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Dedication

To........

Dear father
Loving mother
My lover
My family
My friends
With my passion
Eimo
Acknowledgement

I would like to express my sincere gratitude to my supervisor Dr. Dafaalla Ali Ibrahim who spared much of his valuable time to help, and it would not have been possible to conduct the study without this support.

Gamal Eldien Elghazali was very helpful for allowing his ph. D. these as a reference for pollen me to use identification.

My sincere thanks to the staff in Botany Department.

Last but not least, I would like to express my deep gratitude to all members of my family special thanks to my parents for their patience and gratuitous support.
ABSTRACT

Pollen analytical examination of three faecal samples of animal (Goats, camels and donkeys) was carried out. The samples were collected from Shambat.

The method applied for the pollen analysis in this study are those of Faegri and Iverson (1989).

A total number of 12 pollen types were identified to different taxonomic levels. The results obtained are presented in absolute counts of individual pollen types in the various sampling sites. Relative abundance of these pollen types.

The highest percentage (90%) of pollen grains is shown by (Gramineae), while the lowest percentage (0.15%) of pollen grains is shown by (Asteraceae).

The pollen type identified from the different samples are from the following plant families: Asteraceae, Euphorbiaceae, Gramineae, Labiatae, Mimosaceae, Papilionaceae, Sapindaceae.

The pollen content of the coprolites sampling reflects the composition of the vegetation zones from which they were recovered, but this is masked by the fact that there are some entomophilous species.

The study throw light on the possible use of polynological studies of animals' coprolites to show preference by animals to some plants.
الخلاصة

أجريت اختبارات التحليل الطُطيسي لثلاث عينات من حبوب اللقاح (أغذام، إبل وحمير) لمنطقة شمسيات.

إتبعت طريقة Faeghi لتحليل حبوب اللقاح وتم التعرف على أحد عشر نوعًا من حبوب اللقاح ثم عرضت النتائج في جدول شملت الأعداد لكل نوع من حبوب اللقاح في كل عينة على حدة وكذلك وضحت الوفرة النسبية.

على النسبة المئوية من بين الأنواع المختلفة كانت 87.1% (الفصيلة النجيلية) بينما أقل نسبة كانت 0.05% (الفصيلة المركبة).

لقد أوضح كذلك أن حبوب اللقاح والتي تم التعرف عليها من العينات هي من الفصائل النباتية الأليفة: المركبة، اللبية، النجيلية، الشفوية، الطحية، الفراشية، السابنية.

إن محتملات روت الحيوانات من حبوب اللقاح عكست بشكل واضح تكوين الغطاء النباتي لهذه المنطقة والأصل الجغرافي الذي جمعت منه تلك العينات، ولكن هناك مجموعة من العوامل يمكن أن تؤثر على صحة أي إنتاج يمكن أن ينطلق إليه الباحث من ضمن هذه العوامل: آلية النقل (الرخين، الرمادي، الخ) ودرجة قبول حيوانات الرعي (الأغذام، الإبل والحمير) في هذه الدراسة لأوراق أو أزهار النبات المعني.

أظهرت الدراسة الضوء على إمكانية استخدام التحليل الطُطيسي في التعرف على أنواع النباتات التي تتغذى عليها الحيوانات (الأغذام، الإبل والحمير) والتي تفضيلها. وتتنوع الغطاء النباتي في تلك المناطق ومدى التشابه والاختلافات بين الأنواع.
CHAPTER (I)

INTRODUCTION & LITERATURE REVIEW

1.1. Definition Of Pollen Grains:

Pollen grains produced by plants are formed in the so-called male apparatus of the flower, that is, in the anther. The interior of the anther consists of a sporogeneous tissue from which the pollen mother cells originate. The sporogeneous tissue or, later, the mass of pollen grains is surrounded by a wall, which breaks down in some way when the pollen is ripe, and the pollen grains are liberated for transfer to the pistil (generally of another flower) where fertilization takes place.

