POLLEN SPECTRUM OF HONEY PRODUCED IN CERRADO AREAS OF MINAS GERAIS STATE (BRAZIL)

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(With 2 figures)

ABSTRACT

The pollen spectra of honey samples collected in five apiaries situated near *cerrado* areas in Minas Gerais State, Brazil, were studied from April 1996 to April 1998 in order to establish the contribution of different plant species in pollen or nectar production The honey samples were characterized by the following native species: *Astronium* sp., *Alternanthera* sp., *Schinus* sp., and *Serjanea* sp. The pollinic participation percentage of those species was related to the degree of preservation in the areas.

Key words: *cerrado*, honey, pollen.

RESUMO

Espectro polínico do mel produzido em áreas de cerrado do Estado de Minas Gerais (Brasil)

Os espectros polínicos dos méis colhidos em cinco apiários, instalados em áreas de cerrado do Estado de Minas Gerais, foram estudados com o objetivo de estabelecer a participação das diferentes espécies vegetais na produção de pólen ou néctar durante o período de abril/95 a abril/98. O mel foi caracterizado pelas seguintes espécies nativas: *Astronium* sp., *Alternanthera* sp., *Schinus* sp. e *Serjanea* sp. O porcentual polínico dessas espécies está relacionado com o grau de preservação dos campos cerrados no entorno do apiário.

Palavras-chave: cerrado, mel, pólen.

INTRODUCTION

Located in central Brazil, *cerrado* vegetation constitutes an important ecosystem, for both economic and ecological reasons (Carneiro, 1982). It includes about 120 million hectares, of which about 90% is in the states of São Paulo, Minas Gerais, Mato Grosso, Goiás, and Bahia.

The State of Minas Gerais presents great diversity in its vegetation covering, a great part of which consists of a complex of *cerrado*. This complex is physiognomically homogeneous, even though the floristic surveys show a great wealth in number of species and great variety in the floristic composition (Brandão, 1991).

The areas covered by *cerrado* are characterized in accordance with their diversified vegetation, richness of nectar-polliniferous elements, and low density of arboreal elements, which facilitates the rational handling of beehives and as well as a great number of beekeepers.

Bees depend on flowers for food, and plants benefit by pollination in a quite profitable relationship (Pirani & Cortopassi, 1993). Pollen and nectar from flowers constitute practically the only food source for bees, from larval through adult phases (Freitas, 1991).

Pollen supplies bees with proteins, lipids, vitamins, and minerals, being the only nitrogenated source of food available for feeding the larvae. Lacking pollen, the beehive neither grows nor develops and in the absence of protein may die.

Nectar is the basic energy source of bees and the into lipids and glycogen they transform into honey (Freitas, 1991). When extracted from honey storage cells it contains nectar and pollen from different plant species (Santos, 1960; Barth & Melhem, 1988). The pollen grains in honey serve as indicators of its geographic origin and main botanical sources.

Several studies have been done to characterize Brazilian honey: Santos (1961, 1964); Barth (1970a, b, c, 1989); Absy *et al.* (1980); Ramalho *et al.* (1991); Barth (1990, 1998); Carreira & Jardim (1994); Bastos (1993, 1995a); and Bastos *et al.* (1995b, 1998).

The present work aims to study the pollen spectra of honeys produced during the dry season in areas covered by *cerrado*, correlating them with their botanical and geographic origins.

MATERIAL AND METHODS

The studied areas were chosen for being representative of the typical *cerrado* vegetation, partly preserved and partly anthropically disturbed. These areas were in the municipalities of Cachoeira da Prata (44°27'11"W and 19°31'29"S), Jaboticatubas (43°44'35"W and 19°31'18"S), Matozinhos (44°04'57"W and 19°33'28"S), Prudente de Morais (44°09'20"W and 19°28'01"S), and Santana do Riacho (43°42'52"W and 19°10'07"S).

Monthly systematic collections were made from April 1996 to April 1998 of both mature honey and blooming species. Plants were identified and stored in the herbarium of the Empresa de Pesquisa Agropecuária do Estado de Minas Gerais (EPAMIG).

Reference slides of pollen from plants were made according to the direct method (Louveaux *et al.*, 1970). Anthers were removed from flower buds of fresh and herbarium plants and pollen grains concentrated with the aid of a drop of alcohol in the center of a glass slide. The grains obtained by this procedure were put in glycerin jelly on glass slides and sealed with paraffin. These slides were included in the reference slide collection of the Serviço de Microscopia of the Fundação Ezequiel Dias (FUNED) for later comparison with the pollinic types found in the honey samples.

Obtainment of honey sediment for microscopic analysis

The preparation of honey samples followed the standardized method of Louveaux *et al.* (1970): 10 g of well-homogenized honey were dissolved in 20 ml of distilled water and centrifuged during 3 to 5 minutes at 2500 rpm. The decanted sediment was washed with 5 to 10 ml of distilled water. After another centrifugation, the sediment was resuspended in 5 ml of 1:1 glycerin:distilled water and then centrifuged again, decanted, and mounted with glycerin jelly on microscopic slides which were sealed with paraffin.

