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RESEARCH ARTICLE

MELISSOPALYNOLOGY AND CLIMATIC VARIATION: CASE OF HONEY ATTRIBUTED TO EUPHORBIA RESINIFERA, REGION OF AZILAL (MOROCCO).

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Abstract

This work is an example of the use of honey in the study of the impact of global warming on nectar production and the relationship between plants and pollinators. It is the result of the melissopalynological analysis of 42 honey samples attributed to *Euphorbia resinifera* Berg, from the region of Azilal (Morocco). Quantitative analysis showed that these honeys are mostly poor in botanical elements. Although beehives were established during the flowering period of *Euphorbia resinifera*, in areas dominated by it, only 16.7% of honeys harvested showed the monofloral character associated with the species. The others are multifloral or honeydew produced mainly by the holm oak (*Quercus ilex*). The qualitative analysis of the honeys showed the presence of 55 botanical taxa belonging to 24 families. Pollen from herbaceous species is better represented than pollen from shrubs and trees. Entomophiles are dominant. The evolution of the pollen percentages of *E. resinifera* in the pollen spectrum has shown that the precocity of its flowering related to the increase of the temperature and the diminution of the precipitations has negatively influenced its nectar production, its attraction for bees, and its contribution to the elaboration of honey.

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Introduction:-

Morocco has a remarkable floristic diversity, with more than 4500 species of vascular plants (Anonymous, 2014) of which about a quarter is endemic. This flora is at the origin of different varieties of monofloral and multifloral honeys with a good national and international reputation. Three of these honeys are derived from cactiform and succulent endemic species of the genus *Euphorbia* (Euphorbiaceae): *Euphorbia officinarum* L. subsp. *Echinus* (Hooker fil. & Cosson) Vindt, *Euphorbia officinarum* L. subsp. *Officinarum* (Hooker fil. & Cosson) Vindt and *E. resinifera* Berg.

These honeys were the subject of many scientific studies (Naman et al., 2005; Aazza et al., 2014; Crousilles, 2014; Terrab et al., 2014; Bettar et al., 2015; Bouhlali et al., 2016; Chakir et al., 2016; Petretto et al., 2017; Moujanni et al., 2017). For honeys of *E. resinifera*, although they have benefited from the Protected Geographical Indication "PGI" (Anonymous, 2012), no palynological study has been undertaken. Thus, the goal of this work is to fill this gap.

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Euphorbia resinifera "zekkoum in the Moroccan dialect", is a succulent plant with erect stems, very tight little ramous, up to 1m high and forming tufts of 0.5 to 2m in diameter. The glabrous branches are tetragonal, rarely trigonal, with very vulnerable, conspicuous spines (Fennane et al, 2014). The inflorescence is a simple solitary cyme, with yellow cyathia, developing on the edges, at the upper end of the stems. The flowering period depends on the weather conditions. The fruits are tricoic capsules, with explosive dehiscence. The different parts of the plant contain milky latex, the resiniferatoxin, which causes irritation in contact with the skin.

The plant is confined essentially to arid, often carbonated rocky piedmonts and low mountains of the Atlas of Beni-Mellal and Demnate (Benabid, 2000) where the coverage may exceed 60%. The main taxa, both woody and shrubby, associated with it are *Acacia gummifera*, *Ceratonia siliqua*, *Chamaerops humilis*, *Olea europaea*, *Pistacia lentiscus*, *Rhus pentaphylla*, *Tetraclinis articulata*, and *Ziziphus lotus*. Typically Mediterranean genera such as *Asphodelus*, *Ballota*, *Biscutella*, *Cistus*, *Ferula*, *Hippocrepis*, *Lavandula* and *Ruta* are well represented (White, 1983). For its melliferous potential, *Euphorbia resinifera* is a nectariferous plant that produces a rare, highly sought after honey for its medicinal and economic value.

The present study was carried out during 2014 and 2015 in order to specify the palynological characteristics of monofloral honey of *Euphorbia resinifera*, an endemic species of Morocco which dominates the flora of certain areas of the Region of Azilal (Morocco).

Material and methods:-

Sampling areas:

In order to have a good representation of the area of the *Euphorbia*, we chose 5 areas representing different eco-geographical situations (Fig. 1):

- Ait Attab (840 m), a forest area consisting mainly of holm oak (*Quercus ilex*), cedar and of two juniper species (*Juniperus oxycedrus* and *J. phoenicia*). In this location, *Euphorbia resinifera* spreads over large areas along the forest;
- Foug Jamâa (890m), located in a generally forest environment where *Euphorbia resinifera* is associated with cedar (*Tetraclinis articulata*) and red juniper (*Juniperus phoenicea*) and where cereal crops, almond and olive tree cultivation are dispersed on small fields at the edge of the forests;
- Tanant (940 m), the *Euphorbia* colonizes an important area of a forest consisting mainly of cedar, red juniper and of holm oak;
- Azilal (1300 m), a mid-mountain area where oak is associated with cedar, red juniper, lentisk (*Pistacia lentiscus*) and cistus (*Cistus villosus*); *Euphorbia* occupies the slopes;
- Ait Mhamed (2000 m), an area of high mountains where the *Euphorbia* occupies the slopes dominated by holm oak.



