantitatively. Results showed that pollen types *Elaeis* (23.99%), *Mimosa pudica* (22.78%) and *Cecropia* (13.68%) were the most abundant among the samples. These also showed the highest relative frequencies of the material studied and were important pollen sources for bees in the study area.
Key words: *Apis mellifera*, Atlantic Forest, beekeeping, melissopalynology, pollen type

Introduction

Pollen is an interesting subject for apiculture. Bees harvest the pollen grains as loads, transporting them to hives and storing them in cells a long way from the honeycombs. This product will be used for feeding, especially of the larvae. The pollen grains are also good indicators of the botanical and geographical origin of bee products (Borges *et al.* 2006).

The literature is still poor in studies on palynological characterization of pollen loads carried by honeybees. For Bahia state, there are a few works such as Ramalho *et al.* (2007) and Novais *et al*. (2009).

Most palynological studies are focused on honey analyses and pollen characterization of nectariferous plants. In Bahia, pollen analysis of honey is also scarce in the specialized literature (for example: Carvalho *et al.* 2001; Santos Jr. & Santos 2003; Novais *et al.* 2006; Oliveira *et al.* 2010).

According to Wiese (1985), knowing the bee flora is an important step towards rational exploitation and conservation of bees, contributing to apiary management, as well as identification, preservation and multiplication of plant species that are most important for apiculture in an area.

The prominence of the Brazilian Northeast with its high extractive production of bee products contrasts with the local trade of this production, which has low market values. With botanical certification it is possible to increase these values and, therefore, improve social and economic conditions of agricultural workers, especially beekeepers.

Although honey has been the most widespread bee product, the bee pollen trade is undergoing expressive growth. The municipality of Canavieiras, Bahia state (BA), stands out on the national scene. The quantity and quality of the bee pollen produced in this municipality has attracted increased attention for Brazilian apiculture.

This work aims to identify the botanical origin of the pollen loads collected by *Apis mellifera* L. in Canavieiras (BA), and to give scientific support to local cooperatives of beekeepers by indicating important plants for the development of regional apiculture, through identification of pollen types.

Material and methods

The municipality of Canavieiras (15º41'S, 38º57'W), located in the "Litoral Sul" economic micro-region of Bahia state, is characterized by ample mangrove areas, but also has large tracts of forest, restinga and dune vegetation, with emphasis on palms (Arecaceae). Each of these ecosystems has a rich flora with polliniferous and nectariferous plant species, which are important for apiculture. Flowering time of these species covers the entire year, peaking between August and September (BAHIA 2002).

The material examined was supplied by the Beekeepers Association of Canavieiras (ACAP), between 2002 (samples 01-06) and 2003 (samples 07-35). Thirty-five dehydrated bee pollen samples, regulary found in commerce were analyzed. Each 5-grame sample was dissolved in 25 mL of distilled water, following the methodology of Alvarado & Rueda (1985), with some modifications. After complete homogenization of the mixture, 2 mL from

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each sample were taken and submitted to the acetolysis method (Erdtman 1960). The sediment was mounted on slides in glycerin jelly (stained with safranine) and sealed with paraffin wax.

For each sample five slides were provided. Subsequently qualitative and quantitative analyses of the pollen grains were carried out. For the qualitative analysis, exploratory observations were made to identify the main pollen types present, which were botanically classified by the palynological literature available (Roubik & Moreno 1991; Lima *et al.* 2008). Also comparisons were made of some pollen types encountered in the samples with a pollen reference library for different areas in Bahia state.

For the quantitative analysis, 1,500 pollen grains per sample were counted (Vergeron 1964). Then relative and average abundances and relative frequency of the pollen grains in the samples were calculated. According to Louveaux *et al.* (1978), if 1,200 pollen grains are counted, the percentages have an accuracy of 1% and the use of digits after the decimal point is not justified. Pollen types with abundance less than 1% were considered as "present".

Results and discussion

The qualitative analysis revealed 46 pollen types whose botanical affinity was established at least to family level. Leguminosae (9) (Mimosoideae, 5 and Papilionoideae, 4), Asteraceae (4), Euphorbiaceae (4), and Scrophulariaceae (4) had the highest richness of pollen types. All other families were represented by one pollen type, except Myrtaceae with 3 types, and Anacardiaceae and Sapindaceae, 2 pollen types each (Tab. 1).

