Acta Bot. Croat. 60 (1), 11–24, 2001

CODEN: ABCRA 25
ISSN 0365–0588
UDC 638.138 (469)

Palynological analysis of honeys from Palencia Province (Spain)

BAUDILIO HERRERO[1*], ROSA MARÍA VALENCIA-BARRERA[2]

[1] Departamento de Ciencias Agroforestales. Universidad de Valladolid. Avda. Madrid, 57 E-34004 Palencia, Spain.

[2] Departamento de Biología Vegetal. Universidad de León. E-24071 León, Spain.

A pollen analysis of 49 honey samples from Palencia province has been carried out. According to the pollen spectra found, most of them are multifloral (27); 22 samples were monofloral. The monofloral honeys were *Erica* type followed by *Centaurea*, *Reseda*, *Onobrychis*, *Rubus*, *Cytisus* and *Hedera*. 126 different pollen types were recorded, belonging to 41 families. 53 of them reached percentages over 3% in some samples. The other 73 types did not reach percentages over 3% in any of the 49 samples. The families present in the highest number of samples were: *Fabaceae*, *Asteraceae*, *Cistaceae* and *Rosaceae*; the families that had the highest percentages were: *Fabaceae*, *Asteraceae*, *Ericaceae* and *Rosaceae*. The pollen types that appeared in the most samples were: *Papaver rhoeas* (39 samples) and *Rubus ulmifolius* (38); the pollen types that reached the highest abundance percentages were: *Erica arborea*, *Onobrychis viciifolia* and *Reseda luteola*. The pollen types of *Ericaceae* and *Lavandula latifolia* can be used as indicators in order to know the zone of origin zone of honeys produced in Palencia, and it allows us to detect any possible commercial frauds concerning the origin of honeys.

Keywords: pollen, honey, melissopalynology, microscopical analysis, Palencia, Spain

Introduction

The composition of local flora, is a factor of great interest, as this flora is the only source of pollen. The bees forage in the plants most abundant near the hives. The cultivated flora has no indicator value. These plants contain pollen with the highest nourishment value. They are rich in appetizing substances for bees (terpenos) and are also nectar producers (LOUVEAUX 1958).

In some cases the pollen types present in the honeys come from plants that provide mostly nectar, whereas sometimes they belong to plants that provide pollen. However some cases supply both, such as *Ericacae* family, which is considered very important for its nectar as well as its pollen (LOVEAUX and VERGERON 1964, ESPADA 1984, ARROYO and

* Corresponding author: Fax: 0034979 712099, e-mail: baudilio@agro.uva.es

HERRERA 1988, MONTERO and TORMO 1990, LUIS et al. 1990, SEIJO and JATO 1998). White heath is considered to be a good source of nourishment for bees for several reasons: a good production of nectar and pollen (ARROYO and HERRERA 1988). The major beekeeping interest in the *Fabaceae* family is in its pollen contribution (ARROYO et al. 1986). The work carried out by RICCIARDELLI D'ALBORE (1998) draws attention to the importance of the nectar of the *Reseda* genus.

Honey classification and origin analysis are essential when the commercial quality of this product must be assessed. However, this assessment is difficult because there is not a specific pollen type for each honey production area. Therefore more subtle methods are necessary, where the presence or absence of a certain pollen type is not taken into account but its relative proportion in different spectra.

The honey exploitation of an area mainly depends on its flora and climatology, taking into account the constancy of foraging bees in relation to a certain flower (FREE 1963). The flowering and nectar production seasons can be different for the same species in different areas (FELLER-DEMASLY and PARENT 1989). Hence a specific study of each area is necessary to know its honey potentiality. In Spain, melissopalynological studies have been done in different regions: Andalucia (ARROYO and HERRERA 1988), Aragón (PÉREZ DE ZABALZA and RICCIARDELLI D'ALBORE 1990), Canarias (LA-SERNA et al. 1999), Castilla y León (SÁNCHEZ SÁNCHEZ 1982, GÓMEZ FERRERAS 1989, VALENCIA-BARRERA et al. 1994, VALENCIA-BARRERA et al. 2000), Castilla – La Mancha (BERMÚDEZ-CAÑETE 1978, ORTIZ VALBUENA et al. 1996), Cataluña (ESPADA 1984), Extremadura (GÓMEZ FERRERAS and SÁENZ 1980, MONTERO and TORMO 1990), Galicia (SÁNCHEZ and SÁENZ 1982, SEIJO et al. 1997, SEIJO and JATO 1998), Valencia (BURGAZ MORENO et al. 1994).

This work intends to show those pollen types that can be used to distinguish the origins of the different honey producing areas in Palencia province and its beekeeping potentialities.

In the present work we study the pollen spectrum of honeys in Palencia province in order to know the nectar sources used by bees, and the characteristic pollen types of these honeys so that they can be classified by two different aspects, their botanical origin as well as geographical location.

This is the first work of the kind concerned with Palencia province, in which the objective is to characterise honeys by their pollen types, bearing in mind the main honey production zones in the province.