Fig. 1: Localization of studied areas: AA: Ait Attab; AM: Ait Mhamed ; AZ: Azilal ; FJ: Foug Jemaa ; TA: Tanant.

Analysis methods:

Hives were planted in sites dominated by *E. resinifera*, at the beginning of its flowering, from mid-April in the lower elevation areas (Ait Attab, Foug Jemâa and Tanant) and for the second week of May in the highest sectors (Azilal and Ait Mhamed). We also established a reference collection of pollen grains from the flora of the region during the study period. The samples were collected at the end of the floraison period of *Euphorbia resinifera* in July for the two years of study.

The melissopalynological analyzes, quantitative and qualitative, were performed according to the method described by Louveaux et al. (1978), reviewed by Ohe et al. (2004) and summarized in Terrab et al. (2014). Analyzes are done on a 10 grams of honey basis. The determination of the different palynomorphs, their counting and their photographs were done under the Leitz laborlux S microscope.

The identification of pollen grains is based on their morphological criteria. For their botanical attribution, we used our reference collection and the Atlas of literature (Moore et al., 1991; Reille, 1992; Valdés et al., 1987). Some taxa are determined up to the species or genus. When a set of genera of the same family coexisted during the foraging period and have the same pollen type, we assigned the pollen with the same characteristics to the most dominant genus with the indication "type" which follows the name of the genre (i.e: *Lotus* Type).

For the classification of honeys, we followed the approach proposed by the International Commission for Bee Botany (ICBB) (Louveaux et al., 1978) based on the percentages of the various elements of the melissopalynological residue (pollen grains and elements of honeydew). For each sample, we counted and determined a minimum of 1000 pollen grains which we grouped according to the 4 frequency classes defined by Louveaux et al., (1970, 1978) designating as :

1. Dominant or predominant pollen ($n > 45\%$ of a specific type of pollen);
2. Accompanying or secondary pollen ($15\% < n < 45\%$);
3. Minor important or tertiary pollen ($3\% < n < 15\%$);
4. Minor or rare pollen ($n < 3\%$).

For the botanical attribution, we used the measurement of electrical conductivity (EC), an important parameter according to the International Honey Commission (IHC) (Bogdanov et al., 1997, 2004), to differentiate flower honeys from those of honeydew ($EC > 800 \mu S/cm$ for honeydew's honey and $EC < 800 \mu S/cm$ for nectar's honey). The proportions of the different pollen grains of nectariferous taxa allowed us to decide between monofloral and multifloral honeys.

Results:-

The harvested honeys showed the following sensory characteristics: amber colored with a sweet smell and a persistent taste sticking to the throat after swallowing. These characteristics allow beekeepers, resellers and consumers to consider this type of honey as *Euphorbia* monofloral.

The results of the quantitative analysis (Table 1) show that the number of pollen grains per 10 g of honey varies between 3133 (sample 19) and 1190667 (sample 31). According to Maurizio classification (1979), 50% of the collected honey (21 samples) are poor in pollen and belong to class I, 47.6% (20 samples) have an average content (class II and III) and only one sample is very rich (class V). The honeydew indicator elements (HDIE) are present in all honeys analyzed with a number varying from 448 (sample 17) to 924667 (sample 31). Their ratio to nectarine pollen grains (HDE / NPn) or honeydew index (HDI) is between 0.02 and 3.55.

The qualitative analysis (Table 2) reveals the presence of 55 pollen types belonging to 24 families. The pollens of herbaceous species are better represented than those of shrubs and trees. Entomophilous species are dominant. 80% of the taxa encountered are nectariferous and 20% belong to anemophiles or to entomophiles poor in nectar or nectarless (Fig. 2). The number of pollen forms per sample varies from 5 (sample 1) to 22 (sample 35) with an average value of 13.

Table 1: Results of the quantitative analysis of the 42 honeys studied.

