
# FINAL REPORT

## Mycobiota Survey of Wadi El-Arbae'en, Saint Katherine Protectorate

By

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**2005**

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# Introduction

Sinai desert, which covers approximately 6% of the total land area of Egypt, is considered one of extreme habitats. It is a part of the Sahara-Arabian deserts (McGinnies *et al.,* 1968; Danin, 1983). It is characterized by an arid to extremely arid climate with Mediterranean influences. Most of Sinai receive less than 50mm annually of the average precipitation; however the share of Southern part is around 65-100mm (Moustafa and Klopatek, 1995).

## Fungi as a target, why?

In 1935, Sabet started his pioneer study on soil mycobiota of Egypt. Several studies have been carried out on mycobiota of cultivated, desert and salt marshes soils by several investigators (Aboul-Nasr 1981; Abdulla *et al.* 1987; Ezz El-Din 1988; Moubasher *et al.* 1990; Abdul-Wahid 1990; Abdel-Azeem 1991, 2003; Moubasher 1993; Ibrahim 1999; Abdel-Hafez 2000).

Up to the present and under these extremely arid environmental conditions, the mycology of Sinai has been given a little attention. Thus, the information concerning the mycology of this area is almost lacking and fragmentary. The occurrence of different ecological groups of mycobiota and their diversity have not been reported yet except the pioneer study of Abdel-Azeem & Ibrahim (2004) which considered as a preliminary one on diversity of terrophilous mycobiota of Sinai.

Kassas (2002) in his article titled as "Gaps in knowledge" mentioned many gaps in biodiversity they are:

- The ***first gap*** in biodiversity knowledge relates to the inventory of the global species diversity, that is, the number of species on Planet Earth. The gap is remarkable. The Global Biodiversity Strategy (WRI-IUCN-UNEP, 1992, p. 9).
- The ***second gap*** relates to the biodiversity of the less conspicuous organisms. These include ***fungi***, bacteria, algae, protozoa, etc., and to their role in world ecology.
- The ***third gap*** relates to the role played by each species among biotic elements of ecosystems.
- The ***fourth gap*** relates to human ability to assess and forecast bio-ecological degradation. Comprehensive assessment of all components of an ecosystem is a laborious task, even if carried out on limited scale. This has led to ideas related to bio-indicators, e.g. Hawksworth (1992); identification of certain species whose change in density, ecological behavior or

physiological performance should provide indicators to the status of the ecosystem as a whole.

To these four broad gaps in present knowledge may be added those gaps related to specific ***geographical areas*** including country-level issues, and gaps related to ***specific taxonomic*** units including inventories of genetic materials. Such gaps could be covered in national biodiversity research programmes that would provide for intensive studies.

So from my point of view and as mentioned before fungi or mycobiota survey in South Sinai area will fill a part in the biodiversity knowledge gap in Egypt.

## Materials & Methods

**Study area:** The study was carried out in St. Katherine area, South Sinai (Fig. 1) at an elevation of 1500 to 2624 m a. s. l. which includes the main mountains in the area. Gebel Katherine represents a series of mountains at different elevations with four large valleys, (W. El-Esbae'a, W. Rutig, W. El-Arbaie'en and W. Tala'a). Said (1990) described the study area as predominantly smooth - faced granite outcrops forming mountains such as Gebel Serbal and Gebel Ras Safsafa. Black mountains consisting of old volcanic rocks are rather common. Generally, the area is formed of igneous and metamorphic rocks; chiefly granites are intensely dissected and rugged. The geomorphology of Saint Katherine area forms a part of highly rugged mountains with acid plutonic and volcanic rocks belonging to the Precambrian basement complex of the southern part of Sinai Peninsula.

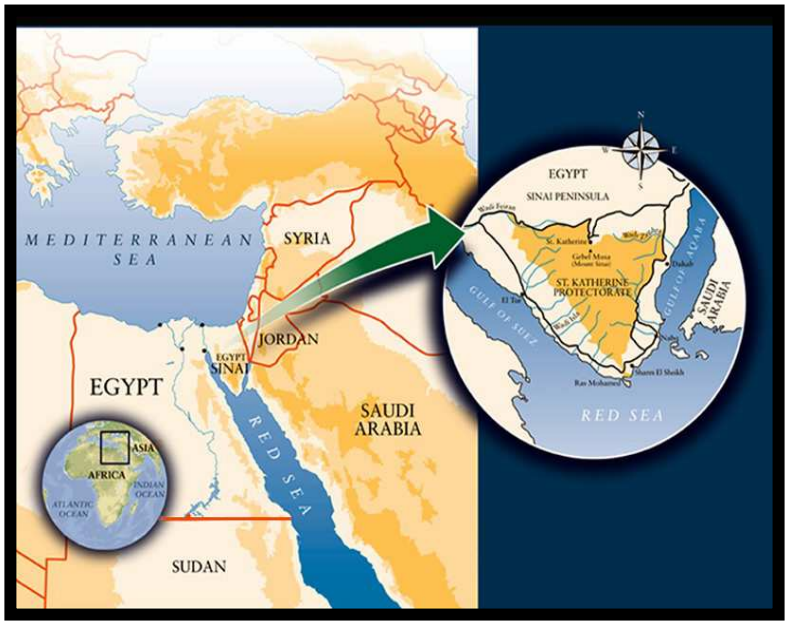



**Figure 1: South Sinai area.**

**Wadi El-Arbae'en** was chosen due to many reasons they are:

1. Very narrow, shaded and closed wadi.
2. One of the most beautiful wadis in Saint Katherine area due to its nice landscape.
3. Being one of the most floristically richest wadis in the whole area with estimated plant species about > 100 species.
4. Subjected to tourists actions

The main objects of the present work are:

1- **To throw** some light on the structure and diversity of mycobiota at different ecological habitats and their interaction with Bedouin life in South Sinai area.

2- **To find** out the impact of tourism upon the diversity of fungi and their distribution.

3- **To fill** the gap of the microbial diversity in Egypt and because of the information concerning the mycology of this area is almost lacking and fragmentary**.**

**Sampling**

**90** soil samples and **18** plant species belonging to **9** families (Table 1, Fig. 2) were collected from 18 different sites throughout the wadi. Samples were collected in sterile polyethylene bags, closed by rubber band and thereafter transferred to the laboratory and kept until plating out. Air mycobiota were isolated by using **90** air catches from 18 sites. **150** herbivore dung samples of three animals namely camels, donkeys and goats were collected in sterile plastic bags. **Samples collection was takes place under the permission of Saint Katherine protectorate for scientific purposes.**

**Soil analysis**

Mechanical analysis of soil samples by sieving method was applied according to the method adopted by Fathy *et al*. (1975). The pH values of water extracts of soil samples were determined with a pH meter (model 201, Orion research Co.) in 1: 5 (wt/v) soil extract to avoid the error through higher dilution (Jackson, 1967). Total soluble salts of soil extract were determined using electric conductivity meter (EC-meter) as described by Jackson (1967). Gravimetric methods were used to determine moisture content, whereas organic carbon content was determined by loss-on-ignition (LOI), where loss was calculated in percent of the oven-dried sample (Wilde, *et al.* 1972).

**Table 1: Taxonomic assignment of plant species after Boulos (1995)**

| Family | Species |
|---|---|
| **Asclepiadaceae** | ***Asclepias sinaica*** |
| **Boraginaceae** | ***Alkanna orientalis*** |
| **Compositae** | ***Artemisia herba-alba*** |
| | ***Echinops spinosus*** |
| | ***Pulicaria undulata*** |
| | ***Achillea fragrantissima*** |
| **Cruciferae** | ***Zilla spinosa*** |
| **Labiatae** | ***Stachys aegyptiaca*** |
| | ***Phlomis aurea*** |
| | ***Ballota undulata*** |
| | ***Teucrium leucocladum*** |
| | ***Teucrium polium*** |
| | ***Origanum syriacum*** |
| | ***Mentha longifolia*** |
| **Moraceae** | ***Ficus palmata*** |
| **Peganaceae** | ***Peganum harmala*** |
| **Scrophulariaceae** | ***Verbascum sinaiticum*** |
| **Zygophyllaceae** | ***Fagonia mollis*** |

**Isolation and identification of fungi**

**Soil mycobiota** were isolated using dilution technique (Johnson *et al.*, 1960) while **leaf surface** fungi of the plant species under investigation by using the washing technique. From each plant, ten grams of fresh leaves were used. Leaves thereafter are washed in 100 ml sterile distilled water and plated out. Ten plates were used for each sample. The plates were incubated at 28 $^{o}$C for 10 days and the developing fungi were counted. As a transfer medium, **air** is expected to contain spores of fungal taxa coming from other substrates. Spore populations were investigated using the deposition plate technique. Five plates containing isolation medium were exposed, for 15 minutes, at each site in the wadi (for GPS readings please see Table 2). **Dung** of different herbivore animals (50 samples each) was collected and their mycobiota were screened. Dung samples, on moistened filter paper, in transparent plastic containers, were kept and placed near diffuse light. Regular microscopic examination of samples was followed up to two months. Czapek's agar supplemented with 0.5 % yeast extract (CYA), amended with Rose bengal (1/15000) and chloramphenicol (50 ppm) was used for primary isolation.

**Figure 2: Some common plant species in Wadi El-Arbae'en**

For maintaining cultures and for proper identification, pure cultures of isolated fungi were grown on standard media such as Vegetable Agar (V8), Oatmeal Agar (OA), Malt Extract Agar (MEA) Potato Dextrose Agar (PDA) and Potato Carrot Agar (PCA).

For the identification of fungal isolates down to the species level, the most relevant references were consulted are; for ***Aspergillus***, Raper & Fennell (1965), for ***Penicillium***, Raper & Thom (1949) and Pitt (1979) for ***Chaetomium*** Arx *et al. (*1986) and Cannon (1986), for ***Fusarium***, Booth (1971) for dark-coloured Hyphomycetes, Ellis (1971 and 1976); Samson (1974) for ***Paecilomyces*** and some allied Hyphomycetes, for general taxonomy, Domsch *et al.* (1980) and Arx (1981). For identification of coprophilous fungi another relevant references were consulted such as Bell (1983), Richardson & Watling (1997). (Classification system proposed by Kirk *et al.* (2001) has been used to classify the isolated taxa during the present study.

