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**Survey of Some Major Pollen Sources for Bees in Radom
Area South Darfur State**

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DEDICATION

To my Father and Mother.

To my Sisters and Brothers.

To those who love the honey bees.

Iman

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English Abstract

This study was carried out in Radom area in South Darfur State in the period from September 2013 to February 2014. Three samples of bee wax combs were used from different sites in Radom area, to describe the pollen grains inside combs, and report pollen sources collected from Radom area.

A laboratory experiments were conducted at National Centre for Environmental Research (NCER). Pollen grains were collected by using forceps and located separately on glass slide. The separated pollen grains were dissolved in few drops of potassium hydroxide (koh). Then these samples treated with alcohol of 50% concentration, Faving stain was used for pollen staining on the slide. The samples were washed with 60%, 70% and 80% alcohol, and fixed by zylol solution. Then the slides were covered and fixed with D.B.X. Finally these slides were checked up under electronic microscope in the National Centre for Environmental Research (NCER).

This investigation was done in zoom of 40 micron. The results showed that: Most of pollen grains belong to family Mimosaceae. This family is distributed in all parts of Radom area. Twenty two different types of pollen grains were recorded for the different plant sources, such as forest trees (*Combretum glutinosum*), herbs (*Clematis hirsute*), vegetable plants (*Corchorus olitorius*) and fodder (*Medicago sativa*).

There were different shapes and sizes of pollen grains that collected from bee combs. Most of pollen grains have circular type, followed by semi- angular type, angular, circular to semi- angular, elongated and compressed biconvex disc. Family Mimosaceae was found to contain the highest percentage of plant species.

ملخص البحث

اجريت هذه الدراسة في منطقة الردوم ولاية جنوب دارفور في الفترة من سبتمبر 2013 الى فبراير 2014 م.

أستخدمت ثلاثة عينات من اقراص شمع النحل من مواقع مختلفة في منطقة الردوم, لوصف حبوب اللقاح داخل الاقراص, ولمعرفة مصادر حبوب اللقاح التي جمعت من منطقة الردوم. أجريت التجارب المعملية في المركز القومي لبحوث البيئة (NCER).

تم جمع حبوب اللقاح باستخدام ملقط ثم وضعت في شريحة زجاجية. تم ازابتها ببضع قطرات من محلول هيدروكسيد البوتاسيوم (Koh). ثم عوملت هذه العينات بكحول تركيزه 50% أستخدمت صبغة الفاكسين لتثبيت حبوب اللقاح في الشريحة. غسلت العينات بكحول تركيزه 60%, 70% و80% على التوالي. وثبتت بمحلول الزايلول ثم غطيت الشرائح وثبتت بواسطة DBX, واخيرا فحصت تحت المجهر الإلكتروني في المركز القومي لبحوث البيئة وكان الفحص بتكبير (40) ميكرون وأظهرت النتائج ما يلي:

معظم حبوب اللقاح تنتمي للعائلة Mimosaceae , تنتشر هذه العائلة في جميع انحاء منطقة الردوم. اثنين و عشرون نوع مختلف من حبوب اللقاح سجلت لمصادر نباتية مختلفة, مثل الاشجار الغابية (*Combretum glutinosum*), الاعشاب (*Clematis hirsute*), محاصيل الخضر (*Corchorus olitorius*) و الاعلاف (*Medicago sativa*).

هنالك اشكال واحجام مختلفة لحبوب اللقاح التي جمعت من الاقراص الشمعية. معظم حبوب اللقاح دائرية الشكل, تليها الشكل شبه المثلث و المثلث والاسطوانى و القرص المضغوط ثنائي التحدب.

اعلى نسبة مئوية من الانواع النباتية. Mimosaceae احتوت عائلة

CHAPTER ONE

1-1 Introduction

Pollen is a fine to coarse powder consisting micro gametophytes (pollen grains), which produce the male gametes (sperm cells) of seed plants. A hard coat covering the pollen grain protects the sperm cells during the process of their movement between the flowers to the pistil of next flower.

Honey bees and plants have a special relationship. Each one can benefit from the other. Flowering plant provide food for honey bees in turn, bees provide pollination for many plants and enabling them to produce honey (www.Pollen.grain.net).

Pollen itself is not the male gamete. Each pollen grain contains vegetative (non-reproductive) cell and a generative (reproductive) cell containing two nuclei: a tube nucleus (that produces the pollen tube) and a generative nucleus (Johnstone, 2001).

Pollen is produced in the 'microsporangium'). Pollen grains come in a wide variety of shapes (most often spherical), sizes, and surface Markings characteristic of the species (Pleasants *et. al.* 2001). The pollen wall protects the sperm while the pollen grain is moving from the anther to the stigma; it protects the vital genetic material from drying out and solar radiation. The pollen grain surface is covered with waxes and proteins, which are held in place by structures called sculpture elements on the surface of the grain. The outer pollen wall, which prevents the pollen grain from shrinking and crushing the genetic material during desiccation, is composed of two layers (Sporne, 1972).

Pollen contains water, amino acid, proteins, lipids, carbohydrates, minerals, vitamins, enzymes and other micro nutrients.

Composition depends in plants species collected by bees. Supplements of pollen have been used in treatment of anemia, disorders of digestive system,

mental disorders like depression, asthenia and alcohol dependence and as a food.

The Chinese, Egyptians, ancient Romans, and the Anglo-saxsons, among any others, regarded bee pollen to be very beneficial to health (AL Banbi, 2001) (in Arabic).

Objectives:

Radom area in South Darfur State

- a. To describe the pollen grains inside combs from Radom area in South Darfur State
- b. To report pollen sources collected from Radom area in South Darfur State.

CHAPTER TWO

LITERATURE REVIEW

2.1. Biology of honey bees:

Three different kinds of honey bees live inside a bee hive. The hive cannot survive unless it has all

three. Each of the honey bees, the Queen, the Worker, and the Drone all have their distinctive job to do (Albert, 2010).

2.1.1. The Queen Bee:

The Queen's sole job is to lay eggs. She has a retinue of young worker bees who stay with her at all times to feed her and take care of her needs. During the egg laying season, which in the USA, is roughly from early January to the start of Fall, she lays eggs continuously and can lay up to 800 or so a day. This maximum production is intended to build up the supply of Worker Bees to be ready and get out there to gather nectar when the flowers first emerge in the spring.

She can live three or four years or so. However, her egg laying ability may deteriorate in mid-life. In this case the Worker Bees will decide that it is time to replace her and will begin to build special larger cells, which resemble peanut shells, in which to raise new Queens. This is a process called 'supercedure' (Albert, 2010).

2.1.2: The Worker Bee:

The Worker Bees is really only interested in doing her job, which is to fly out and visit flowers and suck up the nectar to bring back to the hive that eventually gets turned into honey that we all love to eat. In the process she also brings back pollen that gets gathered on her rear legs. Pollen is used as food for the young pupa. When she first emerges from her cell as a mature bee after 21 days, she performs various jobs inside the hive which can involve being an attendant to the Queen, cleaning old material out of cells for the

Queen to lay an egg in, carrying out dead bee bodies, transferring honey and pollen from the incoming Workers into cells, standing by the entrance to the hive in hot weather to fan her wings and move air inside the hive to keep it cooler, etc. (Albert, 2010).

2.1.3: The Drone:

This male honey bee is the largest bee living in the hive, at least in its width and bulk. Its body is longer than the Worker Bee and shorter than the Queen Bee. The noise their larger wings make when flying around my head remind of the sound of World War II Bombers flying overhead.

