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Pollen analysis of honeys from the central zone of the Argentine province of Entre Ríos

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Pollen analysis of honeys from the central zone of the Argentine province of Entre Ríos

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Abstract
Based on the melissopalynology 38 honey samples collected in the central region of the Argentine province of Entre Ríos were classified by botanical and geographical origin. According to qualitative analysis, 20 honey samples were monofloral and 18 were multifloral. Dominant pollen types were *Scutia buxifolia* Reissek (Rhamnaceae) in six samples, *Baccharis* spp. (Asteraceae) in five, *Lotus* spp. (Fabaceae) in three, *Eucalyptus* spp. (Myrtaceae) and *Eryngium* spp. (Apiaceae) in two, *Ammi visnaga* (L.) Lam. (Apiaceae) and *Trithrinax campestris* (Burmeist.) Drude & Griseb. (Arecaceae) in one sample. One hundred and nineteen pollen types were identified belonging to 52 families; 75% of which were native species. The families best represented in number of species were Asteraceae and Fabaceae. Pollen types such as *Scutia buxifolia*, *Trithrinax campestris*, *Schinus* spp. (Anacardiaceae), Mimosoideae from *Prosopis* spp., *Acacia* spp., *Mimosa ostenii* Speg. *ex* Burkart, and *M. strigillosa* Torr. & A. Gray are considered the indicators for this geographical origin. The studied honeys were also characterized by a high frequency of Apiaceae, Brassicaceae, Astereae, *Echium plantagineum* L. and cultivated Papilionoideae forage species such as *Melilotus albus* Desr., *Lotus* spp. and *Trifolium* spp. Honeydew elements were scarce.

Keywords: *Melissopalynology, Entre Ríos province, Argentina, unifloral honey,* Scutia buxifolia, Baccharis, Lotus

Argentina is the third largest honey producer and the second largest honey exporter in the world (FAO, 2005). The country extends over 33° of latitude with a wide variety of habitats that result in a great diversity of honeys. The knowledge about the botanical origin of Argentina's honey is restricted to the works of Costa (1982), Tellería (1988, 1992, 1996*a*, *b*), Naab (1993), Costa et al. (1995), Valle et al. (1995), Basilio and Romero (1996), Basilio (1998), Andrada et al. (1998), Forcone and Tellería (1998, 2000), Salgado and Pire (1998, 1999), Andrada et al. (1999), Tellería and Forcone (2000), Andrada (2001), Irurueta et al. (2001), Naab et al. (2001), Andrada and Tellería (2002), Forcone (2002) and Fagúndez and Caccavari (2003).

Honeys from the Pampean phytogeographic province are the best-known and studied (Cabrera, 1976) because they represent the highest volume of Argentine honey production. This region is characterized by a grass plain, where the preference range of honeybees corresponds to either adventitious or cultivated exotic flora (Tellería 1988, 1992, 1996*a*; Irurueta et al. 2001).

The Entre Ríos province is located in the littoral region of the Republic Argentina (Figure 1). With an area of 78 781 km^2, it is sixteenth largest province of Argentina and fourth largest producer of honey (SAGPyA, 2005). It has a moderate climate with an annual precipitation ranging from 900 to 1 200 mm. This results in a great diversity of meliferous plants that allows to the honey production over the whole territory.

Vegetation of study area

The study area consists of a transitional region between semi-xerophilous forest and gramineous

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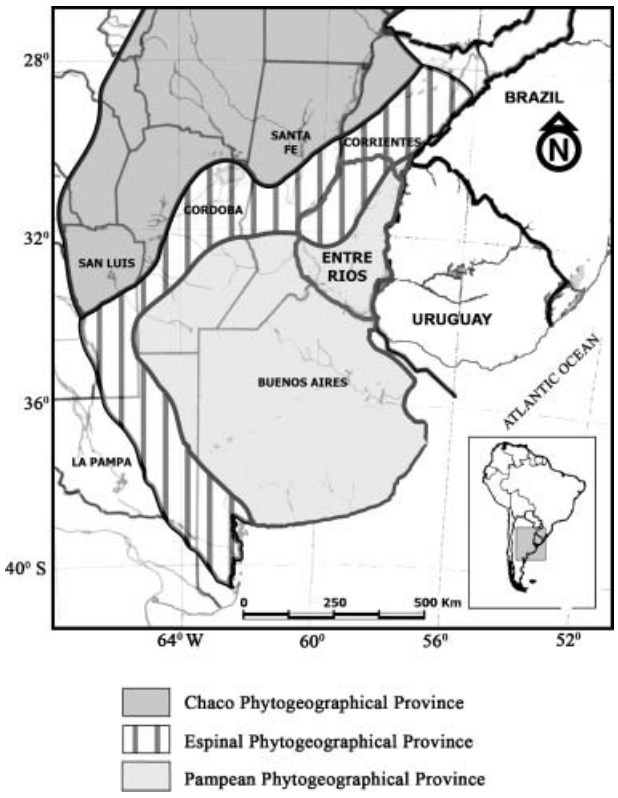


Figure 1. Map showing location of the study area.

meadow which has been strongly altered by grazing and the planting of several cultivated [*Triticum aestivum* L., *Zea mays* L., *Glycine max* (L.) Merr., *Oryza sativa* L.] and forage crops, (*Lotus* spp., *Medicago sativa* L., *Trifolium repens* L., *T. pratense* L. and *Melilotus albus*).

The semi-xerophilous forest is located in the Ñandubay District of the Espinal phytogeographic province (Cabrera, 1976) (Figure 1). It is characterized by the presence of ''ñandubay'' (*Prosopis affinis* Spreng) and black carob tree [*Prosopis nigra* (Griseb.) Hieron] forests. This forest contains only one tree stratum that is seldom over 10 m tall, a shrub stratum, and a herbaceous stratum. Some tree species that are abundant in the community include *Acacia caven* (Mol.) Mol., *Geoffroea decorticans* (Gillies *ex* Hook. & Arn.) Burkart (Fabaceae), *Schinus longifolia* (Lindl.) Speg., and *Scutia buxifolia*. It is noteworthy, to include the occurrence of a palm, *Trithrinax campestris*, that is often intermingled in the forest or constitutes more or less extensive pure stands. The meadows belong to the Uruguayan District in the Pampean phytogeographic province (Cabrera, 1976) (Figure 1) and are characterized by a grass plain, with predominance of Stipeae, Festuceae and Eragrosteae, such as *Stipa neesiana* Trin. & Rupr., *Stipa tenuissima* Trin., *Poa lanigera* Nees and *Eragrostis cilianensis* (All.) Vignolo *ex* Janch. Between the shrubs there are the common genera *Margyricarpus* (Rosaceae), *Heimia* (Lythraceae), *Baccharis* (Asteraceae) and *Eupatorium* (Asteraceae) among others.

Studies carried out on the botanical origin of honey from this province are limited (IPROSA, 1995; Basilio & Romero, 1996; Basilio, 1998; Irurueta et al., 2001; Fagúndez & Caccavari, 2002, 2003). The aim of this work was to characterize the honey produced in the central region of the Entre Ríos province and to increase our understanding of nectar preferences of honey bees in Argentina.

