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Botanical origin of honey from south of Caldén district (Argentina)

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We performed palynological analysis of 75 honey samples from the south of Caldén district, which is the part of the phytogeographical province del Espinal. *Prosopis caldenia*, "caldén" (Fabaceae) is the dominant arboreal species in this region. 79 pollen types that belong to 36 plant families were identified. Honeydew elements are absent or present in negligible amounts. Native flora is intensely utilized. Main nectar sources that characterize monofloral honey samples, are these natives *Condalia microphylla* (Rhamnaceae), *Prosopis* sp. and *Vicia* sp. (Fabaceae), *Larrea divaricata* (Zygophyllaceae) and Brassicaceae, which are foreign to the area. The pollen from these plants along with the pollen of *Trichocline* sp. (Asteraceae) and *Prosopidastrum globosum* (Fabaceae), *Schinus fasciculatus* (Anacardiaceae), Astereae and *Lycium* sp.(Solanaceae), characterize honey from Caldén.

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The growing demand of typified honey over the international market and the interest in improving beekeepers' profitability have stimulated the development of melissopalynological research in different regions of our country. With the exception of some surveys carried out in Delta del Paraná (Basilio & Romero 1996), in Espinal (Costa et al. 1995), and in the East District of the Chaqueña Province (Salgado & Pire 1998), where the native vegetation is predominant, most regions survey the present vegetation disturbed by cattle-breeding.

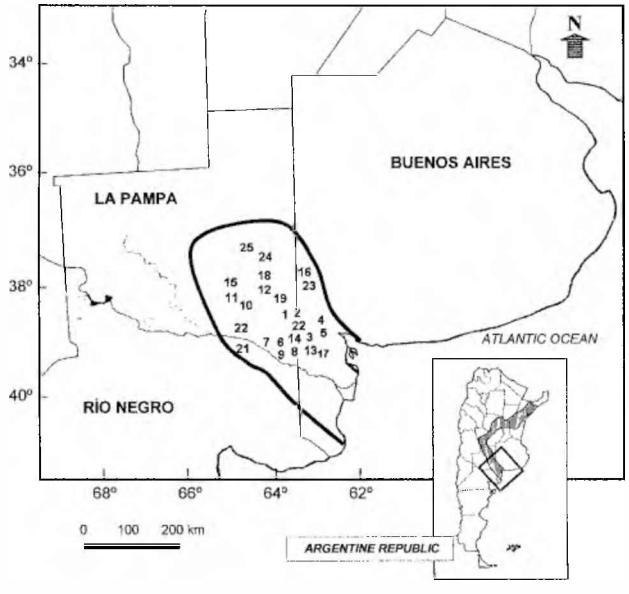

Fig. 1. Study area and location of the apiaries investigated.

Table I. *Apiary number, site of origin, date of extraction and identification number of sample analysed.*

Apiary number	Locality	Date of extraction	Number of melisso-palynotheque
1	Jacinto Arauz (North)	15/01/98	1-26-51
2	Jacinto Arauz (South)	15/01/98	2-27-52
3	Chasicó (Northeast)	21/12/97	3-28-53
4	Chasicó (East)	21/12/97	4-29-54
5	Chasicó (South)	22/12/97	5-30-55
6	Gaviotas	30/12/97	6-31-56
7	Anzoategui	29/12/97	7-32-57
8	Montes de Oca (East)	03/01/98	8-33-58
9	Montes de Oca (West)	03/01/98	9-34-59
10	Saltfield Colorado Grande (North)	24/12/97	10-35-60
11	Saltfield Colorado Grande (West)	23/12/97	11-36-61
12	Hucal	24/12/97	12-37-62
13	Nicolas Levalle	24/12/97	13-38-63
14	Laguna Chasicó (East)	23/12/97	14-39-64
15	Saltfield Lihuel Calel (East)	24/12/97	15-40-65
16	Puán (West)	24/12/97	16-41-66
17	Snas Chicas (East)	24/12/97	17-42-67
18	Abramo	24/12/97	18-43-68
19	Bernasconi	24/12/97	19-44-69
20	La Adela (North)	24/12/97	20-45-70
21	Rio Colorado (North)	24/12/97	21-46-71
22	Jacinto Arauz (Southeast)	10/01/98	22-47-72
23	Puán (South)	13/01/98	23-48-73
24	General Acha (North)	14/01/98	24-49-74
25	Macachin (South)	15/01/98	25-50-75