NBE: number of botanical elements; **NPF:** number of pollen forms; **HDI:** honeydew index; **EC:** Electrical conductivity; **FH:** Flower's honey.

| Sites | Date | Samples | NBE | NPF | HDI | Class | Type | EC (μS/cm) |
|--------------------|---------|---------|---------|-----|------|-------|----------|------------|
| Ait Mhamed | 7- 2014 | 1 | 6221 | 5 | 0,6 | I | FH | 423,3 |
| | 7- 2014 | 2 | 14640 | 11 | 0,76 | I | FH | 500,5 |
| | 7- 2014 | 3 | 15490 | 13 | 0,28 | I | FH | 428,6 |
| | 7- 2014 | 4 | 6555 | 10 | 0,99 | I | FH | 392,6 |
| | 7- 2014 | 5 | 11493 | 11 | 0,28 | I | FH | 413,1 |
| | 7- 2014 | 6 | 6477 | 8 | 1,7 | I | FH | 582,2 |
| | 7- 2014 | 7 | 11753 | 13 | 0,37 | I | FH | 326,5 |
| | 7- 2014 | 8 | 6159 | 11 | 1,05 | I | FH | 436,5 |
| | 7- 2014 | 9 | 12637 | 8 | 0,32 | I | FH | 508,7 |
| | 7- 2014 | 10 | 23639 | 15 | 0,19 | II | FH | 512 |
| | 7- 2014 | 11 | 45341 | 13 | 0,14 | II | FH | 411,6 |
| | 7- 2014 | 12 | 21769 | 14 | 0,2 | II | FH | 515,8 |
| | 7- 2014 | 13 | 14750 | 15 | 0,25 | I | FH | 376,9 |
| Ait Attab | 7- 2014 | 14 | 50761 | 10 | 0,09 | II | FH | 394,8 |
| | 7- 2014 | 15 | 7690 | 12 | 0,17 | I | FH | 426,6 |
| | 7- 2014 | 16 | 7571 | 11 | 0,24 | I | FH | 401,4 |
| | 7- 2014 | 17 | 8148 | 9 | 0,06 | I | FH | 541,8 |
| | 7- 2014 | 18 | 37527 | 17 | 0,08 | II | FH | 315,5 |
| Foum Jemaa | 7- 2014 | 19 | 3133 | 8 | 0,42 | I | FH | 431,1 |
| | 7- 2014 | 20 | 22653 | 9 | 0,02 | II | FH | 444,6 |
| Azilal 2014 | 7- 2014 | 21 | 18641 | 7 | 0,83 | I | FH | 375 |
| | 7- 2014 | 22 | 25017 | 12 | 0,36 | II | FH | 547,5 |
| | 7- 2014 | 23 | 10905 | 14 | 0,33 | I | FH | 510,2 |
| | 7- 2014 | 24 | 8432 | 8 | 1,16 | I | FH | 602 |
| | 7- 2014 | 25 | 3206 | 11 | 0,78 | I | FH | 803 |
| | 7- 2014 | 26 | 10089 | 13 | 0,42 | I | FH | 770,3 |
| | 7- 2014 | 27 | 6196 | 8 | 0,88 | I | FH | 402,8 |
| Azilal 2015 | 7- 2015 | 28 | 50909 | 15 | 3,55 | II | Honeydew | 1165 |
| | 7- 2015 | 29 | 98250 | 18 | 2,75 | II | Honeydew | 1063.5 |
| | 7- 2015 | 30 | 203667 | 20 | 2,33 | III | Honeydew | 1247 |
| | 7- 2015 | 31 | 1190667 | 14 | 3,48 | V | Honeydew | 1148 |
| | 7- 2015 | 32 | 28462 | 11 | 0,1 | II | Honeydew | 1431 |
| | 7- 2015 | 33 | 94378 | 18 | 1,43 | II | Honeydew | 1017 |
| | 7- 2015 | 34 | 85400 | 19 | 2,5 | II | Honeydew | 1055.5 |
| | 7- 2015 | 35 | 65764 | 22 | 2,32 | II | Honeydew | 1130.5 |
| | 7- 2015 | 36 | 92733 | 14 | 0,28 | II | FH | 720 |
| | 7- 2015 | 37 | 25380 | 16 | 0,8 | II | FH | 636.5 |
| | 7- 2015 | 38 | 15050 | 8 | 2,5 | I | Honeydew | 1362 |
| | 7- 2015 | 39 | 37567 | 13 | 1,33 | II | Honeydew | 1365 |
| | 7- 2015 | 40 | 194674 | 12 | 0,09 | III | FH | 381.7 |
| | 7- 2015 | 41 | 404082 | 11 | 0,02 | III | Honeydew | 1456 |
| | 7- 2015 | 42 | 78050 | 13 | 2,5 | II | Honeydew | 1099.5 |

