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The pollen spectra of honeys from different Northeastern Regions of Algeria

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Abstract

A melissopalynological analysis was conducted on 50 samples of honey collected during different seasons in four different phytogeography regions in extreme of North-East Algeria. 64 botanical families were identified in samples inventoried the studied honeys that are contained 203 pollen types. 15 samples belong to Class V, which explains their high pollen, 5 samples of Class IV, and 15 samples correspond to Class III, Class II have 12 samples, and finally 3 samples are in Class I. pollen spectrum varies significantly between honeys coastal region compared to the honeys of the internal region including an average of 17.38 pollen types per sample. 17 mono-flower honeys were typified, *Eucalyptus* sp pollen grains were found with an important number in seven samples, five honeys were dominated with *Eucalyptus camaldulensis* L. pollen grain, The *Hedysarum* type dominate two honeys, and both of three honeys were dominate respectively with *Myrtus communis* L., *Echium plantagineum* L. and *Melilotus officinalis* L. The majority of honeys are polyfloral characterized by the absence of dominant pollen. Finally, qualitative pollen analysis has established a list of regularly visited plants by bees.

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Introduction

In 2005, Algeria has 21,259 beekeepers with a total of 748 000 modern hives and 102,000 traditional hives. Beekeeping is practiced mostly in the north of the country where the bee flora is distributed over a wide area, ranging from coastal to the arid regions provides several successive honeys throughout the season. Wide variety of honeys was existed in particular the Northeast Region of Algeria. This vocation is due to its plant diversity and its rich habitats (Natural forests, plantations, crops) favor the development of beekeeping. Unfortunately, this potential for honey production is not sufficiently exploited (Aouadi, 1989). Honey production is the work of industrious bees foraging on many species honey Northeast Algerian while playing a big role in the cross-fertilization, the ecological interest of the bee is well established. The majority of honeys harvested by beekeepers in the region are mostly polyfloral honey, the flower honeys, originating from a particular plant species are rare, the type of bee used in Algeria (*Apis mellifera intermissa*). Honey that is among the most ancient food of mankind causes at present a renewed interest due to the orientation of part of consumers to exclusively natural products. Honey is a biological product of very complex composition for consumers, and it is characterized by color, consistency and spoon on the tongue taste, and perfume. Finally, according to the floral origin, geographic origin honey enjoys appellation that value and must be justified. The first reports about beekeeping in Algeria held from 1903 (Hussein, 2001) and from the main work on the botanical origin of honey Algerian research we note (Louveaux *et al.*, 1984) who carried pollen analyzes of 28 samples Eucalyptus honey.

The pollen analysis of honeys harvested in various parts of East Algerian, from honeybee (*Apis mellifera L.*), promises to be full of interest when considering the geographical location, climate, agriculture and 'country of forestry and giving accurate information on major honey plants and allows the characterization of honeys by their botanical or geographical origin. It provides important information on the foraging behavior of bees. Furthermore, the pollen content of honey can control their quality, increasing their economic value (Tellería, 1988).

The present work is to analyze 50 samples from Northeast of Algeria, and is to enhance the bee flora of some parts of Northeast Algerian and knowledge of botanical origin through quantitative and qualitative pollen analysis and estimating the diversity of pollen composition by determining the types of pollen dominant and their frequencies.

Material and method

Sampling

We analyzed 50 samples of honey Algerians collected or acquired during the period of the years (2000, 2001, 2002, 2003.2004 and 2005) for all sampling areas in the far north-east Algerian spread of a heterogeneously over 4 Wilayas (Annaba, El Tarf, Guelma and Souk Ahras). These honeys were collected either by extraction or manually. Each honey sample consisting of a 20g pot was used for pollen analysis (Made in palynological laboratory, Faculty of Sciences, University Badji Mokhtar Annaba Algeria). Floristic surveys were conducted in the outskirts of hives. The geographic location of the samples is carried on a different map (Fig. 1).

Method of melissopalynology analysis

Palynology determination requires lot of information and knowledge concerning the fundamental and specific characters of pollen grains: morphology, aperture type, ornamentation, and measure dimensions and color of the pollen. A working group or in collaboration with teams (Laboratories) specialized in the field of palynology, a thorough knowledge of the life of bees. In our study, the successful identification of different types of pollen in honey is the result of several factors realization of a collection of references blades which is the essential element to any palynology work, identification honey plants have been guided by the many consultation works on bee flora in particular (Maurizio and Louveaux, 1965; Ricciardelli D'Albore, 1979; Ricciardelli D'Albore and Persano Oddo, 1978).

Making the preparations for quantitative and qualitative analysis

We used the direct method proposed by Louveaux (1970) and also were performed according melissopalynological analysis, the method described by Louveaux *et al.* (1978) and Von Der Ohe *et al.* (2004).

The pollen grains present in honey are counted using a light microscope "Zeiss" until complete exhaustion of all fields. The preparations were fully explored at different magnifications (×100, ×400) until it is no longer new pollen documented Layka (1989). The study of each sample relates to the formed elements plants present in a given quantity of honey (Batttesti, 1990).

Quantitative analysis (Extraction of figurative elements in honey)

Measures the richness of each sample pollen grains, to have an idea on the extraction method, the type of hive and the skills of the beekeeper, the pollen grains in wealth is expressed according to the classification proposed by Maurizio (1939) which has five classes depending on the quantity of pollen grains in ten grams of honey (Class I <20 000 pollen grains; Class II = 20 000-100 000; Class III = 100 000-500 000; Class IV = 500 000-1000 000; Class V> 1000 000) samples were classified into one of five groups.