The pollen types found in the honey samples were identified, counted, and classified, according to their percentages, as dominant pollen (more than 45% of the total pollen grains counted), accessory pollen (from 15% to 45%), important-isolated pollen (from 3% to 15%), and occasional-isolated pollen (less than 3%). Between 300 and 500 pollen grains were counted (Barth, 1970a, b, c).

Sub-factors and super-representation were considered in interpreting the data (Barth, 1989).

RESULTS AND DISCUSSION

Municipality of Cachoeira da Prata

During the experiment (April 1996 to April 1998), 11 samples of mature honey produced in the municipality of Cachoeira da Prata were analyzed. These samples showed (Table 1) 38 pollen types in the qualitative analysis. Dry-season honeys were the richest, with 36 pollen types, and rainy-season ones the poorest, with 13 types.

During the dry season, the pollen of *Astronium* sp. (*aroeirão*) (Fig. 1.1) was classified as accessory pollen (34%). This is a nectariferous species and the main source of maintenance honey for the beehives in preserved *cerrado* areas (Bastos *et al.*, 1998). Pollen grains of *Eucalyptus* sp. (Fig. 1.2) were classified as dominant pollen (43.15%). This confirms the nectariferous and polliniferous potential of this abundantly-blooming, exotic genus cultivated in reforestation areas around the apiary. Similar data had already been obtained in previous studies in the *Zona da Mata* area (Bastos, 1995a, b).

TABLE 1

Percentage (%) of pollen types in 11 samples of honey collected in the Municipality of Cachoeira da Prata, from April/96-April/98.

Family Genus/species	Pollen grains percentual index *	
	Dry season (April-October)	Rainy season (November-March)
ACANTHACEAE		
Ruelia sp.	0.01	–
AMARANTHACEAE		
Alternanthera sp.	0.05	–
ANACARDIACEAE		
Astronium sp.	34	–
ASTERACEAE		
Baccharis dracunculifolia	4.5	6.4
Conyza sp.	–	5.36
Elephantopus sp.	0.01	0.13
Eupatorium sp.	0.05	–
Montanoa sp.	1.38	–
Senecio sp.	2.21	2.81
Trixis sp.	0.02	–
Vernonia sp.	3.01	–
BIGNONIACEAE		
Pirostegia sp.	0.01	–
BRASSICACEAE		
Brassica sp.	0.65	–
EUPHORBIACEAE		
Croton sp.	0.01	–
Manihot sp.	0.11	–
Ricinus sp.	0.1	–
LAMIACEAE		
Hyptis sp.	3.14	4.69
Salvia sp.	0.16	2.4
LAURACEAE		
Persea sp.	2.5	–

TABLE 1 (*Continued.*)

Family Genus/species	Pollen grains percentual index *	
	Pollen grains percentual index *	**Pollen grains percentual index ***
LEGUMINOSAE		
Anadenanthera sp.	0.26	0.67
Merremia sp.	0.03	–
Mimosa sp.	1.02	65.41
Piptadenia sp.	0.02	–
Schrankia sp.	–	2.27
LYTHRACEAE		
Cuphea sp.	0.02	–
MALPIGHIACEAE		
Banisteriopsis sp.	0.03	–
MALVACEAE		
Sida sp.	0.10	0.13
MELASTOMATACEAE		
Marcetia sp.	0.45	–
MYRTACEAE		
Eucalyptus sp.	43.15	7.9
Myrcia sp.	0.2	–
POLYGONACEAE		
Antigonum leptopus	–	1.03
PROTEACEAE		
Protium sp.	0.45	0.67
Roupala sp.	0.2	–
RUBIACEAE		
Borreria sp.	0.02	–
Richardia sp.	0.03	0.13
RUTACEAE		
Citrus sp.	0.04	
SAPINDACEAE		
Serjanea sp.	0.72	–
POLLEN non-identified	1.20	

* dominant pollen + 45%; accessory pollen between 15% and 44%; isolated pollen < 15%; isolated occasional pollen.

During the rainy season, the pollen of *Mimosa* sp. (Fig. 1.3) was dominant (65.41%) and that of *Eucalyptus* (Fig. 1.2), which was not at blooming peak during this season, was classified as occasional-isolated pollen. The honey produced in this season was characterized as wild and heterofloral, with dominance of *Mimosa* sp. (Fig. 1.3) and also presenting the following pollen types: *Eucalyptus* sp. (Fig. 1.2), *Conyza* sp., *Baccharis* sp. (Fig. 1.4), *Hyptis* sp. (Fig. 1.8), and *Schrankia* sp. (Fig. 1.6).

Characteristic plants of anthropic areas were present as occasional-isolated and isolated pollen in the two studied seasons, being represented by the genera: *Baccharis* (Fig. 1.4), *Elephantopus* (Fig. 1.7), *Eupatorium* (Fig. 1.5), *Vernonia* (Fig. 1.9), *Hyptis* (Fig. 1.8), *Mimosa* (Fig. 1.3), and *Sida*, confirming once again the great apicultural potential of these ruderal species (Bastos, 1995).