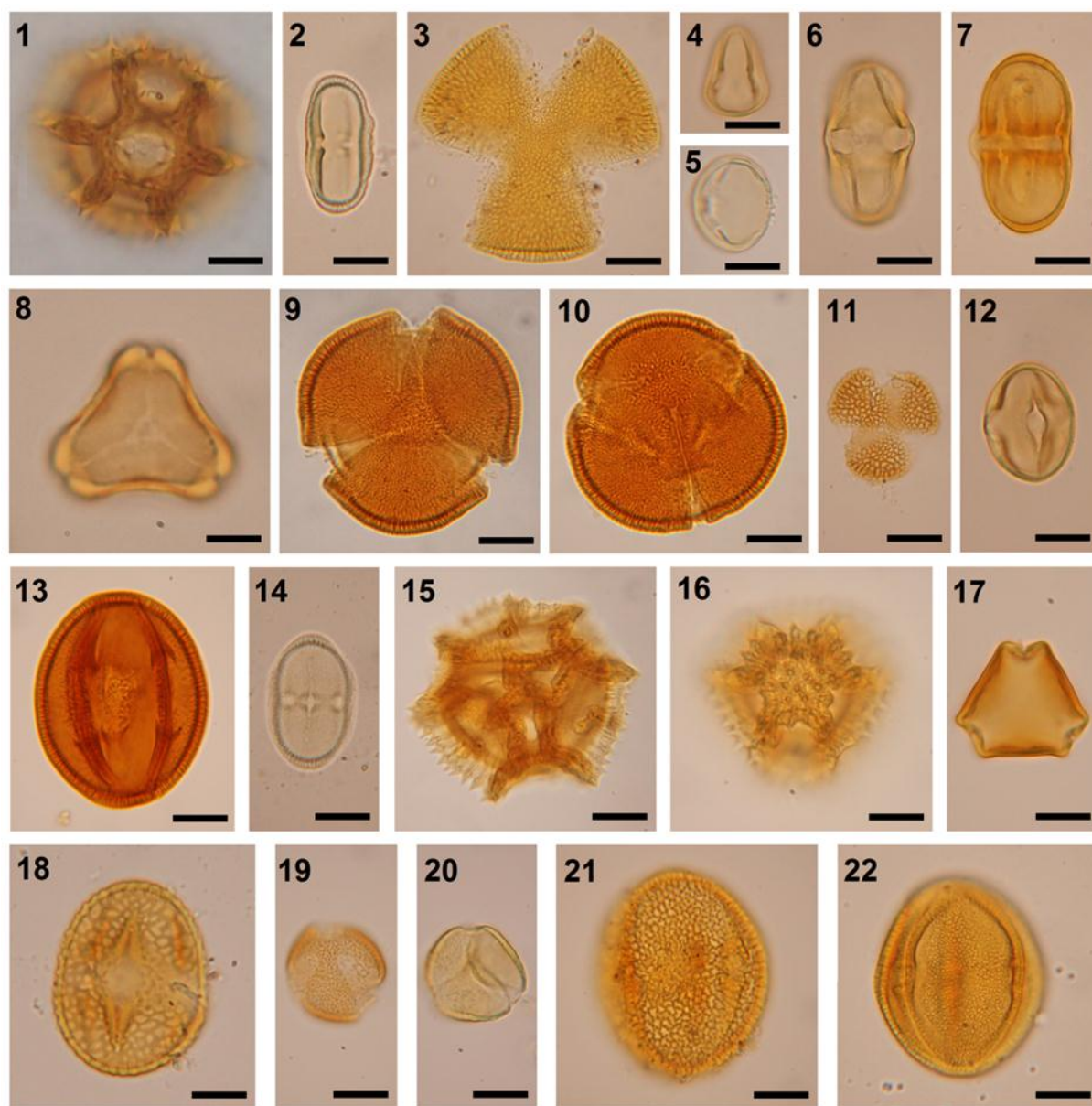


Fig. 2: Photon microscopy of the pollen morphology of the main nectariferous taxa (1 to 18) and low nectariferous (19 to 22); Scale bar = 10 μm.

1 : *Cichorium* Type ; 2 : *Conium* Type ; 3 : *Convolvulus* sp. ; 4 : *Echinus* sp. ; 5 : *Reseda* sp. ; 6 : *Eryngium triquetrum* ; 7 : *Eryngium variifolium* ; 8 : *Eucalyptus* sp. ; 9, 10 et 13 : *Euphorbia resinifera* ; 11 : *Hirschfeldia incana* ; 12 : *Lotus* Type ; 14 : *Melilotus* sp. ; 15 : *Scolymus hispanicus* ; 16 : *Taraxacum* Type ; 17 : *Ziziphus lotus* ; 18 : *Trifolium* Type ; 19 : *Papaver* sp ; 20 : *Quercus ilex* ; 21 : *Cistus laurifolius* ; 22 : *Cistus villosus* .

Pollen in equatorial view: 1, 2, 4-7, 12-15, 18, 21- 22; **Pollen in polar view:** 3, 8-9, 11, 16-17; **Pollen in slant view:** 10, 19-20.