Study area

Palencia province is located in the Northwest of Iberian Peninsula (Fig. 1). It covers an area of 8,035 km^2, in which two large morphological units can be clearly distinguished: one is mountainous in the north and other is flat in the centre and south, covering more than 80% of the province's surface. Maximum altitude is at 2,520 m at Mt Curavacas and a minimum at 750 m in the southwest part of the province. Four geomorphological zones (Fig. 1) can be distinguished: Zone I (Montaña), Zone II (Páramo detrítico), Zone III (Tierra de Campos) and Zone IV (Cerrato).

The Montaña zone presents a rugged outline with altitudes ranging between 2,400 m and 1,100 m. It is made up of limestones and Palaeozoic quartzites, combined alternatively. The Páramo detrítico is made up of a clay Pliocene mould with rolling stones varying in

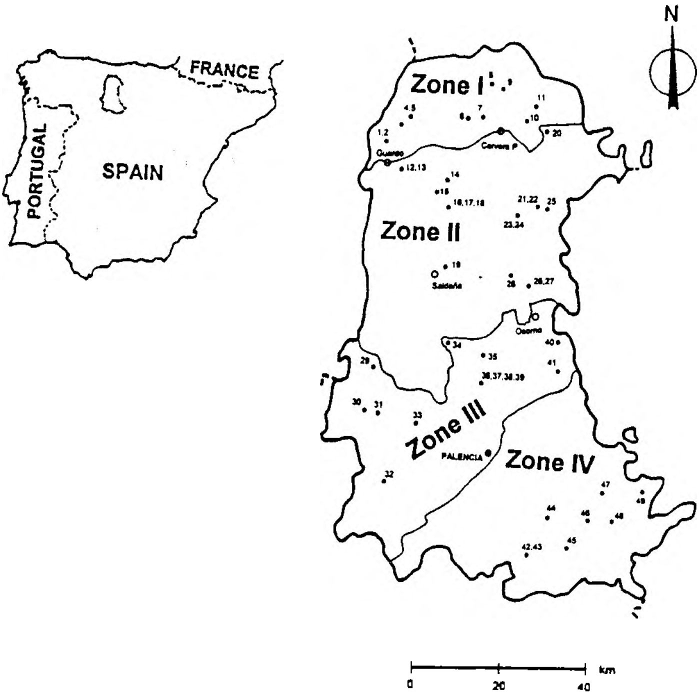

Fig. 1. Geomorphological units of Palencia province and location of honey samples. Zone I (Montaña) Zone II (Páramo detrítico) Zone III (Tierra de Campos) Zone IV (Cerrato)

thickness. The average altitude is 900 m. Tierra de Campos, consisting of yellowish ochre clay soil, forms an eroded plain. The average altitude is 800 m. Cerrato is made up of marls and calcareous plateaus that are fragmented and eroded. The average altitude is 850 m.

Vegetation

The Montaña zone belong to the Eurosiberian biogeographical region; there are beech woods (*Fagus sylvatica* L.), birch woods (*Betula celtiberica* Roth. et Vasc.), oak woods (*Quercus pyrenaica* Willd. and *Q. petraea* (Mattus.) Liebl.). The other three zones are part of the Mediterranean region. The Páramo detrítico is mainly dominated by oak woods (*Quercus pyrenaica*). This is due to the acid nature of the substratum. In Tierra de Campos and Cerrato, due to the nature of the bedrock the potential dominant vegetation consists of holm oak woods (*Quercus rotundifolia* Lam.) and oak (*Quercus faginea* Lam.) together. White juniper (*Juniperus thurifera* L.) is present in the coldest places, where soil is scarce.

Of the total province surface, 60% is cultivated. Heath, scrubs and pasture cover about 18% and leafy species 16% (CEÑAL et al. 1988). Palencia province has 6,200 beehives. The annual honey production is 120 t, representing 0.5% of annual honey production in Spain (HERRERO 1990).

Climatology

The mountainous zone presents an Atlantic influence and the rest of the province has characteristics of a continental Mediterranean climate. Precipitation ranges from 1,100 mm in the north to a minimum of 400 mm in the south. It shows a decreasing gradient from the most northwest part of the province down to the southeast. The dry season ranges from 2 months in the north to 4 months in the south. The annual mean temperature varies from 6 °C in the north to 12 °C in the farthest south, with thermal oscillations up to 18 °C.

Materials and methods

Forty nine honey samples obtained from honey bee colonies with a centrifugal machine (36) or by decanting (13) in 37 places of Palencia province have been studied. We obtained the samples during the last quarter of 1994 (from October to December), and they were by beekeepers between 1992 and 1994. The beehives were sedentary and of the Dadant type. The origin of the honeys studied (origin zone, place, UTM co-ordinates with 10×10 km^2, method of extraction) is shown in table 1.

They come from only one annual extraction. The material used consisted of the honey samples collected in the target area by some beekeepers, whom we visited personally. The number of samples recorded in each geographical zone was 11 (Montaña), 17 (Páramo detrítico), 13 (Tierra de Campos) and 8 (Cerrato). The honey samples come from beehives that were not intentionally placed in those zones so that a certain honey type would be obtained.