Material and methods

Thirty-eight honey samples produced by *Apis mellifera* L. were harvested from different apiaries located in the central region of the province of Entre Ríos (Figure 1) during 1998 and 2002. Samples were extracted by cell centrifugation, pressing or decanting after pollen cell removal. The samples were stirred before taking sub-samples for the qualitative and quantitative analysis. The sub-samples were removed after the honey was heated or liquefied. Qualitative analysis and processing followed to Louveaux et al. (1978). A sub-sample of 20 g of honey was dissolved in distilled water, centrifuged, washed once with distilled water, centrifuged again, acetolyzed mounted in glycerin jelly, and sealed with paraffin. The samples were centrifuged to 2 500 rpm in a Rolco CM 2036 centrifuge, with a radius from the centre of the rotor to the sample during centrifugations being 15.4 cm (Pendleton, 2006). A minimum of 1 200 pollen grains were counted on two slides, prepared independently, from the same sample. Pollen from plants within the study area were also acetolyzed, mounted in glycerin jelly, and sealed with paraffin. Pollen was also mounted from unacetolyzed honey to determine honeydew elements. To determine frequency of honeydew elements (HDE), a HDE/P rate was calculated for each honey. The honeydew elements were calculated by counting the numbers of honey dew elements (HDE) and dividing by the total frequency of pollen grains from nectariferous plants (P) following Louveaux et al. (1978). We counted all pollen grains and honeydew elements from each honey sample, covering the whole surface of each slide.

The following frequency types were defined: dominant pollen, ''D'' (>45%); secondary pollen, ''S'' (16–45%); important minor pollen, ''M'' (3–15%); trace pollen, ''T'' (1–3%); and sporadic pollen, ''+'' (<1). A honey was considered monofloral when there was a dominant pollen type, except in *Eucalyptus* spp.: 70% and ''clovers'' (including *Trifolium* spp., *Melilotus* spp., *Medicago sativa* and

Table I. Pollen types and their frequency in the 38 honeys analysed.

Family	Pollen type	D	S	M	T	+	FO
Acanthaceae	*Type *Justicia*	–	–	–	–	2	5
	*Type *Ruellia*	–	–	–	–	4	11
Alismataceae	**Sagittaria montevidensis* Cham. & Schltdl.	–	–	–	1	26	71
	*Type *Echinodorus*	–	–	–	1	20	55
Amaranthaceae	*Type *Alternanthera aquatica* (D. Par.) Chodat	–	–	–	1	17	47
	*Type *Amaranthus*	–	–	1	9	17	71
	*Type *Gomphrena perennis* L.	–	–	–	–	1	3
Anacardiaceae	**Schinus* sp.	–	–	–	1	13	37
Apiaceae	*Ammi majus* L.	–	3	5	5	22	92
	Ammi visnaga (L.) Lam.	1	2	7	3	23	95
	**Eryngium* spp.	2	2	5	2	22	87
	Foeniculum vulgare Mill.	–	–	–	–	8	21
	**Hydrocotyle* sp.	–	–	–	–	7	18
Arecaceae	**Trithrinax campestris* (Burmeist.) Drude & Griseb.	1	8	8	3	7	71
Asteraceae	*Type *Ambrosia*	–	–	–	–	20	53
	*Astereae 1	–	5	12	3	17	97
	*Astereae 2	–	–	–	–	12	32
	*Astereae 3	–	1	2	1	10	37
	*Astereae 4	–	–	1	2	12	40
	*Astereae 5	–	–	–	–	1	3
	*Astereae 6	–	–	–	–	1	3
	*Anthemideae	–	–	–	–	28	74
	**Baccharis* spp.	5	8	8	1	2	63
	Carduus spp.	–	–	–	2	28	79
	Centaurea sp.	–	–	–	–	17	45
	Cichorium intybus L.	–	–	–	4	22	68
	Cirsium vulgare (Savi) Ten.	–	–	–	1	20	55
	*Heliantheae	–	–	–	1	13	37
	Helianthus annuus L.	–	–	1	–	15	42
	**Holocheilus hieracioides* (D. Don) Cabrera	–	–	–	–	8	21
	*Type *Hypochoeris*	–	–	–	–	6	16
	*Type *Perezia*	–	–	–	–	2	5
	*Type *Senecio*	–	–	1	–	16	45
	*Type *Solidago chilensis* Meyen	–	1	3	3	9	42
	Type *Sonchus*	–	–	–	–	1	3
	**Tessaria integrifolia* Ruiz & Pav.	–	–	–	–	1	3
	*Type *Trixis*	–	–	–	–	1	3
	*Type *Xanthium*	–	–	1	5	14	53
	**Vernonia* sp.	–	–	–	–	1	3
Bignoniaceae	*Type *Tabebuia*	–	–	3	2	19	63
Boraginaceae	*Echium plantagineum* L.	–	3	3	5	23	90
Brassicaceae		–	–	7	13	18	100
Butomaceae	**Hydrocleys nymphoides* (Willd.) Buchenau	–	–	–	–	8	21
Calyceraceae	**Acicarpha tribuloides* Juss.	–	–	1	2	22	66
Casuarinaceae	*Casuarina cunninghamiana* Miq.	–	–	1	2	4	18
Celtidaceae	*Type *Celtis*	–	–	–	–	18	47
Cucurbitaceae	*Type *Cayaponia*	–	–	–	–	4	11

Table I. (*Continued.*)

Family	Pollen type	D	S	M	T	+	FO
Cyperaceae	**Cyperus* spp.	–	–	–	1	8	24
Euphorbiaceae	*Type *Acalypha*	–	–	–	1	1	5
	**Manihot flabellifolia* Pohl.	–	–	–	–	2	5
	**Sapium haematospermum* Müll. Arg.	–	–	–	–	2	5
Fabaceae	**Acacia bonariensis* Gillies *ex* Hook. & Arn.	–	–	–	–	3	8
	**Acacia caven* (Molina) Molina	–	–	–	1	9	26
	**Acacia praecox* Griseb.	–	–	–	–	2	5
	**Adesmia* spp.	–	–	–	–	12	32
	*Type *Cercis*	–	–	–	1	–	3
	*Type *Desmodium*	–	–	–	–	2	5
	**Geoffroea decorticans* (Gillies *ex* Hook. & Arn.) Burkart	–	–	–	–	1	3
	Glycine max (L.) Merr.	–	1	13	–	8	58
	Lotus spp.	3	7	9	6	7	84
	Medicago sativa L.	–	1	–	–	17	47
	Melilotus albus Desr.	–	–	1	12	16	76
	**Mimosa ostenii* Speg. *ex* Burkart	–	1	1	–	5	18
	**Mimosa strigillosa* Torr. & A. Gray	–	–	1	–	8	24
	Mimosoideae	–	–	–	–	2	5
	Papilionoideae 1	–	–	–	1	3	11
	Papilionoideae 2	–	–	–	–	1	3
	**Prosopis* spp.	–	1	3	4	25	87
	Trifolium pratense L.	–	–	2	2	22	68
	Trifolium repens L.	–	–	–	–	27	71
	Trifolium sp.	–	–	–	–	4	11
Fagaceae		–	–	–	–	1	3
Lamiaceae	**Hyptis* sp.	–	–	–	–	7	18
	Leonurus sibiricus L.	–	–	–	–	2	5
	**Salvia* sp.	–	–	–	–	2	5
	**Scutellaria racemosa* Pers.	–	–	3	4	15	58
	**Teucrium* sp.	–	–	–	1	5	16
Liliaceae	Type 1	–	–	–	–	1	3
	Type 2	–	–	–	–	8	21
	Type 3	–	–	–	–	2	5
	*Type *Sisyrinchium*	–	–	–	1	12	34
Linaceae	**Linum usitatissimum* L.	–	–	–	–	3	8
Loganiaceae	*Type *Buddleja*	–	–	–	–	1	3
Lythraceae	**Heimia salicifolia* Link	–	–	–	–	1	3
Malvaceae	*Type *Sida*	–	–	–	–	2	5
Meliaceae	*Melia azedarach* L.	–	–	–	–	5	13
Moraceae	Type *Morus*	–	–	–	–	2	5
Myrtaceae	*Eucalyptus* spp.	2	–	5	2	2	42
	*Type *Myrcianthes*	–	–	3	1	24	74
Oleaceae	*Ligustrum lucidum* W.T. Aiton	–	–	–	–	12	32
Onagraceae	**Ludwigia* sp.	–	–	–	–	4	11
Passifloraceae	**Passiflora* sp.	–	–	–	–	3	8
Phytolaccaceae	**Phytolacca dioica* L.	–	–	–	1	3	11