Qualitative analysis

It aims to define the pollen content by establishing an inventory of taxa and determining their respective proportions, the results are expressed as relative percentages to the total number of counted pollen grains in each sample (Vergeron, 1964). The results were expressed in percentages and divided into the following frequency classes (D: dominant pollen, being equal to or greater than 45% of the pollen spectrum, A: accompanying pollen, representing between (15% and 45%) of the pollen spectrum, I: important pollen, attaining between (3% and 15%) of the pollen spectrum, R: minor pollen, representing between (1% and 3%), P: present pollen, always lower than (1%). The count is based on the calculation of the frequency distribution of relative taxa to all samples and the pollen spectra established by the relative frequencies of pollen taxa encountered with respect to the total pollen grains counted in each sample of the honey. The distribution of a taxa frequency defined by the presence or absence of taxa in all samples studied honey. The frequency distribution or frequency of occurrence of different taxa is calculated according to the number of samples of honey in which they are found, according to Feller-Demasly *et al* (1987) and Feller-Demasly et Parent (1989) in very frequent taxa (>50%), common taxa (20-50%), infrequent taxa (10-20%), rare taxa (<10 %).

Factors considered in the sample

Geographical location

Samples are harvested in different areas ranging from the coast to house, taking into account the different components of the environment (Relief, weather conditions, vegetation) and give more information on the distribution of samples according to the climate and flora (Fig. 1).

Apiarian conduct

The nature of honey and its characterization depend on the place of harvest (Vegetation and climate), the adaptation of these colonies to environmental conditions, and also to conduct beekeeping. These parameters are interdependent since the beekeeper chooses the locations involved in the stimulation of colony development cycle, by transhumance and the time of harvesting honey developed (Battesti,1990).

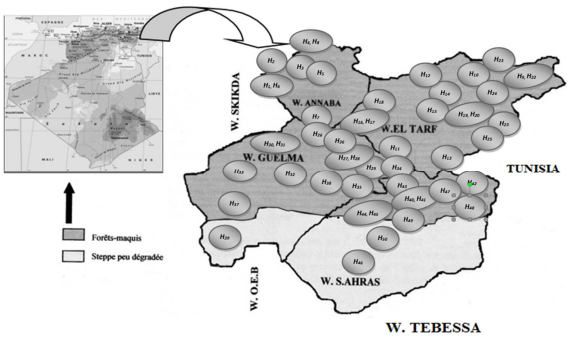

Fig. 1. Map of the big floristic formations and the cloud of the points of sampling localization of honeys by Willaya.

Results and discussion

Quantitative analysis

Represented by the number of pollen grains in honey 10g shows that pollen counts among samples from the coastal areas varies from 1,400 grains/g in the sample (H_{18}) of the region of El Tarf and 116,424,000 grains/g in the sample (H_6) in the region of Annaba an average content of pollen 10,267,237.36 grains/g in the inner regions of a number includes 4,200 grains/g in the sample (H_{50}) the Souk Ahras region

and 5.41 million grains/g in the sample (H_{29}) of the Guelma region with an average content of pollen 627,005.2 grains/g. The results of pollen analysis of various honey samples collected, we notice at first, a significant variation in the richness of pollen each, Furthermore, there is existing variations in the number of pollen to samples that come from the same place: the case of two samples of localities (H_{27}) (H_{28}) and samples (H_{44}) (H_{45}).

The climate is a very important element that determines the nectar secretion and pollinferous generation (Prost, 1987). It has been shown that the succession of several days of good weather and wet weather during flowering promotes the production of pollen grains (Signorini, 1979); (Louveaux, 1980). The samples (H_{18}, H_{28} and H_{50}) indicate that the beekeeper has using artificial feeding (sugar) or the bees have visiting only the nectafirous plant in foraging.

According to the classification of (Maurizio,1939) there are, among the studied samples of honey (3 of 50) very poor pollen samples belonging to the class I, (12 of 50) Class II samples of honey from of nectar species, (15 of 50) samples of class III, (5 of 50) samples of the class IV, (15 of 50) samples of class V are honeys really very rich in pollen three samples of honey the Souk Ahras region and Guelma and twelve samples from the coastal regions of both of El Tarf and Annaba, beekeepers have not filtered honey before packaging. The distribution of samples to the classes Maurizio (1939) reflects their richness in pollen. There are important differences between honeys coastal areas and internal area for samples of coastal areas, the twenty-five samples of honeys show that (24%) of all pollen grains are counted in the class V, (16%) in class III, and (8%) in class II, finally (2%) in class I. what we allow to see that (12 of 25) samples have considerable pollen content so remarkable importance, while samples from internal regions, three samples belong to class V (6%), five samples to class IV (10%), seven samples in class III with (14%) and eight samples as class II (16%), and finally (4%) in class I with only two samples (Table 1). The richness in natural pollen honey harvested only frames the rise and filtered depends on their botanical origin.

Table 1. Distribution of honeys in Maurizio's classes (1939).

	Maurizio's classes (1939)				
Sector	Classe I (≤20.000 pollen g^{-1})	Classe II (20.000-100.000 pollen g^{-1})	Classe III (100.000-500.000 pollen g^{-1})	Classe IV (500.000-1.000.000 pollen g^{-1})	Classe V (≥1.000.000 pollen g^{-1})
Annaba			H_1		H_2, H_3, H_4, H_5, H_6 H_7, H_8
El-Tarf	H_{18}	H_{16}, H_{17}, H_{19}, H_{24}	H_{10}, H_{11}, H_{15}, H_{20}, H_{22} H_{25}, H_{38}		H_9, H_{12}, H_{13}, H_{14}, H_{21}
Guelma	H_{28}	H_{26}, H_{35}, H_{38}	H_{42}, H_{43}, H_{45}, H_{46}, H_{49}	H_{30}, H_{31}, H_{34}	H_{27}, H_{29}
Souk-Ahras	H_{18}	H_{42}, H_{43}, H_{45}, H_{46}, H_{49}	H_{46}, H_{49}	H_{44}, H_{47}	H_{48}
Total number samples	3	12	15	5	15

Qualitative analysis

We could identify in our 203 pollen types were identified belonging to 64 botanical families surveyed in our study samples of honey (board 1). The total number of taxa identified in each sample is variable. We have on one hand the systematic determination level reaches 104 species, 94 genera and 5 families in taxa that was specified. We counted on the other hand, between 4 and 46 types of pollens in honey sample an average of 17.38 kinds/sample (Figs 2,3,4 and 5), show the relationship between the number of morphological types, the botanical families and the number of samples in which they appear.