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Table II. *Pollen types and their frequency classes in the 74 honey analysed.*

D: dominant pollen (>45%); S: secondary pollen (45–15%); M: minor pollen (15–3%) and T: trace (<3%); FO: percentage of frequency of occurrence.

Family	Pollen type	D	S	M	T	FO
AMARANTHACEAE	**Gomphrena* sp.	–	–	–	2	3
ANACARDIACEAE	**Schinus fasciculatus*	–	1	2	43	61
APIACEAE	*Ammi* sp. *Conium* sp.	–	–	–	14	19
	Apiaceae	–	–	1	8	12
ASTERACEAE	*Ambrosia tenuifola*	–	–	–	2	3
	Artemisia sp.	–	–	–	1	1
	*Astereae	–	–	–	44	59
	**Brachyclados lycioides*	–	–	–	21	28
	Carduus sp.	–	–	3	52	73
	Carthamus lanatus	–	–	–	5	7
	Centaurea sp.	–	11	14	43	91
	Cichorium intybus	–	–	–	13	17
	Cirsium vulgare	–	–	–	2	3
	Cynara cardunculus	–	–	–	1	1
	**Chuquiraga erinacea*	–	–	1	15	21
	**Gaillardia megapotamica*	–	–	–	16	21
	Heliantheae	–	–	–	10	13
	Helianthus annuus	–	–	–	29	39
	Matricaria recutita – Anthemis cotula	–	–	–	9	12
	*Mutisieae	–	–	–	8	11
	Onopordon acanthium	–	–	–	5	7
	**Senecio* sp.	–	–	–	3	4
	Sonchus sp.	–	–	–	1	1
	**Trichocline* sp.	–	1	1	7	11
BERBERIDACEAE	**Berberis ruscifolia*	–	–	–	3	4
BRASSICACEAE	*Brassicaceae	3	17	25	29	99
BORAGINACEAE	**Heliotropium* sp.	–	–	–	2	3
CACTACEAE	**Cereus aethiops*	–	–	–	2	3
CARYOPHYLLACEAE	**Cerastium junceum*	–	–	–	5	7
	Silene gallica	–	–	–	3	4
CUPRESSACEAE	Cupressaceae (P)	–	–	–	2	3
CYPERACEAE	*Cyperaceae (P)	–	–	–	10	13
CHENOPODIACEAE	*Cheno-Amaranthaceae (P)	–	–	–	26	35
ELAEAGNACEAE	*Elaeagnus angustifolia*	–	–	–	3	4
EPHEDRACEAE	**Ephedra triandra* (P)	–	–	–	8	11
FABACEAE	*Acacia* sp.	–	–	–	2	3
	**Adesmia* sp.	–	1	–	18	25
	**Geoffroea decorticans*	–	–	–	3	4
	**Hoffmannseggia* sp.	–	–	–	4	5
	Lotus sp.	–	–	–	23	31
	Melilotus albus	–	1	8	30	52
	Medicago minima	–	–	–	6	8
	Medicago sativa	–	–	1	3	5
	**Prosopis* sp.	12	22	23	18	100
	**Prosopidastrum globosum*	–	–	–	62	83
	Trifolium sp.	–	–	1	8	12
	**Vicia* sp.	2	–	6	36	59
FUMARIACEAE	*Fumaria officinalis*	–	–	–	1	1
JUGLANDACEAE	*Juglans regia*	–	–	–	4	5
MALVACEAE	*Malva sylvestris*	–	–	–	–	1
	**Sphaeralcea australis*	–	–	–	19	25
MYRTACEAE	*Eucalyptus* sp.	5	10	12	38	87
OLEACEAE	*Fraxinus* sp.	–	–	–	1	1
PINACEAE	*Pinus* sp. (P)	–	–	–	19	25
PLANTAGINACEAE	**Plantago* sp. (P)	–	–	–	6	8
POACEAE	*Poaceae (P)	–	–	–	48	64
	**Zea mays* (P)	–	–	–	4	5
POLYGALACEAE	**Bredemeyera microphylla*	–	–	–	5	7
POLYGONACEAE	*Polygonum* sp.	–	–	–	2	3
PORTULACEAE	*Portulacca aleracea*	–	–	–	2	3
RHAMNACEAE	**Condalia microphylla*	30	24	13	7	99
	**Discaria americana*	–	–	1	28	39