The melissopalynological method proposed by the International Commission for Bee Botany (ICBB) and described by LOUVEAUX et al. (1978) has been used, and the fractions were analysed without acetolysis. At least four hundred grains of pollen were identified in each sample, according to the suggestion made by MONTERO and TORMO (1990). Total pollen content was determined without prior acetolysis in 10 g of honey. A Thoma chamber (Haemocytometer Phywe) was used for the quantitative analysis of the pollen content. These values depend on the procedure for pollen analysis (LOW et al. 1989, LUTIER and VAISSIÈRE 1993). The samples were classified according to Maurizio´s classification (MAURIZIO 1939). The pollen types were determined following VALDÉS et al. (1987). The botanical nomenclature was used following Flora Europaea (TUTIN et al. 1964–1993). The means are given with their standard deviation.

Results

Analysis quantitative

The average number of pollen grains identified in each samples was 465 ± 92 (n = 49). A total of 19,992 pollen grains were identified. The number of grains per gram of honey ranges between 908 and 62,840. Sixty-one per cent of the samples are rich in pollen with over 10,000 grains/g honey. The average number of pollen grains in 1 g of centrifuged honey was 19,465 ± 18,430 (n = 36) and 36,376 ± 23,497 (n = 13) in the decanted samples.

Tab. 1. Geographical location, method of extraction, characterization and quantitative values of the honeys studied.

Zone	Sample	Locality	UTM	Extr. Meth.	Kind	Nº P. types	Nº families
I. Montaña	1	Velilla del Río Carrión	30TUN44	Centrifuge	*Cytisus*	30	16
	2	Velilla del Río Carrión	30TUN44	Centrifuge	Multifloral	31	18
	3	Otero de Guardo	30TUN55	Centrifuge	*Centaurea*	20	15
	4	Camporredondo	30TUN55	Centrifuge	Multifloral	32	21
	5	Camporredondo	30TUN55	Centrifuge	Multifloral	29	17
	6	San Martín de los Herreros	30TUN75	Decantation	Multifloral	27	14
	7	Ventanilla	30TUN74	Decantation	Multifloral	46	25
	8	Polentinos	30TUN75	Centrifuge	Multifloral	32	15
	9	Estalaya	30TUN75	Centrifuge	Multifloral	38	21
	10	Vallespinoso de Cervera	30TUN84	Centrifuge	*Erica*	30	15
	11	Mudá	30TUN84	Centrifuge	Multifloral	27	16
II. Páramo detrítico	12	Intorcisa	30TUN53	Decantation	Multifloral	27	15
	13	Intorcisa	30TUN53	Centrifuge	Multifloral	27	14
	14	Respenda de la Peña	30TUN63	Centrifuge	Multifloral	30	15
	15	Fontecha	30TUN53	Decantation	Multifloral	21	13
	16	Cornoncillo	30TUN62	Centrifuge	*Erica*	18	11
	17	Cornoncillo	30TUN62	Centrifuge	*Erica*	24	17
	18	Cornoncillo	30TUN62	Centrifuge	*Centaurea*	27	18
	19	Relea	30TUN60	Decantation	*Rubus*	23	15
	20	Quintanaluengos	30TUN84	Centrifuge	*Erica*	16	12
	21	Pisón de Ojeda	30TUN73	Decantation	*Erica*	21	12
	22	Pisón de Ojeda	30TUN73	Decantation	*Erica*	22	13
	23	Báscones de Ojeda	30TUN72	Centrifuge	*Centaurea*	21	13
	24	Báscones de Ojeda	30TUN72	Decantation	*Centaurea*	21	10
	25	Berzosa de los Hidalgos	30TUN82	Decantation	*Erica*	19	13
	26	Espinosa de Villagonzalo	30TUN80	Centrifuge	Multifloral	31	17
	27	Espinosa de Villagonzalo	30TUN80	Centrifuge	Multifloral	32	16
	28	Villorquite de Herrera	30TUN80	Centrifuge	Multifloral	32	19
III. Tierra de Campos	29	Ledigos	30TUM49	Centrifuge	Multifloral	37	21
	30	Cisneros	30TUM47	Decantation	Multifloral	33	17
	31	Villalumbroso	30TUM57	Centrifuge	Multifloral	35	21
	32	Capillas	30TUM45	Centrifuge	Multifloral	15	11
	33	Paredes de Nava	30TUM66	Centrifuge	Multifloral	24	16
	34	Carrión de los Condes	30TUM68	Centrifuge	*Onobrychis*	20	11
	35	Villovieco	30TUM78	Centrifuge	Multifloral	23	14
	36	Amayuelas de Arriba	30TUM77	Centrifuge	*Onobrychis*	27	15
	37	Amayuelas de Arriba	30TUM77	Centrifuge	*Onobrychis*	23	11
	38	Amayuelas de Arriba	30TUM77	Centrifuge	*Reseda*	24	16
	39	Amayuelas de Arriba	30TUM77	Centrifuge	Multifloral	23	15
	40	Osornillo	30TUM99	Decantation	*Rubus*	27	19
	41	Astudillo	30TUM97	Centrifuge	Multifloral	24	15
IV. Cerrato	42	Cevico de la Torre	30TUM83	Centrifuge	Multifloral	26	13
	43	Cevico de la Torre	30TUM83	Centrifuge	Multifloral	19	10
	44	Valle de Cerrato	30TUM93	Centrifuge	*Reseda*	25	15
	45	Vertavillo	30TUM83	Centrifuge	Multifloral	28	16
	46	Villaconancio	30TUM93	Decantation	*Reseda*	28	15
	47	Baltanás	30TUM94	Centrifuge	*Reseda*	26	18
	48	Cevico Navero	30TVM03	Decantation	*Hedera*	10	7
	49	Antigüedad	30TVM04	Centrifuge	Multifloral	29	16

There were significant differences according to the Mann-Whitney test related to the median of pollen density between the samples obtained by centrifugation or by decanting ($P = 0.0004$).