1.2. Definition Of Pollen Analysis:

Pollen analysis is basically a technique for studying former vegetation. Since the pioneering work of Von Post (1916) (1967), introducing pollen analysis as tool for Quaternary ecological investigation, it has been possible to reconstruct past environments using this technique. The objective of pollen analytical research is to study the vegetational changes and their response to climatic changes in time and space. It is used to reconstruct the environments in which those plants lived. The grains which are preserved in various geologic
deposits can be retrieved and identified through various techniques in the field and in the laboratory. In later stages statistical methods can be used for interpretation of the result (Birks, 1980, Faegri et al., 1989).

The basic factors making pollen such a useful tool in vegetation reconstruction are many:

The exines of pollen grains and spores are resistant to decay and are therefore preserved in non-oxidizing sediments. When retrieved, they can be identified to taxonomic levels ranging from family to species.

Different mechanisms of dispersal and transport of pollen grains provide the basis for a wide and even spread as pollen grains. Therefore they can be used to reconstruct the vegetation including local and distant or regional vegetation.

Pollen grains are produced in great numbers by plants. Thus they provide the basis for statistical methods to be applied, allowing inferences to be made about changes in vegetation patterns in space and time.

The microscopic size of pollen grains spores (10 - 100 microns) makes it normally possible to use very small amounts of sediments for adequate samples (Birk & Birks, 1980).

Pollen Analysis as a technique for studying past vegetation in Sudan is at the infant stages, being used by Ibrahim (1993) for that purpose. Pollen morphology of the Sudan flora is the subject matter of a comprehensive study undertaken by El. Ghazali.
Kordofani and Ingrouille (1992) have conducted pollen studies on some of the Sudanese acacias.

1.3. History Of Palynological Research In The Sudan:

Previous work in the Sudan related to Quaternary palynology has been sporadic and focused on the arid north and western parts of the country. In the North, it was aimed at discovering pluvial periods in the hyper-arid regions during the Holocene (Haynes, 1987; Ritchie et al., 1985). It is clear that most palynological and paleoclimatic studies mentioned have been concentrated in the arid parts of north and west Sudan. Work in central Sudan has been concerned mainly with paleoecology, geomorphology, and geology.

Most workers so far mentioned have tried to apply classical pollen analysis methods designed originally for temperate regions. That is to say applying established research techniques in geographic areas for which it is not precisely suited.

Studies have been carried out by El-Ghazali (1989, 1993a, 1993b) on the pollen flora and morphology. His work on the pollen flora of the Sudan (1989; 1993) is indispensable for pollen analysts working on the Sudan or other East African countries. It was used here as an basis for pollen identification. Studies by Kordofani and Ingrouille (1992) have been undertaken in the field of pollen morphology and variation in pollen grains.

Thus it is obvious that many problems face palynologists working in tropical or savanna regions. For example in the Sudan
there are very few localities where pollen deposition conditions in these sediments from which historical pollen records can be obtained. This is due to the fact that organic matter is very quickly oxidized owing to the high temperatures and alkalinity of the lakes, a third problem is that most of the taxa in the landscape are zoophilous plants and many produce very small amounts of pollen.

1.4. Definition Of Coprolites:

Coprolites contain the indigestible proteins of foods. Meat protein for example, may be completely absorbed during digestion, leaving no traces in the coprolite, Fry (1985). This is not the case with Pollen, because the exine is usually not digested. Second, coprolites may reflect seasonal or other short-term dietary intake. Individual coprolites may reflect a person ate earlier on the day the coprolites was excreted, or up to month previously William Dean (1978) Sobolik (1988). Year-round dietary intake of individuals is therefore not determinable just form a few coprolites.

1.5. Pollen Analysis Of Coprolites:

In coprolite analysis a distinction between insect and wind pollination is important. High frequency of wind pollinated pollen in a sample may not indicate diet, but merely accidental ingestion. A high frequency of insect pollinated pollen, however, indicates the intentional ingestion of food containing such pollen. Bryant (1975) has shown that in the lower Pecos region of West Texas the frequency
of entomophilous pollen is greater than 2% in a coprolite suggests intentional ingestion, and a frequency greater than 10% is convincing evidence of intentional ingestion.