Table I. (*Continued.*)

Family	Pollen type	D	S	M	T	+	FO
Pinaceae	Type *Pinus*	–	–	–	–	1	3
Plantaginaceae	**Plantago* sp.	–	–	–	1	8	26
Poaceae		–	–	1	5	29	92
	Zea mays L.	–	–	–	1	13	37
Podocarpaceae	Type *Podocarpus*	–	–	–	–	1	23
Polygalaceae	*Type *Polygala*	–	–	–	–	2	5
Polygonaceae	**Polygonum* spp.	–	–	–	–	14	37
Pontederiaceae	**Eichhornia* spp.	–	–	–	–	3	8
Ranunculaceae	*Type *Clematis*	–	–	–	–	11	29
Rhamnaceae	**Scutia buxifolia* Reissek	6	2	1	1	3	34
Rosaceae	Type *Prunus*	–	–	–	–	7	18
Rubiaceae	*Type *Borreria*	–	–	–	–	2	5
Rutaceae	Type *Citrus*	–	–	–	–	1	3
Salicaceae	**Salix* sp.	–	–	–	–	11	29
	Type *Populus*	–	–	–	–	1	3
Sapindaceae	*Type *Serjania*	–	–	–	1	1	5
Sapotaceae	**Pouteria salicifolia* (Spreng.) Radlk.	–	–	–	–	2	5
	*Type *Sideroxylon*	–	–	–	1	1	5
Scrophulariaceae	**Agalinis communis* (Cham. & Schltdl.) D'Arcy	–	–	–	–	9	24
Solanaceae	**Cestrum parqui* L'Hér.	–	–	1	1	12	37
	**Solanum* sp.	–	–	–	2	5	18
Typhaceae	**Typha* sp.	–	–	–	–	3	8
Verbenaceae	**Aloysia gratissima* (Gillies & Hook.) Tronc.	–	–	1	1	16	47
	**Phyla* sp.	–	–	–	–	8	21
	**Verbena* sp.	–	–	–	–	1	3
Vitaceae	**Cissus* sp.	–	–	1	1	3	13

D – dominant pollen (>45%); S – secondary pollen (16–45%); M – important minor pollen (3–15%); T – trace pollen (1–3%) and "+" – sporadic pollen (<1%); FO – percentage of frequency of occurrence; * – Native species.

Lotus spp.): 45% (Resolution 274/95 SAGPyA, 1995). Quantitative analysis followed Moar (1985), incorporating tablets of *Lycopodium clavatum* L. spores (Stockmarr, 1971). Were used two tablets per sample, except in the samples number 15 and 16 (*Eucalyptus* spp.) in which 5 and 8 tablets were used respectively. The count of grains of pollen and spores was continued until the predetermined total standard error was <7%, according to the equation established in Stockmarr (1971). Frequency of pollen type appearances in the whole of samples was determined (Feller-Demalsy et al. 1987). Pollen richness was classified following the Maurizio's scheme (1939).

For the identification of pollen a reference collection from the CICyTTP (Centro de Investigaciones Científicas y Transferencia de Tecnología a la Producción) Regional Flora Palynotheca was used. A bibliography describing the pollen flora of the area, and general pollen morphology of various taxa were also consulted (Caccavari, 1972, 1983, 1985; Arbo, 1974;

Table II. Pollen spectrum in the honeys of Central Region of the province of Entre Ríos.

Family	Pollen type	1	2	3	4	5	6	7	8	9	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	36	37	38
Acanthaceae	*Type *Justicia*																																			+	+		
	*Type *Ruellia*								+																				+	+	+								
Alismataceae	**Sagittaria montevidensis* Cham. & Schltdl.	+	+				+	+	+	+	+	+	+	+	+	+	+	+	+	+	+		+						T	+	+	+	+	+	+		+	+	
	*Type *Echinodorus*	+	+	+		+	+	+			+	+			+	+	+			+		+				+	T		+		+	+	+	+				+
Amaranthaceae	*Type *Alternanthera aquatica* (D. Par.) Chodat	+	+						T	+	+	+			+	+					+				+				+		+	+	+	+		+		+	+
	*Type *Amaranthus*	+	+		+			+	+	+	T	T	T		+	+		T	+						+		+	+	T	T	T	+	T	+	+	+	+	T	M
	*Type *Gomphrena perennis* L.	+																																					
Anacardiaceae	**Schinus* sp.		+							+						+	T		+	+	+	+	+			+	+	+			+								+
Apiaceae	*Ammi majus* L.		+	+	+	+	+	M	T	T	T	+	+	+	+	+	+	+	+	S	M	+	S	M		+	+		+	+	+	T	M	M	S	+	+	T	+
	Ammi visnaga (L.) Lam.	+	+	+	+	+	+	M	S	+	M	+	T	+	+	+	+	+	D	+	M	+	M	T		+	+	+	+	S	T	+	M	M	M	+	+	+	
	**Eryngium* spp.		+	+	T			+	M	+	+	+	+	M	+	+	+	+	+	M	S	D	M	S	D	+		+	+	T	+	+	+	+	+	+	+	M	
	Foeniculum vulgare Mill.									+								+			+		+						+	+				+			+		
	**Hydrocotyle* sp.		+																	+			+				+			+					+	+			
Arecaceae	**Trithrinax campestris* (Burmeist.) Drude & Griseb.	T		+		+		M	S	M	T	S	M	M	S	T		M	+	+		+	+					M	S	M	M	S	S	S		D	S	+	
Asteraceae	*Type *Ambrosia*					+		+		+	+	+	+	+	+			+		+	+	+		+		+	+	+	+		+	+		+				
	*Astereae 1		+	+	+	+	+	+	+	S	M	S	S	M	T	+	+	M	+	+	+	+	+	+	T	+	M	M	M	M	S	M	M	M	T	+	M	M	S
	*Astereae 2							+	+									+										+	+		+		+	+	+	+		+	+
	*Astereae 3							+		T								M	+			+	+				+				+		+	+	+	+		M	S
	*Astereae 4							+		T								+	+					+			+	+	+	T		+			+	+	+	M	+
	*Astereae 5																																						+
	*Astereae 6																																						+
	*Anthemidae	+	+	+	+	+	+	+	+	+	+	+	+	+			+	+				+	+	+		+			+	+	+	+	+	+		+		+	+
	**Baccharis* spp.				+			D	S	D	M	S	S	D	M			D		T						+		S	S	S	D	M	S	M	M	M	M	S	M
	Carduus spp.	+	+		+		+	+	+		+	+	+	+	+	+	+	+	T	+	+	+	+	+	+				+	+	+	+	+	+	T	+	+		
	Centaurea sp.	+		+	+			+	+		+					+			+	+	+	+		+		+					+	+	+			+		
	Cichorium intybus L.		+					+	+		+	+	+	+	+		T		+		+	+	+	+		+	T	T		+	+	+	+	+	+	+	T	+	