Table 2: Pollen spectrum of studied honeys (* *nectariferous taxon*)

| Table 21. Pollen spectrum of studied honey (nectariferous plants) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|--------|--------|---|---|----|----|----|----|----|----|--------|----|----|--------|----|----|----|----|----|----|----|----|--------|--------|--------|--------|----|----|--------|----|--------|----|--------|--------|--------|----|----|--------|--|
| Fam- i- l- i- e- s | Tax- o- n- s | 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 | | |
| A- p- i- a- c- e- a- e | * E- r- y- n- g- i- u- m t- r- i- q- u- e- t- r- u- m | | 2 | 2 | | 1 | 2 5 | 1 5 | | | | 2 | | | | 3 | | | 1 | | | | | 2 | | | | | 1 5 | 4 | | | | | 2 4 | | | 4 | 2 4 | | | | 5 | | |
| | * E- r- y- n- g- i- u- m v- a- r- i- i- f- o- l- i- u- m | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 2 5 | 4 1 | 3 4 | 6 | 9 | 3 | 5 | 1 1 | 1 | 3 | 1 5 | 1 5 | 8 | | 6 4 | |
| | * T- h- a- p- s- i- a- g- a- r- g- a- n- i- c- a | | 2 | | | | | | | | 4 | | 2 | | | | 1 0 | | | | | | | | | | | 9 | | | 1 0 | | | | 1 1 | | | 1 | | | | | | | |
| | * T | | | | | | | | | | | | 3 | | | | | 3 | 3 | 1 4 | | | | 1 | 5 | | | | 2 1 | 2 | 1 | 1 | | 1 | 1 | 5 | 3 | 1 | | | 2 | 6 | | | |

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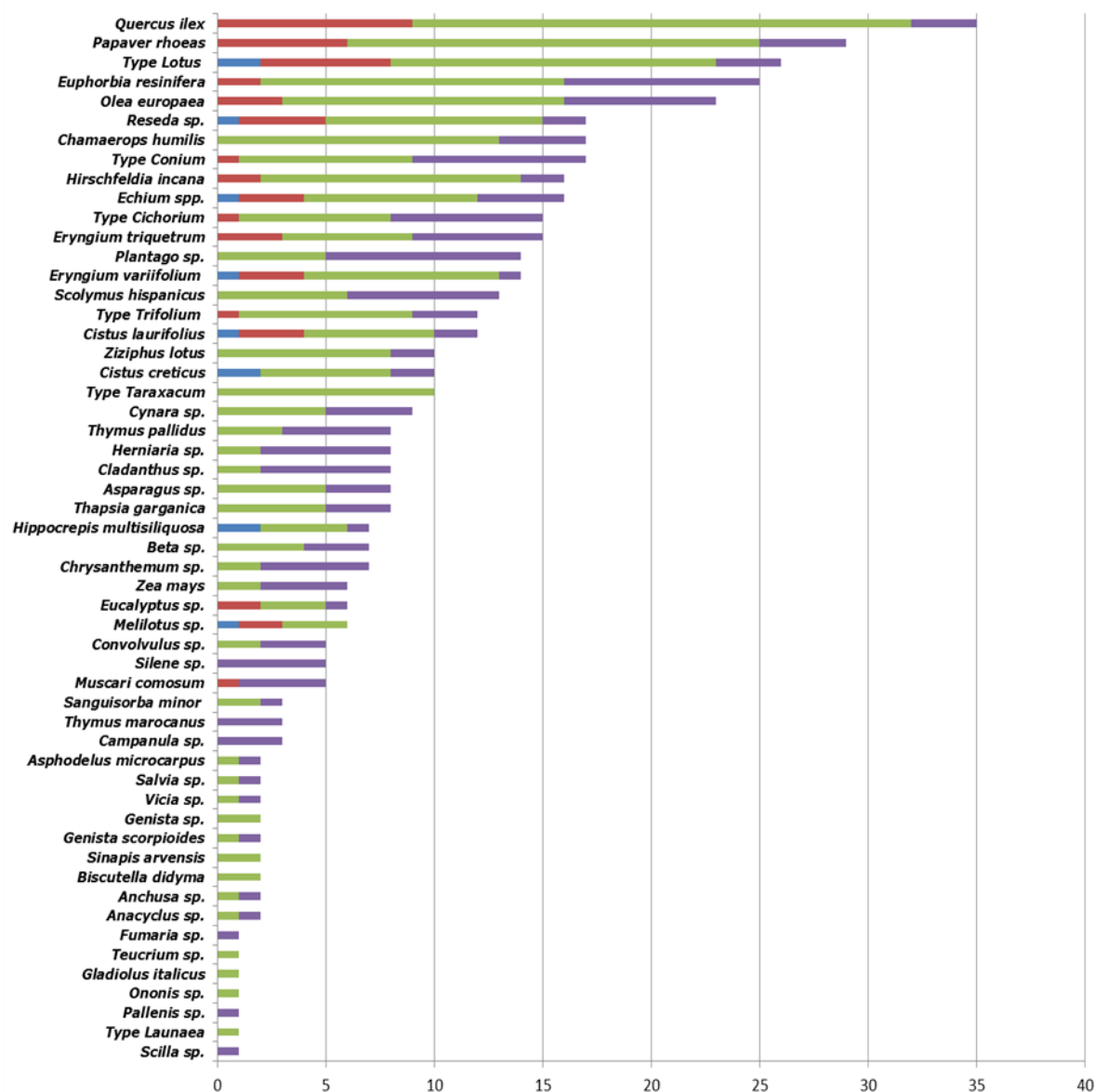


Fig. 3:-Number of pollen grains of the 55 taxa identified in the 42 honey samples represented in the four classes of pollen frequencies.