1.6. Coprolite Uses:

Animals faeces (coprolites) have often been used to study the grazing habits of animals. Pollen grains content of faeces as an indicator of the local vegetation on which animals graze or the composition of fodder given to them is one of the fields of pollen analysis,( Moe, 1983).

Pollen from coprolites can provide information that is not obtainable from coprologic macroremains. Flowers, if ingested, probably will be digested, however, their pollen may be caught in the intestinal rumen and excreted in feces up to one month after ingestion of numerous meals Williams- Dean (1978). Pollen can occur in coprolites through the eating of flowers or seeds or through the unintentional ingestion of pollen in medicinal teas or foods. Pollen in this context is considered “economic” because it is indirectly associated with food or is a medicinal item. Pollen may also be ingested during respiration, and through contaminated food and water, especially if the food is prepared in an open area, Bryant (1974, 1987). This can be especially prevalent during the pollinating season. Such pollen is considered “background” because it is accidentally ingested, and not directly associated with a particular food or medicinal item.
Coprolites are mainly preserved in arid or cold environments (Carbone & Keel 1985). Caves and other enclosed areas such as tombs, are the best places to find them. Coprolites do not occur at all archaeological sites, so that remains recovered from them may reflect a select group of people rather than an entire population. Analysis of coprolites offers direct clues to food items eaten internationally. This type of precise information can not be derived as accurately from other animal or plant debris recovered from archaeological sites.

The limitation of coprolites is twofold. First, the constituents of coprolites do not represent the entire dietary spectrum of an individual or population. Different food it is may pass through the digestive system at different rates, so coprolite contents may not reflect one specific meal.

1.7. Historical Background:

The first observation of coprolites were form the cretaceous in England, Mantell (1822); Agassiz (1833) (1843, v, 2.p.177) and North America Dekay (1830) the lower Jurassic in England Background(1829) and the Eocene in France Robert (1832-33). Observation on non-human Coprolites in North America include those of the Pleistocene ground sloth (Laudermilk & Munz 1938; Martin et al., 1961) and other animals Davis et al ., (1984). The potential of human coprolites as dietary indicators was already appreciated by Harshberger (1896). The first analyses however, were conducted by Smith & Jones (1910), who examined the dried fecal remains from Nubian mummies, and by Young
(1910), Loud & Harrington (1929), and Jones (1936), on North American cave material. Early coprolites analyses also were performed on samples from Danger cave Jennings (1957), sites in Tamaulipas, Mexico, Mac Neish (1958), and caves in eastern Kentucky, Webb & Baby (1957) and on colon contents from a mummy, Wakefield & Dellinger (1936). The processing technique for these early analyses consisted of either cutting open the dray coprolites and observing the large, visible contents, or grinding the samples thorough screens breaking much of the material in process.

Callen & Camenon (1960) developed improved techniques by dehydrating coprolites in tri-sodium phosphate (a strong detergent) to gently break apart the materials for analysis. This technique, still used today, revolutionized coprolite analysis. Diet coprolite pollen analyses followed soon, with the first study conducted by Martin & Sharrock (1964) on material from Glen Canyon, followed other innovative studies Hill & Hevly (1968), Bryant (1974), Bryant & Williams Dean (1975), Hevly et al., (1979).

Reconstructing prehistoric human diets is a complex interdisciplinary process. Pollen in human coprolites may reflect diet, and also may indicate the ingestion of flowers and/or inflorescence for food, medicine, or other cultural purposes.

Determinations of pollen concentration have not been common in coprolite studies, but when done, can help to determine which pollen types were most likely ingested either for food or as medicines. Presence of over 100,000 pollen grains per gram of material indicates pollen was eaten recently.
1.8. Objectives Of Study:

- To determine the relationship between coprolites and the vegetation.
- To give an idea about grazing habits of the animals whose coprolites were studied.
- Pollen transport and precipitation is also of interest in this work, hoping that pollen found in animal will give an idea about this region.
CHAPTER (II)

MATERIAL & METHODS

2.1. Materials:

2.1.1. Faeces Samples:
Goat, Camel and Donkey faeces form Shambat.

2.1.2. Chemicals:
Acetic Anhydride, Basic Fuchsin, Concentrated Sulfuric Acid, Distilled water, Glycerin, Glacial acetic acid, HCL (10%), Potassium hydroxide (10%).