Table II. (*Continued.*)

Family	Pollen type	1	2	3	4	5	6	7	8	9	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	36	37	38
	Cirsium vulgare (Savi) Ten.			+	+		+	+	+						+	+			T	+	+	+	+							+	+	+	+		+	+	+	+	+
	*Heliantheae	+	+										+						+	+		+	+	+		T		+	+	+	+				+				
	Helianthus annuus L.			+					+			+	+				+	+		+	+				+	M	+	+		+				+	+				
	*Type *Holocheilus hieracioides* (D. Don) Cabrera	+		+						+										+	+				+	+										+			
	*Type *Hypochoeris*				+											+	+						+										+		+				
	*Type *Perezia*								+																													+	
	*Type *Senecio*	+	+	+	+	+	+				+		+				+			+		+			+	M				+		+		+			+	
	*Type *Solidago chilensis* Meyen								M	M		+	+													+		M	T	T	+	T	+	+	+	+	+	S	
	Type *Sonchus*	+																																					
	Tessaria integrifolia Ruiz & Pav.																																						+
	*Type *Trixis*																	+																					
	*Type *Xanthium*							M	+	+		+	T	+			T	+	+								+	+		+	+	+	+	+	+	T	T	T		+
	Vernonia sp.																										+												
Bignoniaceae	*Type *Tabebuia*	M	+			+	+	+	+	+	+	+	+			+	M	T	+				+	+	+	M							+	+	T	+	+	+	
Boraginaceae	*Echium plantagineum* L.	+	+	+	T	+	M	+	T	+	+	+		T	+		S	+	+		+	+	+	+	S	S		+	+	+	+	+	+	M	T	+	+	M	T
Brassicaceae		+	+	+	+	+	+	M	T	T	T	T	+	+	+	+	+	+	M	+	+	T	M	M	T	M	T	M	T	T	T	+	+	T	+	+	T	T	M
Butomaceae	*Hydrocleys nymphoides* (Willd.) Buchenau																			+	+		+				+						+		+	+		+		
Calyceraceae	*Acicarpha tribuloides* Juss.		+	+	+	+	+		+	+				+			+			+	+	+			+	+	T			T	+	+	+	+	M	+	+	+	+
Casuarinaceae	*Casuarina cunninghamiana* Miq.									T			+											+													+	T	+	M
Celtidaceae	*Type *Celtis*	+		+		+	+				+	+	+			+				+					+			+		+	+		+		+	+		+	+
Cucurbitaceae	*Type *Cayaponia*																										+	+						+			+		
Cyperaceae	*Cyperus* spp.	+			+			+		+						+	+					+						+											T

Table II. (*Continued.*)

Family	Pollen type	1	2	3	4	5	6	7	8	9	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	36	37	38
Euphorbiaceae	*Type *Acalypha*																T										+												
	*Type *Manihot flabellifolia* Pohl.																										+										+		
	**Sapium haematospermum* Müll. Arg.															+								+															
Fabaceae	**Acacia bonariensis* Gillies ex Hook. & Arn.									+						+							+																
	**Acacia caven* (Molina) Molina			T		+		+			+										+	+			+			+			+				+				
	**Acacia praecox* Griseb.															+											+												
	**Adesmia* spp.							+	+	+									+	+		+				+				+		+		+			+	+
	*Type *Cercis*																T																							
	*Type *Desmodium*																									+				+									
	**Geoffroea decorticans* (Gillies ex Hook. & Arn.) Burkart			+																																			
	Glycine max (L.) Merr.							+		+	M	M	M	+					+	+	+	+						+	M	M	M	S	M	M	M	M	M	M	M
	Lotus spp.		+	M	S	+		T		T	D	M	M	T	S			T	+	D	S	S	D	M	T	+		+	S	M	M	S	M	M	S	+	+	M	T
	Medicago sativa L.	+		+	+	+	+	+											+	+	+						S	+	+	+	+	+	+	+			+	
	Melilotus albus Desr.	+		+	T	+		T	+	+	T	T	T		T	+	+	+		+	T	T		M			+		+	T	+	+	T	T	+		+	T	+
	**Mimosa ostenii* Speg. ex Burkart			+	S		+								+	M			+									+											
	**Mimosa strigillosa* Torr. & A. Gray		+	+	+		+									+	M							+			+				+								
	Mimosoideae					+	+																																
	Papilionoideae 1			+										T																+		+							
	Papilionoideae 2																															+							
	**Prosopis* spp.	+	+	+	+	+	+		T	+	+	+	+	+	+	T	+		T	+	M	+	T	M	+	S	M	+	+		+	+	+	+		+	+	+	
	Trifolium pratense L.	+	+	+	+			+		+	+	+		T	M	+	+	+		+		M	+	+	+		+			+	+	+	+	+				+	T
	Trifolium repens L.	+	+	+	+	+	+	+			+			+		+	+	+	+	+	+	+	+				+	+	+	+		+	+	+	+		+	+	
	Trifolium sp.																					+			+		+									+				
Fagaceae		+																																					
Lamiaceae	* *Hyptis* sp.														+																+	+	+		+	+	+		
	Leonurus sibiricus L.																														+		+						

Table II. (*Continued.*)

Family	Pollen type	1	2	3	4	5	6	7	8	9	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	36	37	38
	**Salvia* sp.														+																							+	
	**Scutellaria racemosa* Pers.	T	+	+	+	+	T				+	T	+				+			+	+	+				+			M	+	+	+	T	M	M			+	
	**Teucrium* sp.		+														T			+									M		+			+					
Liliaceae	Type 1							+													+																		
	Type 2																									+			+			+	+	+		+	+		
	Type 3							+														+		+																
	**Type Sisyrinchium*		+								+			T			+					+	+			+		+			+	+	+	+				+		
Linaceae	**Linum usitatissimum* L.																										+			+				+					
Loganiaceae	**Type Buddleja*	+																																					
Lythraceae	**Type Heimia salicifolia* Link																								+														
Malvaceae	**Type Sida*											+																		+									
Meliaceae	*Melia azedarach* L.	+	+									+		+													+												
Moraceae	Type *Morus*																								+		+												
Myrtaceae	*Eucalyptus* spp.	+	D	+	M		+							T	M	D	M		+	M	+				M			+	T									+	
	**Type Myrcianthes*		+				+	+	+	+	+	+	+		+		+	+	+	+	+	+		+	+	M		+	T	+	+		+	+	+	+	M	M
Oleaceae	*Ligustrum lucidum* W.T. Aiton							+								+		+	+	+	+	+	+			+							+	+				+	
Onagraceae	**Ludwigia* sp.							+								+																+	+						
Passifloraceae	**Passiflora* sp.	+																+																			+		
Phytolaccaceae	**Type Phytolacca dioica* L.					+										+									T			+										
Pinaceae	Type *Pinus*	+																																					
Plantaginaceae	**Plantago* sp.			+					+								+			+	T	+				+				+				+					

Table II. (*Continued.*)