One hundred and twenty six pollen types were identified, belonging to 41 families. Nectar producing taxa account for 75.5% and 24.5% of the taxa produce pollen or honeydew. The average number of pollen types per sample was 26 ± 6.4 (n = 49) and the number of families represented in each sample was 15.3 ± 3.4 (n = 49). Multifloral honey samples presented a higher number of families than monofloral samples.

In Zone I (Montaña) the average number of pollen types per honey sample was 31 ± 6.6 (n = 11) and 97 pollen types were recorded, belonging to 36 families. The average number of families per sample was 17 ± 3.5 (n = 11). In Zone II (Páramo detrítico) the average number of pollen types per sample was 24 ± 5 (n = 17) and 75 pollen types were identified, belonging to 29 families. The average number of families per sample was 14 ± 2.5 (n = 17). In Zone III (Tierra de Campos) the average number of pollen types per sample was 26 ± 6.1 (n = 13) and 75 pollen types were classified, belonging to 32 families. The average number of families per sample was 15 ± 3.4 (n = 13). In Zone IV (Cerrato) the average number of pollen types per sample was 24 ± 6.4 (n = 8) and 57 pollen types were recorded, belonging to 26 families. The average number of families per sample was 14 ± 3.6 (n = 8).

Qualitative analysis

Of the 49 samples we analysed, most samples are multifloral (27), with none of the pollen types having percentages higher than 45%, and 22 were monofloral (table 1). The most frequent monofloral honeys were heath (7), with white heath (*Erica arborea*) being the predominant species. These honey only appear in Zones I (Montaña) and II (Páramo detrítico). The others unifloral honeys characterized were: 4 monofloral samples of *Centaurea*, whose predominant pollen type is *Centaurea cyanus, Erica arborea* is their secondary or minor pollen type, and *Plantago lanceolata* appears as minor pollen in two of them. We characterized 4 monofloral samples as *Reseda*, with the percentages of *Reseda luteola* pollen type ranging between 50.5% and 67%; honeys of this type are frequent in Cerrato, where this species is very abundant on the borders of fields. Their secondary pollen types are *Onobrychis viciifolia* and *Ononis spinosa*; *Helianthus annuus* and *Helianthemum salicifolium* appear as minor pollen types.

Three samples are monofloral sainfoin (*Onobrychis*). This species grows in large areas in Tierra de Campos, where *Trifolium repens* and *Rubus ulmifolius* appear as minor pollen types. Two samples are monofloral *Rubus*. *Rubus ulmifolius* is the predominant pollen type. One sample is monofloral *Cytisus* with 53.6% of the *Cytisus scoparius* type; another is monofloral *Hedera*, 71.5% of it being represented by the *Hedera helix* type.

In figure 2 we show the percentage of samples in which each family is present, taking into account the zone or geomorphological unit considered. Out of the 41 families recorded, the ones that are present in the greatest number of samples are *Fabaceae*, *Asteraceae*, *Cistaceae* and *Rosaceae*. Five families (12%) are only present in one sample with very low representation percentages.