Exotic species like *Antigonum leptopus* (Fig. 1.10), a typical garden plant, and *Eucalyptus* sp. (Fig. 1.2), present in reforestation areas, were visited by the bees. In the crops of 1996/1998 in the Municipality of Cachoeira da Prata, the nectar and pollen sources for the beehives were the components of the *cerrado* flora, the local ruderal flora, and *Eucalyptus* sp.

Municipality of Jaboticatubas

Eleven samples of mature honey were obtained in the Municipality of Jaboticatubas from April 1996 to April 1998. In the qualitative analysis of the samples (Table 2), 33 pollen types were observed, for which the dry season was the richest, with 33 types, and the rainy season the poorest, with 20 types.

The quantitative analysis (Table 2) demonstrated the participation of typical *cerrado* species and anthropic flora in the honey composition. In the dry season, *Eucalyptus* sp. (Fig. 1.2) was dominant pollen (49.61%). Due to the presence around the apiary of some plants of *Astronium* sp. (*aroeirão* – Fig. 1.1), typical of *cerrado* areas, its pollen was represented as accessory (41.28%).

In the rainy season, accessory pollen responsible for the honey composition was from the species *Astronium* sp. (28.40%), *Schinus terebentifolius* (28.21%), and *Eucalyptus* sp. (28.54%) (Figs. 1.1, 1.11, 1.2).

The isolated pollen present in the dry- and rainy-season samples included the genera: *Baccharis* (Fig. 1.4) and *Mimosa* (Fig. 1.3) in anthropic areas, and *Richardia* (Fig. 1.12) in *cerrado* areas. The other pollen types were classified as occasional-isolated pollen: *Anadenanthera* sp. (Fig. 2.13), *Alternanthera* sp., *Cordia* sp., *Manihot* sp. (Fig. 2.14), and *Serjanea* sp. (Fig. 2.15).

The area around the apiary is highly degraded and the great influence of the few specimens of *Eucalyptus* sp. in the surroundings can be observed in the honey. The genera *Astronium* and *Schinus* appeared as accessory pollen, indicating a smaller number of representatives of these genera in the degraded *cerrado* areas of the Municipality of Jaboticatubas.

In the crops of 1996-1998 in the Municipality of Jaboticatubas, the nectar and pollen sources for the beehives were the components of the *cerrado* flora, the local ruderal flora, and the *Eucalyptus* sp.

Municipality of Matozinhos

Thirteen samples of mature honey were obtained in the Municipality of Matozinhos, in the period from May 1996 to October 1998. In the qualitative analysis of the samples (Table 3), 32 pollinic types were observed, the dry season being the richest, with 29 types, and the rainy season the poorest, with 20 types.

The quantitative analysis (Table 3) demonstrated the participation of some typical *cerrado* species, anthropic flora, and exotic species of *Eucalyptus*.

During the dry season, the main accessory pollen in honey composition honey was represented by the genera *Astronium* – 24.85% (Fig. 1.1) and *Eucalyptus* – 35.44% (Fig. 1.2). In the rainy season, there were no representatives at this level.

In the rainy season, the principle dominant pollen in honey composition was represented by the genus *Mimosa* – 76.41% (Fig. 1.3).

The main isolated pollen in honey composition was represented by the genera: *Alternanthera*, *Mimosa* (Fig. 1.3), *Antigonum* (Fig. 1.10), during the dry season and by *Euphorbia*, *Anadenanthera* (Fig. 2.13), and *Eucalyptus* (Fig. 1.2) in the rainy season.

TABLE 2

Percentage (%) of pollen types in 11 samples of honey collected in the Municipality of Jaboticatubas, from April/96-April/98.

Family Genus/species	Pollen grains percentual index *	
	Dry season (April-October)	Rainy season (November-March)
AMARANTHACEAE		
Alternanthera sp.	0.02	0.14
ANACARDIACEAE		
Astronium sp.	41.28	28.40
Schinus sp.	0.26	28.21
ASTERACEAE		
Baccharis dracunculifolia	0.52	3.15
Elephantopus sp.	0.07	–
Eupatorium sp.	0.18	0.07
Montanoa sp.	0.05	
Trixis sp.	0.01	0.09
Vernonia sp.	1.01	1.23
BORAGINACEAE		
Cordia sp.	0.03	0.94
COMBRETACEAE		
Terminalia sp.	0.19	0.55
CUNONIACEAE		
Weimania sp.	0.09	0.21
EUPHORBIACEAE		
Manihot sp.	0.02	0.55
Ricinus sp.	0.08	–
LAURACEAE		
Persea sp.	0.03	–
LEGUMINOSAE		
Acacia sp.	0.02	–
Anadenanthera sp.	0.02	–
Mimosa sp.	3.78	1.67
Piptadenia sp.	0.10	–
Schrankia sp.	0.02	–
LORANTHACEAE		
Struthantus sp.	0.11	–
MALVACEAE		
Sida sp.	0.08	–
MYRTACEAE		
Eucalyptus sp.	49.61	28.54
Myrcia sp.	0.64	0.27

TABLE 2 (*Continued*.)