**Table 2: GPS readings of the selected eighteen sites in the study area**.

| Site No. | GPS-N | GPS-E | Elevation (m) | Plant Species |
|---|---|---|---|---|
| 1 | 25.55368 | 33.9488 | 1595 | *Asclepias sinaica* |
| 2 | 28.55085 | 33.95008 | 1600 | *Alkanna orientalis* |
| 3 | 28.54779 | 33.95243 | 1610 | *Artemisia herba-alba* |
| 4 | 28.54389 | 33.95702 | 1664 | *Echinops spinosus* |
| 5 | 28.54224 | 33.95884 | 1664 | *Pulicaria undulata* |
| 6 | 28.54486 | 33.95468 | 1675 | *Achillea fragrantissima* |
| 7 | 28.54486 | 33.95468 | 1675 | *Zilla spinosa* |
| 8 | 28.54486 | 33.95468 | 1675 | *Stachys aegyptiaca* |
| 9 | 28.54486 | 33.95468 | 1675 | *Phlomis aurea* |
| 10 | 28.54486 | 33.95468 | 1675 | *Ballota undulata* |
| 11 | 28.54486 | 33.95468 | 1675 | *Teucrium leucocladum* |
| 12 | 28.53535 | 33.96404 | 1763 | *Teucrium polium* |
| 13 | 28.53535 | 33.96404 | 1763 | *Origanum syriacum* |
| 14 | 28.53535 | 33.96404 | 1763 | *Mentha longifolia* |
| 15 | 28.53535 | 33.96404 | 1763 | *Ficus palmata* |
| 16 | 28.53535 | 33.96404 | 1763 | *Peganum harmala* |
| 17 | 28.53535 | 33.96404 | 1763 | *Verbascum sinaiticum* |
| 18 | 28.53535 | 33.96404 | 1763 | *Fagonia mollis* |

**Characterization of fungal community**

Some parameters pertaining to: the degrees of occurrence, richness, diversity, similarity were used. Abundance of fungi has been presented in terms of frequency i.e. as number of cases of isolation. To find out if any similarity of species composition exists among different sites, the similarity coefficient suggested by Sorenson (1948) was used to compare between different sites. Species richness is calculated after Barbour et al. (1987), while species diversity is calculated as Simpson's diversity index (Bakus 1990). In the present study, two trends of multivariate analysis were applied on the obtained data: classification & ordination. Both trends have their merits in summarizing, explanation and the vegetation and environmental phenomena. Classification technique was Two Way Indicator Species Analysis (TWINSPAN) and ordination one was Canonical Correspondence Analysis (CCA). The input data in both techniques were in the form of stands versus species importance values data matrix and stands versus environmental factors data matrix.

Two Way Indicator Species Analysis (TWINSPAN) (Hill, 1979; Gauch and Whittaker, 1981) is a hierarchical, polythetic and divisive classification technique, in which, stands are first classified and then this classification is used to obtain a classification of the species according to ecological preferences. Classification using TWINSPAN was done using a computer program (CAP, Community Analysis Package, version 1.3.1, Henderson & Seaby, 1999).

In addition, the two way classification is used to obtain an ordered table that expresses the species synecological relations. Also TWINSPAN program identifies "indicator species" and each species is treated as a series of "pseudospecies" according to the estimated importance value of that species at site.

On other hand, ordination was performed using the (CCA) Canonical Correspondence Analysis, which was established by (ter Braak 1986; 1988; ter Braak & Prentice 1988), it is a method of multivariate direct gradient analysis in which gradients of community composition are directly related to variation in a set of "external variables". Ordination axes (representing gradients of change in community composition) are extracted as in unembellished correspondence analysis, but with the additional constraint that the axes are linear combinations of pre-defined external variables which have been scored for each sample. The species are assumed to have unimodal response

surface with respect to linear combinations of external variables. The external variables of interest in this study are habitat factors.

**Statistical analyses**

Obtained data were subjected to statistical analyses, including descriptive statistics, graphical presentations using Excel software (Microsoft Office-XP Package, 2002), Minitab software (version 12.21, 1998) and Statistica software (version 5.1 F, 1997).

# Results

## 1- Soil Parameters

- The organic matter of the soil samples was ranged between 1.18-7.6%.
- Moisture contents were ranged between 1.61-10.31 % the majority of sites between 2.17 and 7.5%.
- Soil pH ranged between 7.17 and 8.28.
- Soil textures were assessed as sandy to gravelly sandy.
- Total dissolved salts ranged mainly between 60 and 365 ppm

## 2- Mycobiota

### General observations

During the course of the present study, on mycobiota in Wadi El-Arbae'en, it was possible to encounter as many as **105** species belonging to **55** genera from the various habitats and sources under investigation namely: soil, dung, leaf surface and air catches (please see the appendix). Taxonomically, isolated or recorded species are assigned to five classes, seven orders, and ten families. While Mitosporic fungi had **twenty** genera, **fifty-two** species and **50%** of total fungi isolated; Ascomycota had **nineteen** genera, **thirty-four** species and **32 %**; Zygomycota had only **16 %** of the total fungi isolated represented by **twelve** genera, and seventeen species. Basidiomycota recorded the only **2%** of the total fungi isolated (Fig. 3).

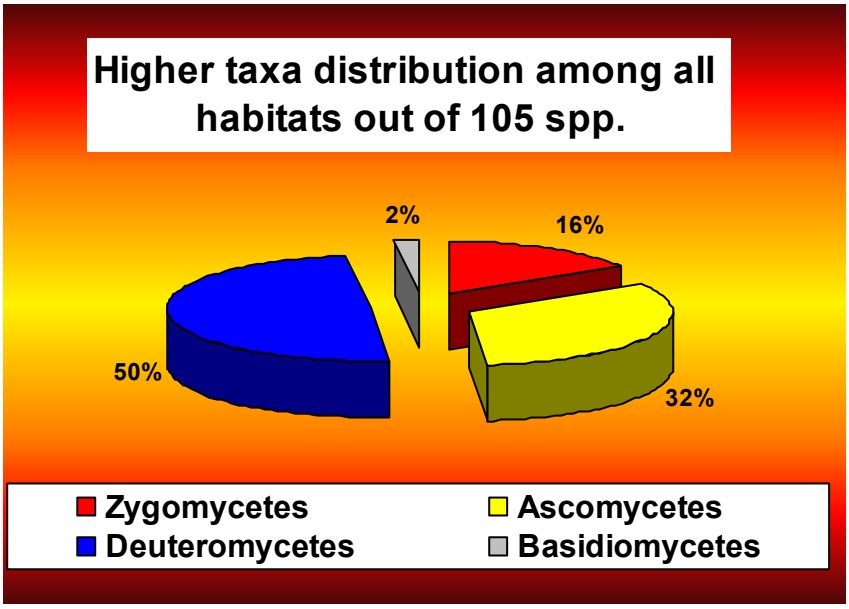



**Figure 3: Higher taxa distribution among all habitats out of 105 species.**

The species richness at the generic level shows that *Aspergillus* is the most diverse (represented by 12 species) followed by *Penicillium* (9 species), *Chaetomium* (6 species) and *Fusarium* (5 species). All the remaining genera were represented by one to three species each (Fig. 4).

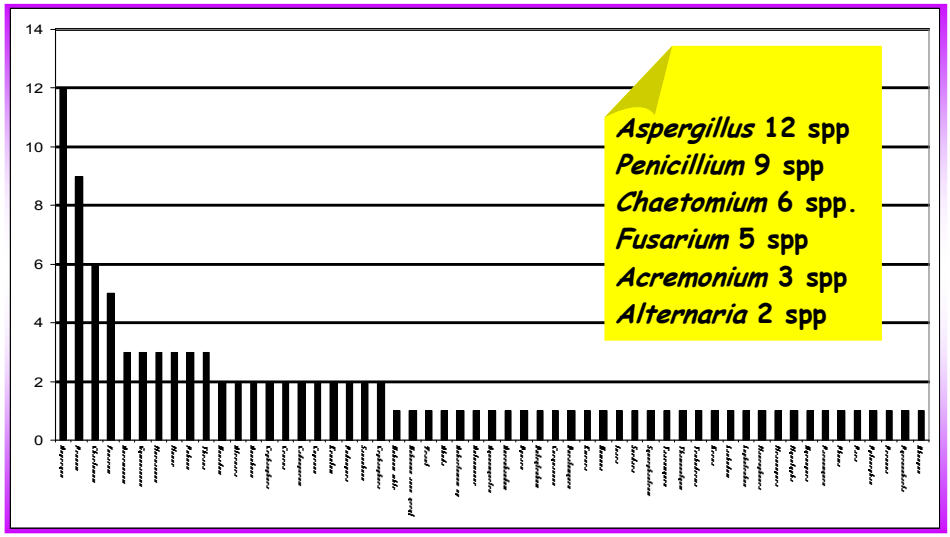



**Figure 4: Distribution of species among the isolated genera..**

## 2.1- Coprophilous fungi

### General features

Fungi developing on dung samples, collected from various locations and incubated in moist chambers were followed up for several weeks. From the three dung-types under investigation it was possible to report 54 taxa, of which 26 were true ascosporic. The following pie chart (Fig. 5) indicated that dung is a very rich substrate especially for ascosporic fungi nevertheless, the species richness varied tremendously from dung-type to another. While the dung of donkey showed a relatively broad spectrum of species, goat showed the lowest value.

Regarding **succession** of coprophilous fungi on dung (Fig. 6), it was noticed that, Pilobolaceae developed first after 3 days followed by *Lasiobolidium aegyptiacum,* a cleistothecial ascomycete. It was followed by the apothecial forms of Ascobolaceae (*Ascobolus, Saccobolus*). Cleistothecial-Pyrenomycetes (e.g. *Kernia, Thielavia, Corynascus*) and Perithecial-Pyrenomycetes (e.g. *Sordaria, Podospora, Chaetomium*) appeared by the beginning of the third week. Pseudothecial forms came late by the 4$^{th}$ and 5$^{th}$ weeks.