Total pollen types identified in each sample varies depending on the sampling season, method of extraction and the geographical area of floral origin. In honeys of Annaba, the number of pollen per sample type between (9 and 28) respectively in the sample (H_1, H_5 and (H_6), most samples are between (10 and 17) different pollen spectra, the average being 17 pollen types, in all of these samples, 91 pollen types were identified belonging to 36 botanical families observed in samples of Annaba honey. Samples of honeys El Tarf pollen types are between 4 to the sample (H_{22}) and 36 in (H_{25}), with an average of 15.50 pollen spectra, 97 pollen types were identified in samples belonging to 42 botanical families.

However, samples of Souk Ahras honeys have the highest average pollen type (19.82), ranging from 12 in the sample (H_{22}) and 44 in the sample (H_{25}) pollen types, 113 pollen forms are identified are distributed in 47 families. In honeys from the Guelma region, with a total of 45 botanical families include 103 different pollen types were identified, with an average of 17.86 pollen types, therefore the sample (H_{27}) containing a higher relative value all 50 samples with 46 pollen types and the low value in terms of pollen spectra sample for the sample (H_{37}) 6 pollen types.

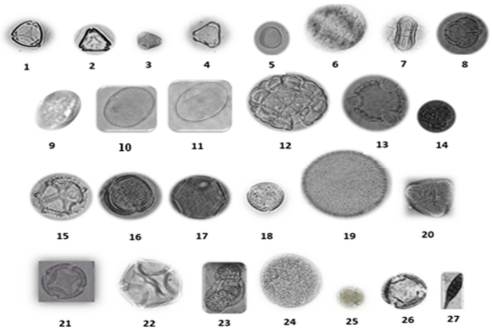

Plate 1. of some pollen types contained in the honey samples analyzed (x1000).

1- Eucalyptus camaldulensis, 2- Eucalyptus globulus, 3- Myrtus communis, 4- Loranthus europaeus, 5- *Echium* sp., 6- Echium plantagineum,7- Daucus carota, 8- Erica arborea, 9- Acacia seyal, 10- Hedysarum coronarium, 11- Melilotus officinalis, 12- Vicia sp., 13- Galactites tomentosa L., 14- Taraxacum sp., 15- Urospermum dalechampii, 16- Brassica napus, 17- *Thymus* sp., 18- Papaver rhoeas, 19- Cucurbita pepo, 20- *Prunus* sp. 21- Citrus sp., 22- Alnus glutinosa, 23- *Pinus* sp., 24- Zea mays, 25- Fraxinus sp., 26- Olea europaea, 27- *Alternaria* sp.

Von Der Ohe *et al* (2004) reported that honey is considered unifloral if the relative frequency of pollen from this taxon is greater than 45%. According to the authors, there are variations in the types of pollen that may be under- or over-represented in terms of the species, pollen spectrums found in our study of honeys Northeast Algeria are different from those reported in some work done on the honeys of the plains and mountains of northern Algeria.

They are characterized by pollen spectra dominated by pollen kinds of *Citrus*, *Eucalyptus*, *Hedysarum*, *Rubus* et *Rosmarinus* (Ouchemoukh *et al.,* 2007; Nair *et al.,* 2013).

The Fabaceae family contains 29 botanical taxa growing in all bioclimatic zones and study areas. This family typically includes cultivated and wild plants, followed by Asteraceae with a number of 25 taxa, the third position is occupied by the Apiaceae with 11 taxa, Lamiaceae with 10 taxa, Boraginaceae and Rosaceae represented by 9 taxa, *Brassicaceae* grouping 7 taxa, Scrofulariaceae with 6 taxa, Liliaceae by 5 taxa, families Ericaceae, the Fagaceae and Myrtaceae with 4 taxa and represented by 3 taxa including Cistaceae, the Cucurbitaceae, Euphorbiaceae; the *Iridaceae*, the Papaveraceae, the Primulaceae, 15 families are represented by two taxa and 31 botanical families each with a single taxa.

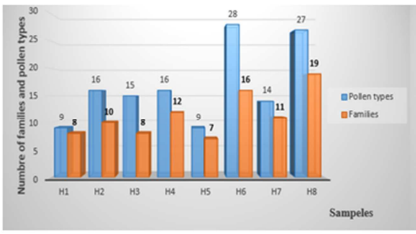

Fig. 2. The number of species and families of each honey sample the region Annaba

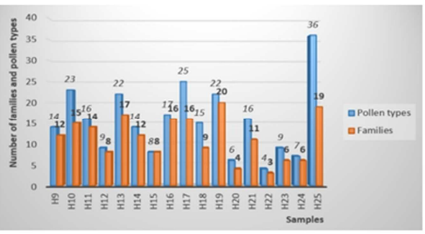

Fig. 3. The number of species and families of each honey sample the region El Tarf

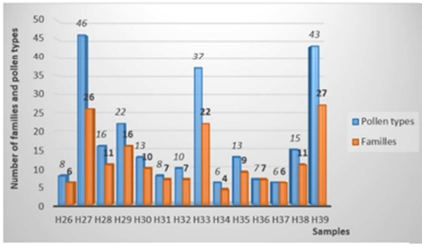

Fig. 4. The number of species and families of each honey sample the region Guelma

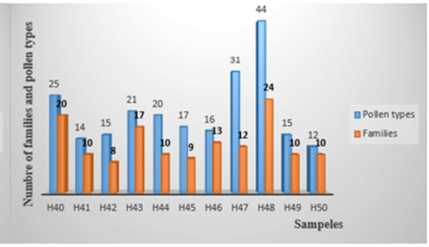

Fig. 5. The number of species and families of each honey sample the region Souk Ahras

For a typology of honey based on the distribution of taxa in each spectrum, it is necessary initially to conduct taxon analysis ore by ore of the frequency distribution for (Table 2). Each one of 50 samples can isolate taxa with frequencies are highest, and thus consolidate the spectra where they stand, the classification of taxa based on the maximum damage frequency is given in (Table 2) the botanical characterization or floral label of honey is based on the study of pollen content from its total gross encrypted spectrum and distribution analysis of each taxon, it provides a classification of honeys.

Table 2. Frequency class of the pollen types and number of taxon and their distribution relative frequency the honeys samples.