The drone performs no useful functions inside the hive of any kind. It goes inside the hive to rest and eat. It also does not have a stinger to defend itself or its hive. Its sole function in its life is to fly around about hundred feet or so above the ground ever on the alert for a Virgin Queen Bee on her once in a lifetime maiden flight. Most men may think that this is the ideal lifestyle. Not so, as the act of sex with the Queen Bee will culminate with its seminal sack being ripped out of its body to be stored for future use inside the body of the Queen Bee. Now if he is one of the gazillion drones who don't have the good fortune to hook up with a Virgin Queen Bee, he is not long for this world in the end. When the cold weather comes along in the fall, all the drones are either kicked out of the hive or are no longer allowed to come inside (George, 2004).

In addition to these adult bees the colony will contain variable number of immature stages of the honey bee. These consist of eggs, larvae- pearly white legless maggot- and pupae. The number of these young will vary with the time of year. All the immature bees are housed in the cell of the honey bee comb, each individual in a separate cell, and are collectively spoken of as brood (Ted, 1983).

2.2: The Emergency Feeding of Bees:

Occasion may arise when it becomes necessary to feed a colony of bees during winter. This occasion should never arise in the normal way of bee-

keeping, but should for instance, the beekeeper discover a colony in mid-winter, which is obviously in a state of starvation, when the course, something drastic has to be done.

If the stock is not fed somehow, then it will surely perish. If it is fed, then either it perishes in spite of, or because of the feeding, or it survives and prospers, and if the feeding is done in time, the latter eventuality is more likely to occur. Feed then, not candy, but sugar syrup, thick and very rapidly (George, 2004).

2.3. Honey Bee Behavior:

Bee behavior is conditioned by the climatic factors, particularly temperature. Insects are cold-blooded, and the honey bee is no exception. At temperatures below 50F., the wing muscles of the honey bee become inactive, and flight impossible. In temperatures below 45F., bees are paralysed and, being unable to walk, their lives are in danger. The honey bee does not hibernate, but the winter is a period of rest and maximum quiescence. Throughout the long cold months, the honey bee utilizes, the principle of chemical combustion resulting from muscular activity to raise the temperature and maintain warmth the colony (Stanley, 2010).

The queen bee, although the indispensable head of the colony, is no ruling sovereign, but the servant of the community. Even the joys of a constitutional monarch are not hers, for she is guided and controlled in her every action by the worker bees. Here one duty as a reigning queen is to lay eggs in the cell of the brood combs (Stanley, 2010).

2.4. Pollination:

To provide of successful pollination, plant for interplanting of varieties had to be based on the knowledge of the bee activity in the orchard and studies were undertaken for the same.

In India honey bees have been deemed necessary for pollination and good setting of Bersem (*Trifolium alexandrium*). Increase in the production of strawberries, around 50% acre, has been recorded, when an apiary was

located near strawberry plot. Almonds were made productive by interplanting of cross fruit varieties and source (Mahindru, 2007).

Radish and pumpkin are highly preferred by the bees. They spend on an average 6.34 and 38.0 seconds/flower respectively, the later being more, probably on account of the bigger size of the flower, it is seen that with lesser time spent per flower. The number of flowers visited is more for feeding bout and bees revisit the some flowers. This explains the low productivity of entomophilous plant where bee pollination is not made an essential cultivation practice (Mahindru, 2007).

2.5. The structure and formation of pollen

Each pollen grain contains vegetative (non-reproductive) cells and a generative (reproductive) cell containing two nuclei: a tube nucleus. The group of cells is surrounded by a cellulose-rich cell wall called the intine, and a resistant outer wall composed largely of sporopollenin called the exine. Pollen is produced in the 'microsporangium' (contained in the anther of an angiosperm flower, male cone of a coniferous plant, or male cone of other seed plants). Pollen grains come in a wide variety of shapes, sizes, and surface markings characteristic of the species. Pollen grains of pines, firs, and spruces are winged. The smallest pollen grain, that of the forget-me-not (*Myosotis* spp.), is around 6 μm (0.006 mm) in diameter. Wind-borne pollen grains can be as large as about 90–100 μm . (Pleasants, *et al*, 2001).

In angiosperms, during flower development the anther is composed of a mass of cells that appear undifferentiated, except for a partially differentiated dermis. As the flower develops, four groups of sporogenous cells form within the anther. In angiosperms, during flower development the anther is composed of a mass of cells that appear undifferentiated, except for a partially differentiated dermis. After the formation of the four microspores, which are contained by callose walls, the development of the pollen grain walls begins.

The callose wall is broken down by an enzyme called callase and the freed pollen grains grow in size and develop.

Their characteristic shape and form a resistant outer wall called the exine and an inner wall called the intine. The exine is what is preserved in the fossil record. (Sporne, 1972).

The pollen grain surface is covered with waxes and proteins, which are held in place by structures called sculpture elements on the surface of the grain. . In some flowering plants, germination of the pollen grain often begins before it leaves the microsporangium, with the generative cell forming the two sperm cells (Judd, et.al., 2004).

2.6 The composition of pollen:

The composition of pollen changes from species to species, variation in absolute amounts of the different compounds can be very high. Protein contents of above 40% have been reported, but the typical range is 7.5 to 35%: typical sugar content ranges from 15 to 50% and starch content is very high (up to 18%) in some wind-pollinated grasses. The major components are proteins and amino acid, lipids and sugars (Rychlewski , and Kazlmierz,1975).

2.7 Foraging by the bees:

The oldest among field bees the most experienced are the scouts. They find new sources of nectar and pollen, bring samples in the hive for others to taste, and perform dance to convey the information on their location. There is flexibility among the forages as to collect i.e. nectar or pollen or both. In study it was observed that 58% of foragers collected only nectar, 25% only pollen, and 17% both nectar and pollen.

Both adult and larval honey bees can survive on a purely carbohydrate diet for some time, but are un able to grow and develop normally without protein, all of which, except perhaps for the trace present in some nectars, is derived from pollen(Butler, 1977).

Attempts to discover the kinds of pollen which are most frequently collected by worker honey bees were made with pollen traps designed to rob a certain number home-coming, hive (plate 1 and 2). No method of automatic trapping so far devised can be accepted to yield really accurate results, since the proportion of the loads which are taken from the bees during a given period by any trap depends to a considerable extent upon the size of loads themselves, which vary considerably (Butler, 1978).

A pollen collector bees generally takes 10 minutes to prepare its load in the pollen basket and the weight ranges between 10-30 mg. Under good weather conditions field workers of a colony of 50,000 can make 163,000 trips in a day and can theoretically collect their yearly provisions in about a month. When a field workers comes to her hive she transfer the load to the nearest house bee, take a minute or two to eat some food, wipes her tongue between the forefeet, rubs her eyes, cleans her antennae and takes off for the field(Salcedo, 2010).

2.8 Antioxidant/anti-aging:

The oxidative damage caused is free radicals have been implicated in quite a number of disease processes, and is the primary factor in aging. Interestingly, bee pollen appears to provide significant antioxidant activity, which may explain its traditional use as an anti-aging food (Harish,1997).

One animal study demonstrated that bee pollen was able to abolish the effects of harmful ionizing radiation on the brain. This was a function of bee pollen antioxidant properties (Anan'eva, 1999). Another study demonstrated that bee pollen was able to markedly decrease lipoperoxide levels in animals fed a limited diet, compared to animals not receiving bee pollen. In a study on humans, bee pollen and several other Chinese herbs were found to increase the number of red blood cells (Iversen, 1997).



Plate (1): Sample of pollen grains trap



Plate (2): Pollen grains

2.9 Artificial Pollination:

Since Butler (1987) demonstrated the feasibility of the use of hand pollination of fruit trees, there have been many attempts to use some artificial method of pollination. The subject has been summarized by Butler (1987) suggested was a pot ten comb which, when exposed in a tree, was supposed to accomplish pollination. Other method was to blow pollen by mean of a bellows. Type duster on the blossoms. This technique was found to be wasteful of pollen and resulted in an un even set of fruit. Water pollen sprays have also been attempted but proved unsatisfactory (Butler, 1987).