2.1.3. Equipments:
- Microscope slides and Cover slips for checking samples.
- Graduated cylinder (50 ml), Pipette, Test tube, Rack, centrifuge, Water bath, Heater, Digital Camera, Sieves (ca. 0.2 mm), Nail Polish, Vials: to keep final samples.

2.2. METHOD:
The method that was used in this study is that of Faegri et al., (1989). (fig 2-1).

Five grams of Goat, Camel and Donkey from Shambat were dried before any chemical analysis was done. This was important to
remove any pollen that might have settled on the surface of the droppings. They were then crushed and sieved, using a 0.2 mm sieves. This was important to remove any macro-remains.

2.2.1. KOH (10%) Treatment:

Potassium Hydroxide (70 g) pellets were dissolving in 700 ml distilled water.

KOH is added to the sample. Humic acids, i.e. unsaturated organic soil colloids, were removed by a short boiling with KOH (10%) for 3-5 minutes. After heating it is transferred into centrifuge tubes and centrifuged for five minutes.

Then it is decanted and mixed with distilled water and shaken up in centrifuge tubes. The process is repeated until a clear solution is obtained. All Humic acids are therefore removed.

2.2.2. Acetolysis Technique:

This step is meant to remove cellulose materials. Three steps were undertaken.

1. One ml of Glacial acetic acid were added to the pollen residue, centrifuge and decanted.
2. The acetolysis mixture (9 ml acetic anhydride and 1 ml of concentrated Sulfuric acid) was added to the residue in drops then kept in a water bath for 10 minutes, centrifuged and decanted.
3. Step (1) was repeated.
2.2.3. **Addition of KOH:**

The residue from the previous step was boiled with KOH (10%), centrifuged and decanted. Washing was then carried out with water repeatedly until a clear solution was obtained. The step is meant to neutralize excess acidity resulting from the previous step.

2.2.4. **Staining:**

Basic fuchsin was used as a stain. The residue was washed with a diluted solution of the stain, centrifuged and decanted.

2.2.5 **Mounting:**

Few drops of glycerin were added and residue was stored in small plastic vials.

2.2.6. **Identification:**

In each faeces sample the pollen number was counted and the plant species were identified.

2.2.7. **Photomicrography:**

Photomicrography is done by using a digital camera fixed on the eyepiece.
Boil with KOH (10%), centrifuge & decant

Wash with distilled water, centrifuge & decant

Add concentrated Acetic Acid, centrifuge & decant

Boil with (acetic anhydride:Sulfuric acid) (9:1), centrifuge & decant

Wash with concentrated Acetic Acid, centrifuge & decant

Wash with water, centrifuge & decant

Boil with KOH (10%), centrifuge & decant

Wash with distilled water, centrifuge & decant (Three times)

Staining. (Basic Fuchsine)

Mounting (with glycerin)

Microscopic analysis

Fig. (2.1): FLOWCHART OF POLLEN ANALYSIS
CHAPTER (III) 

RESULTS

3.1. Pollen counts:

Twelve pollen types were encountered in the three samples from Shambat. The pollen was identified to various taxonomic levels.