Table II. *(Continued)*.

Family	Pollen type	D	S	M	T	FO
ROSACEAE	**Margyricarpus pinnatus*	–	–	–	5	7
	*Rosaceae	–	–	–	6	8
RUBIACEAE	**Galium richardianum*	–	–	–	5	7
SALICACEAE	**Salix* sp.	–	–	2	1	4
SCROPHULARIACEAE	**Gerardia* sp.	–	–	–	5	7
SOLANACEAE	**Lycium* sp.	–	–	2	29	41
	*Solanaceae	–	–	–	1	1
TAMARICACEAE	*Tamarix* sp.	–	–	1	15	21
ULMACEAE	*Celtis australis* (P)	–	–	–	3	4
	Populus sp. (P)	–	–	–	4	5
VERBENACEAE	**Acantholippia seriphioides*	–	–	2	18	27
	**Aloysia gratissima*	–	–	–	7	9
	**Glandularia pulchella*	–	–	–	8	11
	**Phyla canescens*	–	–	–	3	4
	**Junellia seriphioides*	–	–	–	2	3
ZYGOPHYLLACEAE	**Larrea divaricata*	1	7	18	34	80
	Tribulus terrestris	–	–	–	3	4

The aim of the present paper is to characterize the honey from Caldén District (particularly from southern its part), which belongs to the Phytogeographical Province of Espinal (Cabrera 1971). Native vegetation is still predominant in this area (Cabrera 1971, Fernández et al. 1989), and beekeeping is a complement to cattle breeding. The apicultural period goes from late August until early January. When summer time sets in, temperatures are too high and flowering decreases. At the time beekeepers collect their hives to protect them from the spontaneous wildfires.

We used palynological analysis of honey in order to know the sources of nectar available in southern Caldén District. This paper is a contribution to a project to know and to evaluate the polliniferous and nectariferous sources of this region (Andrada: in prep.).

Local vegetation

The Caldén District, usually called Caldenal extends over an area of 2590 km^2 in the central semi-arid region of Argentina (Fernández et al. 1989). It is a homogeneous plant community, characterized by quite untouched vegetation with open woods, a poor shrubby stratum and an herbaceous stratum rich in Poaceae (Cabrera 1971).

Prosopis caldenia (caldén) is the dominant arboreal species, with *P. nigra*, *P. flexuosa*, *Geoffroea decorticans* (All Fabaceae) and *Schinus fasciculatus* (Anacardiaceae) following in importance. The most abundant shrubs are: *Condalia microphylla* (Rhamnaceae), *Ephedra triandra* (Ephedraceae), *Prosopidastrum globosum*, *P. alpataco* (Fabaceae both), *Larrea divaricata* (Zygophyllaceae), *Lycium chilense* (Solanaceae), *Discaria americana* (Rhamnaceae) and *Chuquiraga erinacea* (Asteraceae).

In the herbaceous stratum, the most dominant are *Stipa* sp. (Poaceae), *Glandularia pulchella* (Verbenaceae), *Nierembergia aristata* (Solanaceae), *Plantago patagonica* (Plantaginaceae), *Hysterionica jasionoides* (Asteraceae) and *Turnera sidoides* (Turneraceae) among others (Cabrera 1971).