**Figure 5: Higher taxa distribution in dung out of 54 species**

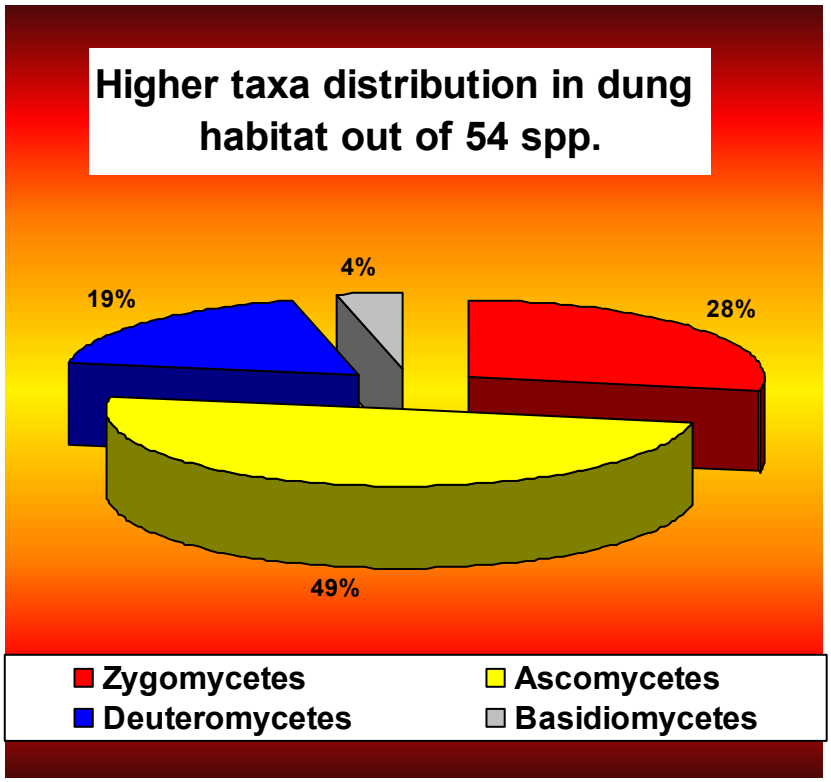
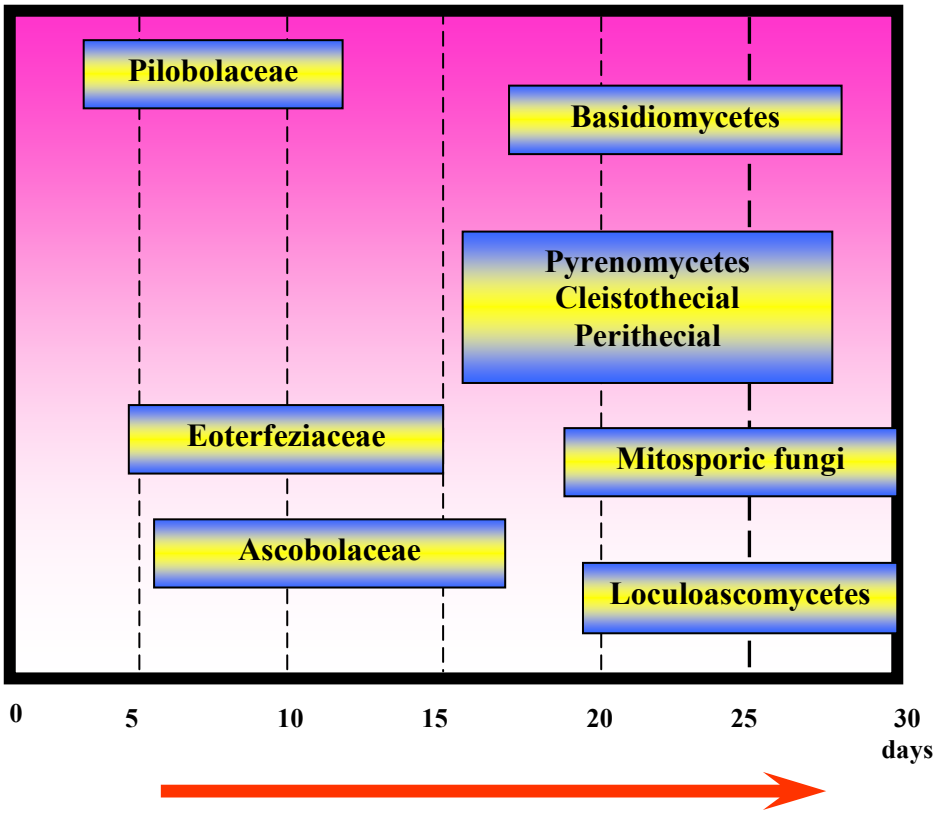



**Fig. 6: Schematic representation of the succession of fungi on dung**



The distribution pattern of coprophilous fungi on different types of dung (Fig. 7) indicated that, some species such as *Absidia corymbifera, Cephaliophora irregularis, Chaetomium globosum*, and *Saccobolus glaber* are common to all types of dung. Some species, on the other hand, showed slight indication toward a substrate preference, of these:

i- *Thielavia* showed occurrence restricted to camel dung.

ii- *Lasiobolidium* showed better occurrence on camel than any other type of dung.


**Fig. 7: Distribution pattern of coprophilous fungi on different types of dung**

## 2.2-Leaf surface fungi

### General features

34 species recorded from the phyllosphere of all plants under investigation. Only five taxa were ascosporic while the remainders were non-ascosporic. Among the non-ascosporic fungi aspergilli & penicillia were by far the most frequent followed by cladosporia, fusaria, *Ulocladium* and *Alternaria*. The distribution pattern of phyllosphere fungi on different types of plants (Fig. 8) indicated that, *Artemisia herba-alba* showed no growth of fungi while *Fagonia mollis* showed the highest number of isolated taxa (9 spp.). Some species of fungi such as *Aspergillus niger, A. flavus,* and yeast are common to all plant species. Some other species, on the other hand, showed slight indication toward a substrate preference, of these *Talaromyces stiptatus*.


**Fig. 8: Distribution pattern of leaf-surface fungi on different plant species.**

## 2.3- Air mycobiota

Data obtained by plate deposition technique show that ascospore-producing fungi were completely absent in air samples. Regarding fungal diversity, air samples revealed a total of 17 taxa none of which belong to the ascosporic group. In view of frequency value *Aspergillus niger* & *A. flavus* were by far the most frequent followed by *Cladosporium cladosporioides* and *Alternaria alternata*.

## 2.4- Soil mycobiota

In the present study, soil as a habitat is represented by 90 samples and obtained data were subjected to statistical analysis. Also, since it is not possible to tell about the origin of colonies developing on the isolation plates whether arising from dormant spores or from active vegetative cells, it was found better to express counts as Colony Forming Units (CFU). 39 taxa were reported from desert soils. The majority of taxa were hyphomycetous (31 spp.) followed by ascospore-producing fungi (5 spp) while the remainders are zygomycetous (for more details please see appendix).

Regarding higher taxa diversity in all the studied habitats, **Hyphomycetes** are came the first by accommodating 52 species, while **Ascomycetes** were represented by 34, **Zygomycetes** by 17 species and **Basidiomycetes** by 2 species.

## 2.5- Fungal species-habitat relationships

Throughout the present study, eighteen different sites were investigated for the presence of mycobiota. Several species of different frequencies were reported or isolated from each habitat however an important question remained to be answered: are fungal species the same in all habitats? or do each habitat has its characteristic group of species?. To find an acceptable answer, obtained data from all habitats were subjected to various statistical treatments to clear up possible relationships existing among studied habitats. Analyses used are: **Similarity** coefficient and **Multivariate analyses**.

### 2.5.1. Relationships based on similarity coefficient

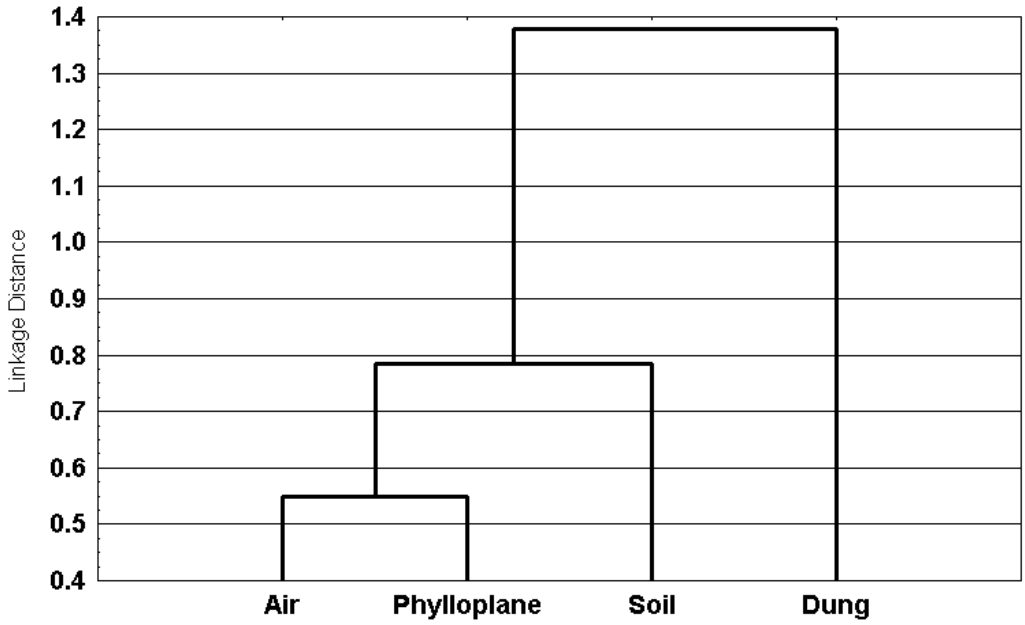
Similarity coefficient values obtained were represented in Table 3. The data indicated that dung is a highly specific habitat by showing the lowest values if compared with other habitats. Reasonable values between 0.32 and 0.63 were prominent in many cases, i.e. between soil and leaf surface, soil and air.

**Table 3: Similarity coefficients among investigated habitats**

| | Dung | Soil | Leaf-Surface fungi | Air |
|---|---|---|---|---|
| **Dung** | a | **0.09** | **0.07** | **0.6** |
| **Soil** | **0.09** | a | **0.49** | **0.32** |
| **Leaf-Surface fungi** | **0.07** | **0.49** | a | **0.63** |
| **Air** | **0.6** | **0.32** | **0.63** | a |

Using Sorenson's similarity coefficient data dendogram showing possible interrelations among habitats was obtained (Fig. 9). The dendogram in Fig. 9 shows that lagomorph mycotas (species in common) formed two subgroups. Distinct from that of the dung, the first sub-group includes soil and the second subgroup is further divided into two sub-groups in which air and leaf surfaces were occurred.

**Fig. 9: Habitat dendogram based on Sorenson's similarity coefficient**




## 2.5.2- Relationships based on Multivariate Analyses

### 2.5.2.1-Classification

Multivariate analysis was used to analyze the data of 18 plant species in the study area along Wadi Arbaie'en. A two-way table results from the application of the TWINSPAN program which is used in the construction of the dendogram. The resulting dendogram from the TWINSPAN produced six clusters (Fig 10). Each cluster comprises a set of unique plants with greater homogeneity of the isolated fungal species qualitatively and quantitatively when compared with other clusters.

**Cluster I** contained only one species (*Artemisia herba-alba*) which considered the most outlier group in the dendogram in the right hand side. This plant is characterized by absolute absence of any mycobiota.

**Cluster II** contained also one species, *Alkanna orientalis*, which nested directly to *Artemisia herba-alba*. It is indicated by a group of fungal species they were *Absidia corymbifera*, *Emericella nidulans* and *Talaromyces stiptatus*.

**Custer III** contained two plant species (*Origanum syriacum* and *Mentha longifolia*) which characterized by a series of fungal species namely: *Aspergillus alutaceus*, *A. fumigatus*, *Ulocladium* atrum, *Acremonium terricola* and *Alternaria phragmospora*.

**Cluster IV** is characterized by four plant species namely *Stachys aegyptiaca*, *Phlomis aurea*, *Ballota undulata* and *Fagonia mollis*. This group indicated by the following taxa: *Microascus cinereus*, *Penicillium chrysogenum*, *Emericella nidulans* and *Aspergillus sydowii*.

**Cluster V**. It is the largest group among the six groups it contained seven plant species they are: *Echinops spinosus*, *Achillea fragrantissima*, *Teucrium leucocladum*, *Ficus palmata*, *Peganum harmala*, *Zilla spinosa* and *Verbascum sinaiticum*. This group indicated by Aspergillus *sydowii*, *Penicillium chrysogenum*, Agonomycete, *Chaetomium globosum*, *Microascus cinereus*, P. *corylophilum*, and *Rhizopus stolonifer*.