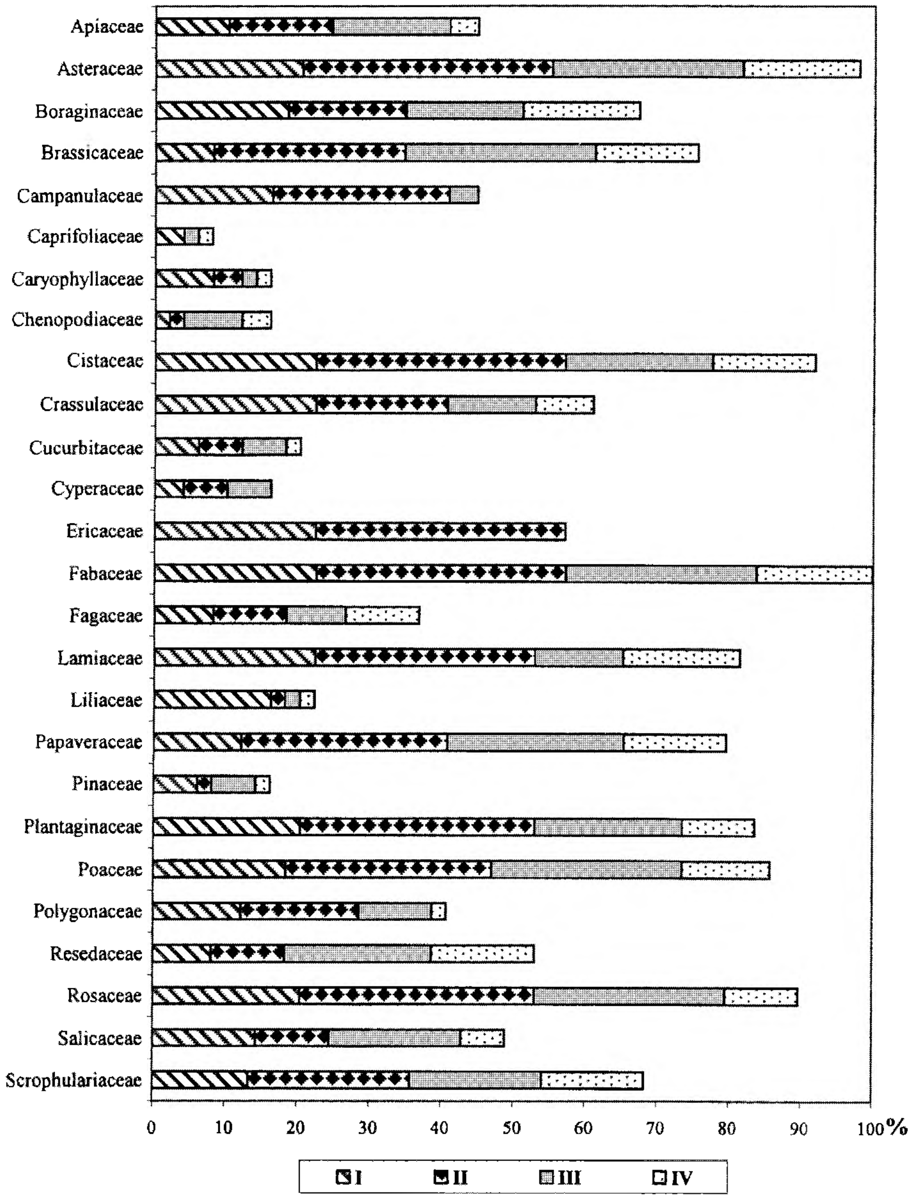

Fig. 2. Presence percentage of the most important families in the honey samples. I (Montaña) II (Páramo detrítico) III (Tierra de Campos) IV (Cerrato)

In table 2 we show the pollen types which are present in the greatest number of samples. The following ones stand out among them: *Papaver rhoeas* (39 samples), *Rubus ulmifolius* (38), *Helianthemum salicifolium* (37), *Mentha aquatica* and *Festuca arundinacea* (36), *Cytisus scoparius* and *Trifolium repens* (35). At the same time, we observed the absence of pollen from *Ericaceae* in Zones III and IV and *Helianthus annuus* in Zone I.

Tab. 2. Most frequent pollen types and number of samples where they are present depending on their zone of origin. I (Montaña) II (Páramo detrítico) III (Tierra de Campos) IV (Cerrato)

	Total	I	II	III	IV
Number of samples	49	11	17	13	8
Pollen type					
Calluna vulgaris	19	8	11		
Capsella bursa-pastoris	22	2	7	7	6
Centaurea calcitrapa	21	9	6	5	1
Centaurea cyanus	33	8	17	8	
Cirsium vulgare	25	5	8	10	2
Crataegus monogyna	33	8	10	10	5
Cytisus scoparius	35	11	14	6	4
Echium vulgare	31	7	7	9	8
Erica arborea	26	10	16		
Erica australis	19	7	12		
Eryngium campestre	18	5	6	7	
Festuca arundinacea	36	9	13	8	6
Helianthemum salicifolium	37	11	10	9	7
Helianthemum syriacum	17	6	9	2	
Helianthus annuus	27		6	13	8
Jasione montana	22	8	12	2	
Lotus corniculatus	23	6	7	9	1
Lotus creticus	15	5	3	2	5
Mentha aquatica	36	11	14	4	7
Onobrychis viciifolia	31	3	11	10	7
Ononis spinosa	24	5	7	6	6
Papaver rhoeas	39	6	14	12	7
Plantago lanceolata	28	7	14	5	2
Plantago media	19	6	4	6	3
Prunus spinosa	16	5	4	4	3
Raphanus raphanistrum	26	3	10	7	6
Reseda luteola	26	4	5	10	7
Rubus ulmifolius	38	10	13	12	3
Salix fragilis	15	6	3	6	
Scrophularia canina	26	4	8	7	7
Sedum acre	30	11	9	6	4
Sinapis arvensis	24	1	7	12	4
Teucrium scorodonia	21	7	5	3	6
Trifolium repens	35	9	8	12	6

In table 3 we show the predominant, secondary, and important minor pollen types of the different honey samples studied. Out of the 126 pollen types recorded, 53 have percentages in some samples of > 3%. The other 73 pollen types do not have percentages of > 3% in any of the 49 samples.

White heath appears in 7 samples as predominant. *Centaurea cyanus* and *Reseda luteola* in 4 samples respectively, *Onobrychis viciifolia* appears in 3 samples as dominat. *Rubus ulmifolius* in 2 samples with percentages > 45%.