Families	Pollen types	D	A	I	R	P	Nbr	NP	Max	(%)	Frequency of distribution Classes			
											r (>10)	p (10-20)	f (20-50)	d (<50)
Anacardiaceae	*Pistacia lentiscus*	-	-	1	-	1	2	48	3.57	4	*			
	Schinus molle	-	-	-	-	2	2	48	0.80	4	*			
Apiaceae	*Anethum* sp.	-	-	1	1	2	4	46	5.09	8	*			
	Ammi vulgaris	-	-	-	-	1	1	49	0.70	2	*			
	Apium nodiflorum.	-	1	3	1	2	*7*	43	26.35	*14*		*		
	Cachrys sp.	-	-	-	1	2	*3*	47	2.35	6	*			
	Daucus carota	-	4	7	6	4	*21*	29	25.21	*42*			*	
	Eryngium sp.	-	-	1	-	-	1	49	9.55	2	*			
	Ferula communis	-	-	-	1	2	3	47	1.16	6	*			
	Foeniculum vulgare	-	-	-	1	1	2	48	1	4	*			
	Ligusticum sp.	-	-	-	1	-	1	49	1.55	2	*			
	Pimpinilla sp.	-	1	3	-	1	5	45	19.33	10		*		
	Seseli sp.	-	-	1	1	-	2	48	7	4	*			
Araliaceae	*Hedera helix*	-	-	-	2	1	3	47	4	6	*			
Asteraceae	*Aster sp*	-	-	-	2	2	4	46	1.55	8	*			
	Ambrosia sp.	-	-	-	1	-	1	49	1.50	2	*			
	Artemisia sp.	-	1	-	2	1	4	46	27.51	8	*			
	Carduus crispus	-	-	-	-	1	1	49	0.50	2	*			
	Centaurea sp	-	-	3	4	2	9	41	5.95	14		*		
	Crepis sp.	-	-	-	1	2	3	47	2.11	6	*			
	Cichorium intybus	-	-	1	4	4	9	41	5	18		*		
	Cirsium sp	-	-	1	-	2	3	47	3.03	6	*			
	Cotula sp.	-	-	-	-	1	1	49	0.25	2	*			
	Echinops spinosa	-	-	-	-	1	1	49	0.71	2	*			
	Helianthus annuus	-	-	-	1	-	1	49	2.33	2	*			
	Helichrysum sp.	-	-	-	-	2	2	48	0.10	4	*			
	Hypochoeris sp.	-	-	-	-	2	2	48	0.38	4	*			
	Galactites tomentosa	-	-	2	5	4	11	39	10.51	22			*	
	Inula viscosa	-	-	1	-	1	2	48	5.33	4	*			
	Launæa sp	-	-	-	-	1	1	49	0.30	2	*			
	Leontodon sp	-	-	-	-	2	2	48	0.24	4	*			
	Pallenis sp.	-	-	-	-	1	1	49	0.14	2	*			
	Scolymus hispanicus	-	-	-	-	1	1	49	0.3	2	*			
	Senecio sp	-	-	-	4	1	5	45	1.89	10		*		
	Silybum marianum	-	-	-	2	-	2	48	2	4	*			
	Tanacetum annuum	-	-	-	-	1	1	49	0.5	2	*			
	Taraxacum sp.	-	-	1	1	3	5	45	10.20	10		*		
	Tolpis barbata	-	-	-	-	2	2	48	0.84	4	*			
	Urospermum dalechampii	-	-	-	-	1	1	49	0.71	2	*			
Betulaceae	*Alnus glutinosa*	-	-	1	1	2	4	46	6.77	8	*			
	Type Betula	-	1	3	-	1	5	45	27.75	10		*		
Boraginaceae	*Anchusa sp.*	-	-	-	-	1	1	49	0.37	2	*			
	Borago officinalis	-	-	2	-	6	8	42	5	16		*		
	Cerinthe major	-	-	1	-	1	2	48	6.35	4	*			
	Cynoglossum sp.	-	-	-	-	1	1	49	0.66	2	*			
	Echium flavum.	-	-	-	-	1	1	49	0.50	2	*			
	Echium plantagineum.	1	-	-	-	-	1	49	71.42	2	*			
	Echium sp.	-	2	13	4	1	20	30	32	40			*	
	Echium vulgare	-	4	-	1	1	6	44	28.22	12		*		
	Pulmonaria officinalis	-	-	-	-	1	1	49	0.10	2	*			
Brassicaceae	*Biscutella didyma*	-	-	-	1	1	2	48	2.74	4	*			
	Brassica napus	-	1	7	5	3	16	34	30.66	32			*	