2.10. Use of pollen grain for humans

A variety of producers have started selling bee pollen for human consumption, often marketed as a food (rather than a dietary supplement). The largest constituent is carbohydrates, with protein content ranging from 7 to 35 percent depending on the plant species collected by bees (Sanford, 1975). Honey produced by bees from natural sources contains pollen derived p-coumaric acid, an antioxidant (Mao, et. al. 2013).

The U.S. Food and Drug Administration (FDA) have not found any harmful effects of bee pollen consumption, except from the usual allergies (Sanford, 2007).

2.11. Factors Influencing Field Activity:

Field activity of honey bee in a colony is regulated by a number of factors; space for storing food. The honey bees make most economic use of their collective energy. In most places the appearance of flowers is seasonal and bees instinctively build up their colony strength in preparation (Butler, 1987).

2.11.1 Weather Conditions:

Naturally bees will visit flowers at a certain time of the day when food is available to them for exploitation of that source. Pollen collected bees are very active in the morning hours when pollen is available (Mahindru, 2007).

2.11.2 Light

During good weather the intensity of light does not affect bee activity but when weather is cold and there is food in a colony the bees are stimulated by bright light to forage even through the outside temperature might be as low as 44F(www.envirobee.com/beepollen.htm).

2.11.3 The health of bees:

The health of bees is very importance both in term of the amount of work done in a day and the total number of days for which bees live to work. Their health is affected by a number of virus, protozoa, mite and diseases (Amoros,1994).

2.11.4. Wind:

It is generally stated that a wind of 25 miles per hour will stop bee flight and lesser velocities will reduce flight.

To summarize the effects of climatic conditions on the flight of honey bee, solitary bees, and bumble bees the flowing facts are stated:

1- Much more experimental work is need before reliable conclusions can be drawn.

2- In general, the bumble bee is least effected by climatic.

3- Honey bees appear superior to most solitary bees in adverse climatic condition (Johnstone, 2001).

2.12. Uses of bee pollen grains:

2.12.1 for the honey bees colony:

The pollen stored by honeybees undergoes lactic acid fermentation and is thus preserved. This final storage product is called beebread.

Beebread is usually found on brood combs or combs near the brood nest. Social bees usually store their pollen in special containers separate from the brood combs. These "pollen pots" can therefore be harvested without destroying the nest, but caution is necessary not to deplete the food sources completely (www.pollen grain.net).

2.12.2 How to take Bee Pollen for humans:

Adults: Start with 1 tsp. in the morning (1/2 hour before breakfast) followed with some water, juice or milk. Increase your intake every day by a few grains until reaching 2 tsp. a day (10 ml). For normal daily intake you may take up to 1 tbsp. (15 ml)

Children: Start from 3 grains, increasing by 2 grains every few days until reaching 1/2 tsp. a day. You may mix pollen with raw honey and eat it, or dilute it in a liquid at room temperature.

(www.envirobee.com/beepollen.htm).

2.13. Forensic biology:

In forensic biology, pollen can tell a lot about where a person or object has been, because regions of the world, or even more particular locations such a certain set of bushes, will have a distinctive collection of pollen species. Pollen evidence can also reveal the season in which a particular object picked up the pollen. Pollen has been used to trace activity at mass graves in Bosnia (Wood, 2004) catch a burglar who brushed against a *Hypericum* bush during a crime, and has even been proposed as an additive for bullets to enable tracking them (Mildenhall, 2006).

2.14. Pollen as a carrier of ecological information in plants:

Russian theoretical biologist Geodakyan (1985) has suggested that the quantity of pollen reaching a pistil late flower can transmit ecological information and also regulate evolutionary plasticity in cross-pollinating plants. Plentiful pollen indicates optimum environmental conditions.

Geodakyan believes that the quantity of pollen reaching a pistil late flower defines the sex ratio, dispersion and sexual dimorphism of a plant population (Geoddakyan, 1985).

Dependence of offspring phenotype variety on amount of pollen was observed by Ter-Avanesyan (1949). All studied species of plants showed

dependence in the direction forecast by the theory-fertilization with a small amount of pollen resulted in an increase in the diversity of the offspring. Ter-Avanesian writes that as a result of a limited pollination Ter-Avanesian (1978).

CHAPTER THREE

MATERIALS AND METHODS

3.1 Site Location:

3.1.1 Radoom area:

Is a biosphere reserve in South Darfur, Sudan, Africa. It is 1,250,970 hectares (3,091,200 acres) in size-.The Adda and Umblasha Rivers form the park's northern and southern boundaries. Approximately 90% of the habitat is shrubland, while the remainder is forest. Annual rainfall ranges between 900–1,700 millimetres (35–67 in); the mean annual relative humidity ranges between 57-65%; and the average annual temperature is 16-27 C (Hassan, *et. al.*, 2005).

Forests cover (48%) of the area of state, or about (7- 15) millions acre natural forests, fork tree in the north, broadleaf trees in the south, where prevail savannah- rich and contribute to these forests in production gum, gana, Mohogani, Saro, Taleh and Aradab trees (Hatim, 2006) (in Arabic).

3.1.2 Beekeeping activities in South Darfur:

About beekeeping activities, there are traditional beekeepers, use local bee hives known as Tangels (plate 3 and 4), made from traditional material such as stems of tree, hay tie with rop and coating it with mud and putting it on top of a tree for three to four months, the bees then inter the Tangel and produce honey (Dinar, 2006).

In the past the local beekeepers had an important activity, yet it is practices have had terrible implication on the environmental and bee species. Cutting and burning down of tree and cracking out barks of tree for bee hives. Production and harvesting were un friendly ways. But today, there are many

organizations like (UNDP). Works with farmers to identify a suitable structure to introduce essential training and methodology. Training about how to inspect and manage bee hives sustainably and how to improve handling and quality of the honey produced. The honey produced in South Darfur is particularly favored by an increasingly wild base of national and regional market (<http://www.sd.undp.org/index.htm>), (UNDP).



Plate (3) Traditional beekeeper with his bee hive ready to be used:



Plate (4) Types of traditional bee hives (Tangels) made from mud and hay tie in Radom area

This experiment was conducted in the National Centre for Environmental Research (NCER). In Khartoum State.

3.2 Material of the study:

- Forceps
- Slides
- Slide covers
- Bee comb
- Alcohol concentrating (50-60-70-80-95%)
- Petri dishes
- Potassium hydroxide (koh)
- Water
- Zylol solution
- D-B-X

3-3 METHODOLOGY

1- Collection Procedure (comb collection):

The three bee combs were collected from different site in Radom area by using smoke.

2- Sample Preparation:

-Pollen grains were collected by using the forceps; each pollen grain was located separately on glass slide.

-There after the separated pollen grain was dissolved in few drops of potassium hydroxide (koh).

-Then the three samples were washed with 50%, of alcohol.

-Faxing stain was used for pollen staining on the slide.

- The slide was washed three times using 60%,70%and 80% of alcohol respectively.

-Zylol sample fixation, Zylol solution was used.

-The slide has been washed with 95% of alcohol.

-The cover slide was fixed by D.B.X.

-For pollen grains detection electronic microscope supplied with camera in the zoom 40 micron.

-Result analysis was done in the National Centre for Environmental Research (NCER).

The experiment design:

The experiment was arranged in complete randomized design with 3 replicates (wax combs from three sites in Radom area).

Data analysis was done using Atlas reference (Ghazali, 1989) to describe the pollen grains.

CHAPTER FOUR

RESULTS

This study was carried out in Radom area in South Darfur State, and the samples (Three bee combs) collected during period September 2013-February 2014, from different sites in Radom area, which contain different of pollen grains estimated about 22 pollen grains sources collected by honey bee from different plants. Most of pollen grains belong to family Mimosaceae, this family is distributed in all parts of state, and their form was compressed biconvex disc type (Table, 2, 4 and 6).