Tab. 3. Pollen spectrum of Palencia honeys. P = predominant pollen type (>45%) S = secondary pollen type (45–16%) I = important minor pollen (16–3%)

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	39	40	41	42	43	44	45	46	47	48	49
Allium sphaerocephalum						I																																											
Anarrhinum bellidifolium					I																																												
Calluna vulgaris													I		I		S		I																														
Capsella bursa-pastoris											I																				I				I								I						
Centaurea calcitrapa						S	I	I		I																							I																
Centaurea cyanus			P				I				S	S	S	I	I		I	P	S		I	I	P	P	I		I	I			S		I		I					I									
Chenopodium album																																								I									
Cistus laurifolius																		S								I																							I
Cistus psilosepalus																		I																															
Corrigiola littoralis															I																																		
Crataegus monogyna	I				I	I	I	I																			I				I			I								I							
Cytinus hypocistis	I																																																
Cytisus scoparius	P	I		S	S	S	I	S	I	I	I			I													I			I																		I	
Echium vulgare																										S		I	S	S					I					I					I				
Erica arborea			I	I			I	I	S	P	S	I	S	S	S	P	P	I		P	P	P	I	S	P	I																							
Erica australis		I		I				I													I																												
Erica cinerea			I																								I																						
Erica umbellata		I		I																																													
Eryngium campestre							I																																	I									
Festuca arundinacea																																															I		
Filipendula vulgaris		I								I				S													I																						
Hedera helix																																																P	
Helianthemum salicifolium			I								I		I													I	I		I													I	I		I				I
Helianthemum syriacum							I											S																															
Helianthus annuus																			I							I							I		I	I	I					I	I		I		I	I	I
Hypecoum procumbens																																S						I						I					
Jasione montana		I						I																							I																		

Tab. 3. – continued

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	39	40	41	42	43	44	45	46	47	48	49
Lavandula latifolia																																											I						
Lotus corniculatus									S	I		I											I			S	I				I	S				S			I										
Lotus creticus				S																			I																			S	S						I
Melilotus officinalis																							I																										
Mentha aquatica	I		I			I	I			I				I																																			
Onobrychis viciifolia			S								I	I	I									I				I	I	S	I	S				P	S	P	P	I	S		S			I	I	I	I		S
Ononis spinosa						I																				I	I	I											I				I			I	I		
Papaver rhoeas			I								I				I							I		S	I					I		S									I	I	I	I	I		S		S
Plantago lanceolata																			I																														
Plantago media																		I															I						I									I	
Quercus rotundifolia																																													I				
Raphanus raphanistrum													I		S												I	I																	I				
Reseda luteola																											I					I	I					P	I			I	S	P	S	P	P		S
Rubus ulmifolius	I						I												P											S	S		S	I		I	I		I	P		I							
Rumex conglomeratus																		I																															
Salix fragilis																																		I															
Salix triandra																I																		I															
Scrophularia canina															S	I											I	I	S				I							I								I	
Sedum acre		S		I	I	I		I	I			I									I	I					I		I																		I		I
Sinapis arvensis																											I								I							I							
Stachys romana																																										I							
Teucrium scorodonia	I																																											I					
Trifolium pratense																			I																														
Trifolium repens					S			S	S		I	I							I							I	I		I	I				I	I	I	I	I	I		S	I							
Vicia sativa																												I																					
Zea mays																																								I									
	Zone I											Zone II																	Zone III													Zone IV							

The pollen types *Onobrychis viciifolia*, *Centaurea cyanus*, *Erica arborea* and *Trifolium repens* are present in the greatest number of samples with the highest representation percentages.

There are hardly any pollen differences between the honeys in Zone I and II. The pollen types that appear as dominant or abundant in Zone I are *Cytisus scoparius*, *Erica arborea* and *Trifolium repens*. *Helianthus annuus* pollen is not present. In Zone II *Erica arborea* and *Centaurea cyanus* are the most important pollen types in the samples. In this zone, *Cytisus scoparius* and *Mentha aquatica* has a lower percentage in comparison with honeys in Zone I. Honeys in Zones III and IV can be clearly distinguished from those above by the absence of *Ericaceae* pollen. The samples from Tierra de Campos present very low percentages of *Lamiaceae*, < 2%. *Rosaceae* pollen types, especially *Rubus ulmifolius* type, are more abundant in this zone than in other three.

The honeys in Zone IV stand out for having *Reseda luteola*. The samples here do not present *Centaurea cyanus*, and in all the samples *Lamiaceae* pollen appears between 3 and 10%. *Lavandula latifolia* is only present in the honeys from this zone. *Mentha aquatica* is present in 36 samples although it has low percentages in each sample, only 12% of the samples having > 3%. However, the nectar of the *Lamiaceae* family significantly improves the taste and aroma of honey for commercial use.

The *Cistaceae* family is highly represented in the samples analysed, providing important pollen quantities. *Papaver rhoeas* is a type that supplies pollen to most honeys. Its high level of frequency in honeys is the consequence of the proportion of the land area used for farming. We are dealing with an agrophilous and ruderal species.

All the pollen grains of the *Poaceae* family observed are included in the *Festuca arundinacea* pollen type, which is often found in the honeys though it has a very low percentage in each sample. This pollen type has no melissopalynological interest.

Discussion

Multifloral honeys are abundant in the 4 zones of province, the abundance of these honey types is the result of there being only one annual extraction, a mixture of nectar from different vegetable species occurring. Monofloral heath honeys only appear in Zone I and II. This is due to the siliceous nature of the substrata, which is in contrast to the other two zones. White heath was the most abundant type in all the samples classified as monofloral heath. *Erica arborea* honeys are produced in France, Italy, the former Yugoslavia and Tunisia (RICCIARDELLI D'ÁLBORE and VORWHOL 1979); however, they contain *Lavandula*, *Olea* and *Fagopyrum* pollen types, unlike Palencia heather honeys.