Family Genus/species	Pollen grains percentual index *	
	Dry season (April-October)	Rainy season (November-March)
POLYGONACEAE		
Antigonum leptopus	0.05	0.07
PROTEACEAE		
Protium sp.	0.45	0.46
ONAGRACEAE		
Fuchsia sp.	0.05	–
Ludwigia sp.	0.20	–
RUBIACEAE		
Borreria sp.	0.02	–
Richardia sp.	0.02	4.47
RUTACEAE		
Citrus sp.	0.02	0.09
SAPIDANCEAE		
Serjanea sp.	0.78	0.70
POLLEN non-identified	0.19	0.19

* dominant pollen + 45%; accessory pollen between 15% and 44%; isolated pollen < 15%; isolated occasional pollen < 3%.

The other pollen types were represented as occasional-isolated pollen and characterize the geographical origin of the honey: *Ruelia* sp. (Fig. 2.16), *Baccharis* sp. (Fig. 1.4), *Vernonia* sp. (Fig. 1.9), *Manihot* sp. (Fig. 1.14), *Richardia* sp. (Fig. 1.12), *Acacia* sp. (Fig. 2.18), and *Serjanea* sp. (Fig. 1.15). Among these, some are characteristic of *cerrado* and others of anthropic areas.

Municipality of Prudente de Morais

Eleven samples of mature honey were obtained in the Municipality of Prudente de Morais from May 1996 to October 1998. In the qualitative analysis of the samples (Table 4), 36 pollen types were observed. The dry season was the richest, with 31 types, and the rainy season the poorest, with 24 types.

During the dry season, the pollen of *Eucalyptus* sp. (Fig. 1.2) was the dominant pollen (51.9%) and *Astronium* sp. (Fig. 1.1), the accessory pollen (21.89%). The isolated pollen most important as nectar source for the bees were represented by the genera: *Baccharis* (Fig. 1.4), *Anadenanthera* (Fig. 2.13), and *Mimosa* (Fig. 1.3). The other pollen types were represented as occasional-isolated pollen during the dry season.

During the rainy season, the dominant pollen was represented by the genus *Mimosa* (47.87%) and the accessory pollen represented by *Eucalyptus* sp. (21.96%). The important isolated pollens in honey composition were represented by: *Astronium* sp. (Fig. 1.1), *Baccharis* sp. (Fig. 1.4), *Schrankia* sp. (Fig. 1.6), and *Richardia* sp. (Fig. 1.12).

The native species characterizing honey from the *cerrado* areas are: *Astronium* sp. (Fig. 1.1), *Schinus terenbenthifolius* (Fig. 1.11), *Serjanea* sp. (Fig. 2.15), *Ruelia* sp. (Fig. 2.16), *Cordia* sp., *Manihot* sp. (Fig. 2.14), *Alternanthera* sp., *Richardia* sp. (Fig. 1.12), *Bauhinia* sp., *Anadenanthera* sp. (Fig. 2.13), and *Piptadenia* sp. (Fig. 2.17). The pollen percentage of these species is related to the representativity of *Eucalyptus***.** Those species have been mentioned as being typical of *cerrado*, and their pollen types were described by Laboriau (1973).

TABLE 3

Percentage (%) of pollen types in 11 samples of honey collected in the Municipality of Matozinhos, from May/96-October/98.

Family Genus/species	Pollen grains percentual index *	
	Dry season (April-October)	Rainy season (November-March)
ACANTHACEAE		
Ruelia sp.	0.02	–
AMARANTHACEAE		
Alternanthera sp.	7.6	–
ANACARDIACEAE		
Astronium sp.	24.85	1.00
AQUIFOLIACEAE		
Ilex sp.	0.01	
ASTERACEAE		
Baccharis dracunculifolia	0.73	0.63
Eupatorium sp.	0.04	–
Senecio sp.	0.10	1.69
Vernonia sp.	0.67	0.05
COMBRETACEAE		
Terminalia sp.	0.02	–
EUPHORBIACEAE		
Euphorbia sp.	0.01	3.82
Manihot sp.	0.03	–
Myrcia sp.	0.20	0.41
Ricinus sp.	0.38	0.84
LAMIACEAE		
Hyptis sp.	0.23	0.84
Salvia sp.	0.01	–
LAURACEAE		
Persea sp.	0.09	–
LEGUMINOSAE		
Acacia sp.	0.08	0.31
Anadenanthera sp.	–	4.89
Mimosa sp.	14.25	76.41
Piptadenia sp.	–	1.48
Schrankia sp.	0.01	–
MALVACEAE		
Sida sp.	0.11	0.15
MYRTACEAE		
Eucalyptus sp.	35.44	5.56
Myrcia sp.	0.20	0.41

TABLE 3 (*Continued*.)