The best represented families are the Asteraceae (nine types), the Fabaceae (eight types), the Apiaceae and the Lamiaceae (four types), the Asparagaceae and the Brassicaceae (three types). The Boraginaceae, the Caryophyllaceae, the Cistaceae, the Euphorbiaceae and the Papaveraceae are represented by two types. A single pollen type represents each of the families of Arecaceae, Campanulaceae, Chenopodiaceae, Convolvulaceae, Fagaceae, Iridaceae, Liliaceae, Myrtaceae, Oleaceae, Plantaginaceae, Poaceae, Resedaceae, Rhamnaceae, and Rosaceae.

No pollen is present in all the studied honey. Although all these honeys were sampled in plant formations dominated by *Euphorbia resinifera*, only 25 samples contain pollen of this species, with a percentage ranging from less than 1 to 37%. The most common pollens are those of *Quercus ilex* (36 samples), *Papavers* sp. (30 samples). *Olea europaea* is present in 23 samples, *Chamaerops humilis* in 17 and *Echium* sp., *Hirschfeldia incana* and *Reseda* sp. in 16 samples (Fig.2). Table 2 summarizes the frequency of pollen in the samples studied as well as their class of abundance.

For their botanical origin, and according to the electrical conductivity values (Table 1), all honeys harvested in 2014 are nectarous honey whereas in 2015, 12 are attributed to honeydew and 3 are from flowers.

Among the thirty flower honeys, seven are monofloral of *E. resinifera* (samples 2, 3, 5, 9, 10, 12, and 26) with a percentage of pollen grains from this species varying between 25% and 58% among pollen grains of nectariferous taxa. *Euphorbia* pollen is among the underrepresented group and a result of 25% of pollen presence is sufficient to qualify a honey as monofloral (Damblon, 1988; Terrab et al., 2014). These honeys have a low botanical content (five belong to Maurizio's class I (1979) and two to class II with an average of = 14027 grains / 10g). Their honeydew index is very low (average = 0.362), a characteristic value of monofloral honeys (Louveaux et al., 1970, 1978; Von Der Ohe, 2004). The remaining flower honeys are multifloral, and belong to classes I, II or III, with an average of 26953 grains / 10g and a low honeydew index (average = 0.508).

Honeydew honeys have an electrical conductivity that varies between 1017 and 1456 $\mu\text{S} / \text{cm}$, a honeydew index of less than 3 (average = 2.067) for most samples and an average content of botanical elements with two samples belonging to class I, eight to class II, two to class III and one to class V (average = 196020). The very large number of botanical elements of the last sample results from the fact that this honey was very adherent to the alveoli and we were forced to extract it by pressing (Table 1).

Discussion:-

The study was carried out during 2014 and 2015 characterized by a precocious flowering, a low yield of honey per hive (4 kg/hive for 2014 and 3 kg/hive for 2015) compared to a normal year (11 kg/hive on average) and a small contribution of *Euphorbia resinifera* to honey production. The melissopalynological characteristics of the studied samples did not reflect the dominance of *E. resinifera*, nor the sensory characteristics that allowed beekeepers to label honeys from the Azilal region as monofloral. Of the 42 samples analyzed, only seven (16.7%) had characteristics of monofloral honey of *Euphorbia resinifera*, the others are either honeydew or multifloral.

Early flowering of *Euphorbia resinifera*:

The flowering period of *E. resinifera* is between June and July (Gattefossé and Vindt, 1954; Gómiz-García, 2001; Aafi et al., 2002). In recent years and according to beekeepers in the region, for a year with normal yield, flowering started from the second week of May. During the two years of study, the first flowers appeared in mid-April in the areas of Ait Attab, Fom Jemâa, and Tanant (840, 890, and 940 m of altitude respectively), late April-early May in Azilal (1300 m) and during the second week of May at Ait Mhamed (2000 m). These different findings reveal a stability of flowering for the mountainous area and a precocity more and more pronounced towards areas of low altitudes.

Early flowering has been reported by several authors in response to global warming (Defila and Clot, 2001 ; Menzel et al., 2005, 2006 ; Hovenden et al., 2008 ; Gallagher et al., 2009 ; Rumpff et al., 2010 ; Chmielewski et al. 2011; Anderson et al., 2012 ; Chambers et al., 2013 ; Rawal, 2014; Burghardt et al. 2016; Rather et al., 2018). Bakke (1936), had observed a comparable precocity to that of *E. resinifera*, at *Euphorbia esula* L. 1753, an invasive weed introduced in North America in the late 19th century. Under normal conditions, this species begins to flower in late May - early June (Hanson and Rudd, 1933; Bakke, 1936; Galitz and Davis, 1983; Hunt et al 2004; Gesch et al., 2007; John and Tilley, 2014). According to Bakke (1936), in 1934, the flowering of *E. esula* started in mid-May near Hawarden, Iowa. The author explains this anticipation of flowering by the softening of winter. It is the result of interannual variations of the spring climate for Foley et al., (2009). For Franks et al. (2007), summer drought is an early flowering factor.