Monofloral *Centaurea* honeys were found in the Montaña and Páramo detrítico zones, these kinds of honeys have not been described in Spain before.

Monofloral *Reseda* honeys are typical in Cerrato. In Spain monofloral *Reseda* honeys were recorded in La Palma island, Canary Isles (LA-SERNA et al. 1999), where *Castanea sativa* is present as secondary pollen type; this never appears in the Palencia samples. *Foeniculum vulgare* does not appear in honeys of this kind. However, it is present isolatedly in Canary Isles' samples.

In Tierra de Campos sainfoin honeys are often present. In this zone, extensive sainfoin crops are very typical, the *Onobrychis viciifolia* pollen type appearing as predominant in 3 samples; this kind of honey has also been described in Huesca province (PÉREZ DE ZABALZA and RICCIARDELLI D'ALBORE 1990).

The *Fabaceae* family was the most abundant in the honeys studied as regards the number of pollen types recorded.

The monofloral honeys of *Rubus* have *Centaurea cyanus* as secondary pollen type; *Trifolium repens* and *Echium vulgare* appear as minor pollen. These kind of honeys are frequent in inland Galicia, which usually have *Castanea sativa* as secondary pollen type (SEIJO and JATO 1998).

One sample is described as monofloral *Hedera*. This sample stands out for it low pollen diversity, only ten pollen types, and also for the high representation of *Hedera helix*. *Hedera helix* flowers in winter, and the honey produced with this nectar is used for nourishing bees during this time, instead of being collected by beekeepers.

The monofloral honey of *Cytisus* presents as important minor pollen types the secondary pollens: *Crataegus monogyna*, *Mentha aquatica*, *Rubus ulmifolius* and *Teucrium scorodonia*; honeys of this pollen type have also been described in Galicia (SEIJO et al. 1997).

We cannot establish a relation between the kind of honey and its pollen richness. Therefore, we can find a very variable grain density for the same kind of honey. Honeys harvested by decanting had a higher pollen density than those obtained by centrifugation. We could not compare the average density value due to the lack of symmetry and great dispersion.

We found a major diversity of pollen types in the samples from Zone I and III. In the first, a greater variability of substrata and vegetation appear. In Zone III, pollen types from wild species are combined with those from cultivated species. The diversity of pollen types was similar in samples harvested by decanting and centrifugation. LUTIER and VAISSIÈRE (1993) recorded similar diversity values in samples which were filtered or not in the procedure for pollen analysis.

Since the honeydew index is very low or zero in all the samples, the honeys have a floral origin.

In the honeys in Zone III, the present of sainfoin is relevant, which makes a contrast with the abundance of sunflower pollen in the same geomorphological unit in León province (VALENCIA-BARRERA et al. 2000).

Honeys in Palencia do not contain some pollen types, such as *Eucaliptus* and *Castanea*, which are very highly represented in honeys in Cáceres (GÓMEZ FERRERAS and SÁENZ 1980), Pontevedra (SÁNCHEZ and SÁENZ 1982), Asturias (LUIS et al. 1990) and Galicia (SEIJO and JATO 1998), where these genera are cultivated and are of great interest in the foraging behaviour of the bees. The *Boraginaceae* family does not have the importance described in other honeys in the plateau, such as those from La Alcarria (BERMÚDEZ-CAÑETE 1978), Salamanca (SÁNCHEZ SÁNCHEZ 1982), Zamora (GÓMEZ FERRERAS 1989) or Extremadura (MONTERO and TORMO 1990), despite the fact that their pollen grains are highly represented.

Some pollen types can be used as indicators in order to determine the zone of origin of a certain kind of honey. We can use the presence of *Ericaceae* in the first two zones in contrast with its absence in Zone III and IV. In Zone IV appears *Lavandula latifolia*, which is absent in other zones. This pollen type is mentioned as being infrequent is Spanish honeys (LOUVEAUX and VERGERON 1964). These indicators can help in the discovery of any commercial frauds.

Acknowledgements

We thank Ms. C. Fraile for her kind English translation of the manuscript.

References

ARROYO, J., DEVESA ALCARAZ, J. A., HERRERA MALIANI, J., ORTIZ BALLESTEROS, P., TALAVERA LOZANO, S., 1986: Resumen del proyecto de investigación: La flora melitófila en Andalucia Occidental. Vida Apíc. 18, 33–39.

ARROYO, J., HERRERA, J., 1988: Producción y arquitectura floral en *Ericaceae* de Andalucia Occidental. Lagascalia 15 (extra), 613–622.

BERMÚDEZ-CAÑETE, C., 1978: Estudio del sedimento polínico en miel de la Alcarria. Bol. Estac. Central Ecol. 14, 39–51.

BURGAZ-MORENO, M. E., MATEU, I., GÓMEZ-FERRERAS, C., 1994: Estudios palinológicos de mieles de Valencia (España). In: LA-SERNA, I. (ed.), Polen y esporas: contribución a su conocimiento. pp. 241–252. Universidad de La Laguna, Tenerife.