Family Genus/species	Pollen grains percentual index *	
	Dry season (April-October)	Rainy season (November-March)
POLYGONACEAE		
Antigonum leptopus	11.15	0.10
PROTEACEAE		
Protium sp.	0.01	0.15
ONAGRACEAE		
Ludwigia sp.	0.06	–
RUBIACEAE		
Borreria sp.	0.02	–
Richardia sp.	0.06	0.94
SAPINDACEAE		
Sapindus sp.	0.14	–
Serjanea sp.	2.36	–
SOLANACEAE		
Datura sp.	–	0.05
POLLEN non–identified	1.03	0.27

* dominant pollen + 45%; accessory pollen between 15% and 44%; isolated pollen < 15%; isolated occasional pollen < 3%.

TABLE 4

Percentage (%) of pollen types in 11 samples of honey collected in the Municipality of Prudente de Morais, from May/96-October/98.

Family Genus/Species	Pollen grains percentual index *	
	Dry season (April-October)	Dry season (November-March)
ACANTHACEAE		
Ruelia sp.	0.04	0.01
AMARANTHACEAE		
Alternanthera sp.	0.12	0.02
ANACARDIACEAE		
Astronium sp.	21.89	3.10
Schinus sp.	0.4	–
ASTERACEAE		
Ambrosia sp.	–	0.13
Baccharis dracunculifolia	8.42	3.71
Elephantopus sp.	0.15	–
Eupatorium sp.	0.02	–
Trixis sp.	0.13	3.71
Vernonia sp.	0.28	0.8

TABLE 4 (*Continued*.)

Family Genus/species	Pollen grains percentual index *	
	Dry season (April-October)	Dry season (November-March)
BORAGINACEAE		
Cordia sp.	0.25	0.07
COMBRETACEAE		
Terminalia sp.	0.1	–
CONVOLVULACEAE		
Ipomoea sp.	0.03	–
CUNONIACEAE		
Weimania sp.	–	0.15
EUPHORBIACEAE		
Croton sp.	–	0.02
Manihot sp.	0.52	0.29
Ricinus sp.	1.95	6.31
LAMIACEAE		
Hyptis suaveolens	0.16	0.32
LAURACEAE		
Persea sp.	0.02	–
LEGUMINOSAE		
Anadenanthera sp.	4.14	0.17
Bauhinia sp.	0.04	–
Mimosa sp.	4.55	47.87
Piptadenia sp.	0.05	0.10
Schrankia sp.	0.7	2.67
LORANTHACEAE		
Struthantus sp.	0.02	–
MALVACEAE		
Sida sp.	0.11	0.18
MELASTOMATACEAE		
Marcetia sp.	0.05	–
MYRTACEAE		
Eucalyptus sp.	51.9	21.96
POLYGONACEAE		
Antigonum leptopus	0.02	–
PROTEACEAE		
Protium sp.	0.22	0.22
ONAGRACEAE		
Ludwigia sp.	0.91	–

TABLE 4 (*Continued*.)

Family Genus/species	Pollen grains percentual index *	
	Dry season (April-October)	Dry season (November-March)
RUBIACEAE		
Richardia sp.	0.12	7.92
RUTACEAE		
Citrus sp.	–	0.05
SAPINDACEAE		
Serjanea sp.	0.67	0.2
POLLEN non-identified	0.02	–

* dominant pollen + 45%; accessory pollen between 15% and 44%; isolated pollen < 15%; isolated occasional pollen < 3%.

Around the apiary is a large *Eucalyptus* reforestation area frequently visited by honey-producing bees. A similar fact was observed in previous studies (Bastos, 1995a, Bastos *et al.*, 1995b).

The genus *Astronium* was responsible for the honey production in all the studied municipalities and is the most important indicator of the geographical origin of honey produced in this ecosystem.

In the crop of 1996-1998 in the municipality of Prudente de Morais, the components of the *cerrado* flora, the local ruderal flora, and the *Eucalyptus* sp., were observed to be the nectar and pollen sources for beehive maintenance.

Municipality of Santana do Riacho

Eleven samples of mature honey were obtained in the municipality of Santana do Riacho from April 1996 to October 1998. In the qualitative analysis of the samples (Table 5), 50 pollinic types were observed, the dry season being the richest, with 46 types, and the rainy season the poorest, with 28 types.

The quantitative analysis (Table 5) demonstrated the contribution of typical *cerrado* species to the honey composition. There was no dominant pollen, which characterizes the honey produced in this area as wild and of heterofloral origin.

During the dry season, the species responsible for the botanical origin of the honey were represented as accessory pollen: *Astronium* sp. (aroeirão) – 43.07% (Fig. 1.1) and *Serjanea* sp. (cipó-uva) – 23.95% (Fig. 2.15). In the rainy season, the accessory pollen responsible for the formation of the honey were: *Astronium* sp. (39.56%) and *Mimosa* sp. (16.5%) (Fig. 1.3).

The isolated pollen, present in the dry-season samples, that constitutes good nectar and/or pollen sources was represented by the genera: *Tagetes* sp. and *Vernonia* sp. (Fig. 1.9), both representatives of anthropic flora, and the genera *Aeschymone* sp. (Fig. 2.19) and *Schrankia* sp. (Fig. 1.6), representatives of *cerrado* flora.