Families	Pollen types	D	A	I	R	P	Nbr	NP	Max	(%)	Frequency of distribution Classes			
											r (>10)	p (10-20)	f (20-50)	d (<50)
	Capsella bursa pastoris.	-	1	1	2	2	6	44	18.40	12		*		
	Diplotaxis sp	-	-	-	-	1	1	49	0.11	2	*			
	Malcolmia sp	-	-	1	-	-	1	49	4.73	2	*			
	Raphanus raphanistrum	-	-	1	-	-	1	49	4.30	2	*			
	Sinapis arvensis	-	-	5	1	1	7	43	10.67	14		*		
Cactaceae	*Opuntia ficus indica*	-	-	-	-	1	1	49	0.14	2	*			
Campanulaceae	*Campanula dichotoma*	-	-	3	2	7	12	38	12.62	24			*	
Caryophyllaceae	*Seline galica*	-	-	1	-	-	1	49	9.09	2	*			
Chenopodiaceae	*Chenopodium* sp	-	-	-	-	1	1	49	0.29	2	*			
Cistaceae	*Cistus* sp.	-	-	3	1	2	6	44	9.09	12		*		
	Halimium sp	-	-	1	-	-	1	49	3.03	2	*			
	Helianthemum sp.	-	-	-	-	1	1	49	0.21	2	*			
Convolvulaceae	*Convolvulus* sp.	-	1	3	1	5	10	40	16.33	20			*	
Cucurbitaceae	*Cucurbita melo*	-	-	-	1	1	2	48	2.30	4	*			
	Cucurbita pepo	-	-	2	5	2	9	41	5..76	18		*		
	Ecballium elaterium	-	-	-	-	1	1	49	0.37	2	*			
Cupressaceae	*Juniperus communis*	-	-	-	1	4	5	45	1.56	10		*		
	Cupressus sempervirens.	-	2	2	-	5	9	41	21	18		*		
Dispsacaceae	*Knautia* sp.	-	-	-	1	1	2	48	1.48	4	*			
	Scabiosa sp.	-	-	-	-	1	1	49	0.38	2	*			
Ephedraceae	*Ephedra* sp.	-	-	-	-	2	2	48	0.29	4	*			
Ericaceae	*Arbutus unedo*	-	-	-	1	-	1	49	1.58	2	*			
	Erica arborea	-	-	5	3	5	13	37	13.30	26			*	
	Erica cinerea	-	-	-	1	1	2	48	1	4	*			
	Erica multiflora	-	-	-	-	2	2	48	0.49	4	*			
Euphorbiaceae	*Chrozophora* sp.	-	-	-	-	1	1	49	0.05	2	*			
	Euphorbia regis	-	1	-	-	-	1	49	23.65	2	*			
	Euphorbia sp.	-	-	9	6	5	20	30	11.60	40			*	
Fabaceae	*Type papilionaceae*	-	-	-	2	-	2	48	1.20	4	*			
	Acacia cyanophylla	-	-	1	-	-	1	49	4.25	2	*			
	Acacia horrida	-	-	-	-	4	4	46	0.80	8	*			
	Acacia seyal.	-	-	-	-	1	1	49	0.30	2	*			
	Acacia sp.	-	-	3	1	1	5	45	4.23	10		*		
	Anthyllis sp.	-	-	1	1	-	2	48	3.10	4	*			
	Calycotome spinosa	-	1	1	-	-	2	48	18.90	4	*			
	Ceratonia siliqua	-	-	-	-	2	2	48	0.29	4	*			
	Cicer sp.	-	-	-	-	1	1	49	0.87	2	*			
	Cytisus sp.	-	-	-	1	1	2	48	1.10	4	*			
	Dorycnium sp.	-	-	1	5	1	7	43	4.29	14		*		
	Genista radiata	-	-	1	-	-	1	49	4.50	2	*			
	Hedystrum coronarium	-	-	-	1	-	1	49	2.20	2	*			
	Hedysarum sp.	2	7	10	5	1	25	25	78.88	50				*
	Hippocrepis sp.	-	-	-	-	1	1	49	0.51	2	*			
	Lathyrus sp.	-	1	9	2	2	14	36	25.50	28		*		
	Lotus corniculatus	-	1	-	-	-	1	49	26.80	2	*			
	Lotus creticus	-	-	1	-	-	1	49	10	2	*			
	Lotus sp.	-	-	2	1	-	3	47	10.48	6	*			
	Lupinus sp.	-	-	-	1	-	1	49	2.25	2	*			
	Medicago sp.	-	-	3	1	5	9	41	5.25	18		*		
	Melilotis officinalis	1	2	5	2	1	11	39	59.30	22			*	
	Onobrychis sp.	-	2	-	1	2	5	45	19.04	10		*		
	Ononis alopecuroïdes	-	-	-	-	1	1	49	0.35	2	*			
	Ononis sp.	-	-	5	1	4	10	40	9.09	20			*	
	Ononis spinosa.	-	-	1	-	-	1	49	11.33	2	*			
	Robinia pseudo-acacia	-	-	1	1	-	2	48	10	4	*			
	Trifolium repens	-	-	4	3	2	9	41	9.58	18		*		
	Vicia sp.	-	2	1	1	2	6	44	33.33	12		*		
Fagaceae	*Castanea vulgaris.*	-	-	-	-	4	4	46	0.60	8	*			
	Quercus ilex	-	-	1	1	3	5	45	6.36	10		*		
	Quercus sp.	-	1	2	1	5	9	41	23.80	18		*		
	Quercus suber	-	-	-	1	-	1	49	1.66	2	*			
Fumariaceae	*Fumaria* sp.	-	-	1	-	-	1	49	9.09	2	*			
Gentianaceae	*Centaurium umbellatum*	-	-	-	1	-	1	49	1.20	2	*			
	Gentiana sp.	-	-	-	-	1	1	49	0.24	2	*			