**Cluster VI**. This group occupied the left hand side of the dendogram. It is characterized by the presence of three plant species, *Asclepias sinaica*, *Pulicaria undulata* and *Teucrium polium*. The indicator mycobiota for this group are: *Aspergillus flavus*, *A. niger* and *A. versicolor*, *P. chrysogenum*, *P. funiculosum*, *Nigrospora oryzae* and *Rhizopus stolonifer*.

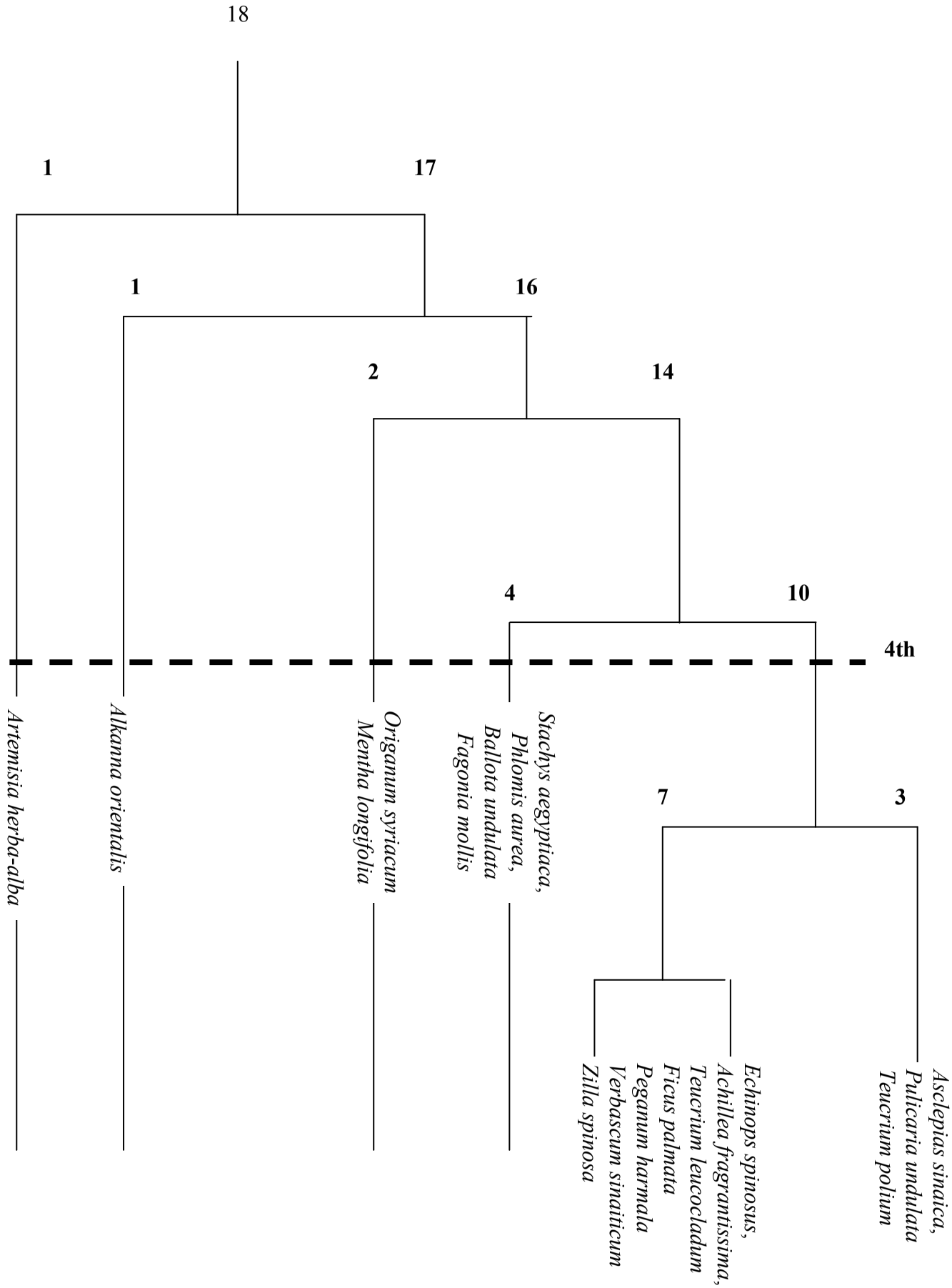



**Fig. 10: Clusters dendogram based on TWINSPAN multivariate analysis**

**Table 4: Characterization table of the six TWINSPAN clusters.**

| Stands / Parameters | I | II | III | IV | V | VI |
|---|---|---|---|---|---|---|
| **Mycobiota** | | | | | | |
| *Absidia corymbifera* | -- | + | + | -- | -- | -- |
| *Acremonium terricola* | -- | -- | -- | + | + | -- |
| Agonomycete | -- | -- | + | -- | + | -- |
| *Alternaria alternata* | -- | -- | + | + | -- | + |
| *Alternaria phragmospora* | -- | -- | -- | + | -- | -- |
| *Aspergillus candidus* | -- | -- | + | -- | -- | -- |
| *Aspergillus flavus* | -- | -- | -- | + | + | + |
| *Aspergillus fumigatus* | -- | -- | -- | -- | + | -- |
| *Aspergillus japonicus* | -- | -- | + | -- | -- | -- |
| *Aspergillus niger* | -- | -- | + | + | + | + |
| *Aspergillus sydowii* | -- | -- | -- | + | + | -- |
| *Aspergillus terreus* | -- | -- | -- | -- | + | + |
| *Aspergillus versicolor* | -- | -- | -- | + | + | + |
| *Aureobasidium pullulans* | -- | -- | -- | -- | + | -- |
| *Chaetomium globosum* | -- | -- | -- | -- | -- | + |
| *Cladosporium cladosporioides* | -- | -- | -- | -- | + | -- |
| *Cladosporium herbarum* | -- | -- | -- | -- | + | -- |
| *Emericella nidulans* | -- | -- | + | -- | + | -- |
| *Eurotium amstelodami* | -- | + | -- | -- | -- | -- |
| *Fusarium oxysporum* | -- | -- | -- | -- | + | -- |
| *Fusarium solani* | -- | -- | -- | -- | + | -- |
| *Microascus cinereus* | -- | -- | + | + | + | -- |
| *Nigrospora oryzae* | -- | -- | -- | -- | + | -- |
| *Penicillium chrysogenum* | -- | -- | + | + | + | -- |
| *Penicillium corylophilum* | -- | -- | -- | -- | -- | + |
| *Penicillium funiculosum* | -- | -- | -- | + | -- | -- |
| *Rhizopus stolonifer* | -- | -- | -- | + | -- | -- |
| *Talaromyces stiptatus* | -- | -- | -- | -- | + | -- |
| *Ulocladium atrum* | -- | + | -- | + | + | -- |
| *Ulocladium chartarum* | -- | -- | -- | + | -- | + |
| Unknown White mycelium | -- | + | -- | -- | + | -- |
| Unknown grey mycelium | -- | -- | + | -- | -- | + |
| Yeast | -- | -- | -- | + | + | -- |
| *Zygorhynchus heterogamus* | -- | -- | -- | + | -- | -- |
| ***Soil Analysis (mean)*** | | | | | | |
| **pH** | 8.2 | 8.02 | 8.06 | 8.14 | 7.8 | 7.94 |
| **Moisture content** | 5.6 | 7.5 | 4.78 | 2.50 | 4.5 | 3.55 |
| **Organic matter** | 1.38 | 1.18 | 4.96 | 1.72 | 3.55 | 4.55 |
| **Total soluble Salt** | 107 | 188 | 275.7 | 223.61 | 194.30 | 268.22 |
| ***Biodiversity*** | | | | | | |
| **No. of plant/group** | 1 | 1 | 2 | 4 | 7 | 3 |
| **Mean Simpson' Diversity index** | 0 | 0.552 | 0.782 | 0.759 | 0.675 | 0.721 |
| ***Plant Characters**** | | | | | | |
| Hairiness | + | + | + | + | + | + |
| Alkaloid & glycosides | - | + | - | + | + | + |
| Volatile oils | + | - | + | + | + | + |
| Phenolic compounds | + | + | + | + | - | + |
| Latex | - | - | - | - | - | + |

***** For more details please see appendix

## 2.5.2.2-Ordination

The ordination diagrams provided by the first two axis of Canonical Correspondence Analysis (CAA) are shown in the following figures (Figs. 11 & 12). These diagrams consists of two sets of points including sampled stand as points and edaphic factors as arrows in the first ordination plane and fungal biota (points) and edaphic factors as arrows in the second ordination plane. The angel between each arrow and each axis is a reflection of its degree of correlation with the axis. Thus the soil variables, e.g. organic matter, fine sand…….etc are distributed among the four quarter of the plane.

Medium sand, total dissolved salts, electric conductivity, boulders, pH, landform and coarse sand are correlated with axis I, while gravel, cobbles, moisture content, organic matter, stones, fine sand and silt & clay are correlated with axis 2.

The sites namely 6, 7, 10 and 11 are occupying the top right side of the diagram and it is correlated with electric conductivity, total dissolved salts and boulders. On the other hand sites 2, 12, 13, 14 and 18 are occupying the top left side of the diagram and correlated with coarse sand, pH and landform.

In the bottom right side of the diagram a clear correlation is shown between sites 1, 4 and 5 with high organic matter, high percentage of silt and clay and high percentage of fine sand.

The bottom left side of the diagram where gravel, cobbles and moisture are displayed by their arrows, a clear correlation pattern is shown between these factors and sites namely 9, 13, 15, 16 and 17.

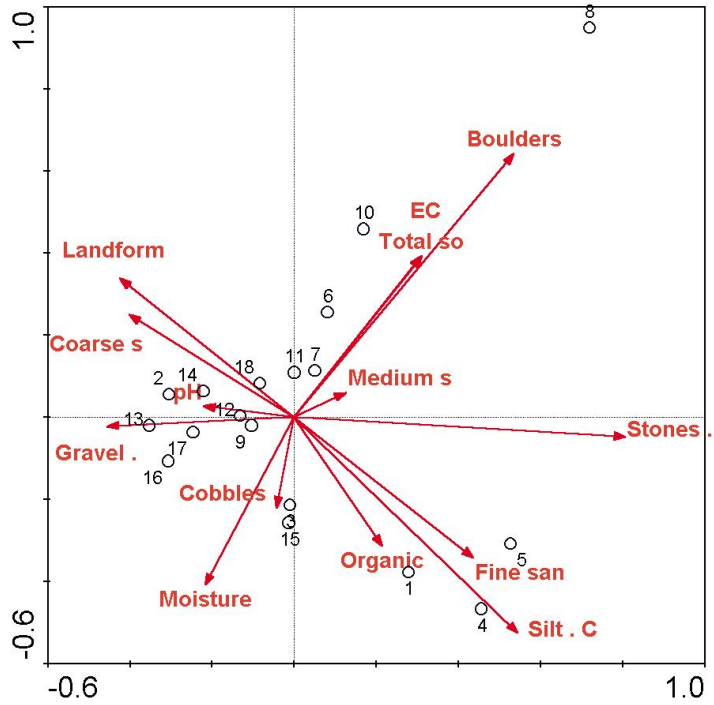



Fig. 11: CCA biplot ordination diagram of 13 environmental variables represented by arrows and the 18 sampling sites represented by points located in Wadi Al-Arbaie'en, St. Katherine, Southern Sinai.