CEÑAL, M. A., GLARIA, G., BLANCO, A., BERMEJO, M. A., 1988: Análisis del medio físico. Delimitación de unidades y estructura territorial de Palencia. Junta de Castilla y León, Valladolid.

ESPADA, T., 1984: Contribución al conocimiento de las mieles de producción nacional: espectro polínico de la miel de brezo de Cataluña. Vida Apíc. 11, 17–20:

FELLER-DEMASLY, M. J., PARENT, J., 1989: Analyse pollinique des miels de l'Ontario, Canada. Apidologie 20, 127–138.

FREE, J. B., 1963: The flower constancy of honey bees. J. Anim. Ecol. 2, 119–131.

GÓMEZ FERRERAS, C., 1989: Contribución al análisis polínico de mieles de la provincia de Zamora (España). Bot. Complut. 14, 157–165.

GÓMEZ FERRERAS, C. & SÁENZ, C., 1980: Análisis polínico de mieles de Cáceres (España). An. Jard. Bot. Madrid 36, 191–201.

HERRERO, B., 1990: La apicultura en Castilla y León. Boletín Agropecuario 18, 26–28.

LA-SERNA, I., MÉNDEZ, B., GÓMEZ-FERRERAS, C., 1999: Aplicación de nuevas tecnologías en mieles canarias para su tipificación y control de calidad. Caja General de Ahorros de Canarias, Tenerife.

LOUVEAUX, J., 1958: Recherches sur la récolte du pollen par les abeilles *(Apis mellifica* L.). M. Sc.thesis, University of Paris.

LOUVEAUX, J., VERGERON, Ph., 1964: Étude du spectre pollinique de quelques miels espagnols. Ann. Abeille 7, 329–347.

LOUVEAUX, J., MAURIZIO, A., VORWHOL, G., 1978: Methods of melissopalynology. Bee World 59, 139–157.

LOW, N. H., SCHWEEGER, C., SPORNS, P., 1989: Precautions in the use of melissopalynology. J. Apicult. Res. 28, 50–54.

LUIS VILLOTA, P., VORWHOL, G., GÓMEZ FERRERAS, C., 1990: Estudio polínico de las mieles asturianas. Vida Apícola 43, 38–45.

LUTIER, P. H., VAISSIÈRE, B. E., 1993: An improved method for pollen analysis of honeys. Rev. Palaeobot. Palynol. 78, 129–144.

MAURIZIO, A., 1939: Untersuchungen zur quantitativen Pollenanalyse des Honigs. Mitt. Geb. Lebensm. Hyg. 30, 27–69.

MONTERO, I., TORMO, R., 1990: Análisis polínico de mieles de cuatro zonas montañosas de Extremadura. An. Asoc. Palinol. Leng. Esp. 5, 71–78.

ORTIZ VALBUENA, A., FERNÁNDEZ, M. C., SUBRÁS, E., 1996: Principales características de la miel de La Alcarria. Junta de Comunidades de Castilla-La Mancha, Toledo.

PÉREZ DE ZABALZA, A., RICCIARDELLI D'ALBORE, G., 1990: Pollen spectrum of the honeys of Huesca, Spain. Apicoltura 6, 131–152.

RICCIARDELLI D'ALBORE, G., 1998: Mediterranean melisopalynology. Institute of Agricultural Entomology, University of Perugia.

RICCIARDELLI D'ALBORE, G., VORWHOL, G., 1979: Tipo de miel monofloral de la región del Mediterráneo, verificadas mediante análisis microscópicos de la miel. Actas de XXVII Congreso Internacional de Apicultura (Apimondia), Atenas, 201–208.

SÁNCHEZ SÁNCHEZ, J., 1982: Análisis polínico de mieles de la provincia de Salamanca. Universidad de Salamanca, Salamanca.

SÁNCHEZ, C., SÁENZ, C., 1982: Análisis polínico de mieles de Pontevedra (España). Lazaroa 4, 253–268.

SEIJO, M. C., JATO, M. V., 1998: Palynological characterization of honeys from Galicia (Northwest Spain). Grana 37, 285–292.

SEIJO, M. C., JATO, M. V., AIRA, M. J., IGLESIAS, I., 1997: Unifloral honeys of Galicia (north-west Spain). J. Apic. Res. 36, 133–139.

TUTIN, T. G., HEYWOOD, V. H., BURGES, N. A., MOORE, D. M., VALENTINE, D. H., WALTERS, S. M., WEBS, D. A., eds., 1964–1993. Flora Europaea. Vols. 1–5, Cambridge University Press.

VALDÉS, B., DÍEZ, M. J., FERNÁNDEZ, I., 1987: Atlas polínico de Andalucia Occidental. Instituto de Desarrollo Regional, Universidad de Sevilla-Diputación de Cádiz, Sevilla.

VALENCIA-BARRERA, R. M., FOMBELLA-BLANCO, M. A., FERNÁNDEZ GONZÁLEZ, D., DÍAZ GONZÁLEZ, T. E., 1994: Les spectres polliniques des miels de différentes régions phytogéographiques de la Province de León (N. O. de l'Espagne). Grana 33, 268–275.

VALENCIA-BARRERA, R. M., HERRERO, B., MOLNÁR, T., 2000: Pollen and organoleptic analysis of honeys in León province. Grana 39, 133–140.