Families	Pollen types	D	A	I	R	P	Nbr	NP	Max	(%)	Frequency of distribution Classes			
											r (>10)	p (10-20)	f (20-50)	d (<50)
Geraniaceae	*Geranium* sp.	-	-	-	1	-	1	49	1	2	*			
Hypericaceae	*Hypericum* sp.	-	-	-	-	1	1	49	0.51	2	*			
Iridaceae	*Gladiolus segetum*	-	-	-	1	-	1	49	2.04	2	*			
	Iris sp.	-	-	1	-	2	3	47	4.29	6	*			
	Sisyrinchium sp.	-	-	1	1	1	3	47	8.60	6	*			
Lamiaceae	*Lamium* sp.	-	-	-	1	-	1	49	2.85	2	*			
	Lavandula stoechas	-	1	9	6	8	24	26	20	48			*	
	Lavandula vera	-	-	-	1	-	1	49	1.10	2	*			
	Mentha aquatica	-	-	1	-	-	1	49	8.73	2	*			
	Mentha pulegium	-	1	3	1	4	9	41	15.20	18		*		
	Rosmarinus officinalis	-	-	2	1	-	3	47	4.76	6	*			
	Satureia montana	-	-	1	-	2	3	47	3.20	6	*			
	Sideritis sp.	-	-	-	-	1	1	49	0.30	2	*			
	Stachys sp.	-	-	-	1	1	2	48	2.04	4	*			
	Thymus sp.	-	1	6	5	5	17	33	24	34			*	
Lemnaceae	*Lemna minor*	-	-	-	-	1	1	49	0.05	2	*			
Lentibulariaceae	*Type lentibulariaceae*	-	-	-	-	1	1	49	0.29	2	*			
Liliaceae	*Allium* sp.	-	-	2	3	4	9	41	8.46	18		*		
	Asphodelus sp.	-	-	1	2	1	4	46	3	8	*			
	Colchicum sp.	-	-	-	1	2	3	47	2	6	*			
	Ornithogallum sp.	-	-	-	-	1	1	49	0.64	2	*			
	Smilax aspera	-	-	-	-	2	2	48	0.29	4	*			
Linaceae	*Linum* sp.	-	-	-	-	4	4	46	0.37	8	*			
Loranthaceae	*Loranthus europaeus*	-	1	3	1	3	8	42	15.70	16		*		
Malvaceae	*Lavatera* sp.	-	-	1	1	1	3	47	4	6	*			
	Malva sylvestris	-	-	5	2	4	11	39	8	22			*	
Moraceae	*Ficus carica*	-	-	-	-	2	2	48	0.41	4	*			
	Morus sp.	-	1	-	-	4	5	45	20	10		*		
Myricaceae	*Myrica* sp.	-	-	-	1	-	1	49	2	2	*			
Myrtaceae	*Eucalyptus camaldulensis*	5	4	2	1	1	13	37	85.89	26			*	
	Eucalyptus globulus	-	1	3	-	-	4	46	32.18	8	*			
	Eucalyptus sp.	7	12	8	2	5	34	16	80.66	68				*
	Myrtus communis	1	2	13	4	3	23	27	84.28	46			*	
Onagraceae	*Epilobum roseum*	-	-	-	-	2	2	48	0.50	4	*			
Oleaceae	*Jasminum fruticans*	-	-	1	-	1	2	48	3.90	4	*			
	Olea europea	-	-	1	1	-	2	48	8.16	4	*			
Oxalidaceae	*Oxalis* sp.	-	-	2	3	4	9	41	5.33	18		*		
Papaveraceae	*Glaucium* sp.	-	-	1	1	-	2	48	4.76	4	*			
	Hypecoum sp.	-	-	1	-	3	4	46	10.60	8	*			
	Papaver rhoeas	-	1	2	1	10	14	36	44	28			*	
Pinaceae	*Pinus* sp.	-	-	-	1	-	1	49	1.58	2	*			
Plantaginaceae	*Plantago* sp.	-	-	1	-	4	5	45	3.36	10		*		
Plumbaginaceae	*Armeria* sp.	-	-	-	-	1	1	49	0.40	2	*			
Poaceae	*Poa* sp.	-	-	1	-	4	5	45	4.33	10		*		
	Zea mays	-	-	-	1	1	2	48	1.88	4	*			
Polygalaceae	*Polygala monspeliaca*	-	-	-	-	1	1	49	0.50	2	*			
Polygonaceae	*Polygonum* sp.	-	-	1	-	3	4	46	4.25	8	*			
	Rumex sp.	-	1	2	1	1	5	45	27.50	10		*		
Primulaceae	*Anagallis arvensis*	-	-	-	-	1	1	49	0.33	2	*			
	Androsace maxima	-	-	1	2	1	4	46	4.33	8	*			
	Primula farinosa	-	-	-	-	2	2	48	0.66	4	*			
Rafflesiaceae	*Cytinus hypocistis*	-	-	2	-	1	3	47	14.96	6	*			
Ranunculaceae	*Adonis* sp.	-	-	-	-	3	3	47	0.29	6	*	*		
	Ranunculus sp.	-	-	6	4	-	10	40	9.53	20			*	
Resedaceae	*Reseda alba*	-	-	-	-	1	1	49	1.50	2	*			
Rhamnaceae	*Rhamnus* sp.	-	-	-	1	-	1	49	2.26	2	*			
	Ziziphus lotus	-	-	-	1	-	1	49	1.16	2	*			
Rosaceae	*Crataegus azarolus*	-	1	3	2	1	7	43	17.40	14		*		
	Crataegus monogyna	-	-	1	1	-	2	48	4.08	4	*			
	Malus sp.	-	-	2	2	1	5	45	6.34	10		*		
	Potentilla sp.	-	-	-	1	2	3	47	1.25	6	*			
	Prunus amygdalus	-	-	1	-	1	2	48	4.66	4	*			
	Prunus sp.	-	-	4	-	2	6	44	13.20	12		*		
	Pyrus sp.	-	-	1	1	4	6	44	7.90	12		*		
	Rosa sp.	-	-	7	5	3	15	35	13.60	30			*	
	Rubus sp.	-	-	3	-	2	5	45	4.76	10		*		
Rubiaceae	*Rubia peregrina*	-	-	-	-	1	1	49	0.76	2	*			

Families	Pollen types	D	A	I	R	P	Nbr	NP	Max	(%)	Frequency of distribution Classes			
											r (>10)	p (10-20)	f (20-50)	d (<50)
Rutaceae	*Citrus* sp.	-	-	-	1	5	6	44	1.50	12		*		
	Ruta graveolens.	-	-	-	2	2	4	46	2.98	8	*			
Salicaceae	*Salix alba*	-	-	1	2	2	5	45	10.88	10		*		
Santalaceae	*Osyris* sp.	-	-	1	-	1	2	48	6.13	4	*			
Scrofulariaceae	*Bellardia trixago*	-	-	2	-	4	6	44	11.50	12		*		
	Euphrasia sp.	-	-	1	-	-	1	49	3.15	2	*			
	Linaria sp.	-	-	-	2	2	4	46	2.32	8	*			
	Pedicularis sp.	-	-	1	-	1	2	48	4.09	4	*			
	Scrofularia sp.	-	-	1	3	4	8	42	3.50	16		*		
	Verbascum sp.	-	-	-	1	1	2	48	2.04	4	*			
Solanaceae	*Solanum* sp.	-	-	1	2	2	5	45	4.73	10		*		
Thymeleaceae	*Daphne gnidium*	-	-	-	1	1	2	48	1.95	4	*			
	Thymelaea hirsuta	-	-	-	-	1	1	49	0.38	2	*			
Typhaceae	*Typha latifolia*	-	1	6	-	1	8	42	17.60	16		*		
Urticaceae	*Urtica urens*	-	-	4	1	2	7	43	10.18	14		*		
	Urtica dioica	-	1	-	-	-	1	49	21.92	2	*			
Valerianaceae	*Fedia* sp.	-	1	-	-	-	1	49	36.36	2	*			
Zygophyllaceae	*Zygophyllum* sp.	-	-	-	1	-	*1*	49	1.74	*2*	*			
Algae and Fungi	*Spores*	-	-	1	-	1	2	48	9.09	4	*			
Indeterminate type		-	1	15	4	9	29	21	22.32	58				*

D- dominant pollen (≥45%); A- accompanying pollen, (15%–45%); I- important pollen, (3%–15%); R- minor pollen, (1%–3%); P-present pollen, (<1%). NP- not present; Max.- maximum value (%) on pollen content; (%) Percentage of frequency of relative distribution, (d) Taxon very frequency, (f) Taxon frequency, (p) Taxon little frequency, (r) Taxon rare, (Nbr) Samples Number.