Determination of the botanical family using pollen morphology is not difficult. However, it is not so easy to distinguish genera using only pollen grain characteristics. In most cases, it is not possible to establish the plant species, so it is necessary to recognize only pollen type (Joosten & De Klerk 2002).

Of the 35 samples analyzed, 13 had all pollen types identified. Nevertheless, 7 samples had some unidentified pollen types, whose relative abundance varied from 1.33% (sample 02) to 16.47% (sample 23); in 14 other samples, relative abundance was very low for the unidentified pollen types, <1% (Tab. 1).

The difficulty in identifying the botanical affinity of a pollen grain is linked to the knowledge of the regional flora (Borges *et al.* 2006), likewise the acetolysis use, affecting the structure of some grains and making identification a difficult process. There are also pollen grains from different plant families with similar morphology, like the 3-colp(or)ate and microreticulate pollen, very common among the Angiosperms.

Elaeis (Arecaceae), *Cecropia* (Cecropiaceae) and *Mimosa pudica* (Leguminosae-Mimosoideae) pollen types occurred in many samples and also show high abundance values (Tab. 1 and 2).

Other pollen types like *Spondias* (Anacardiaceae), *Eupatorium* (Asteraceae), *Ricinus* (Euphorbiaceae), *Centrosema* (Leguminosae-Papilionoideae), *Eucalyptus* (Myrtaceae), *Scoparia* (Schrophulariaceae), Schrophulariaceae type 1 and *Triunfeta* (Tiliaceae), in spite of having low relative abundance values (Tab. 2), had values above 1%.

In a review on plants used by bees for collecting trophic resources in Neotropical regions, Ramalho *et al.* (1990) verified that the families Anacardiaceae, Arecaceae, Asteraceae, Balsaminaceae, Euphorbiaceae, Fabaceae, Lamiaceae, Leguminosae, Moraceae, Proteaceae, Rubiaceae and Sterculiaceae are important to *Apis mellifera*. Many of these families were observed in our study with large representation, especially Leguminosae and Asteraceae.

According to Carvalho *et al.* (1999), the fact that some species present low abundance values (<1%) may be related to plant biology factors, such as low pollen production, or linked to the harvest behavior of the bee (indirect collection and/or collected resource). However, it is also possible that pollen grains had accidently contaminated the pollen masses carried during foraging activities, contributing to increase the number of pollen types with low representation.

Despite the botanical diversity in the Atlantic Forest, Camillo & Garófalo (1989) explain that the exclusion of some species from the list of plants visited by bees may be due either to the fact that the plants do not attract these insects, or the bees may prefer certain supply sources because of the ease of harvesting the reward; likewise the quantity and quality of trophic resources available and interactions with competitors may affect this event.

Eusocial bees are considered to be specialists in high floral densities. They choose the resources from which they can obtain larger quantities of food and so monopolize them, utilizing similar strategies of foraging. In other words, intensive use of few floral resources (Imperatriz-Fonseca et al., 1984). Some authors state that bees have a generalist habit of foraging (for example, Aguiar *et al.* 2002; Aguiar 2003), but show certain floral preferences (Imperatriz-Fonseca *et al.* 1984).

The pollen types *Elaeis*, *Cecropia* and *Mimosa pudica*, respectively, were the most frequent in the samples analyzed (Tab. 2). *Elephantopus*, *Eupatorium* and Poaceae types, although few, abundant in the samples where they occurred, presented high relative frequencies, once they were calculated in relation to the totality of the material analyzed.

Some of the pollen types encountered in our samples have been considered important (even when they are found at low frequency) because they are indicators of ecosystems. For example, *Alchornea* (Euphorbiaceae), *Brosimum* (Moraceae), *Cecropia* (Cecropiaceae) and *Elaeis* (Arecaceae) are indicators of hygrophilous forests (Mori *et al.* 1983). Also registered were pollen types associated with Myrtaceae species that can be related to the restinga ecosystem and hygrophilous forest.