Evolution of pollen spectra and the contribution of *E.resinifera* to honey production:

The presence of honeydew in all honeys results from the overlapping of the flowering period of *Euphorbia resinifera* with that of the green oak exudation (end of May to the beginning of June) whose honey is characterized by a honeydew index less than 3 (Sierra et al., 1987; Mateo and Bosch-Rei, 1998; Persano Oddo L. and Piro R. 2004; Atanassova et al., 2016; Jaafar et al., 2017; Terrab et al. 2019) and conifers (*Juniperus oxycedrus*, *Juniperus phoenicea*, and *Tetraclinis articulata*).

Both years of study experienced modest rains (423 mm in 2014 and 274 mm in 2015), irregular in time and space and fluctuations of temperatures during the flowering period (Fig. 4). For 2014, the cumulative rainfall of the 4 months preceeding the flowering period (January-April) was 220 mm compared to 169 mm for 2015.

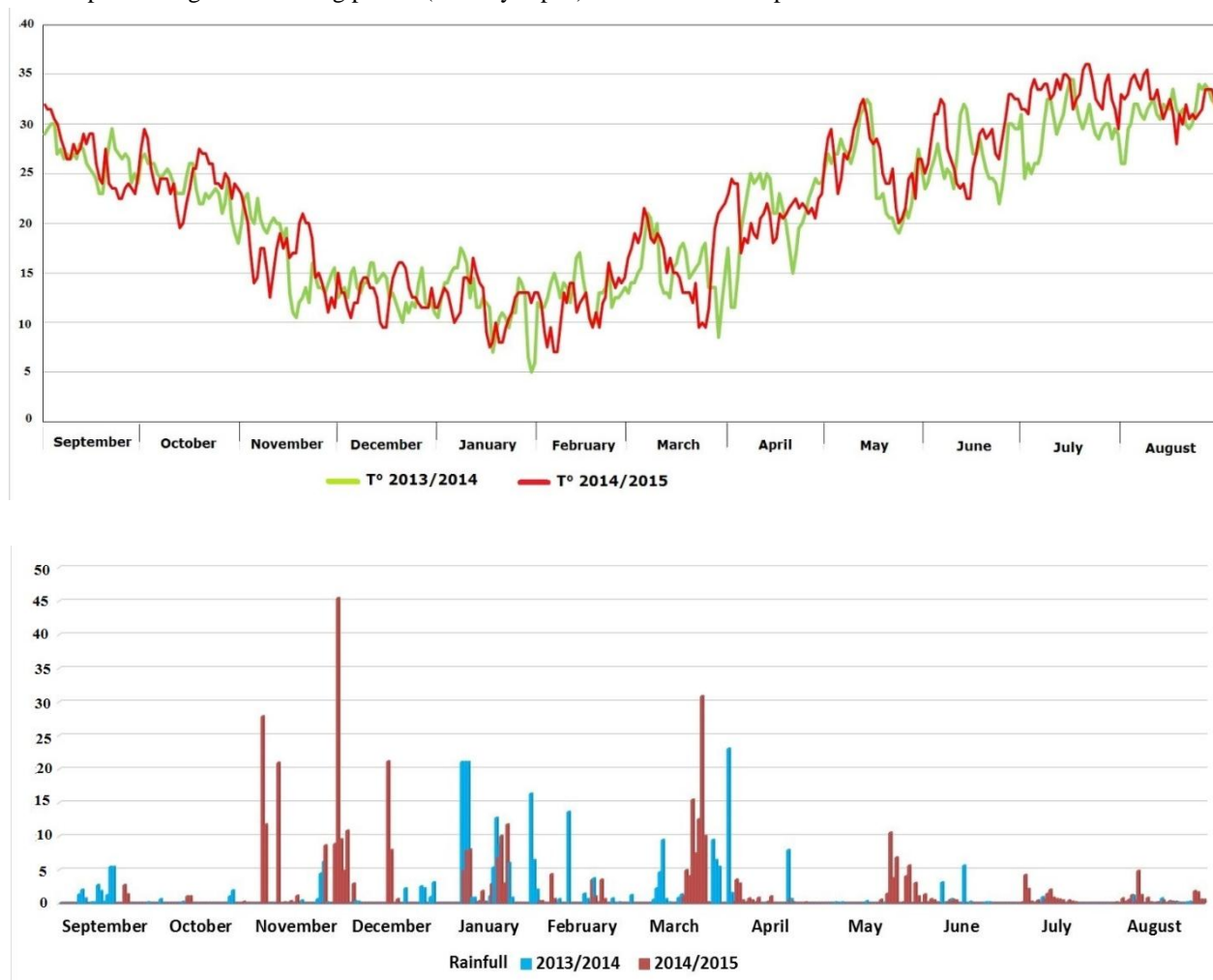


Fig 4:-Variation of temperature and rainfall in the Azilal region From September 2013 to August 2015. (meteo-maroc)