Family	Pollen type	1	2	3	4	5	6	7	8	9	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	36	37	38
Poaceae		+	+	+	+	+	+	+	+	T	+	+	+	T	+	+	+	T	+	+		+	+	+		+	+	+	+	+	T	T	+	+		+	+	+	M
	Type *Zea mays* L.								+								+	+		+		+		+			T	+			+	+	+	+	+		+		
Podocarpaceae	Type *Podocarpus*																									+													
Polygalaceae	*Type *Polygala*															+						+																	
Polygonaceae	**Polygonum* spp.							+		+		+		+	+			+		+							+			+			+	+		+	+		+
Pontederiaceae	**Eichhornia* spp.				+							+																				+							
Ranunculaceae	*Type *Clematis*	+							+						+	+				+			+		+	+	+			+			+					
Rhamnaceae	**Scutia buxifolia* Reissek	D	M	D	S	D	D							+		S	D		+	+					T		D												
Rosaceae	Type *Prunus*									+								+		+										+			+	+	+				
Rubiaceae	*Type *Borreria*																												+	+									
Rutaceae	Type *Citrus*														+																								
Salicaceae	**Salix* sp.	+	+		+							+		+		+								+						+							+	+	+
	Type *Populus*									+																														
Sapindaceae	*Type *Serjania*	T							+																														
Sapotaceae	*Type *Pouteria salicifolia* (Spreng.) Radlk.								+						+																								
	*Type *Sideroxylon*									+																	T												
Scrophulariaceae	*Type *Agalinis communis* (Cham. & Schltdl.) D'Arcy									+				+						+								+	+			+	+	+				+	
Solanaceae	*Type *Cestrum parqui* L'Hér.			+	+	+	M					+				+	+					+					T	+						+		+		+	+
	**Solanum* sp.					+					+			+								+			T		T											+	
Typhaceae	**Typha* sp.																												+			+					+		

Table II. (*Continued.*)

Family	Pollen type	1	2	3	4	5	6	7	8	9	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	36	37	38
Verbenaceae	**Aloysia gratissima* (Gillies & Hook.) Tronc.	+	+	+	T				+			+	+	M								+		+	+				+					+	+	+	+	+
	**Phyla* sp.	+				+	+				+						+		+				+										+					
	**Verbena* sp.											+																											
Vitaceae	**Cissus* sp.	+	M	+	T											+																							
Indetermined pollen			+	+	+		+		+		+	+	+		+			+			+		+		+		+		+	+	+	+		+		+	+
Total Pollen types		39	36	34	33	27	28	37	34	38	34	37	28	31	30	39	37	32	33	42	32	41	31	27	28	32	38	35	36	43	42	43	49	50	37	37	38	45	35

D – Dominant pollen (>45%); S – secondary pollen (16–45%); M – important minor pollen (3–15%); T – trace pollen (1–3%) and + – sporadic pollen (<1%); * – Native species.

Markgraf & D'Antoni, 1978; Tellería, 1987, 1995, 2000; Roubik & Moreno Patiño, 1991; Pire et al., 1998, 2002; Caccavari & Domé, 2000; Fagúndez, 2001, 2003). When it was possible, pollen types were identified at species rank otherwise, at a genus, tribe or family ranks. If it was considered of importance, the most common species in the study area are indicated between parentheses.

Results

Quantitative analysis reveals eight samples belonging to Class I (21%), 22 to Class II (59%), seven to Class III (18%) and one to Class IV (3%) (Maurizio, 1939) (Figures 2, 3). *Baccharis* spp. unifloral honeys were placed into the lowest class (class I and II) while *Eucalyptus* spp. unifloral honeys were placed into the highest (class III and IV). The multifloral honeys were mainly in Class II (Figure 2).

One hundred and nineteen pollen types were identified, belonging to 52 families, 75% of which were from native species (Table I). Pollen from Asteraceae and Fabaceae were the best represented in number of species, with 25 and 20 pollen types respectively. Apiaceae and Lamiaceae presented five pollen types; Liliaceae presented four; Amaranthaceae, Euphorbiaceae and Verbenaceae presented three; Acanthaceae, Alismataceae, Myrtaceae, Poaceae, Salicaceae, Sapotaceae, and Solanaceae presented two, and the rest of the families presented only one pollen type (Table II).

Twenty samples were monofloral honey and 18 were multifloral. Dominant pollen types included *Scutia buxifolia* found in six samples (Figures 3, 4… etc. A, B, F: a), *Baccharis* spp. (*B. punctulata* DC., *B. dracunculifolia* DC.) in five (Figure 4H: o),

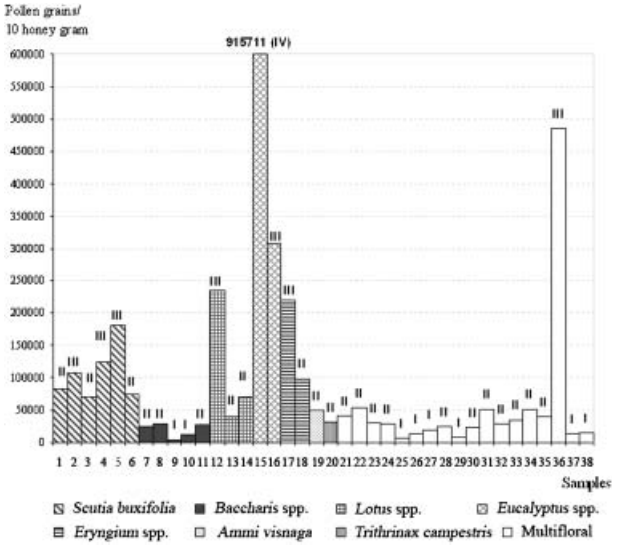


Figure 2. Pollen richness according to Maurizio's Class (The Roman numbers indicate the Class)

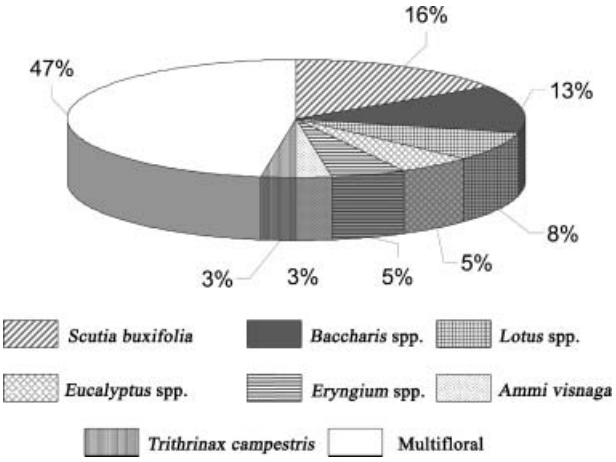


Figure 3. Botanical origin of honeys from the central zone of the Argentine province of Entre Ríos.

Lotus spp. in three (Figure 4E: i), *Eucalyptus* spp. (Figure 4F: k) and *Eryngium* spp. (Figure 4C, D: g) in two, and *Ammi visnaga* (Figure 4G: n) and *Trithrinax campestris* (Figure 4A, C, G, H: c) in one sample (Figure 2).

Pollen diversity per sample varied between 27 and 50 taxa, with an average of 36. The most of the samples (87%) contained between 31 and 40 taxa. Considering only pollen types with values higher than 1%, the number of taxa varied between one and 14 (Table II).

The occurrence frequency (FO) showed that 28 pollen types were very frequent and found in more than 50% of the samples. In this category, Brassicaceae, Astereae type 1, *Ammi visnaga*, Poaceae, *Ammi majus* L., *Eryngium* spp., *Echium plantagineum*, *Carduus* spp. (*C. nutans* L., *C. thoermeri* Weinm.), *Prosopis* spp. (*P. nigra*, *P. affinis*), *Melilotus albus*, Myrtaceae, *Trifolium repens*, Anthemidae type and *Sagittaria montevidensis* Cham & Schltdl, were outlined with values superior to 70%. Thirty three pollen types were frequent types (20–50% of the samples), 16 were less frequent (10–20%) and 42 were rare (<10%) (calculated from Table I).