To study the importance of pollen grains, the result is shown as following:

Wax comb collected in September, 2013 from Radom area, South Darfur State. Its found in this study different types of pollen grain sources, which collected from Radom area, such as *Cassia senna*, *Tamarindus indica*, *Sorghum virgatum*, *Fedherbia albida* and *Combretum glutinosum*. Results showed in tables (1, 3 and 5), showed were found significant differences among the size and shape of pollen grains this differences attributed to differences in pollen grain sources, (tables 2, 4 and 6) and plates (6- 15). Results also showed difference plant families to bee pollen sources, which collected from Radom area. Table (7) showed the percentage of each family. And in figures (1, 2 and 3), and its found in it a lot of plant sources, such as forest trees, like (*Fedherbia albida* and *Hyphaene thebaica*), fodder plants (*Sorghum virgatum* and *Medicago sativa*), herbs (*Diospyros mespliformis*) and vegetable plants (*Corchorus olitorius*).

Table 1: Classification of pollen grains sources collected from Radom area, First site:

Number of slide	Family	Scientific name	English name	Arabic name
1	Cruciferae	<i>Eruca sativa</i>	Rocket salad	جرجير
2	Caesalpiniaceae	<i>Cassia senna</i>	Alexandrian senna	سنة مكة
3	Caesalpiniaceae	<i>Cassia italica</i>	Italian senna	سنة سنة
4	Broaginaceae	<i>Heliotropium strigosum</i>	-	-
5	Liliaceae	<i>Asparagus flagellaris</i>	-	شعر البنات
6	Ranunculaceae	<i>Clematis hirsuta</i>	-	شعلوب
7	Aizoaceae	<i>Glinus lotoides</i>	-	رمت
8	Malvaceae	<i>Corchorus olitorius</i>	Mallow, Mulukhiyah	ملوخية
9	Combretaceae	<i>Combretum glutinosum</i>	-	هيبيل

Table 2: Diameters and shapes of pollen grains which collected from Radom area

Family	Scientific name	Dimensions	Poll
Cruciferae	<i>Eruca sativa</i>	p= 23.9µm E=21.2µm k= 0.83	Circu
Caesalpinaceae	<i>Cassia senna</i>	P=50.5µm, E=38.6µm, K=0.84	Circu
Caesalpinaceae	<i>Cassia italica</i>	P=41.9µm, E=35.5µm K=0.80	Circu
Broaginaceae	<i>Heliotropium strigosum</i>	P=50.4µm E=39.2µm K=0.94	Sime
Liliaceae	<i>Asparagus flagellaris</i>	long axis=33.8µm short axis 18.3µm k=0.86	Elon
Ranunculaceae	<i>Clematis hirsuta</i>	P=28.7µm E=30.3µm k=0.91	Circu angu
Aizoaceae	<i>Glinus lotoides</i>	P=30.2µm E=32.5µm K=0.86	Circu
Tiliaceae	<i>Corchorus olitorius</i>	P=58.5µm, E=41.2µm, K=.90	Circu angu
Combretaceae	<i>Combretum glutinosum</i>	P=31.4µm, E=28.4µm, K=0.92	Stria

Key: **D**=Diameter **E**= Equatorial axis

K=Conversion factor **P**= Polar axis

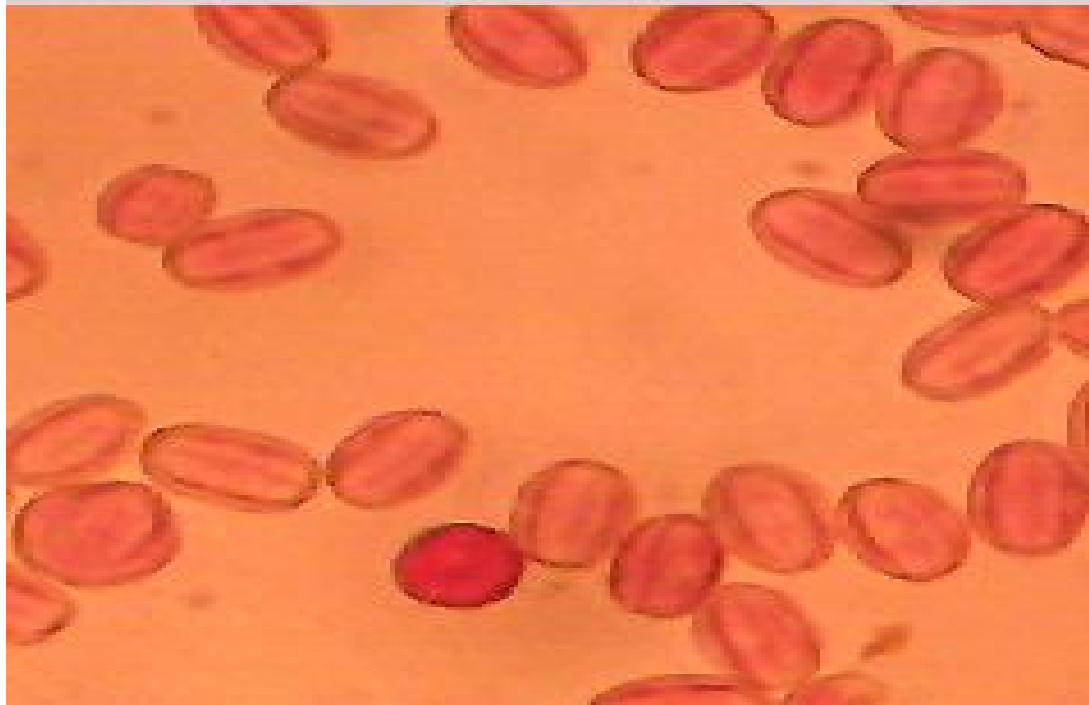


Plate (5) Shapes of pollen grains for different plants

1- S.N: *Corchorus olitorius*

2- S.N: *Asparagus flagella*

3-S.N: *Eruca sativa*

4- S.N: *Cassia italica*

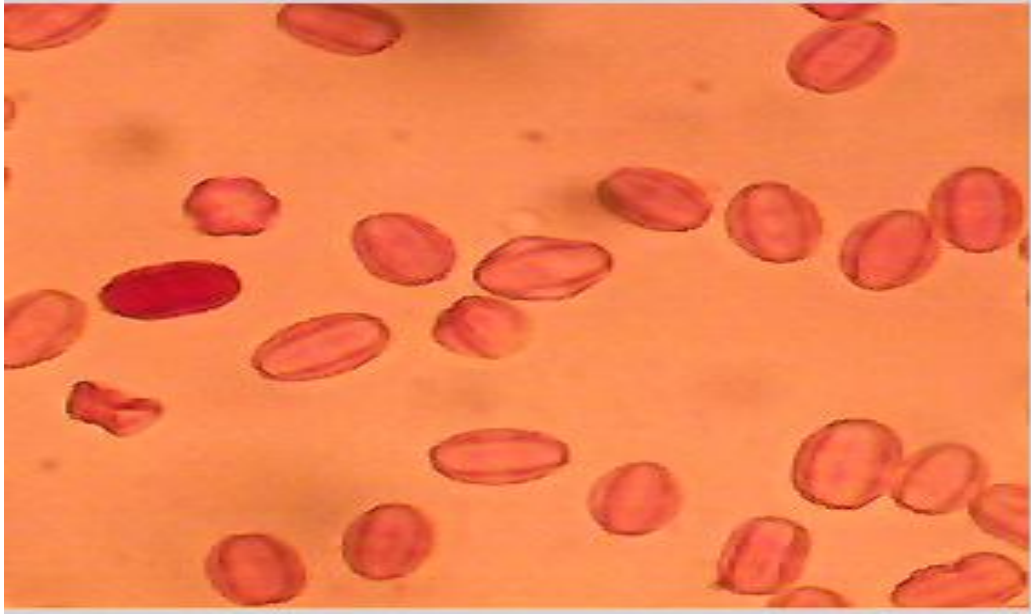


Plate (6) Shapes of pollen grains collected from different plant sources:

1- S.N: *Clematis hirsuta*

2- S.N: *Combretum glutinosum*

3- S.N: *Glinus lotoides*

4- S.N : *Cassia senna*

Table 3: Classification of pollen grains sources collected from Radom area, Second site:

Number of slide	Family	Scientific name	English name	Arabic name
1	Balanitaceae	<i>Balanites aegyptica</i>	Soapberry	هجليج
2	Caesalpinaceae	<i>Tamarindus indica</i>	Tamarind	عرديب
3	Acanthaceae	<i>Hygrophila auriculata</i>	-	ابو شويكة
4	Euphorbiaceae	<i>Euphorbia abyssinica</i>	Cndelara spurge	شجر السم
5	Papilionaceae	<i>Medicago sativa</i>	alfa alfa	برسيم
6	Gramineae	<i>Sorghum virgatum</i>	Tunis grass	عيش الريف
7	Capparidaceae	<i>Capparis decidua</i>	Kerda, Karir	همبك تندب
8	Palmae	<i>Hyphaene thebaica</i>		دوم
9	Malvaceae	<i>Corchorus olitorius</i>	Mallow, Mulukhiya	ملوخية
10	Combretaceae	<i>Combretum glutinosum</i>		هبييل

Table 4: Diameters and shapes of pollen grains which collected from *Acacia seyal* from Rado

Family	Scientific name	Dimensions	P
Balanitaceae	<i>Balanites aegyptica</i>	P=45.4µm, E=38µm, K=0.87	In
Caesalpinaceae	<i>Tamarindus indica</i>	P=52.7µm, E=41.7µm, K=0,93	C an
Acanthaceae	<i>Hygrophila auriculata</i>	P=89.8µm, E=86.1µm, K=0.84	C el
Euphorbiaceae	<i>Euphorbia abyssinica</i>	P=42.4µm E=38.1µm, K=0.81	In
Papilionaceae	<i>Medicago sativa</i>	P=44.2µm, E=37.5µm. K=0.91	Se
Gramineae	<i>Sorghum virgatum</i>	D=52.0µm K=0.90	C
Capparidaceae	<i>Capparis decidua</i>	P=28.0µm. E=22.7µm, K=0.90	C
Palmae	<i>Hyphaene thebaica</i>	Long axis=69.6µm, Short axis=58.3µm, K=0,85	C
Tiliaceae	<i>Corchorus olitorius</i>	P=28.7µm, E=41,2µm, K=0.90	C an
Combretaceae	<i>Combretum glutinosum</i>	P=31.4µm, E=28.4µm, K=0.92	St

D= Diameters

E= Equatorial axis

P= Polar axis

K= Conversion factor

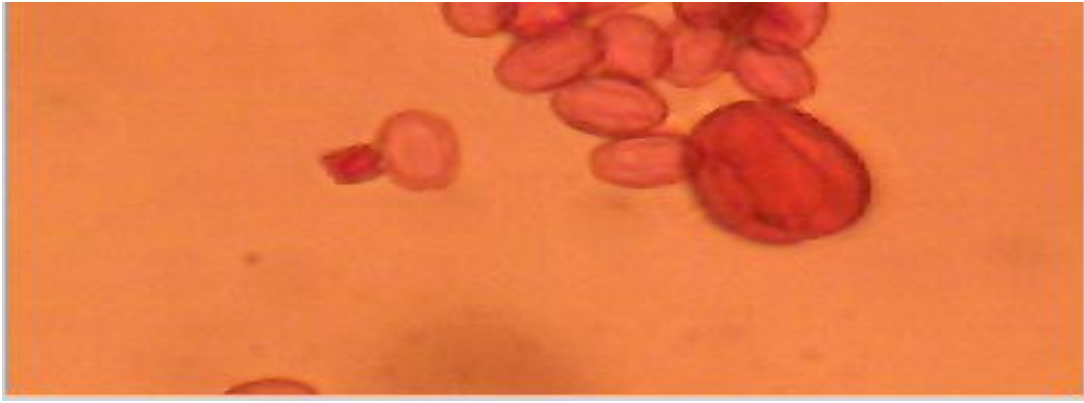


Plate (7): Shapes of pollen grains

1- S.N: *Hygrophila auriculata*

2- S.N: *Capparis decidua*

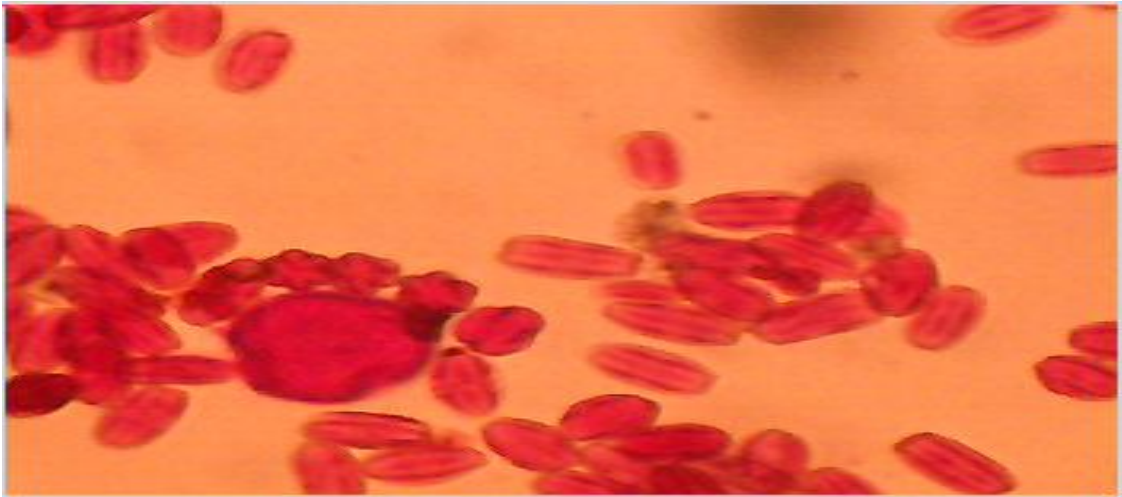


Plate (8) The shapes of pollen grains collected from different plant sources:

1- S.N: *Balanites aegyptica*

2- S.N: *Euphorbia abyssinica*

3- S.N: *Hyphaeme thebaica*



Plate (9): Shape of pollen grain collected from:

S.N: *Sorghum virgatum*

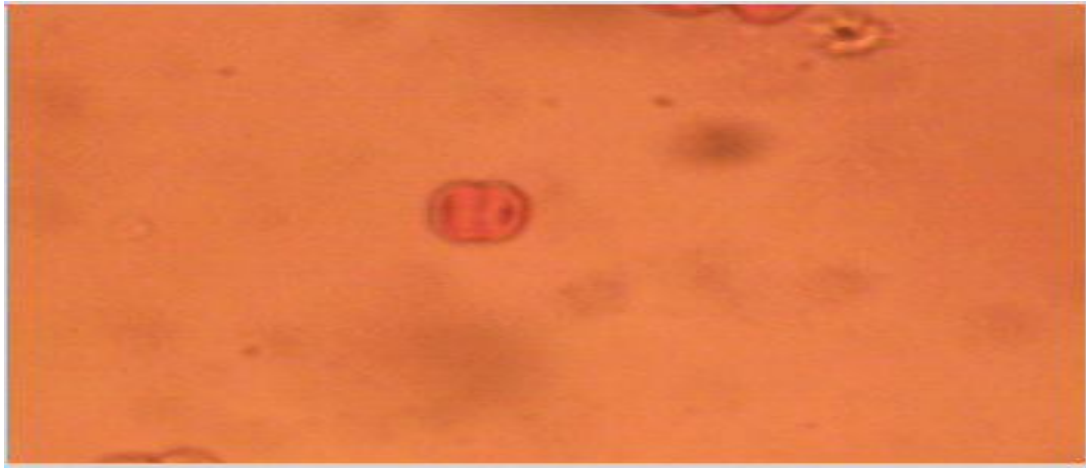


Plate (10): Shape of pollen grain collected by honey bee from Radom area, from:

S.N: *Tamarindus indica*

Table 5: Classification of pollen grains sources collected from Radom area, Third site:

Number of slide	Family	Scientific name	English name	Arabic name
1	Mimosaceae	<i>Fedherbia albida</i>	Applering Acacia	حراز
2	Mimosaceae	<i>Acacia seyal</i>	Whilling thorn	طلح
3	Mimosaceae	<i>Albizia aylmeri</i>	-	قرضاية
4	Ebenaceae	<i>Diospyros mespliformis</i>	African ebony	ابو سبيلة
5	Mimosaceae	<i>Acacia mellifera</i>	-	كتر
6	Liliaceae	<i>Asparagus flagellaris</i>	Maidenhair tree	شعر البنات
7	Malvaceae	<i>Corchorus olitorius</i>	Mallow, Mulukhiya	ملوخية
8	Acanthaceae	<i>Hygyrophila auriculata</i>		ابو شويكة

Table 6: Diameters and shapes of pollen grains which collected from *Acacia seyal* from Radom area

Family	Scientific name	Dimensions	Pollen shape
Mimosaceae	<i>Fedherbia albida</i>	D=151.1µm, K=0.86	Compressed
Mimosaceae	<i>Acacia seyal</i>	D=71.9µm, K=0.85	Compressed
Mimosaceae	<i>Albizia aylmeri</i>	D=109µm, K=0.92	Compressed
Ebenaceae	<i>Diospyros mespliformis</i>	P=59.2µm, E=48.6µm, K=0.93	Circular
Mimosaceae	<i>Acacia mellifera</i>	D=73.8µm, K=0.89	Compressed
Liliaceae	<i>Asparagus flagellaris</i>	long axis=33.8µm short axis 18.3µm k=0.86	Elongated
Tiliaceae	<i>Corchorus olitorius</i>	P=28.7µm, E=41,2µm, K=0.90	Circular to
Acanthaceae	<i>Hygyrophila auriculata</i>	P=89.8µm, E=86.1µm, K=0.84	Circular to

D= Diameter

K= Conversion factor

E= Equatorial axis

P= Polar axis

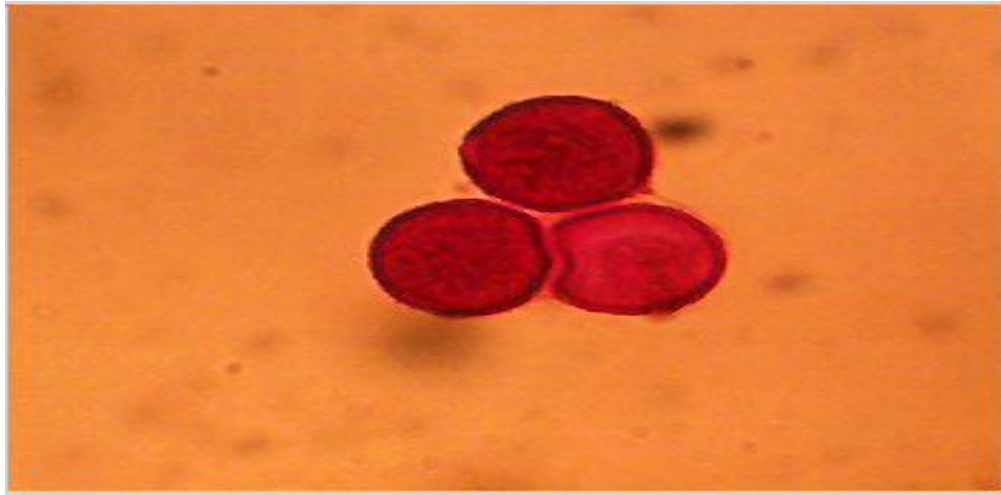


Plate (11): The pollen grain shape collected by honey bees, from:

S.N: *Fedherbia albida*

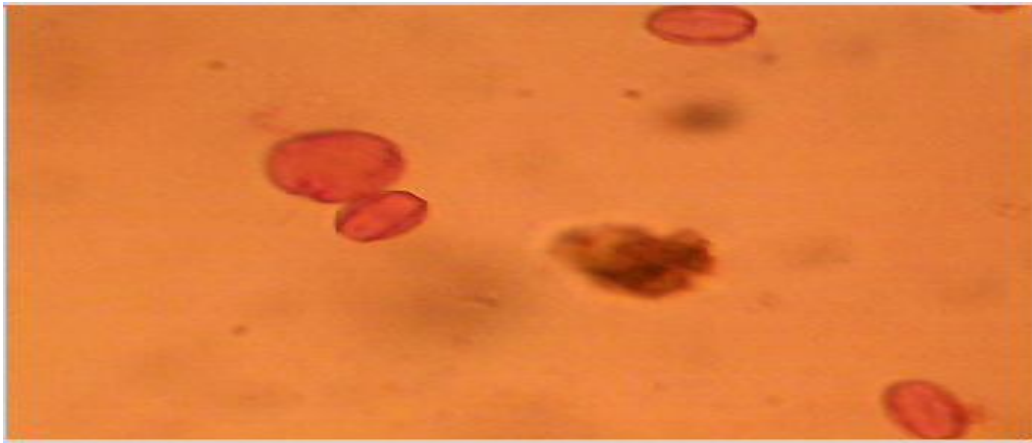


Plate (12): The pollen grain shape collected from Radom area by honey bees from:

S.N: *Medicago sativa*

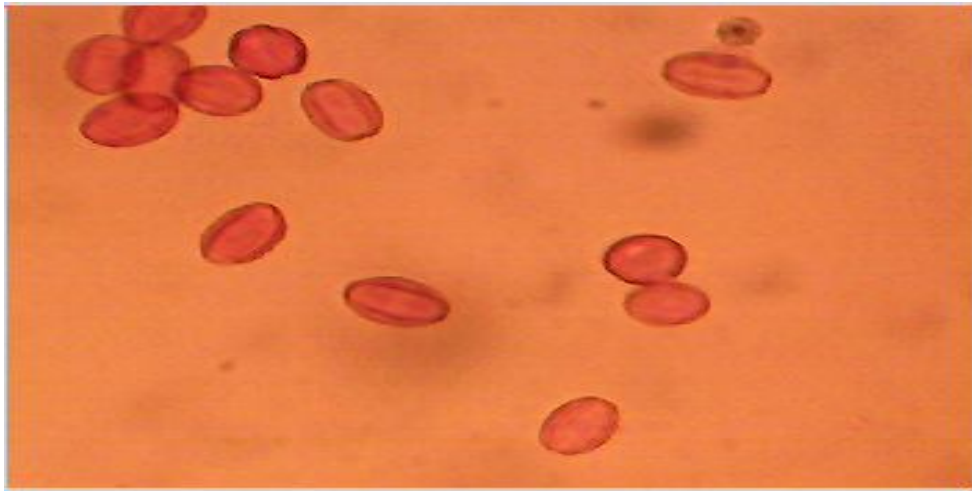


Plate (13): Shapes of pollen grains collected from Radom area from:

1- S.N: *Acacia mellifera*

2- S.N: *Asparagus flagellaris*

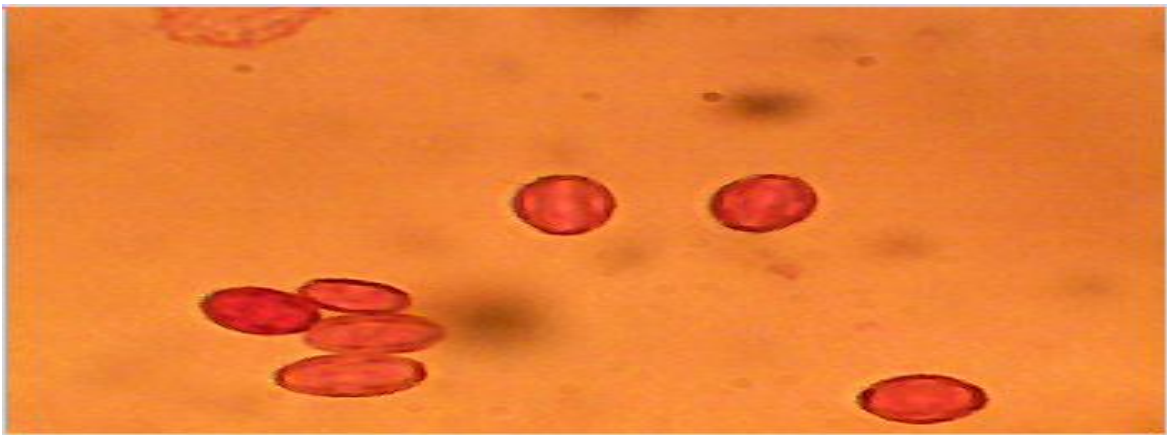


Plate (14) Shapes of pollen grains collected from Radom area from:

1- S.N: *Acacia seyal var seyal*

2- S.N: *Albizzia Aylmer*

Table (7) The Percentages of families.

Family	Number of plant	The percentage of family %
Mimosaceae	4	16%
Malvaceae	3	12%
Caesalpinaceae	3	12%
Liliaceae	2	8%
Acanthaceae	2	8%
Combretaceae	2	8%
Cruciferae	1	4%
Ranunculaceae	1	4%
Aizoaceae	1	4%
Blanitaceae	1	4%
Euphorbiaceae	1	4%
Gramineae	1	4%
Palmae	1	4%
Papilionaceae	1	4%
Caparidaceae	1	4%
Ebenaceae	1	4%

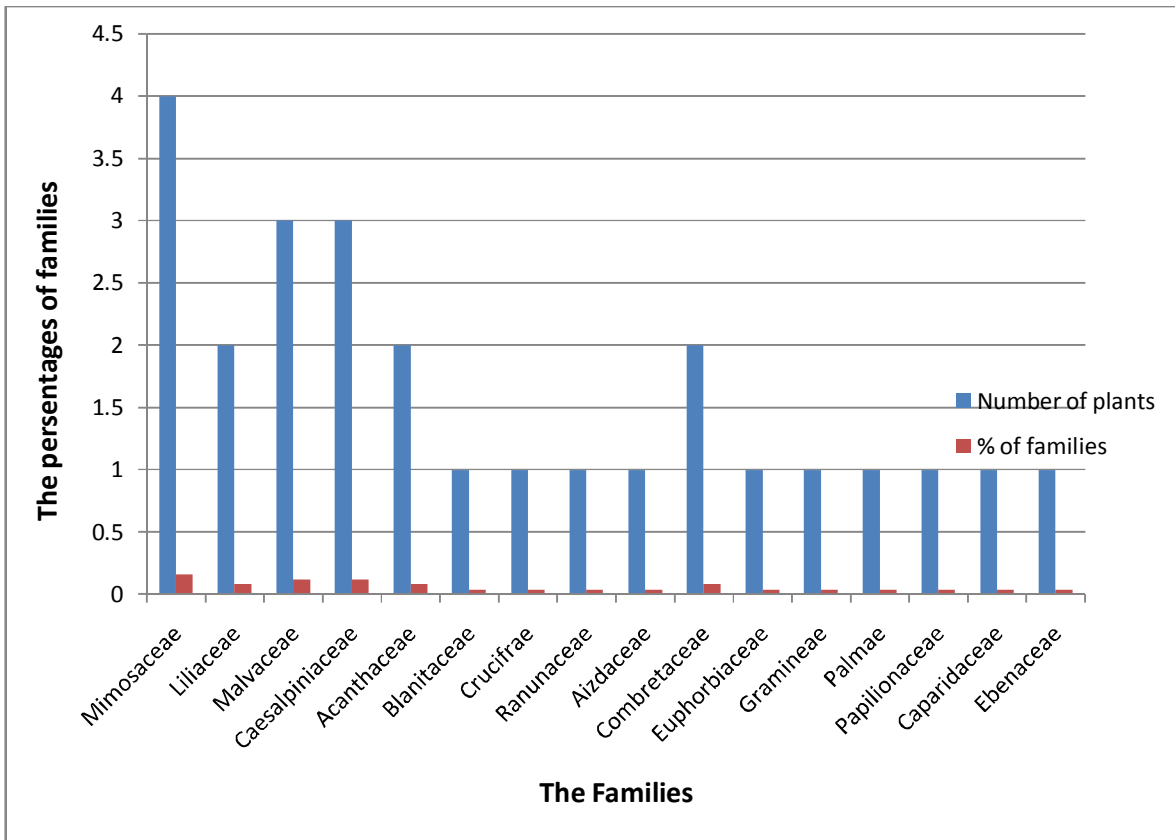


Figure (1) The percentages for families of the pollen grain sources collected by bees in Radom area

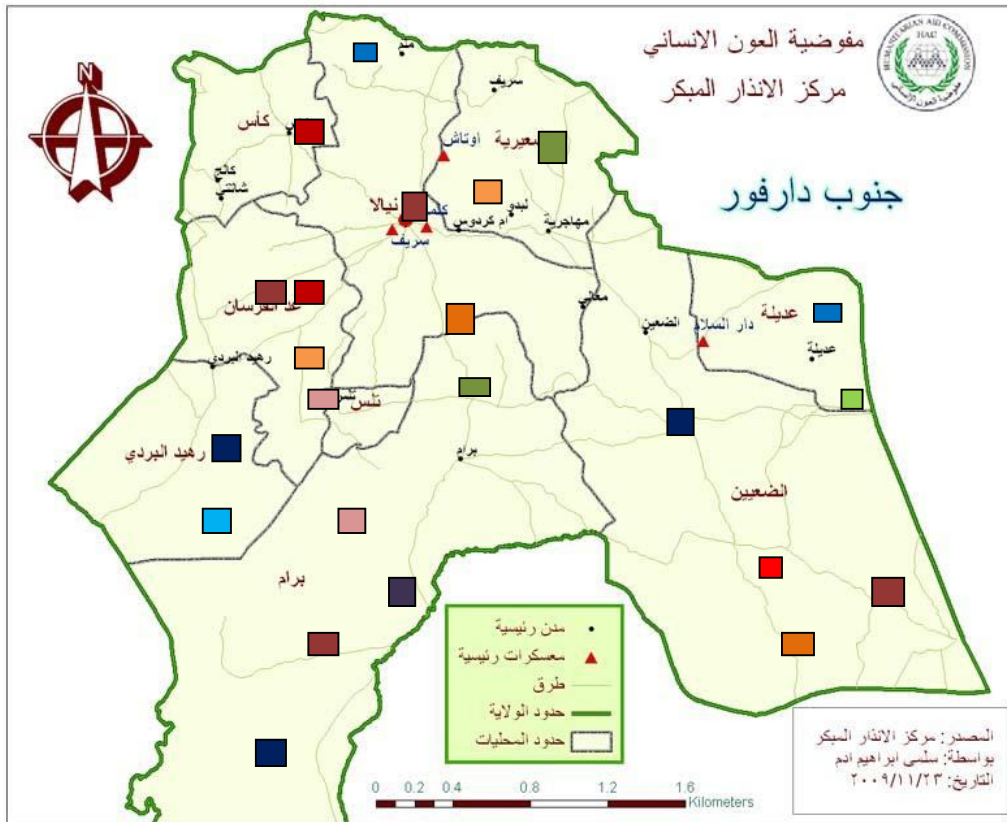


Figure (2) Map of South Darfur with percentages of plant family

Mimosaceae ■

Aizoaceae ■

Malvaceae ■

Euphorbiaceae ■

Caesalpiniaceae ■

Source:

مركز الانذار المبكر.