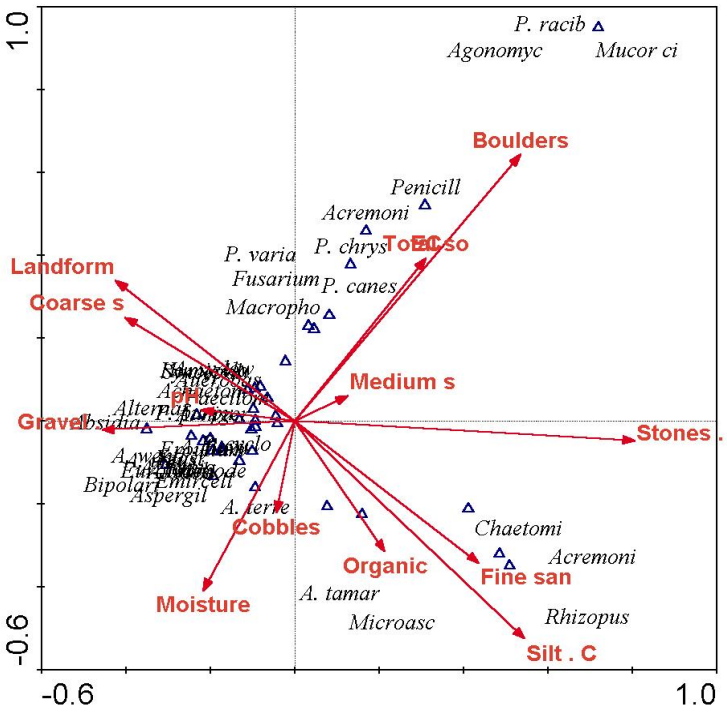



Fig.12:.CCA biplot ordination diagram of 13 environmental variables represented by arrows and the recorded soil mycobiota represented by points located in Wadi Arbaie'en, St. Katherine, Southern Sinai.

Concerning the distribution of soil mycobiota and the environmental variables it is quiet clear that each group of variables played a very characteristic role in their distribution. From the second ordination plane, it obvious that *Penicillium raciborskii*, Agonomycete, *Mucor circinelloides* are correlated with the excessiveness of boulders, while *Penicillium variable*, *P. chrysogenum*, *P. canescens* and *Macrophomina phaseolina* are localized in the soils with high total soluble salts content and sure with high electric conductivity.

In the bottom right side of the graph where *Aspergillus tamarii*, *Microascus cinereus*, *Rhizopus stolonifer* and *Chaetomium globosum* correlated with high organic matter content and higher finer soil fractions.

The majority of mycobiota are restricted to the top and bottom left side of the graph. In the top where both of land form and coarse sand are the prevailing two soil variables. The following species are occurred *Alternaria alternata*, *Humicola fuscoatra*, *Achaetomium* sp., *Absidia corymbifera*. While in the bottom left side where gravel, moisture and cobbles are displayed the following taxa are occurred: *Aspergillus wentii*, *Bipolaris spicifera*, *A. terreus* and *Eurotium amstelodami*.

## 3- The negative effects of tourism on the ecology of mycobiota in Wadi El- Arbae'en

Tourism and the environment have a very complex and interdependent relationship. Today, tourism is one of the largest industries not only in Egypt but also allover the world and is a great source of foreign exchange for many developing countries, whose major assets are their natural resources. At the same time, it is the environmental quality of a place that will determine the success of the tourism industry, since it is the main attraction for tourists. There have been a lot of arguments about whether tourism is beneficial or harmful to the environment. A lot of the developing countries whose main source of foreign exchange is tourism industry overlook certain setbacks such as the fact that sometimes they are not prepared to meet and support such a vast amount of people.

Most people think of tourism in terms of economic impacts, jobs, and taxes. However, the range of impacts from tourism is broad and often influences areas beyond those commonly associated with tourism. Leaders as well as residents who understand the potential impacts of tourism can integrate this industry into their community in the most positive way. The impacts of tourism can be sorted into seven general categories:

1. Economic
2. Environmental
3. Social and cultural
4. Crowding and congestion
5. Services
6. Taxes
7. Community attitude

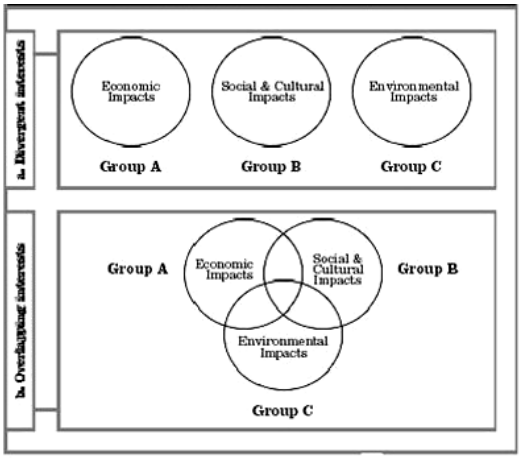



**Fig.13:.Diffrent impacts of tourism**

Each category includes positive and negative impacts. Not all impacts are applicable to every community because conditions or resources differ. Community and tourism leaders must balance an array of impacts that may either improve or negatively affect communities and their residents. Leaders must be sensitive and visionary, and must avoid the temptation of glossing over certain difficulties tourism development creates.

The diversity of plants and microorganisms in Wadi El- Arbae'en is affected mainly by the following factors:

1- Run over the plants.
2- The huge amount of garbage produced by tourists.
3- Rolling of soil particles near the plants.

It was expected that, Saint Katherine as a mountainous area characterized by an elevation of 1500 to 2624 m a. s. l. and very low humidity, will has less taxa of mycobiota than the other habitats in Egypt. About 105 species of fungi were reported and/or recorded throughout this survey. The most isolated taxa either in air or leaf surfaces were originally came from soil due to the impact of tourism on diversity of microorganisms.

Excluding mushroom toxins, approximately 350 to 400 fungal metabolites are considered to be toxic (Tobin *et al.*, 1987). Most of these are relatively small molecules of greater than 200 and the majorities are less than 500 mass units. Perhaps the most important mycotoxins in agriculture are the aflatoxins, the 12,13-epoxytrichothecenes, the fumonisins, and ochratoxin. Species belonging to the genera *Aspergillus*, *Penicillium*, and *Fusarium* are common contaminants of agricultural commodities, and some of the mycotoxins produced by these species are produced by fungi common in dust (Samson, 1992). In addition, some toxigenic fungi produce many different mycotoxins. Other toxigenic fungi include species of *Alternaria, Paecilomyces, Rhizopus, Trichoderma,* and *Trichothecium*. All of these fungi occur commonly in soil, agricultural products, grain dust, and house dust.

Fungi have long been known to affect human well being in various ways, including disease of essential crop plants, decay of stored foods with possible concomitant production of mycotoxins, superficial and systemic infection of human tissues, and disease associated with immune stimulation such as hypersensitivity pneumonitis and toxic pneumonitis. The spores of a large number of important fungi are less than 5 μm aerodynamic diameter, and therefore are able to enter the lungs. They also may contain significant amounts of mycotoxins. Diseases associated with inhalation of fungal spores include toxic pneumonitis, hypersensitivity pneumonitis, tremors, chronic fatigue syndrome, kidney failure, and cancer (Olsen et al., 1988). Species of fungi in which mycotoxins have been reported in the spores include *Alternaria alternata*, *Aspergillus fumigatus* and *Aspergillus flavus*. Several different mycotoxins were demonstrated in these investigations including deoxynivalenol, fumitremorgen and verruculogen, fumigaclavine C, T-2 toxin,

tryptacidin, alternariol and alternariol monomethylether. Gliotoxin has been demonstrated in tissues infected by *A. fumigatus* but was not detected in spores of *A. fumigatus*.

Charcoal root rot, caused by the fungus *Macrophomina phaseolina* (syn. *Sclerotium bataticola*) affects more than 300 species of plants, including many agricultural crop plants, forest tree seedlings, and native weeds. A similar disease, black root rot, is caused by a complex of organisms of which *M. phaseolina* and *Fusarium oxysporum* are the most important components. Black root rot affects the majority of plants in Egypt, and as noticed in my list of taxa *Macrophomina phaseolina* has been isolated. This fungus may be transfered by any mobile group of tourists to the agricultural area.

# Discussion and Recommendations

Information about the mycobiota of Wadi El-Arbae'en, Saint Katherine Protectorate is rather limited and fragmentary. This may be attributed to a main reason that they have never been the sole target of any study before.

To draw as complete as possible a picture about this group of fungi, strategy was put forward whereby several habitats and substrates were subjected to survey using different techniques and various media. Investigated habitats comprised soil, dung, leaf surface and air catches.

From the different habitats used for sampling, 105 species were isolated or reported. Taxonomically these were assigned to eight classes. Four classes are belonging to Ascomycetes, two to mitosporic fungi, both of Basidiomycetes and Zygomycetes are representing by one class only.

Regarding species richness, **at the substrate level**, dung proved to be the richest by showing 54 species followed by soils (39 species), leaf surfaces (34 species) and air (17 species). **At the generic level**, species richness indicated that *Aspergillus* came first by 12 species, followed by *Penicillium* (9 species), *Chaetomium* (6 species) and *Fusarium* (5 species). Other genera were represented by narrow spectra of only one or two or three species each.

Data of the present study regarding **desert soils** showed that counts of fungal populations are relatively low. Similar observations on low count associated with narrow spectra of species were also recorded by Moubasher *et al.* (1985), Abdel-Hafez *et al.* (2000), Abdel-Azeem (1991, 2003) and Abdel-Azeem & Ibrahim (2004). Moisture content of these soils is usually low because of the reduced water holding capacity and to the high rate of evapotranspiration resulting from strong solar radiation. These factors together may account for the relatively low $a_w$ which greatly affects microbial diversity and activity.

The leaf surface as a habitat for ascosporic fungi looks unsuitable where only 4 species. Whether their occurrence is active or passive it is not known because techniques cannot tell. Such weak occurrence of ascosporic species has also been noticed during a study on the surface mycobiota carried out by Abdel-Hafez *et al.* (1990 & 1995).

The data clearly indicated that spore populations of the air are too poor in their ascosporic content where no ascosporic taxa were encountered. This is not surprising because air is just a

transport rather than a growth medium. Fungal spores in the atmosphere come mostly from leaf surfaces which are known to support the presence of hyphomycetous rather than ascomycetous fungi.

Data of the present study indicated clearly that dung is by far the richest substrate for fungi. From three types of herbivore dung, a relatively wide range of 54 taxa were recorded. With regarded to dung type, donkey-dung came first by showing a range of 46 species followed by camel (37 spp.) and goat (32 spp.). In a previous study, on camel dung, by Bagy *et al.* (1986), 12 ascosporic taxa were encountered some of which are apothecial or perithecial while some others are not exclusively coprophilous Ascomycetes such as *Emericella nidulans*.