In general, the samples showed few honeydew elements. The highest HDE/P values were reached in samples 18 and 22, where the HDE/P rate was 1.38 and 1.48 respectively.

Discussion

In the central region of the province of Entre Ríos, nectar sources mostly come from native species. Native nectariferous taxa were the dominant pollen in 36% of the samples, representing 70% of the monofloral honeys. Native taxa also produced bifloral honey in the 26% of multifloral honeys, such is the case of *Trithrinax campestris* (three samples), *Prosopis* spp. (one sample) and *Eryngium* spp. (one sample) (Table II). Seventy percent of species that made up the monofloral honeys are from trees or shrubs (*Scutia buxifolia*, *Baccharis* spp., *Eucalyptus* spp. and *Trithrinax campestris*). Although the honeydew elements were scarce, the values from two samples were high enough to indicate the need for additional research.

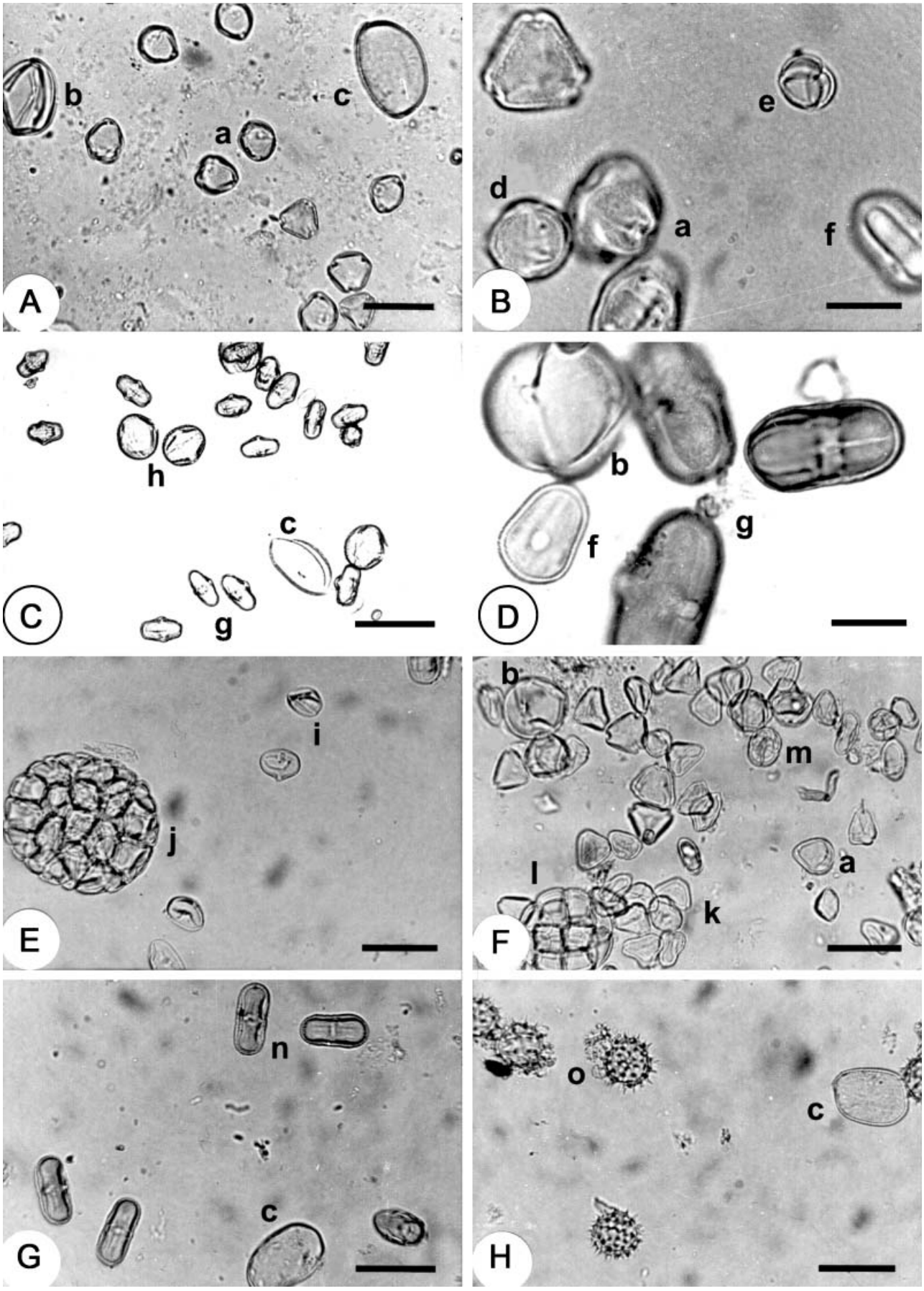
Samples in this study presented the highest pollen diversity in Argentine honeys. Pollen diversity from honey of Delta of Paraná, a geographical zone next to ours, also has high values compared with the rest of the Argentine honeys, but its maximum value was 26 pollen types (Basilio, 1998; Basilio & Romero, 1996). This large number of pollen taxa indicates the high plant diversity of the region.

Typical tree species from Ñandubay phytogeographic district, such as *Trithrinax campestris*, *Scutia buxifolia*, *Schinus* spp., *Prosopis* spp., *Acacia caven*, *A. bonariensis* Gillies *ex* Hook. & Arn., *A. praecox* Griseb., *Mimosa ostenii* and *M. strigillosa* (Figure 4) characterize the studied honeys together with the shrub stratum species like *Eupatorium* spp. and *Vernonia* spp.; and herbaceous taxa like *Acicarpha tribuloides* Juss. and *Eryngium* spp. Some bindweeds like *Passiflora* sp. (*P. coerulea* L.), *Clematis* sp. (*C. montevidensis* Spreng.), typical species in this district were unusually found in honey.

Very frequent pollen types included taxa like Brassicaceae [*Brassica campestris* L., *Rapistrum rugosum* (L.) All.], *Echium plantagineum*, *Carduus* spp., *Prosopis* spp., *Melilotus albus*, *Trithrinax campestris*, *Trifolium repens*, Anthemidae (*Anthemis cotula* L.) and *Sagittaria montevidensis* (Table I).

Pollen content in honeys from the Entre Ríos Central Region differs from that of the Pampean phytogeographic province in the high percentage of native tree and shrub species present in the Entre Ríos honey and the exotic herbaceous species in the

Figure 4. Optical microscope micrographs of pollen from monofloral honey. (**A**) Sample 1 (*Scutia buxifolia*): a, *Scutia buxifolia*; b, *Prosopis* sp.; c, *Trithrinax campestris*. (**B**) Sample 5 (*Scutia buxifolia*): a, *Scutia buxifolia*; d, *Scutellaria racemosa*; e, *Mimosa strigillosa*; f, *Echium plantagineum*. (**C**) Sample 17 (*Eryngium* spp.): c, *Trithrinax campestris*; g, *Eryngium* spp.; h, *Trifolium pratense*. (**D**) Sample 18 (*Eryngium* spp.): b, *Prosopis* sp.; f, *Echium plantagineum*; g, *Eryngium* spp. (**E**) Sample 14 (*Lotus* spp.): i, *Lotus* sp.; j, *Acacia caven*. (**F**) Sample 16 (*Eucalyptus* spp.): a, *Scutia buxifolia*; b, *Prosopis* sp.; k, *Eucalyptus* sp.; l, *Acacia bonariensis*; m, *Mimosa ostenii*. (**G**) Sample 19 (*Ammi visnaga*): c, *Trithrinax campestris*; n, *Ammi visnaga*. (**H**) Sample 11 (*Baccharis* spp.): c, *Trithrinax campestris*; o, *Baccharis* sp.;. Scale bar −30 μm (A, E, F, G, H); 14.5 μm (B, D); 60 μm (C).