Acanthaceae ■

بواسطة: ادم سلمى. (2009.)

Liliaceae ■

Combretaceae ■

Blanitaceae ■

Ranunaceae ■

Palmae ■

Gramineae ■

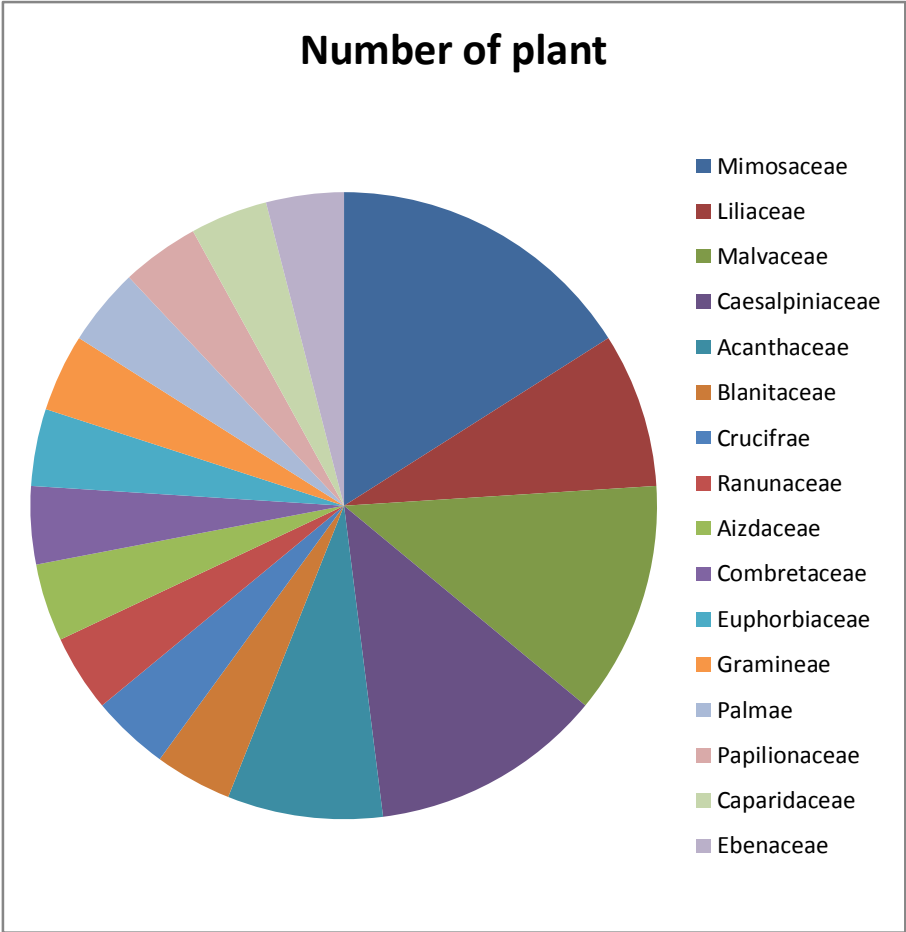


Figure (3) The percentages for families of the pollen grains sources which collected by bees in Radom area:

CHAPTER FIVE

DISCUSSION

This study was carried out in Radom area in South Darfur State during the period Sep, 2013 to Feb, 2014.

Considering the collecting sampling from bee comb as seen in plates (6-15), there were significant differences among the samples of pollen grains, which repaired on three slides.

5.1 Classification, Diameters, and Shapes of Pollen Grains Sources (First site):

Table (1) showed the classification of pollen grains sources collected from Radom area during Sep, 2013- Feb, 2014. It's found (8) families of plant sources.

Family Cruciferae: contain a plant S.N *Eruca sativa* it shape is circular, the percentage of family (4%)

Family Caesalpiniaceae: contain two plants, S.N: *Cassia senna*, it shape is circular, and *Cassia italic*, it shape is circular. This family is located in all parts of state.

Family Broaginaceae: contain a plant, S.N: *Heliotropium stragosum*, it shape is circular.

Family Liliaceae: contain a plant located in northern of the state S.N: *Asparagus flagellaris*, it shape is elongated.

Family Ranunculaceae: contain S.N: *Clematis hirsute* it shape is circular to sime- angular.

Family Aizoaceae: S.N *Glinius lotorius*, it shape is circular

Family Malvaceae: this family contain a plant and spread in all the state, S.N *Corchorus olitorius*, it shape is circular to sime- anguler.

Family Combretaceae: S.N: *Combretum glutinosum*, it shape is striate

Through the analysis of this table we found clear differences in the form and shape of pollen grains. This differences back to different in plant sources and families.

5.2 Classification, Diameters and Shapes of Pollen Grains Sources (second site):

In tables (3 and 4) showed the classification of pollen grains sources collected from Radom area during Sep, 2013- Feb, 2014. We found (10) families of plant sources. And all plants that belong to the same family have the same shape with a difference in dimensions; we found here a lot of plant sources, such as forest trees, fodder plants and vegetable plants.

Forest trees:

Family Blanitaceae: S.N: *Blanaites aegyptica*, it shape is inter sub- angular.

Family Caesalpinaceae: S.N: *Tamarindus indica* it shape circular to sime- angular.

Family: Acanthaceae: S.N *Hygrophila auriculata* it shape is circular to slightly elongated.

Family:Euphorbiaceae: S.N: *Euphorbia abyssinica*, it shape is inter- sub angular.

Family: Palmae: S.N: *Hyphaene thebaica* it shape circular.

Family: Capparidaceae: *Capparis deciduas*.

Family: Combretaceae: *Combretum glutinosum*

Fodders plants:

Family: Papilionaceae: S.N: *Medicago sativait* shape is sime- angular.

Family Graminae: S.N: *Sorghum virgatum*, it shape circular.

And vegetable plant:

Family : Malvaaceae: S.N: *Corchorus olitorius*.

5.3 Classification, Diameters and Shapes of Pollen Grains Sources (third site):

In tables (5 and 6) showed the classification of pollen grains sources collected from Radom area during Sep, 2013- Feb, 2014. It's found (6) families of plant

sources. In most of pollen grains samples were forest trees, herbs and vegetable plant.

Forest plants:

Family: Mimosaceae: This family contains (4) plants:

S.N: *Fedherbia albida*, *Acacia seyal*, *Abizia aylmeri*, and *Acacia mellifera*

All pollen grains collected from this family has some shape, (compressed biconvex disc), also large shape.

Herbs:

S.N: *Diospyros mespliformis*, *Asparagus flagellaris*, and *Hygyrophilla auriculata*.

Vegetable plant like:

Family: Malvaaceae: S.N: *Corchorus olitorius*.

Conclusion:

This study was carried out in Radom area in South Darfur State, and the samples collected during period September 2013- February 2014, from three sites in Radom area, which contain different of pollen grains estimated about (22) pollen grains collected by honey bees from different plant. Most of pollen grains belong to family Mimosaceae, this family is distributed in all parts of state, and their form was compressed biconvex disc type.

All pollen grains that belong to the same plant family have the same shape with a difference in dimensions, and it's found in this study a lot of plants, such as forest trees, fodder plants, herbs and vegetable plants.

Most of pollen grains have circular type, followed by semi- angular type, sub-angular, circular to sime- angular, elongated and compressed biconvex disc. Family Mimosaceae was found to contain the highest percentage of plant species.

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