Based on the value of frequency of occurrence, the distribution pattern of ascosporic species among different types of dung indicated that while some species were of restricted occurrence on certain types of dung e.g. *Thielavia* (on camel dung), some others were of common occurrence in almost all types of dung e.g. *Chaetomium globosum, Podospora appendiculata*, *Saccobolus glaber*. Such observations on the species-substrate relationship have also been reported among coprophilous fungi by Lundqvist (1972), Angel & Wicklow (1975), Parker (1979) and Richardson (2001). They advocated that the physical and chemical properties of dung differ from one animal to another and accordingly dung from a particular animal would favour colonization by certain fungi.

During the follow up of succession of ascosporic species on dung, *Lasiobolidium* was the first ascomycete to develop ascomata followed by other apothecial forms (*Ascobolus* & *Saccobolus*). Perithecial (*Podospora* & *Sordaria*) and cleistothecial forms (*Kernia*) of Pyrenomycetes came next. Pseudothecial forms (e.g. *Preussia*) came last.

Statistical analysis to clear up the possible relationship between habitats and species composition showed that three of the habitats under investigation namely: soil, leaf surface and air are ecologically related while dung is not related to them at all and represent highly specific habitats.

Classification of mycobiota associated with leaf surfaces by TWINSPAN analysis, to reveal species/substrate relationship, showed a tendency toward an affiliation between certain species and particular plant. For instance the following taxa are associated only with one plant, *Zygorhynchus*

*heterogamus* (*Phlomis aurea*), *Aureobasidium pullulans* (*Verbascum sinaiticum*), and *Chaetomium globosum* (*Teucrium polium*).

On the other hand, the ordination showed also that some species are not specific in their occurrence such as *Alternaria alternata*, *Aspergillus fumigatus, A. flavus,* and *A. niger* which are common to a wide range of habitats (leaf surface, soils and air).

Though the present study might add some new elements to our information about mycobiota in Sinai, the list of obtained species is far from being complete as it is not possible at all to give a final or complete picture based on the data of a single study. The present study must be considered, therefore, as a preliminary one waiting for further contributions. It would be recommended here that mycobiota of Sinai deserve an intensive study program as this group of microorganism constitutes a large assemblage of members inhabiting diverse habitats and the nutritional requirements of their sexual states to develop are not simple.

**I'm concluding here that the hazardous effects of isolated and/or reported taxa directly will affect the Bedouin health and agricultural yields (especially garden areas in Saint Katherine) because of the unwise tourist impacts on this wadi. While, a program in order to raise the local awareness of Bedouin and to discuss the hazardous effects of mycobiota on their health and crops must be established.**

## Acknowledgements

I express my deep appreciation to **Prof. A. F. Moustafa** (Botany Department, Faculty of Science, Suez Canal University) who has mad a number of helpful suggessions and identifications. I would like to thanks both of **Prof.. Samy M. Zalat** the national project coordinator and **Prof. Francis Gilbert** the international project coordinator of BioMap for their support throughout the survey. All members of Saint Katherine protectorate for their help and support .for which I extend my thanks.

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# APPENDIX

## Table 5: Distribution of the isolated taxa throughout the different habitats.

| No | Species | Habitats | | | |
|---|---|---|---|---|---|
| | | **Air** | **Leaf** | **Soil** | **Dung** |
| 1. | *Absidia corymbifera* (Cohn) Sacc. & Trotter | + | - | + | + |
| 2. | *Achaetomium sp.* | - | - | + | - |
| 3. | *Acremonium restrictum* (Beyma) Gams | - | - | + | - |
| 4. | *Acremonium rutilum* Gams | - | - | + | - |
| 5. | *Acremonium terricola* (Mill., Giddens & Foster) Gams | + | + | - | - |
| 6. | *Actinomucor elegans* (Eidam) Benj. & Hesselt. | - | - | - | + |
| 7. | Agonomycete | - | + | + | - |
| 8. | *Alternaria alternata* (Fr.) Keissl. | + | + | + | - |
| 9. | *Alternaria phragmospora* Emden | - | + | - | - |
| 10. | *Ascobolus cervinus* Berk. & Broome | - | - | - | + |
| 11. | *Ascobolus immersus* Pers. | - | - | - | + |
| 12. | *Aspergillus alutaceus* Berk. & Curtis | - | - | + | - |
| 13. | *Aspergillus candidus* Link | - | + | - | - |
| 14. | *Aspergillus flavus* Link | + | + | + | - |
| 15. | *Aspergillus fumigatus* Fresen | + | + | + | - |
| 16. | *Aspergillus japonicus* Saito | - | + | - | - |
| 17. | *Aspergillus niger* Tiegh. | + | + | + | - |
| 18. | *Aspergillus sydowii* (Bainier & Sartory) Thom & Church | + | + | + | - |
| 19. | *Aspergillus tamarii* Kita | - | - | + | - |
| 20. | *Aspergillus terreus* Thom | + | + | + | - |
| 21. | *Aspergillus ustus* (Bainier) Thom & Church | - | - | + | - |
| 22. | *Aspergillus versicolor* (Vuill.) Tirab. | + | + | + | - |
| 23. | *Aspergillus wentii* Wehmer | - | - | + | - |
| 24. | *Aureobasidium pullulans* (de Bary) G. Arnaud | - | + | + | - |
| 25. | *Bipolaris spicifera* (Bainier) Subram. | - | - | + | - |
| 26. | *Botryotrichum piluliferum* Sacc. & Marchal | - | - | - | + |
| 27. | *Cephaliophora irregularis* Thaxt. | - | - | - | + |
| 28. | *Cephaliophora tropica* Thaxt. | - | - | - | + |
| 29. | *Chaetomium atrobrunneum* Ames | - | - | - | + |
| 30. | *Chaetomium bostrychodes* Zopf | - | - | - | + |
| 31. | *Chaetomium globosum* Kunze | - | + | + | + |
| 32. | *Chaetomium gracile* Udagawa | - | - | - | + |
| 33. | *Chaetomium nigricolor* Ames | - | - | - | + |
| 34. | *Chaetomium piluliferum* Daniels | - | - | - | + |
| 35. | *Circinella muscae* (Sorokīn) Berl. & De Toni | - | - | - | + |
| 36. | *Circinella umbellata* Tiegh. & G. Le Monn. | - | - | - | + |
| 37. | *Cladosporium cladosporioides* (Fresen.) de Vries | + | + | - | - |
| 38. | *Cladosporium herbarum* (Pers.) Link | - | + | - | - |
| 39. | *Coprinus stercoreus* Fr. | - | - | - | + |
| 40. | *Coprinus* sp2 | - | - | - | + |
| 41. | *Corynascus* Arx | - | - | - | + |
| 42. | *Doratomyces nanus* (Ehrenb.) Morton & Sm., | - | - | - | + |
| 43. | *Emericella nidulans* (Eidam) Vuill. | - | + | + | - |
| 44. | *Eurotium amstelodami* Mangin | - | + | + | - |
| 45. | *Eurotium chevalieri* Mangin | - | - | + | - |
| 46. | *Fusarium equiseti* (Corda) Sacc. | - | - | - | + |
| 47. | *Fusarium lateritium* Nees | - | - | - | + |
| 48. | *Fusarium moniliforme* Sheld. | - | - | - | + |
| 49. | *Fusarium oxysporum* Sm. & Swingle | - | + | - | - |

| No | Species | Habitats | | | |
|---|---|---|---|---|---|
| | | Air | Leaf | Soil | Dung |
| 50. | *Fusarium solani* (Mart.) Sacc. | - | + | + | - |
| 51. | *Gymnoascus dankaliensis* (Castell.) Arx | - | - | - | + |
| 52. | *Gymnoascus desertorum* (Moustafa) Arx | - | - | - | + |
| 53. | *Gymnoascus ruber* Tiegh. | - | - | - | + |
| 54. | *Humicola fuscoatra* Traaen | - | - | + | - |
| 55. | *Isaria felina* (DC.) Fr., | - | - | - | + |
| 56. | *Kernia nitida* (Sacc.) Nieuwl. | - | - | - | + |
| 57. | *Lasiobolidium aegyptiacum* Mustafa & Ezz-Eldin | - | - | - | + |
| 58. | *Lophotrichus plumbescens* Morinaga, Minoura & Udagawa | - | - | - | + |
| 59. | *Macrophomina phaseolina* (Tassi) Goid | - | - | + | - |
| 60. | *Melanospora zamiae* Corda | - | - | - | + |
| 61. | *Microascus albonigrescens* (Sopp) Curzi | - | - | - | + |
| 62. | *Microascus cinereus* Curzi | - | + | + | - |
| 63. | *Microascus trigonosporus* Emmons & Dodge | - | - | - | + |
| 64. | *Mucor circinelloides* Tiegh. | - | - | + | - |
| 65. | *Mucor hiemalis* Wehmer | - | - | - | + |
| 66. | *Mucor racemosus* Fresen. | - | - | - | + |
| 67. | *Mycotypha microspora* Fenner | - | - | - | + |
| 68. | *Nigrospora oryzae* (Berk. & Broome) Petch | + | + | - | - |
| 69. | *Paecilomyces variotii* Bainier | - | - | + | - |
| 70. | *Penicillium brevicompactum* Dierckx | - | - | + | - |
| 71. | *Penicillium canescens* Sopp | - | - | + | - |
| 72. | *Penicillium chrysogenum* Thom | + | + | + | - |
| 73. | *Penicillium corylophilum* Dierckx | + | + | - | - |
| 74. | *Penicillium cyclopium* Westling | - | - | + | - |
| 75. | *Penicillium funiculosum* Thom | + | + | - | - |
| 76. | *Penicillium purpurogenum* Stoll | - | - | + | - |
| 77. | *Penicillium raciborskii* Zalessky | - | - | + | - |
| 78. | *Penicillium variabile* Sopp | - | - | + | - |
| 79. | *Phoma humicola* Gilman & Abbott | - | - | - | + |
| 80. | *Phoma leveillei* Boerema & Bollen | - | - | - | + |
| 81. | *Pilaira negriscens* Tiegh. | - | - | - | + |
| 82. | *Pilobolus crystallinus* (F.H. Wigg.) Tode | - | - | - | + |
| 83. | *Pilobolus kleinii* Tiegh. | - | - | - | + |
| 84. | *Pilobolus sphaerosporus* (Grove) Palla | - | - | - | + |
| 85. | *Piptocephalis arrhiza* Tiegh. & Monn. | - | - | - | + |
| 86. | *Podospora comata* Milovtz. | - | - | - | + |
| 87. | *Podospora communis* (Speg.) Niessl | - | - | - | + |
| 88. | *Preussia minima* (Auersw.) Arx | - | - | - | + |
| 89. | *Rhizopus stolonifer* (Ehrenb.) Vuill. | + | + | + | + |
| 90. | *Saccobolus citrinus* Boud. & Torrend | - | - | - | + |
| 91. | *Saccobolus glaber* (Pers.) Lambotte | - | - | - | + |
| 92. | *Sordaria fimicola* (Roberge ex Desm.) Ces. & De Not. | - | - | - | + |
| 93. | *Syncephalastrum racemosum* Cohn ex Schröt. | - | - | + | + |
| 94. | *Talaromyces stiptatus* Thom) C.R. Benj. | - | + | - | - |
| 95. | *Thamnostylum piriforme* (Bainier) Arx & Upadhyay | - | - | - | + |
| 96. | *Thielavia microspora* Mouch. | - | - | - | + |
| 97. | *Thielavia subthermophila* Mouch. | - | - | - | + |
| 98. | *Thielavia terricola* (Gilman & Abbott) Emmons | - | - | - | + |
| 99. | *Trichoderma pseudokoningii* Rifai | - | - | + | - |
| 100. | *Ulocladium atrum* Preuss | - | + | - | - |
| 101. | *Ulocladium chartarum* (Preuss) Simmons | + | + | - | - |
| 102. | Yeasts | + | + | + | - |
| 103. | *Zygorhynchus heterogamus* (Vuill.) Vuill. | - | + | - | - |

## II- Morphological and chemical description of some plants in the study area

**1-*Achillea fragrantissima***
**Arabic :** *Qaysûm*
**English :** Lavender Cotton
**French :** Garde-robe, Aurone femelle, Santoline.
**Italian :** Cypressengarbe.
**Turkish :** Guarda roba, Santolina**.**
Sarvi otic, Kara-pelin otu.