Unifloral honeys

17 samples of Unifloral honeys studied were typical (13 of 50) of Myrtaceae family, (3 of 50) of Fabaceae and Boraginaceae.

Eucalyptus honey

Seven honey samples (H_{15}, H_{20} H_{22}, H_9, H_{31}, H_{12} and H_{34}) of *Eucalyptus sp.* is between 45% and 80.66%.

Eucalyptus camaldulensis honey

Five samples (H_{37}, H_{40} H_{24}, H_{41} and H_{23}) with a clear dominance of *Eucalyptus camaldulensis*, with a percentage between 48.48% and 85.89%.

Hedysarum sp. honey

Two honey samples show pollen spectra with dominance of *Hedysarum* sp. this species reaches the sample (H_{41}) of very high (78.88%), probably due to the strong gender representation in the region. The *Hedysarum* is a species that is of great importance for the quality of its pollen as much as quantity, Biri (1986) added that it is also a very nectar species.

Echuim plantagenum honey

The sample (H_1) has a dominance of the species *Echuim plantagenum* (71.42%) is partly due to its high performance in the field and on the other hand to a bee affinity to this kind of pollen is small in size, accompanied by significant or tertiary isolated pollens are: *Campanula* sp. (12%) and *Myrtus communis, Ononis* sp. (4.20%) for each of them, a rare isolated pollen *Crataegus azarolus* (1.68%) and 4 pollens (<1%) are successively: *Tolpis barbata, Cistus* sp., *Erica arborea*, *Eucalyptus* sp.

Myrtus communis honey

The sample (H_4) the *Myrtus communis* pollen grains is dominant with a high percentage (84.28%) is associated with *Mentha aquatica* as an important pollen isolated (8.73%), *Lotus sp.* (1.42%), *Malva sylvestris* (1.26%) are isolated rare, 12 types of pollen with values of less than (1%).

Melilotus officinalis L. honey

The analysis of the sample (H_{42}) revealed the dominance of *Melilotus officinalis*, with a percentage of (59.34%) of *Eucalyptus sp.* represented only by (4.39%) of the total pollen count, that the number of individuals of this species is very low, other taxa have low percentages.

Polyfloral honeys

Thus 23 honey samples are polyfloral show no dominant pollen marked, except perhaps samples (H_2, H_7, H_{14}, H_{16}, H_{19}, H_{26}, H_{43}, H_{44} & H_{45}) with slight dominance respectively of pollen *Hedysarum* sp. (44.80%), *Papaver rhoeas* (44%), *Eucalyptus camaldulensis* (40%), *Hedysarum* sp. (34.33%), *Eucalyptus sp*. (32.18%), *Vicia* sp. (33.33%), *Brassica naps* (30.66%), *Melilotus officinalis* (40.26%), *Eucalyptus sp*. (37%), in the analyzes. According to the pollen spectra of honeys Northeast Algeria are relatively rich in various forms, the honeys are placed on the number of pollen types found there, 94% of the total number of taxa identified in each sample is variable, the classification of these polyfloral honeys depending on the number of taxa present allowed to distinguish the groups:

Honeys without dominance from 45 to 49 pollen forms. With only one sample of honey (H_{27}) by (4.35%) the richest in terms of pollen types with 46 types of pollen, whose hives are installed in a mountainous region.

Honeys without dominance with the presence of 40 and 44 pollen forms. Two samples (H_{39}, H_{48}) from different regions make up this group with a percentage of (8.70%).

Honeys without dominance with the presence of 35-39 pollen forms. Two honeys contained in this category are the samples (H_{25}, H_{33}) with different regions (8.70%).

*Honeys without dominance with the presence of 30-34 pollen forms***.** Only a sample (H_{47}) with 31 pollen types (4.35%),

Honeys without dominance with the presence of 25 and 29 pollen forms. Have honeys (H_6, H_8 and (H_{17}) with a percentage of (13.04%), the two first are from the Annaba region.

Honeys without dominance with the presence of 20 and 24 pollen forms. Six honeys from different regions are characterized by the interval (H_{10}, H_{13}, H_{19}, H_{29}, H_{43} and H_{44}) with (13.04%).

Honeys without dominance that 15 to 19 pollen forms. This is the largest group, it contains 10 honey samples (H_2, H_{11}, H_{16}, H_{18}, H_{21} H_{28}, H_{38}, H_{45}, H_{46}, and H_{49}) (43.48%).

Honeys without dominance with the presence of 10-14 pollen forms. Five honey samples up this group (H_7, H_{30}, H_{32}, H_{35} and H_{50}) with (21.74%).

Honeys without dominance contain 5 to 9 pollen forms. Samples (H_5, H_{26} and H_{36}) belong to this group (13.04%) (Fig. 6).

The sample of honey (H_{22}) is considered to be the poorest of all samples representing four pollen types in the crop area monofloral on a small number of wild or cultivated very honey, or with unilateral harvest honeydew, honeys Northeast Algerian contain on average (10-25) forms of pollen, indicating a richer choices of crop species that nectar sources. The number two hundred and three taxa were identified in the fifty samples of honey, the taxa distribution frequency is shown in (Table 3). Battesti (1990) reported that pollen present in honey is markers of flora and environment that taxa that are most representative of a region are those that have both a maximum distribution and a significant presence pollen frequency. Thus, two very common taxa, *Eucalyptus sp* with frequency of 68% of the samples which means the importance of this species for bee colonies, it is a nectariferous and polliniferous plant, which has a range very wide, it can adapt to all soil and climatic environments from the coast to the arid, this specificity to the family of *Myrtaceae* was reported by (Louveaux and Abed, 1984) for honey from north Africa.