MATERIALS AND METHODS

75 honey samples obtained by centrifuging taken from 25 different apiaries (Fig. 1) were analyzed. Three samples were obtained for apiary, one for each year of sampling (1997, 1998 and 1999). Site of origin, date of extraction and identification number of sample are set out in Table I where each sample is preceded by its reference number of its apiary. Pollen grains were identified by comparing them with the collection of pollen reference obtained from plants of the described area. Samples were deposited at the Regional Herbarium of the Departamento de Agronomía of the Universidad Nacional del Sur (BB); and the preparations at the palynotheca of the División of Sistemática Vegetal of the same institution. Studies of Markgraf & D'Antoni (1978) and Tellería (1995, 2000) describing pollen flora of the area and general pollen morphology of the taxa have been studied.

Qualitative analysis of samples was carried out according to Louveaux et al. (1978). The frequency classes of pollen grains were given as dominant pollen (>45%), secondary pollen (16–45%), important minor pollen (3–15%) and traces (1–3%) (Louveaux et al. 1978, Serra & Cañas 1988). Counts were expressed as percentages after counting a minimum of 1000 pollen grains on three slides from sample. Pollen from the plants collected at the surveyed area and pollen from honey samples, were acetolysed, mounted in glycerine gelatine and sealed with paraffin. However, part of the remaining pollen from honey was mounted prior to acetolysis, in order to detect honeydew indicators.

Quantitative analysis was carried out following Moar's methods (1985) by using tablets of *Lycopodium* spores (Stockmarr 1971). Honey was classified according to the number of pollen grains present in 10 grams of honey, into: group I (<20000), II (20000–100000), III (100000–500000), IV (500000–1000000), V (>1000000), (Louveaux et al. 1978).

RESULTS

79 pollen types were identified, out of which 42 were determined at species level, 26 at genus, 3 at tribe and 8 at family (Table II). Brassicaceae type may be assigned to *Diplotaxis tenuifolia*, *Sisymbrium irio* and *Eruca vesicaria* (all Brassicaceae), as these weeds are abundant in the surveyed area and in full bloom during the apicultural period

(Andrada: in prep.); Astereae-type includes *Grindelia tehuelches*, *Hysterionica jasionoides* and *Baccharis* sp.; *Prosopis*-type includes *P. caldenia* (Caldén), *P. flexuosa* (Algarrobo) and *P. alpataco* (Alpataco).

Most represented families in this honey are: Asteraceae (*Ambrosia tenuifolia*, *Artemisia* sp., Astereae, *Brachyclados lycioides*, *Carduus* sp., *Carthamus lanatus*, *Centaurea* sp., *Cichorium intybus*, *Cirsium vulgare*, *Cynara cardunculus*, *Chuquiraga erinacea*, *Gaillardia megapotamica*, Heliantheae, *Helianthus annuus*, *Matricaria recutita-Anthemis tenuifolia*, Mutisieae, *Onopordon acanthium*, *Senecio* sp., *Sonchus* sp. and *Trichocline* sp.), and Fabaceae (*Acacia* sp., *Adesmia* sp., *Geoffroea decorticans*, *Hoffmanseggia* sp., *Lotus* sp., *Melilotus albus*, *Medicago minima*, *M. sativa*, *Prosopis* sp., *Prosopidastrum globosum*, *Trifolium* sp. and *Vicia* sp.).

72 morphological types are present in less than 30% of the samples, 5 types in 30 to 50% and 12 morphological types are present with a frequency of occurrence over 50%: *Schinus fasciculatus* (Anacardiaceae); Astereae, *Carduus* sp., *Centaurea* sp. (Asterace), Brassicaceae; *Melilotus albus*, *Prosopis* sp., *Prosopidastrum globosum*, *Vicia* sp. (Fabaceae); *Eucalyptus* sp. (Myrtaceae); *Condalia microphylla* (Rhamnaceae) and *Larrea divaricata* (Zygophyllaceae).