The other pollen types found were represented as occasional-isolated pollen and are important for the geographic characterization of honey from *cerrado* areas. They are: *Ruelia* sp. (Fig. 2.16), *Schinus* sp. (Fig. 1.11), *Cordia* sp., *Caryocar* sp. (Fig. 2.21), *Myrcia* sp. (Fig. 2.20), *Manihot* sp. (Fig. 2.14), *Anadenanthera* sp. (Fig. 2.13), *Ludwigia* sp. (Fig. 2.22), and *Richardia* sp. (Fig. 1.12). The occasional-isolated pollen represented by the genera *Marcetia* sp. (Fig. 2.23) and *Velozia* sp. (Fig. 2.24), indicates bee visits to the *campos rupestres* areas, adjacent to the apiary.

Pollen of *Eucalyptus* sp. was absent from the analyzed samples because the apiary was far from reforestation areas and the bees collected a large number of pollen types (50). This demonstrates that, where *Eucalyptus* sp. is absent, there is widespread foraging by the bees, guaranteeing enough pollen for brood feeding and nectar for the production of wild and organic honey, so popular in foreign markets.

The honey produced in this *cerrado* area can be differentiated from the honeys produced in anthropic and mountainous areas of the State of Minas Gerais, where the genus *Eucalyptus* sp. is dominant in the pollen spectrum (Bastos, 1995a, Bastos *et al.*, 1995b).

CONCLUSIONS

Some of the *cerrado* areas studied have species represented in the food collected by the bees throughout the year and others in certain periods, due to colony preferences and blooming peaks of the botanical components.

The several plant species bloomed at different times of the year, characterizing two different seasons in the apicultural year, each one with its most important species for the colonies:

1. Dry season (April to mid-November): *Astronium* sp., *Schinus* sp., *Eucalyptus* sp., *Alternanthera* sp., *Serjanea* sp., *Baccharis* sp., *Hyptis* sp., and *Mimosa* sp.
2. Rainy season (November-March): *Mimosa* sp., *Schinus* sp., and *Eucalyptus* sp.

The pollen spectra of the honeys from the *cerrado* areas studied in Minas Gerais under similar climatic conditions is characterized by the dominance of pollen of the genus *Astronium*, with the contribution of *Eucalyptus* during the dry season and dominance of the genus *Mimosa* and contribution of *Eucalyptus* during the rainy season. In the *cerrado* areas where there is no influence of *Eucalyptus*, the dominant pollen in the two seasons is that of the genus *Astronium*, with the contribution of the genus *Serjanea* ("cipó-uva" or "timbó").

TABLE 5
Percentage (%) of pollen types in 11 samples of honey collected in the Municipality of Santana do Riacho, from April/96-October/98.

Family Genus/species	Pollen grains percentual index *	
	Dry season (April-October)	Rainy season (November-March)
AQUIFOLIACEAE		
Ilex sp.	0.14	–
ACANTHACEAE		
Ruelia sp.	0.06	0.35
AMARANTHACEAE		
Alternanthera sp.	0.01	–
ANACARDIACEAE		
Astronium sp.	43.07	39.56
Schinus sp.	0.05	0.14
ASTERACEAE		
Ambrosia sp.	–	0.14
Baccharis dracunculifolia	2.32	2.3
Elephantopus sp.	0.35	–
Eupatorium sp.	0.2	0.05
Tagetes sp.	3.51	0.25
Trixis sp.	1.07	1.05
Vernonia sp.	3.61	0.77
BOMBACACEAE		
Bombax sp.	0.10	–
Pseudobombax sp.	0.05	–

TABLE 5 (*Continued.*)

Family Genus/species	Pollen grains percentual index *	
	Dry season (April-October)	Rainy season (November-March)
BORAGINACEAE		
Cordia sp.	0.03	0.25
CARYOCARACEAE		
Caryocar sp.	0.01	–
CONVOLVULACEAE		
Ipomoea sp.	0.03	–
CUNONIACEAE		
Weimania sp.	0.05	–
EUPHORBIACEAE		
Alchornea sp.	0.03	–
Croton sp.	0.04	–
Manihot sp.	0.19	2.3
Ricinus sp.	0.05	–
LAMIACEAE		
Hyptis suaveolens	0.28	–
LEGUMINOSAE		
Acacia sp.	0.01	–
Aeschymone sp.	6.91	–
Anadenanthera sp.	0.17	0.14
Bauhinia sp.	0.05	–
Diplosodum sp.	0.04	–
Maccherium sp.	–	2.04
Mimosa sp.	1.27	16.5
Piptadenia sp.	0.01	–
Schrankia sp.	2.97	0.84
LORANTHACEAE		
Struthantus sp.	0.05	–
MALVACEAE		
Sida sp.	0.05	0.14
MELASTOMATACEAE		
Marcetia sp.	1.65	0.67
MYRTACEAE	0.27	21.7
Eucalyptus sp.	3.5	1.4
Myrcia sp.	0.24	0.42
PROTEACEAE		
Protium sp.	0.08	–

TABLE 5 (*Continued.*)