Pampean honeys (Tellería, 1988, 1992, 1996*a*; Irurueta et al., 2001).

Compared with other honeys from the Espinal phytogeographic province, honey in the present study share genera like *Prosopis* and *Schinus* (Costa, 1982; Costa et al., 1995; Naab et al., 2001; Andrada & Tellería, 2002). However, the presence of taxa like *Trithrinax campestris*, *Scutia buxifolia* and other genera typical of temperate regions (*Acacia* and *Mimosa*) make it possible to distinguish honey from the other Espinal regions from ours. Another element to note were hydrophilic species: *Polygonum* spp., *Sagittaria montevidensis*, *Echinodorus* sp., *Sapium haematospermum* Müll. Arg., *Hydrocleys nymphoides* (Willd.) Buchenau and *Ludwigia* sp. The presence of these taxa is due to the dense hydrographic network existent in the province of Entre Ríos.

Compared with honeys from the Chaco phytogeographic province (Salgado & Pire, 1998, 1999), they share high frequency of taxa like *Eryngium* spp. and *Baccharis* spp., *Acicarpha tribuloides*, *Mimosa* spp., *Acacia* spp., *Sapium haematospermum*, *Tabebuia* type, Arecaceae and *Polygonum* spp. These taxa have also been found in Brazilian honeys (Barth & Fernándes Pinto Da Luz, 1998; De Camargo Carmello Moreti et al., 2000).

Taxa found in our study are also present in honeys from Oriental Republic of Uruguay (Daners & Tellería, 1998). Daners and Tellería (1998) also found a high frequency of native species such as *Scutia buxifolia*, *Schinus* spp., *Salix humboltiana* Willd. and *Baccharis* spp. Monofloral honeys of *Lotus* spp. have been found in Uruguay (Daners & Tellería, 1998). However, the absence of pollen from Mimosoideae and *Trithrinax campestris* constitutes a significant difference between honeys from the two regions.

Argentine honeys (Sala Linares & Suarez Cervera, 1985; Sawyer, 1988; Ricciardelli D'Albore, 1997) representative of the Pampean region, are mainly from the province of Buenos Aires (Figure 1). This province is the most populated region in Argentina. Much of the land in this province is devoted to agriculture and grazing lands for cows. Thus pristine vegetation sites are rare. Native vegetation in these regions has been replaced by crops and their accompanying weeds, creating a current and important resource for honey production in the region. For this reason, honey produced in the Pampean region is characterized by predominance of non-native species, crops, and poor pollen diversity.

Conclusions

The results of this research enable us to reach a number of conclusions. *Apis mellifera* utilizes a diversity of resources in the Central Region of the province of Entre Ríos, with 119 pollen types belonging to 52 families identified in the honey. Samples in this study record the highest pollen diversity in Argentine honeys, with 27 to 50 taxa per sample.

The nectar sources mostly come from native species (75% of pollen types). Pollen from Asteraceae and Fabaceae were the most represented in the pollen spectra of the honeys.

Monofloral honeys represented 53% of the samples analyzed with the main sources being: *Scutia buxifolia* (Rhamnaceae), *Baccharis* spp. (Asteraceae), *Lotus* spp. (Fabaceae), *Eucalyptus* spp. (Myrtaceae), *Eryngium* spp. (Apiaceae), *Ammi visnaga* (Apiaceae) and *Trithrinax campestris* (Arecaceae). Arecaceae monofloral honey was reported for the first time for Argentina.

The present work presents the second contribution to the knowledge of honeys belonging to the Ñandubay district in the Espinal phytogeographic province. Pollen from taxa of the Ñandubay Phytogeographic district give these honeys their geographical identity.

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References

Andrada, A. (2001). Estudio de la flora melífera y polinífera en la zona sur del Distrito del Caldén, Provincia del Espinal. Bahía Blanca: Univ. Nacl. d. Sur, *Tes. Doct.*

Andrada, A. C. & Tellería, M. C. (2002). Botanical origin of honey from south of Caldén district. *Grana*, *41*, 58–62.

Andrada, A., Valle, A., Aramayo, E., Lamberto, S. & Cantamutto, M. (1998). Análisis polínico de las mieles de las Sierras Australes de la provincia de Buenos Aires, Argentina. *Investig. Agr. Prod. Protecc. Veget.*, *13*, 265–275.

Andrada, A., Valle, A., Aramayo, E., Gallez, L. & Lamberto, S. (1999). Caracterización de las mieles del sector meridional del distrito pampeano austral. *Asoc. Paleontol. Argent., Publ. Esp.*, *6*, 71–75.

Arbo, M. M. (1974). El polen de las palmeras Argentinas. *Bonplandia*, *13*, 171–193.

Barth, O. M. & Fernándes Pinto Da Luz, C. (1998). Melissopalynological data obtained from a mangrove area near to Rio de Janeiro, Brazil. *J. Apic. Res.*, *37*, 155–163.

Basilio, A. M. (1998). *Estudio melitopalinológico de los recursos alimentarios y de la producción de un colmenar en la región del Delta del Paraná (Argentina)*. Buenos Aires: Univ. Buenos Aires. *Tes. Doct.*

Basilio, A. M. & Romero, E. J. (1996). Contenido polínico en las mieles de la región del Delta del Paraná (Argentina). *Darwiniana*, *34*, 113–120.

Cabrera, A. L. (1976). *Regiones Fitogeográficas Argentinas. Enciclopedia Argentina de Agricultura y Jardinería*, T. II (Fasc. 1), 2nd ed. Buenos Aires: ACME S.A.C.I.

Caccavari, M. A. (1972). Granos de polen de Leguminosas de la Argentina II, Subfam. Mimosoideae; Tribu ''Adenanthereae''. *Rev. Mus. Argent. Cienc. Nat. ''Bernardino Rivadavia''*, *4*, 281–320.

Caccavari de Filice, M. A. (1983). Polen de Alismataceae y Butomaceae de la Flora Bonaerense. *Bol. Soc. Argent. Bot.*, *22*, 237–253.

Caccavari, M. A. (1985). Granos de polen de Leguminosas de la Argentina IV. Género Mimosa. *Bol. Soc. Argent. Bot.*, *24*, 151–167.

Caccavari, M. A. & Domé, E. A. (2000). An account of morphological and structural characterization of American Mimosoideae pollen. Part I. Tribe Acacieae. *Palynology*, *24*, 231–247.

Costa, M. C. (1982). Contribución al conocimiento de la flora melífera de la provincia de Córdoba. I. Departamento Río Segundo. *Bol. Soc. Argent. Bot.*, *21*, 247–258.

Costa, M. C., Decolatti, N. & Godoy, F. (1995). Análisis polínico en mieles del norte de la provincia de San Luis (Argentina). *Kurtziana*, *24*, 133–144.

Daners, G. & Tellería, M. C. (1998). Native vs. Introduced bee flora: A palynological survey of honeys from Uruguay. *J. Apic. Res.*, *37*, 221–229.

De Camargo Carmello Moreti, A. C., Lopes de Carvalho, C. A., Marchini, L. C. & Cantalino Fernández de Olivera, P. (2000). Espectro polínico de amostras de mel de *Apis mellifera* L., coletadas na Bahía. *Bragantia*, *59*, 1–6.