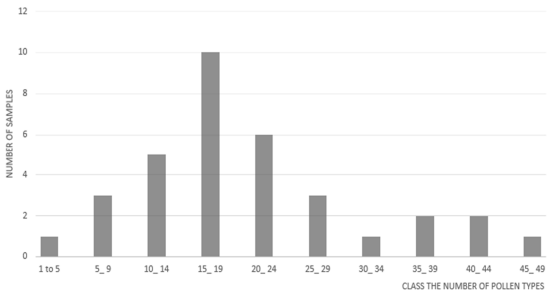

Fig. 6. Frequency histogram of the number of pollen types in honey samples.

The *Hedystrum* sp present in 50% of samples in the same frequency class, then this species is abundant and permanent source of pollen frequently foraged by bees. We seem that honey from northeastern Algeria dominated by the *Myrtaceae* and Fabaceae families, according to (Crane, 1991) the melliferous families that predominate the honeys of the different regions of worldwide, in general, are the Asteraceae, Fabaceae and Brassicaceae. Indeterminate were found in 58% of samples, the difficulty of identifying this range is based on the bursting of the pollen grains, alteration and abortion of the grains before they arrive in full maturity because of exogenous conditions (Climate) or endogenous (Accumulation of cold hours for vernalization and bud mainly in trees (Pesson and Louveaux, 1984). Floristic diversity and the absence of pollen grain Library of Algerian flora for a better comparison and identification, the variability of the procession of a bioclimatic floor to another and variability of the topology that influences the floristic composition. 18 taxa are common belonging to 15 botanical families, each family is represented by one or two taxa, Fabaceae, the Myrtaceae and Lamiaceae 2 taxa each family of the Apiaceae, Asteraceae, the Boraginaceae, Brassicaceae, Campanulaceae, Convolvulaceae, Ericaceae, Euphorbiaceae, Malvaceae, Papaveraceae, Ranunculaceae and Rosaceae by a single bee taxon. 45 taxa are infrequent they are part of 26 botanical families, 25 taxa of the 45 surveyed belong to families already quoted (Apiaceae, Asteraceae, Boraginaceae, Brassicaceae, Fabaceae, Lamiaceae, Ranunculaceae and Rosaceae), the remaining taxa highlights 17 new families (Cistaceae, Cucurbitaceae, Cupressaceae, Fagaceae, Liliaceae, Loranthaceae, Moraceae, Oxalidaceae, Plantaginaceae, Poaceae, Polygonaceae, Rutaceae, Salicaceae, Scrofulariaceae, Solanaceae, Typhaceae and Urticaceae).

We are counted 138 taxa are rarely present in less than 10% of the obtained raw spectra, these taxa belong to 56 botanical families, some taxa belonging to the families already mentioned in previous classes, 30 families more fungal spores and ferns are shown for first time in this class, Table 4 contains the main data on taxa distribution frequency in the 50 honey samples analyzed.

The overall analysis of the results allowed us to notice the pollen spectra of honeys of different samples shows that they can be characterized by the presence in significant percentage (Over 1%) or by the absence of certain elements. These differences are mainly due to climate conditions that affect the expression nectar and pollen plants potential of the place (Battesti *and* Goeury, 1992). According to Louveaux (1968) it is important to know to what extent the absolute pollen content of honey may vary.

According to Damblon (1987) the number of formed elements in traditional honey depends on the arrangements and care taken to honey extraction. A drained honey contains much less pollen than pressed honey. Honey still contains pollen, too much pollen in honey is mostly an aesthetic concern, high pollen content gives honey opaque appearance and can also give it a stronger taste. The variation of the pollen count is probably due to land cover change from one site to another, the honey harvested is mainly related to the location of transhumance, but also sometimes in the original location, so that the selection of potential honey by beekeepers. However, in the case of fixed hives, honey flow, capital phase of the bee life cycle Battesti (1990) notes advantage of the level of adaptation of the colonies themselves to environmental potential.

These findings provide knowledge on the origin source of honey that is necessary to maintain the adequate and abundant supply sources of nectar and pollen for the bees thus maximize honey yields (Hamid *et al.,* 2015). Certain external factors such as environmental and seasonal factors influence the production of honey itself (Khandari, 2011).

The quality of honey and its specific character are determined by the specific flora and vegetation in the area from which the honey originates and the diversity of the ecosystem in which the bees are kept, specifically in non-industrial areas.

Conclusion

The pollen analysis of some samples of honey harvested in different seasons in some localities varied phytogeography Northeast Algeria which is the subject of this study.

203 taxa belonging to 64 botanical families were identified using the pollen grain morphological. The distribution of these taxa is heterogeneous in the samples. The pollen spectra allowed us to differentiate honeys coastal might reign over the honeys internal areas, for samples from coastal areas, the twenty-five samples of honeys show that (24%) of all counted pollen grains are in class V, (16%) in class III, (8%) in class II, finally (2%) in class I. what we allow to note that 12 of 25 samples grading considerable pollen so remarkable importance, while samples from internal regions, three samples belong to class V (6%), 5 samples to class IV (10%), 7 samples in class III with (14%) and 8 samples in class II (16%) and finally (4%) in class I with only 2 samples. 17 unifloral honeys were typified, the majority of samples from study of honey are *polyfloral* are characterized by the absence of dominant pollen. Pollen spectrum shows that the flora found in the composition of the studied honeys mainly spontaneous, very few pollen types of crops are, it is the case of Rosaceae, Cucurbitaceae, in addition to nectar, some samples of honey contain pollen grains of some anemophily or nectar plants like Olea europaea, Papaver rhoeas, Plantago, Juniperus communis, Cupressus sempervirens and Chenopodiaceae type. These taxa seem to attract the bees that visit to collect the same pollen that they do not correspond to entomophily pollens.

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