Family Genus/species	Pollen grains percentual index *	
	Dry season (April-October)	Rainy season (November-March)
ONAGRACEAE		
Fuchsia sp.	0.05	–
Ludwigia sp.	0.2	0.2
RUBIACEAE		
Borreria sp.	0.05	–
Richardia sp.	–	2.5
RUTACEAE		
Citrus sp.	0.04	0.14
SAPINDACEAE		
Serjanea sp.	23.95	1.25
SOLANACEAE		
Datura sp.	0.24	3.59
STERCULIACEAE	0.01	–
TILIACEAE	0.02	0.28
ULMACEAE		
Celtis sp.	–	0.7
VELOZIACEAE		
Velozia sp.	0.47	–
POLLEN non-identified	2.45	0.33

* dominant pollen + 45%; accessory pollen between 15% and 44%; isolated pollen < 15%; isolated occasional pollen < 3%.

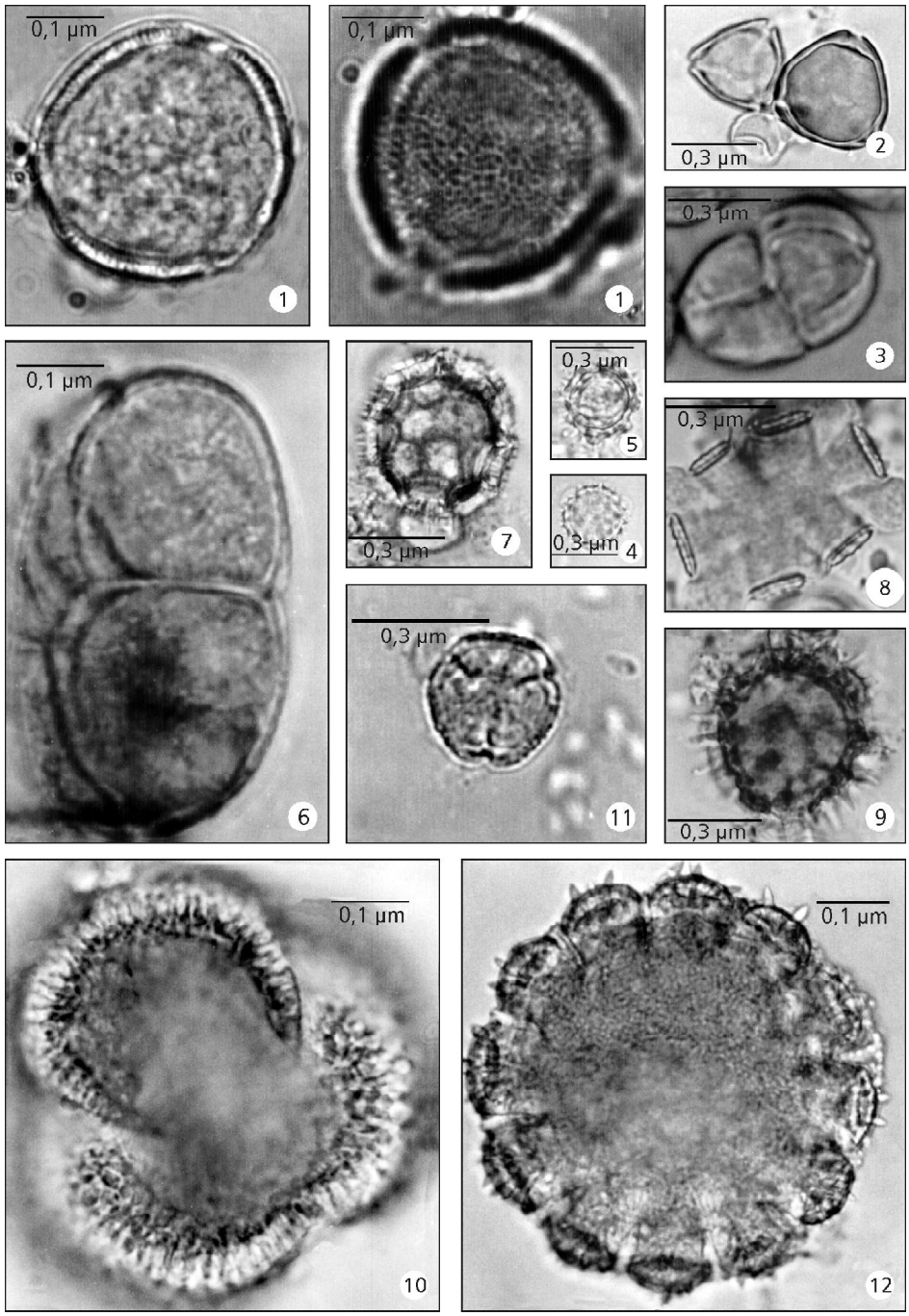

Fig. 1 — Main pollen types in samples of *Apis mellifera* honey. 1. Anacardiaceae: *Astronium* sp.; 2. Myrtaceae: *Eucalyptus* sp.; 3. Leguminosae: *Mimosa* sp.; 4. Asteraceae: *Baccharis* sp.; 5. Asteraceae: *Eupatorium* sp.; 6. Leguminosae: *Schrankia* sp.; 7: Asteraceae: *Elephantopus* sp.; 8. Lamiaceae: *Hyptis* sp.; 9. Asteraceae: *Vernonia* sp.; 10. Polygonaceae: *Antigonum* sp.; 11. Anacardiaceae: *Schinus* sp.; 12. Rubiaceae: *Richardia* sp.