Out of the total samples, 48 were monofloral and 27 mixed or multi-floral; among monofloral samples, 30 are from *Condalia microphylla* (Piquillín; Rhamnaceae), 12 from *Prosopis* sp. (Algarrobo)and 2 from *Vicia* sp. (Fabaceae), 1 from *Larrea* sp. (Jarilla; Zygophyllaceae) and 3 from Brassicaceae, which is foreign to the area. The percentage of pollen of *Eucalyptus* sp. (Myrtaceae), 48 to 69%, was insufficient to classify this honey as monofloral (Serra & Cañas 1988). Secondary pollen comes from: *Centaurea* sp. (*C. calcitrapa*, *C. solstitialis*), *Eucalyptus* sp., *Schinus fasciculatus*, *Melilotus albus*, *Adesmia* sp. and *Trichocline* sp.

Pollen types included in minor importance and trace classes come from the following families: Anacardiaceae, Apiaceae, Asteraceae, Brassicaceae, Berberidaceae, Boraginaceae, Cactaceae, Caryophyllaceae, Chenopodiaceae/Amaranthaceae, Cyperaceae, Cupressaceae, Elaeagnaceae, Ephedraceae, Fabaceae, Fumariaceae, Juglandaceae, Malvaceae, Myrtaceae, Oleaceae, Pinaceae, Plantaginaceae, Poaceae, Polygalaceae, Polygonaceae, Portulaccaceae, Rhamnaceae, Rosaceae, Rubiaceae, Salicaceae, Scrophulariaceae, Solanaceae, Tamaricaceae, Turneraceae, Ulmaceae, Verbenaceae and Zygophyllaceae (Table II). Indicators of honeydew elements were scarce in all samples.

Most samples belong to groups II and III (Fig. 2). Samples presenting the richest pollen belong to multifloral honey and to monofloral honey from *Condalia microphylla* and *Prosopis* sp. Honey from Brassicaceae and honey from *Larrea* sp. have between 20,000 and 100,000 pollen grains, while honey from *Vicia* sp. exhaled less than 20,000 grains every 10 grams of honey (Fig. 3).

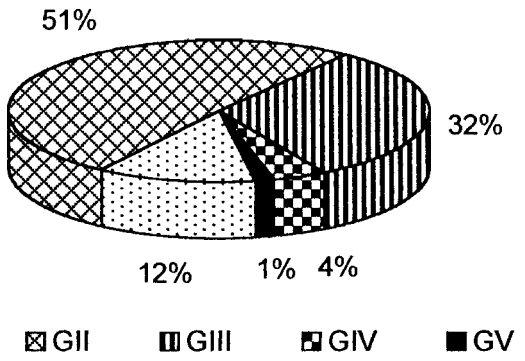

Fig. 2. Honey grouped by pollen amount in 10 g of sample: GI<20000 pollen grains; GII: 20000–100000; Gill: 100000–500000; GIV: 500000–1000000 and GV>1000000.

DISCUSSION and CONCLUSIONS

Botanical origin

Pollen spectrum of honey from south Caldenal reveals the variety of nectariferous sources visited by bees. There exists an extensive foraging of the dominant indigenous plants and of the widespread accompanying weeds (Andrada & Lamberto 1998).

Like in honey from other Argentinian apicultural areas (Basilio & Romero 1996, Tellería 1996, Forcone & Tellería 1998, Andrada et al. 1998) and from different regions of the world (Crane 1991), Asteraceae, Fabaceae and Brassicaceae are the best represented families in these honey samples.

Monofloral honey samples are characterized by *Condalia microphylla*, *Prosopis* sp., *Vicia* sp., *Larrea divaricata* and Brassicaceae as their main nectar source. *Centaurea* sp. (*C. calcitrapa*, *C. solstitialis*), *Eucalyptus* sp., *Schinus fasciculatus*, *Melilotus albus*, *Adesmia* sp. and *Trichocline* sp. are also intensively visited by bees.

Most monofloral honey is made mainly at the expense of nectar from the native species: *Condalia microphylla* and *Prosopis* sp.