The results were presented in percentage of individual pollen types, and consequently the grand total was determined (Table 3.1).
<table>
<thead>
<tr>
<th>Family</th>
<th>Species</th>
<th>Goat</th>
<th></th>
<th>Donkey</th>
<th></th>
<th>Camel</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>No</td>
<td>%</td>
<td>No</td>
<td>%</td>
<td>No</td>
<td>%</td>
</tr>
<tr>
<td>Asteraceae</td>
<td>Bidnes Pilosa</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>0.15</td>
</tr>
<tr>
<td>Euphorbiaceae</td>
<td>Fluegga virosa</td>
<td>16</td>
<td>2.55</td>
<td>36</td>
<td>6.00</td>
<td>19</td>
<td>2.87</td>
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<tr>
<td>Gramineae</td>
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<td>565</td>
<td>90</td>
<td>517</td>
<td>86.16</td>
<td>561</td>
<td>85</td>
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<tr>
<td>Labiatae</td>
<td>Leucas martinicensis</td>
<td>15</td>
<td>2.39</td>
<td>14</td>
<td>2.33</td>
<td>50</td>
<td>7.58</td>
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<tr>
<td>Mimosaceae</td>
<td>Acacia Seyal</td>
<td>6</td>
<td>0.96</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
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<tr>
<td></td>
<td>Acacia Nilotica</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>0.16</td>
<td>18</td>
<td>2.73</td>
</tr>
<tr>
<td></td>
<td>Mimosa pigra</td>
<td>-</td>
<td>-</td>
<td>2</td>
<td>0.32</td>
<td>-</td>
<td>-</td>
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<tr>
<td>Papilionaceae</td>
<td>Indigofera tritoides</td>
<td>4</td>
<td>0.64</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Sesbania sesban</td>
<td>2</td>
<td>0.32</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Sapindaceae</td>
<td>Alphylus rubifolius</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>11</td>
<td>1.67</td>
</tr>
<tr>
<td>Unidentified</td>
<td></td>
<td>19</td>
<td>3.03</td>
<td>30</td>
<td>5.00</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td>627</td>
<td>100</td>
<td>600</td>
<td>100</td>
<td>660</td>
<td>100</td>
</tr>
</tbody>
</table>

Table (3.1): samples (pollen No & %)
3.2. Some Of The pollen Pollen Were Described Below:

**Bidenspilosa**

*Shape class:* porlate – spheroidal.

*Shape in polar view:* circular.

*Pollen class:* tricolporate or stephanocolporate.

---

**Brachiariaramosa**

*Shape:* spheroidal.

*Pollen class:* monoporate.

*Apertures:* simple; pore distinct, with thick annulus, slightly protruding; operculate; operculum deciduous, with the same sculpturing as the rest of the surface.
**Flueggeavirosa**

*shape class*: subprolate.

*Shape in polar view*: trilobed.

*Pollen class*: tricolporate.

*Apertures*: composite.

**Indigoferatritoides**

*Shape class*: subprolate.

*Shape in polar view*: sub angular.

*Pollen class*: tricolporate.

*Apertures*: composite.
CHAPTER (IV)

RESULTS

CONCLUSION & DISCUSSION

4.1. Discussion:

The pollen record does not show a clear picture of vegetation of the area since the pollens of some trees species, known to occur in the area, are not found. This may be due to the fact that most of these trees are insects pollinated.

The limited number of pollen types recorded in the samples is attributed to the fact that pollen dispersal is efficient enough to allow for the presence of many types in the samples. This may also be due to the fact that the majority of plants are insects pollinated.

The results show that the most abundant group of plants is the Gramineae. It is well known that Goats, Donkeys and Camels graze grasses and grass crops such as sorghum. The pollen grains of grasses are also subject to wind dispersal, therefore, they can always be found where the Goats, Donkeys and Camels wording as Bryant (1975) has shown that and Moe (1983).
4.2. CONCLUSION & RECOMMENDATION:

As the results showed, it was clear that the number of pollen taxa and absolute number of pollen grains is not large are some taxa that are frequently recorded. We might therefore, conclude that, the animal concerned are selective in their grazing habits.

The dispersal and transport of pollen can be indicated by the presence of some taxa which are not part of the immediate grazing area.

The vegetation of the areas concerned can not exactly be shown but a fair picture may be drawn from the presence of the pollen of the species found.

This study can therefore, help to show the habit, pollen transferal and vegetation types.

Future work may give/clear picture of the above mentioned lines.

I hope that the study will stimulated future work in the field in an attempt to provide feeding condition for there animals.
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