It is interesting point to out that none of the main pollen types found in the samples were indicators of mangrove vegetation (at least the shrub and tree species), like that related to *Avicennia, Laguncularia* and *Rhizophora* species (Silva & Santos 2009). It is possible that the availability of resources in forest and restinga areas was more attractive to bees, and the apiaries were installed preferentially in those areas.

With reference to *Cecropia* type (indicator of hygrophilous forest), Marques-Souza *et al.* (1993) observed in the Amazon

Table 1. Relative abundance (%) of the occurrence of pollen types in samples of dehydrated bee pollen from Canavieiras, Bahia state. +, relative abundance less than 1%.

Pollen type	Samples																																		
	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35
AMARANTACEAE																																			
Althernantera	+																																		
ANACARDIACEAE																																			
Spondias		78	1	+	+	10	1		1		+	1				2		+												+		1		+	
Tapirira												+																							
AQUIFOLIACEAE																																			
Ilex								1	+													+		+						+	+				
ARECACEAE																																			
Elaeis	1	6	33	1	63	25	6	9	12	1			84	16	76	31	83	8	13	89	1	1	62	26	1	12	11	61	5	33	49	2	99	1	7
ASTERACEAE																																			
Elephantopus		+	2		1	5	7		1	+	1	+	1						1	1	+		+	+			+			1	4		1	+	1
Eupatorium			3			2	17	+	12	+	+			5	15		6	4	78	8	+	+	3	1	3		+	1	+	+		+			
Mikania																							1	1											
Vernonia			1				+	+	+					+		+		+	3	+		+	+	+		+				+	+				
BIGNONIACEAE																																			
Type 1																			+	+															
BOMBACACEAE																																			
Pseudobombax													+																						
CACTACEAE																																			
Cereus																				+															
CECROPIACEAE																																			
Cecropia		2	8	1	30	35	15	8	64	22	25	32			5				+	+		3	4	65	1	9	11	23	15	18	33	16			35
ERIOCAULACEAE																																			
Type 1																1																			
EUPHORBIACEAE																																			
Alchornea							+	1																											
Croton	+						2	1	+	+	+				+				1	1													+		
Croton 2									+																										
Ricinus								44		+	+	+																+							
LEGUMINOSAE - Caesalpinioideae																																			
Type 1																															13				
LEGUMINOSAE Mimosoideae																																			
Acacia bahiensis									+																										
Mimosa arenosa	+					+		27	1				2																						
Mimosa gemmulata																																+			
Mimosa pudica	4	13				3		2			2	4		75	+	60		87	3	+	97	94	9	5	94	78	70	5	76	11		75			
Piptadenia moniliformis						+																													
LEGUMINOSAE Papilionoideae																																			
Centrosema							+	+	+																										
Erythrina																						+													
Machaerium																							4		+	+		1	+						
Type 1																								+											
LYTHRACEAE																																			
Cuphea																					+	+	+						+						
MALVACEAE																																			
Type 1						+																													

Continues

Table 1. Continuation.

Pollen type	Samples																																	
	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35
Type 1							3			2			11								+	+					+		+			+			
MELIACEAE																																			
Guarea							1																												
MORACEAE																																			
Brosimum								2	1	3		7							1						+	+				1					
MYRTACEAE																																			
Eucalyptus							+			72	67	50	1			3					+	1		+		+	7	+	3	36	1	3		1	58
Type 1		+	51	98	7	2	1	+	+									+																	
Psidium																										+	+		1	1		+			+
PASSIFLORACEAE																																			
Passiflora								1																											
POACEAE																																			
Type 1	+			+		1	4	5	1	1	5	5	1	1	4	2	12		+	+			1	+					+						
RUBIACEAE																																			
Borreria			+				+		+										+	+		+				+				+	1				
SAPINDACEAE																																			
Allophylus									3															+											
Serjania							+		+																										
Scoparia																																		99	+
Type 1							5																												
Type 2							36																												
Type 3							2																												
TILIACEAE		b																																	
Triunfeta	93																																		
Unidentified types	1	1	+	+	+	17	1	+	3					3	+	+		+	+		+		16	+	+			9		+	1	3			

region that this pollen type represents an invasive species, which quickly substitutes the original vegetation in disturbed areas, serving as an indicator of environmental impact. Other works have referred to the occurrence of this type in bee products and although it had been considered anemophilous, it plays an important role in the geographical demarcation of these products (Moreti *et al.* 2000; Luz *et al.* 2007; Modro *et al.* 2007). This information agrees with our results when we consider that the *Cecropia* type was one of the most constant among the samples from Canavieiras – a municipality where devastation of the Atlantic Forest is increasing more and more.