**Morphological Description :**
Plants are white-wooly, with erect stems which attain up to 1m high. Leaves small, exstipulate, thick, white to greyish-green, oblong, serrate with undivided lamina. Flower heads, terminal discoid composed of numerous tubular florets with golden-yellow colour. Odour is aromatic and the taste is bitter (Plate 18).

**Ecology :**
The plant grows in the limestone wadis of the north eastern desert and Sinai.

**Distribution :**
**Local :** The eastern desert, Red Sea region, Sinai Oases.

**Regional :** Egypt.

**Global :** The Arabian Peninsula**.**

**Status :** The plant is overexploited by collection for folk medicinal uses. It seems that the rate of exploitation exceeds that of regeneration. The plant could be considered endangered.

**Part used :** Fresh or dry whole plant**.**

**Constituents :** The fresh herb contains volatile oil that reaches about 1.0%, which consists of 59 components of which ? -pinene, ? -pinene, limonene, 1,8-cineole, linalool, carvacrol, eugenol, artemesia ketone, palustrol, sabinene hydrate, ? - and ? - thujones, santolina alcohol and ? - erpineol. Its tannin content reaches 8%. It is composed of resorcin, phloroglucin, methyl phloroglucin and pyrocatechol. It contains, flavonoids, from which froside,cirsimartin,chrysoplenol and cirsiliol were identified, also the fatty acids: lauric, myristic, palmitic, stearic, linoleic, linolenic and oleic, as well as a bitter substance named keissoside. Sesquiterpene lactones: 13-O-desacetyl-1-ß-hydroxyafraglouclide and achilloide A were isolated. Also, taraxasterol and pseudotaraxasterol acetates were identified.

**Folk Medicinal Uses :**
An infusion of the dry, or fresh, flowering herb is used by the Bedouin for the treatment of cough, aromatic bitter stomachic, and anthelmintic**.**

**2-*Artemisia herba-alba***
The plant is an aromatic wooly-canescent undershrub, 30-60 cm high. Stems are many branching from the base. Root leaves and leaves of sterile branches petioled, bipinnatipartite into oblong to oblong-linear lobes, those of flowering branches much smaller, few-lobed and clustered. Heads sessile, ovoid, brownish, somewhat fleshy, orbicular, the inner ones oblong to oblong-linear acute,

with a very broad scariuous margin. The plant is a good range plant growing in the north-western coastal zone of Egypt and in the wadis of Sinai. Due to its content of volatile oil, the plant is commonly used in folk medicine.

**Folk Medicinal Uses:**

Leaves and flowers febrifuge, calmativer for stomach, cough and cephalagia; cures nervous troubles and calms the emotions; used for ophthalmic diseases; enters in mixtures for treating hemorrhagic wounds. Infusion of flowering branches vermifuge, emmenagogue, tonic stomachic. Dr powdered plants for healing wounds and burns, diuretic; infusion for rheumatism, bronchitis; cataplasm of boiled flowers used to ripen and cure abcesses, antidiarhhhoetic. Essential oil distilled from the plant antiseptic and insecticide, also used as parasiticide in veterinary medicine.

**3- *Origanum syriacum***
**Arabic** : *Bardaqoash*

**Morphological Description :**

Leaves, nearly sessile, green, densely hairy, about 1 cm long, and 0.5 cm broad, with characteristic aromatic odour (of Mint smell) and taste. Bracts, small, 4-ranked, white-canescent. Flower heads, often cylinrical, panicled

**Ecology:**

The plant is rare and grows in rocky habitats in the mountains of Sinai

**Distribution:**
**Local :** Sinai
**Regional :** Only in Egypt
**Global :** The countries of the Middle East**.**

**Status:**

The plant is vulnerable.

**Part used** :

The leaves or the whole herb.

**Constituents**:

Volatile oil consisting of more than 80% carvacrol, resin and flavonoids.

**4- *Peganum harmala***
**Arabic :** *Harmal*
**English :** Harmel, Syrian rue, Wild rue.
**French :** Hermale, Harmel, Rue Sauvage.
**German :** Gemeine syrische Raute, Wild Raute.

**Morphological Description:**

A glabrous perennial plant with numerous herbaceous forked-corymbose stems from a shrubby base, 75 (-100) cm tall. Leaves, sessile, 6 (10) cm long, irregularly dissected with acute linear lobes. Flowers, large, terminal, soliary pedicellate and white in colour. The inflorescence is a cymose which is a compound monochasial scorpioid. The pedicel is angular and green in colour. The

flowers are actinomorphic, hermaphrodite. The fruit is a stalked 3-valved loculicidal capsule derived from trilocular superior ovary. The fruit is globular in shape, 6-10 mm in diameter. It contains numerous small dark brown, reticulately pitted, 3-4 mm long seeds arranged on axile placenta. The plant flowers from April to October and bears fruits from April to November

**Ecology:**

The plant is common in the northern coastal region, where it grows in neglected areas and disturbed ground as well as along the roads. It occupies niches that receive runoff water in addition to the recorded rainfall. The plant, being unpalatable, is not affected by grazing. However, the human activities affecting its habitat would be the main reason of the disappearance of the plant from many localities.

**Distribution:**

**Local :** The Mediterranean coastal strip from El-Salloum to Rafah. The Isthmic desert, Sinai

**Regional :** All the North African countries from Egypt to Morocco.

**Global :** South Europe, Asia Minor,Middle east, South Russia, Iran, Afghanstan, Pakistan,Kashmir, Tibet, India, Mexico, Western Asia, North and Latin America. It is considered as a common cosmopolitan weed of waste places, occurring in arid and semi-arid regions up to 4000 m.

**Status:**

The plant is not endangered. However, there is a great need to investigate the methods of cultivating the plant to satisfy the needs for folk or other uses.

**Part used:**

The dried ripe seeds of *Peganum harmala* L.(family Peganaceae*)*. Sometimes, leaves and flowers are also used.

**Constituents:**

Lipids (13.3%), ß-sitosterol and ? -amyrin, harmine, harmaline, harmalol and peganine.

**5-*Teucrium polium***

**Arabic :** *Ja'ada*

**English :** Mountain germander, Cat thyme, Hulwort.

**French:** Pouliot de montagne, Germandrée en capitule, Polium, Germandrée tomenteuse, Germandrée polium.

**German :** Poleigamander, Berggamander

**Italian :** Polio, Camendrio di montag na, Timo bianco, Polio primo, Teucrio tomentose, Canutola.

**Morphological Description**

Is a perennial herb having a pleasant aromatic odour and a bitter taste. It flowers from March to April. It has a tap root with many lateral branches, with dark and wrinkled surface. The herb has a cylindrical stem monopodially branced with short internodes. Both stem and its branches are white in colour. Leaves are opposite decussate, exstipulate, sessile having aromatic odour and bitter taste. Lamina is oblong to linear with curved wings, base symmetric, margin crenate and venation pinnate reticulate. Both surfaces are hairy, the upper one is dark green and lower one is whitish green, inflorescence is verticillaster.

**Ecology:**
The plant grows in rocky habitats and compact fine-textures soils with stones and pebbles.
**Distribution:**
**Local :** The Mediterranean zone, the deserts and Sinai.

**Regional :** All north African countries.

**Global :** Arabia.

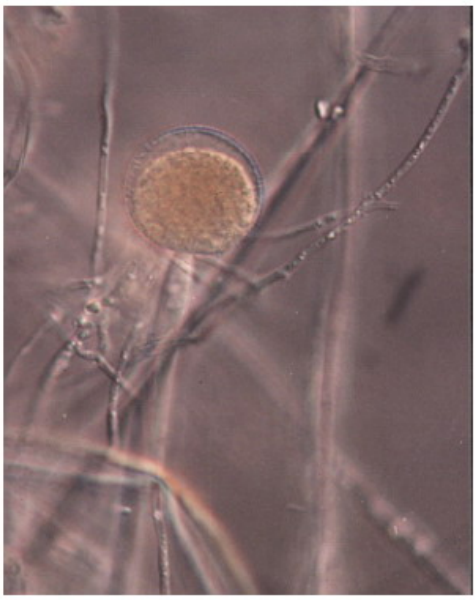
**Status:**
The plant is overcollected to be used in folk medicine. It is threatened

**Part used :**
Stem and flowering tops.

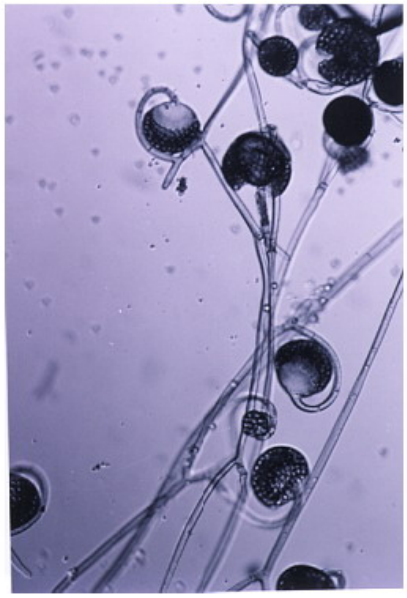
**Constituents :**
Diterpenoids: picropolin, 6-acetyl picropolin, isopicropolin, 19- acetylgnaphalin, teucrins $P_1$, $P_2$ and $P_3$, montanin, teupolins I-V. Iridoids, flavonoids, hedragenin, ursolic acid, ? - and ? -amyrins, and volatile oil.