Therefore, for 2014, the climatic conditions were relatively favorable (higher rainfall and cooler temperatures) for the production of nectar honeys (Table 1), although the yield remains modest. In the field, despite the "heat wave" that hit the region in mid-May (Fig3), *E. resinifera* in flowers dominated the nectarine flora in all areas studied until the end of June. The pollen spectra of the honeys sampled show an increase in the pollen percentages of the *E. resinifera* with altitude. In the highest areas, the percentages are more in line with the situation in the field (Table 2). Seven out of twenty honeys are monofloral (one in Azilal and six, higher, in Ait Mhamed). The honeys in the lower areas are multifloral and are low in pollen of the species (0 to 4.7% among nectarifers). In these areas, the species was less visited than other taxa.

Nectar is offered by plants as a reward to pollinators (Mačukanović-jocić and Djurdjević, 2005; Adgaba et al., 2017). Its production is controlled by environmental factors such as temperature, precipitation, atmospheric and soil moisture, solar radiation, atmospheric CO₂ concentration, and altitude (Corbet 1978; Boose 1997; Lake and Hughes, 1999; Mačukanović-Jocić et al., 2008; Nedić et al., 2013). According to Petanidou and Smets (1996), Adgaba et al. (2012), Alqarni (2015) and Adgaba et al. (2017), there is a positive correlation between temperature rise and nectar production in species in semi-arid regions, up to a maximum, variable from one species to another, beyond which the secretion decreases and then ceases (Mačukanović-jocić and Djurdjević, 2005). Water stress also appears to limit

nectar production (Carrión-Tacuriet al., 2012) and increase sugar concentration (Carroll et al., 2001). Domesticated bees prefer average sugar concentrations (Waller, 1972; Roubik and Buchmann, 1984) however low (Bolten and Feinsinger, 1978) or high concentrations of sugar (Adgaba et al., 2017) in nectariferous plants can limit melittophilia. For Mitchell and Waser (1992) and Mitchell (1993), there is a positive relationship between nectar production and frequency of pollinator visits.

In Morocco, over the past few decades, aridity has continuously transgressed from low to high altitudes and from south to north (Ait Brahim et al., 2016), in response to increasing temperatures and decreasing rainfall (Mokssit, 2012).

Thus, for areas of lower altitudes, more affected by temperature rise and drought, the early flowering of *E. resinifera*, negatively influenced its productivity of nectar, its attractiveness for honey bees, and thus its contribution to honey production. For the mountain areas (Azilal and Ait Mhamed), less affected by climatic variations, the stability of the flowering period of *E. resinifera* is responsible for a more attractive nectar productivity for bees and a sufficient contribution to producing monofloral honeys.

For 2015, there was no harvest for the sectors of Ait Attab and Fom Jemâa. In the Tanant area of comparable altitude but close to the l'Oued Lakhdar and Azilal, the composition of honeys was different compared to 2014. The samples are rich in honeydew. This is related to the evolution of climatic parameters and their impact on flora. As for 2014, the season started in good conditions. This allowed the hive to flourish and the bees to harvest the nectar. But the heat waves that occurred during the study period (Fig. 4), destroyed flowering and weakened the herd. The bees have consumed their stock. It was only after that they started storing honey again during the honeydew period (something that beekeepers found). Hence, the important part of honeydew in these samples and the low contribution of the nectariferous of which *E. resinifera*.

Conclusions:-

Honey is the product of a close collaboration between plants, which secrete the raw material (nectar and honeydew), and the bees that produce it. Studying it allows us to trace the evolution of honeybee-plant interaction under the control of natural and/or anthropogenic factors. Thus, using melissopalynology, this study has highlighted, for the first time, the relationship between the early flowering of *Euphorbia resinifera*, endemic species of Morocco, in response to global warming, on one hand, and its low nectar productivity, its attractiveness for bees and its contribution to honey making, on the other hand.

If the decline in honey yield from hives can be attributed to adverse weather conditions, affecting melliferous plants and bee colonies, several questions, about the relationship between early flowering and the contribution of *Euphorbia resinifera* in the elaboration of honey, need answers. We have already put forward various hypotheses such as the decrease in the quantity of nectar secreted by the species compared to other melliferous plants or the variation of its sugar concentration and / or the proportions of it. Studies are planned to unmask the origin of this low contribution to honey production, its impact on plant pollination and honey bees welfare, and the interaction between pollinators and entomophilous plants in general.

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