Conclusion

The bee pollen produced in the municipality of Canavieiras is constituted by the association of many pollen types, most of which are related to common species from Atlantic Forest. The pollen spectrum presented here indicates some plant species more important to regional bee pasture, as the species *Mimosa pudica* (Leguminosae). Palynological analysis provides an additional tool for development of the regional apiculture.

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Table 2. Average abundance (%) and average frequency (%) of pollen types observed in samples of bee pollen from Canavieiras, Bahia state.

Family	Pollen type	Abundance	Frequency
Amaranthaceae	*Alternanthera*	0.001	2.86
Bombacaceae	*Pseudobombax*	0.002	2.86
Euphorbiaceae	*Croton* 2	0.002	2.86
Leguminosae-Mimosoideae	*Acacia bahiensis*	0.002	2.86
Leguminosae-Mimosoideae	*Piptadenia moniliformis*	0.002	2.86
Leguminosae-Papilionoideae	*Erythrina*	0.006	2.86
Anacardiaceae	*Tapirira*	0.008	2.86
Cactaceae	*Cereus*	0.008	2.86
Leguminosae-Papilionoideae	Type 1	0.009	2.86
Leguminosae-Mimosoideae	*Mimosa gemmulata*	0.011	2.86
Lythraceae	*Cuphea*	0.011	11.43
Malvaceae	Type 1	0.011	2.86
Sapindaceae	*Serjania*	0.011	5.71
Bignoniaceae	Type 1	0.013	5.71
Meliaceae	*Guarea*	0.015	2.86
Eriocaulaceae	Type 1	0.025	2.86
Euphorbiaceae	*Alchornea*	0.028	5.71
Passifloraceae	*Passiflora*	0.034	2.86
Scrophulariaceae	Type 3	0.043	2.86
Asteraceae	*Mikania*	0.057	5.71
Myrtaceae	*Psidium*	0.057	17.14
Rubiaceae	*Borreria*	0.069	25.71
Sapindaceae	*Allophylus*	0.073	5.71
Scrophulariaceae	Type 1	0.129	2.86
Euphorbiaceae	*Croton*	0.137	28.57
Leguminosae-Papilionoideae	*Machaerium*	0.154	14.28
Asteraceae	*Vernonia*	0.168	42.86
Aquifoliaceae	*Ilex*	0.185	17.14
Leguminosae-Caesalpinioideae	Type 1	0.358	2.86
Moraceae	*Brosimum*	0.413	22.86
Melastomataceae/Combretaceae	Type 1	0.485	22.86
Asteraceae	*Elephantopus*	0.776	60.00
Leguminosae-Mimosoideae	*Mimosa arenosa*	0.845	14.28
Poaceae	Gramineae	0.857	54.28
Scrophulariaceae	Type 2	1.024	2.86
Euphorbiaceae	*Ricinus*	1.270	14.28
Leguminosae-Papilionoideae	*Centrosema*	2.002	8.57
Tiliaceae	*Triunfeta*	2.665	2.86
Anacardiaceae	*Spondias*	2.674	40.00
Scrophulariaceae	*Scoparia*	2.817	5.71
Asteraceae	*Eupatorium*	4.389	65.71
Myrtaceae	Type 1	4.657	25.71
Myrtaceae	*Eucalyptus*	8.568	51.43
Cecropiaceae	*Cecropia*	13.683	74.28
Leguminosae-Mimosoideae	*Mimosa pudica*	22.775	65.71
Arecaceae	*Elaeis*	23.994	94.28

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