Fagúndez, G. A. (2001). Estudio palinológico de las Asteraceae (Angiospermas) frecuentes en mieles de Entre Ríos, Argentina. *Asoc. Paleontol. Argent., Publ. Esp.*, *8*, 85–90.

Fagúndez, G. A. (2003). Diagnosis polínica de especies características de mieles ''de isla'' de la provincia de Entre Ríos, Argentina. *Rev. Mus. Argent. Cienc. Nat. N. Ser.*, *5*, 351–361.

Fagúndez, G. A. & Caccavari, M. A. (2002). Mieles entrerrianas ''de isla'': tipificación del origen botánico. *Rev. Argent. Prod. Animal*, *22*, 436.

Fagúndez, G. A. & Caccavari, M. A. (2003). Caracterización polínica y organoléptica de algunas mieles monofloras del centro de la Provincia de Entre Ríos, Argentina. *Polen*, *12*, 77–95.

FAO (Organización de las Naciones Unidas para la Agricultura y la Alimentación). (2005). *http: www.fao.org*

Feller-Demalsy, M., Parent, J. & Strachan, A. (1987). Microscopic analysis of honeys from Alberta, Canada. *J. Apic. Res.*, *26*, 123–132.

Forcone, A. & Tellería, M. C. (1998). Caracterización palinológica de las mieles del valle inferior del río Chubut (Argentina). *Darwiniana*, *36*, 81–86.

Forcone, A. & Tellería, M. C. (2000). Caracterización palinológica de las mieles de la llanura del río Senguerr (Chubut-Argentina). *Darwiniana*, *38*, 267–271.

Forcone, A. (2002). Fuentes de néctar y pólen utilizadas por *Apis mellifera* en el valle inferior del río Chubut (Argentina). Bahía Blanca: Univ. Nacl. d. Sur. *Tes. Doct.*

IPROSA (Instituto de Producción y Salud Animal, Subsecretaría de Asuntos Agrarios, Entre Ríos). (1995). *Estudio apibotánico en la provincia de Entre Ríos.* Proyecto n-042/92 PRONACOEFA (SECYT), Parana.

Irurueta, M., Oliva, A., Giráldez, X. & Sánchez, J. (2001). Análisis polínico de mieles de la provincia de Buenos Aires (Argentina). In M. A. Fombella Blanco, D. Fernández González & R. M. Valencia Barrera (Eds.), *Palinología: Diversidad y Aplicaciones, 12th Simp. Palinol. A.P.L.E. Proc 369–375). León: Univ. León.*

Louveaux, J., Maurizio, A. & Vorwohl, G. (1978). Methods of melissopalynology by International Comission for Bee Botany of IUBS. *Bee World*, *59*, 139–157.

Markgraf, V. & D'Antoni, H. (1978). *Pollen flora of Argentina*. Tucson: Univ. Arizona Press.

Maurizio, A. (1939). Untersuchungen zur quantitativen Pollenanalyse des Honigs. *Mitt. Geb. Lebensmittelunters. Hyg.*, *30*, 27–69.

Moar, N. T. (1985). Pollen analysis of New Zealand honey. *N. Zeal. J. Agric. Res.*, *28*, 39–70.

Naab, O. A. (1993). Análisis polínico de mieles de la Provincia de La Pampa (Argentina). *Act. J. Pampeanas Cienc. Nat.*, *1*, 106–113, [Santa Rosa, La Pampa].

Naab, O. A., Caccavari, M. A., Troiani, H. & Ponce, A. (2001). Melisopalinología y su relación con la vegetación en el departamento de Utracán, La Pampa, Argentina. *Polen*, *11*, 99–113.

Pendleton, M. (2006). Descriptions of melissopalynological methods involving centrifugation should include data for calculating relative Centrifugal Force (RCF) or should express data in units of RCF or gravities (g). *Grana*, *45*, 71–72.

Pire, S. M., Anzótegui, L. M. & Cuadrado, G. (1998). *Flora polínica del Nordeste Argentino*, I. Corrientes: Univ. Nacl. Nordeste.

Pire, S. M., Anzótegui, L. M. & Cuadrado, G. (2002). *Flora polínica del Nordeste Argentino*, II. Corrientes: Univ. Nacl. Nordeste.

Ricciardelli D'Albore, G. (1997). *Textbook of melissopalynology.*, Bucharest: Apimondia Publ. H.

Roubik, D. W. & Moreño Patiño, J. E. (1991). *Pollen and spores of Barro Colorado Island.* St. Louis, Mo. Bot. Gard.

SAGPyA (Secretaría de Agricultura, Ganadería, Pesca y Alimentación). (1995). Resolución 274/95. Sistema de clasificación de la miel teniendo como base su origen botánico. *Bol. Ofic*, *28268*, 2.

SAGPyA (Secretaría de Agricultura, Ganadería, Pesca y Alimentación). (2005) . *Mieles argentinas. http: www.sagpya.mecon.gov.ar*

Sala-Linares, A. & Suarez-Cervera, M. (1985). Sobre la posible existencia de indicadores polínicos en mieles argentinas de importación. *Polen*, *2*, 361–368.

Salgado, C. R. & Pire, S. M. (1998). Análisis polínico de mieles del Noroeste de la Provincia de Corrientes (Argentina). *Darwiniana*, *36*, 87–93.

Salgado, C. R. & Pire, S. M. (1999). Contribución al conocimiento del contenido polínico de mieles de Corrientes, Argentina. *Asoc. Paleontol. Argent., Publ. Esp.*, *6*, 95–99.

Sawyer, R. (1988). *Honey identification*. Cardiff: Acad. Press.

Stockmarr, J. (1971). Tablets with spores used in absolute pollen analysis. *Pollen Spores*, *13*, 615–621.

Tellería, M. C. (1987). Morfología del polen de las especies de *Trifolium* (Leguminosae) de la provincia de Buenos Aires (Argentina). *Bol. Soc. Argent. Bot.*, *25*, 149–161.

Tellería, M. C. (1988). Analyse pollinique des miels du Nord-ouest de la Province de Buenos Aires (République Argentine). *Apidologie*, *19*, 275–290.

Tellería, M. C. (1992). Caracterización botánica y geográfica de las mieles de la Provincia Fitogeográfica Pampeana (República Argentina) I: Distrito Oriental. *Darwiniana*, *3*, 345–350.

Tellería, M. C. (1995). El polen de las mieles del noroeste de la Provincia de Buenos Aires. *Darwiniana*, *33*, 347–364.

Tellería, M. C. (1996a). Caracterización botánica y geográfica de las mieles de la Provincia Fitogeográfica Pampeana (República Argentina) II: Tandilia. *Bol. Soc. Argent. Bot.*, *32*, 91–94.

Tellería, M. C. (1996b). Caracterización botánica y geográfica de las mieles de la Provincia Fitogeográfica Pampeana (República Argentina) III: Noreste de la Provincia de La Pampa. *Darwiniana*, *34*, 245–249.

Tellería, M. C. (2000). Contribución a la identificación del polen de mieles pampeanas (República Argentina). *Bol. Soc. Argent. Bot.*, *35*, 125–136.

Tellería, M. C. & Forcone, A. (2000). El polen de las mieles del Valle de Río Negro, Provincia Fitogeográfica del Monte (Argentina). *Darwiniana*, *38*, 273–277.

Valle, A., Andrada, A., Aramayo, E. & Lamberto, S. (1995). Análisis polínico de las mieles del sudoeste de la provincia de Buenos Aires, Argentina. *Invest. Agr. Prod. Prot. Veget.*, *10*, 375–383.