Honey from *C. microphylla* have an absolute high pollen content, and a high pollen percentage with respect to other morphological types (Fig. 3). Due to these characteristics and considering the required 45% of pollen needed to classify honey (Louveaux et al. 1978), honey from *C. microphylla* could be insufficient for to be typified as monofloral. It would be an over-represented species, such as Eucalyptus sp. (Serra Bonvehí & Cañas Lloria 1988) or Castanea sativa (Louveaux et al. 1978).

Although honey from *Prosopis* sp. (*P. caldenia*, *P. flexuosa* and *P. alpataco*) was also detected in the north-west of La Pampa (Naab 1994, Tellería 1996), it is typical of south Caldenal. Probably, because of the abundant supply of Algarroba flowering in this region (Andrada, in. prep.). The melliferous importance of *Prosopis* sp. was acknowledged by Burkart (1952) in his research about Argentinian Leguminosae and also by Genise et al. (1990); both of them noted the foraging of *Apis mellifera* on Algarroba. Pollen occurrence in honey of *Prosopis* sp. varies, while pollen percentage ranges from 45 to 75% in most samples. Further physical and chemical determinations would improve the characterization of this monofloral honey.

The presence of honey from *Vicia* sp., *Larrea divaricata* and Brassicaceae was less relevant than that from *C. microphylla* and *Prosopis* sp.

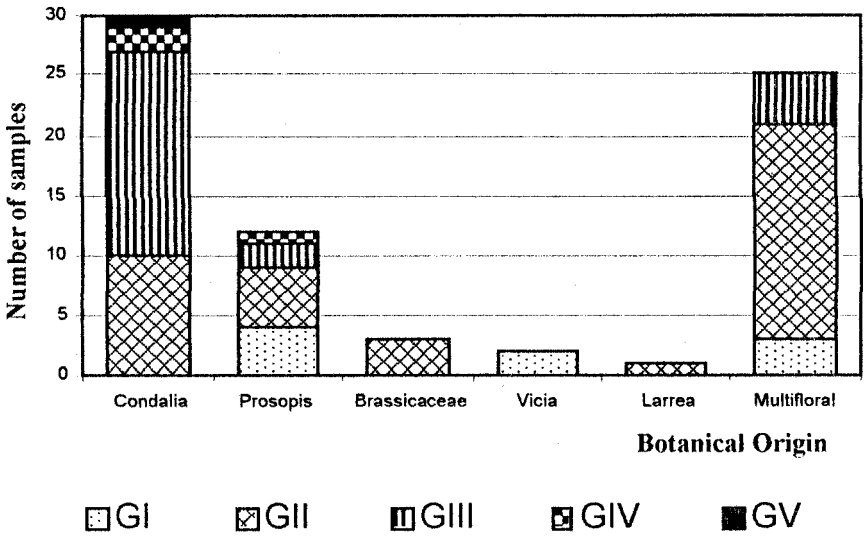

Fig. 3. Pollen amount in 10 g of sample in unifloral and multifloral honey.

Phytogeographical origin

Honey from Caldenal is characterized by typical representatives of this geographical area, such as the association of *Condalia microphylla*, *Prosopis* sp., *Vicia* sp., *Larrea divaricata* and *Trichocline* sp., and a high frequency of *Prosopidastrum globosum*, *Schinus fasciculatus*, Astereae, and *Lycium* sp.. These characteristics differentiate it from any other Argentine honey.

Honey from the north-east of San Luis administrative province, within the Algarroba phytogeographical District, also displays *Larrea* sp. and *Schinus fasciculatus*; yet its dominant types: *Eucalyptus* sp., *Melilotus albus*, *Lippia turbinate* (Verbenaceae) and *Tripodanthus* sp. (Loranthaceae alt. Viscaceae) and the variety of Lamiaceae (Costa et al. 1995) do not belong in the honey dealt with here.

Caldenal honey also shares Brassicaceae, *Prosopis* sp., *Centaurea* sp., *Eucalyptus* sp., *Melilotus albus* and *Helianthus annuus*, with honey from the northeast of La Pampa province (Naab 1994, Tellería 1996), yet the latter lack other representatives, typical for the Caldenal.

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