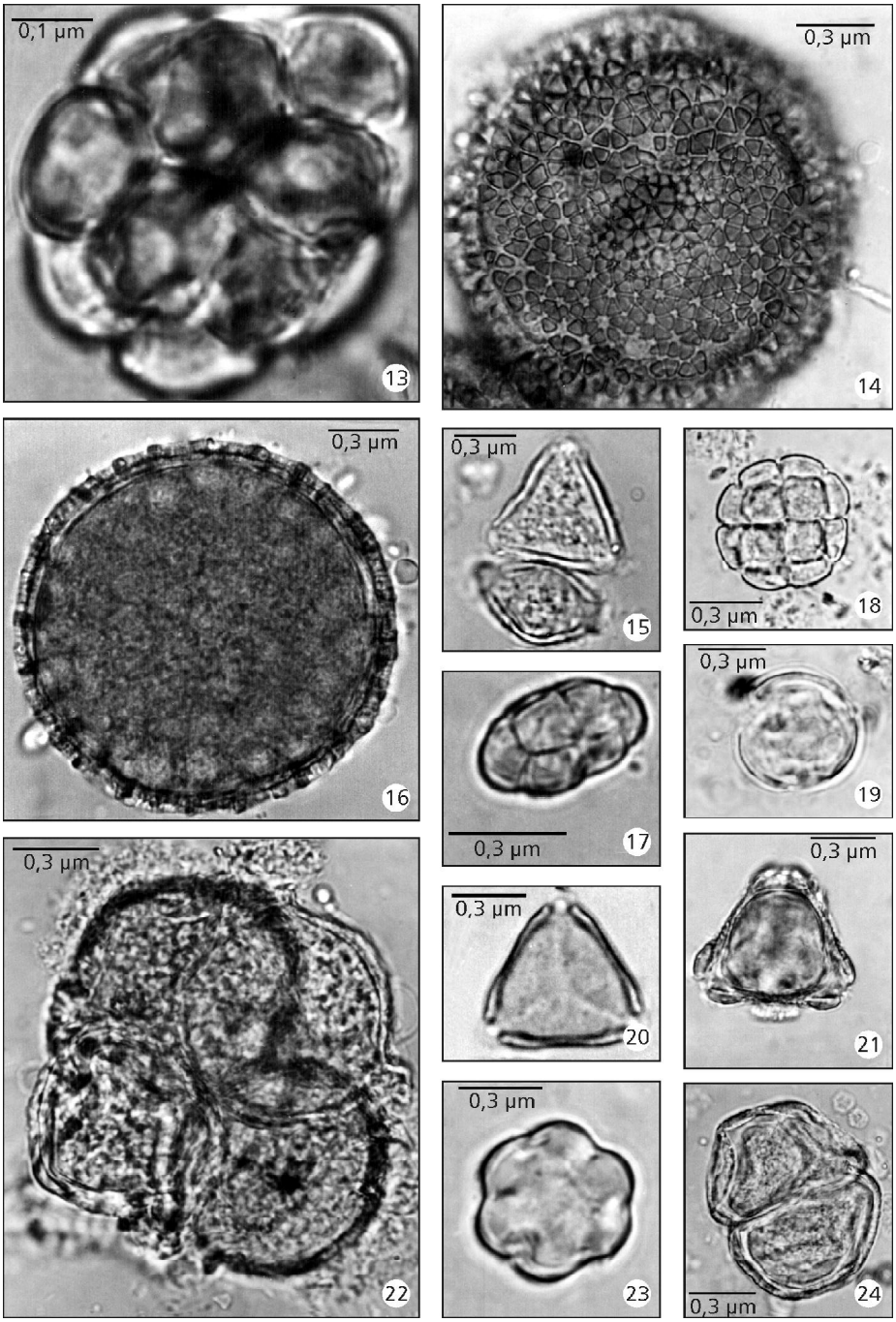

Fig. 2 — Main pollen types in samples of *Apis mellifera* honey. 13. Leguminosae: *Anadenanthera* sp.; 14. Euphorbiaceae: *Manihot* sp.; 15. Sapindaceae: *Serjanea* sp.; 16. Acanthaceae: *Ruelia* sp.; 17. Leguminosae: *Piptadenia* sp.; 18. Leguminosae: *Acacia* sp.; 19. Leguminosae: *Aeschymone* sp.; 20. Myrtaceae: *Myrcia* sp.; 21. Caryocaraceae: *Caryocar* sp.; 22. Onagraceae: *Ludwigia* sp.; 23. Melastomataceae: *Marcetia* sp.; 24. Velloziaceae: *Vellozia* sp.

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