***Pilobolus crystallinus*** (Wigg.) Tode
Sporangium before ejaculation.

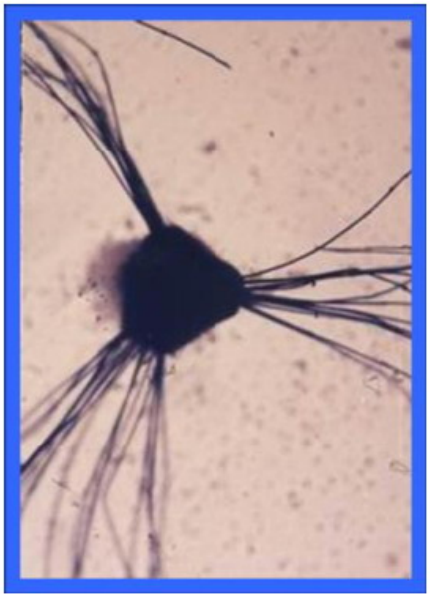
***Mucor hiemalis*** Wehmer
Long sporangiophore showing characteristic globose columella.

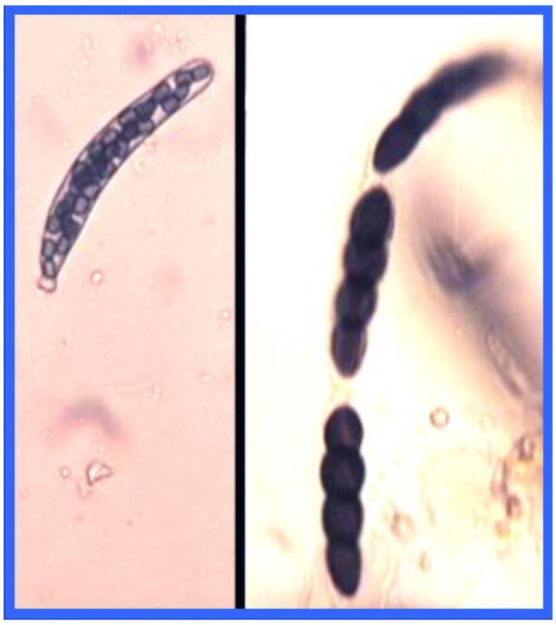


***Circinella muscae*** (Sorokin) Berl. & De Toni
Sporangia and straight spine developing on the same branch

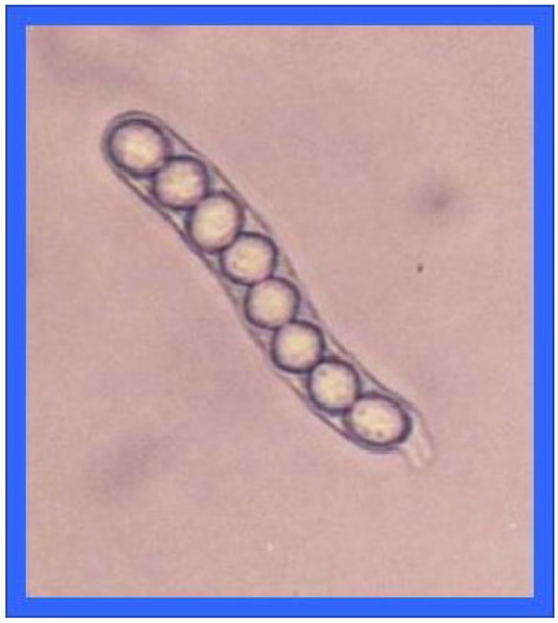


***Kernia nitida*** (Sacc.) Nieuwl.
Polygonal ascomata showing peridial appendages emerging in fascicles





***Preussia minima*** (Auersw.) Arx. Ascus before and after ascospores discharge.



***Lasibolidium aegyptiacum*** Moustafa & Ezz El-Din. Ascus showing ascospores

***Ascobolus immersus*** Pers. Ascospore

***Ascobolus immersus*** Pers. Ascus before and after ascospores discharge.

## الملخص العربي

تغطى صحراء سيناء تقريباً 6 % مِنْ المساحة الكلية لمصر وتُعتَبرُ أحد البيئاتِ القاسيةِ بالإضافة إلى كونها جزء من الصحارى العربيةِ. وتتميز سيناء بمناخ يتراوح مابين القاحل و القاحل جداً متأثرا بمناخ البحر الأبيض المتوسطِ. ويصل متوسط المطر السنوي فى غالبية سيناء أقل مِنْ 50 مليمتر سنوياً أما الجزء الجنوبي من سيناء يصله ما يقرب من 65-100 مليمتر (Moustafa وKlopatek، 1995).

لماذا الفطريات؟

بدأت دراسة فطريات التربة فى مصر على يد العالم يونس ثابت فى عام 1935 وهى تعد من الدراسات الرائدة فى هذا المجال ثم توالت الدراسات المختلفة على فطريات المستنقعات الملحية والأراضي الصحراوية والزراعية من قِبل العدِّيد من الباحثين أمثال (أبو النصر 1981، عبد الله وآخرون 1988، عز الدين 1988، مباشر وآخرون 1990، عبد الواحد 1990، عبد العظيم 1991، 2003، مباشر 1993، إبراهيم 1999، عبد الحافظ 2000).

و حتى وقتنا هذا ومع الظروف البيئية القاحلةِ جداً فإن فطريات سيناء لم تحظى سوى باهتمام قليل من الباحثين المصريين ومن ثم فإن المعلومات المتعلقة بفطريات هذه المنطقةِ مازالت غامضة لكونها إما ناقصة أو متجزئة. وحتى الآن فإن التنوع البيولوجي لفطريات سيناء ومجموعاتها البيئية المختلفة لم تحظى باهتمام الدارسين سوى الدراسة الرائدة لعبد العظيم وإبراهيم عام (2004) والتي تعتبر دارسة مبدئية لفطريات التربة وتنوعها البيولوجي فى سيناء فى 18 موقع من شمال ووسط وجنوب سيناء.

وفى بحثه المعنون فجوات في المعرفةِ" ذكرَ العالم المصري الكبير الدكتور محمد عبد الفتاح القصاص عام 2002 الأسباب الحقيقة للفجوات المعلوماتية للتنوع البيولوجي ليس فى مصر فقط بل فى العالم جمعاء وهذه الفجوات تتلخص فى النقاط التالية:

- "الفجوة الأولى تَتعلّقُ بغياب حصر حقيقي للأنواع العالميةِ وتنوعها البيولوجي بالإضافة إلى ذلك العدد الكلى لأنواع الكائنات الحية على كوكب الأرض وبالتالي فهي من اكبر الفجوات.
- وتَتعلّقُ الفجوةُ الثانية بالتنوع البيولوجي للكائنات الدقيقة وهى تتضمن الفطريات، والبكتيريا، الطحالب، والبروتوزوا، الخ. ، ودورهم في البيئة العالميةِ.
- أما الفجوة الثالثة فتَتعلّقُ بالدور الذي يلعبه كل نوع من الكائنات الحية ضمن المكونات الحية للأنظمة البيئية.
- أما الرابعة فتتعلق بالقدرةِ الإنسانيةِ لتَقييم وتَوقعْ علاقات التحلل البيئيّة-حيوية. فعملية التقييم الشامل لمكوّنات النظام البيئي عملية مهمّة ومرهقة، حتى إذا ما نَفَّذت على نطاق محدودِ.

ويضاف إلى هذه الفجوات في السابقة الفجواتِ المتَعلّقة بالمناطق الجغرافيةِ المعيّنةِ، وفجوات تَعلّقتْ بوحداتِ تصنيفية بعينها والتي تَتضمّنُ دراسة المادةِ الوراثيةِ لبعض الكائنات. مثل هذه الفجواتِ لابد أنْ تُغطي في برامج مسوح التنوع البيولوجي الوطنية حتى تمدنا بنتائج وبحوث مركّزةِ النتائج.

التنوع البيولوجي للفطريات فى مصر من المواضيع الشائكة التي ينظر لها علماء تصنيف الفطريات على إستحياء حيث انه لا توجد دراسة مصرية حقيقية اهتمت بعدد الأنواع الفطرية المصرية وتنوعها البيئي إلا الدراسة المبدئية للدكتور سامي الأبيض والصادرة عن جهاز شئون البيئة من مطبوعات وحدة

***التنوع البيولوجي عام 1997 وهى الدراسة التي غاب منها مكان عزل الكائنات و العالم القائم بالعزل وتاريخ العزل بالإضافة إلى عدم تحديث الأسماء حيث أن بعض الأنواع تم نقله أو إعادة تسميته مرة أخرى وغيرها مما جعلها تحتاج إلى التحديث وجعل لزاما على العاملين فى هذا المجال التكاتف لإصدار دراسة واقعية ترصد حالة التنوع البيولوجي للفطريات فى مصر.***

***لذا مِنْ وجهةِ نظري وللأسباب المذكورة سابقا فإن دراسة التنوع البيولوجي والمجموعات البيئية المختلفة للفطريات فى سيناء سوف تساهم بشكل ما فى سد فراغ المعلوماتية الخاصة بالتنوع البيولوجي للفطريات فى جمهورية مصر العربية.***

***تقع منطقة الدراسةِ في منطقةِ سانت كاثرين، جنوب سيناء على ارتفاع مِنْ 1500 إلى 2624 متر من مستوى سطح البحر وقد تم اختيار وادي الأربعين لإجراء الدراسة للعديد مِنْ الأسبابِ وهى:***

***1. وادي ضيّق جداً، وظليّلَ ومغْلقَ***
***2. أحد أجمل الوديان في منطقةِ سانت كاثرين بسبب منظره الطبيعي اللطيف.***
***3. أنْ يَكُونَ أحد أكثر الوديان تنوعا فى نباتاته حيث يصل أعداد الأنواع النباتية به إلى ما يقرب من 100 نوع (مصطفى، 2001).***
***4. يخضعْ إلى وجود نشاط سياحي مكثف.***

***والأهداف الرئيسية لهذه الدراسة هي:***

***1 – إلقاء الضوء على تركيب وتنوع الفطريات في البيئاتِ المختلفةِ وتأثيراتها على حياة البدو في منطقةِ جنوبِ سيناء.***
***2 – اكتشاف تأثير حركة السياح على تنوع الفطرياتِ وتوزيعِها فى المنطقة.***
***3 – سَدّ جزء من الفراغ المختص بالتنوع الميكروبي في مصر حيث أن المعلوماتِ المتعلقة بفطريات هذه المنطقة شبه معدومة أو ناقصةِ.***

***أخذ العينات***

***تم تجميع 90 عينة تربة من 18 موقع للدراسة فى وادي الأربعين والأجزاء الخضرية (سيقان و أوراق ) من18 نوع نباتي من الأنواع السائدة فى الوادي حيث تنتمي هذه الأنواع إلى 9 فصائل بواقع 10 جرام من النبات الواحد فقط. أما فطريات الهواء فقد تم عُزلهاَ بإستعمال تقنية الترسيب بواقع 5 أطباق لكل موقع. وتم تجميع 150 عينة روثِ للحيوانات آكلة العشب (أبل وحمير وماعز). وقد تم تجميع هذه العينات لأغراض البحث العلمي بعد الحصول على إذن من إدارة محمية سانت كاثرين.***

***وقد أجرى العيد من التحاليل على عينات التربة اشتملت على التحليل الميكانيكي وتقدير الأس الهيدروجيني والأملاح الكلية الذائبة والتوصيلية الكهربائية والمادة العضوية ومحتوى الرطوبة. وتم عزل فطريات التربة بطريقة التخفيف أما فطريات الهواء عن طريق تعريض أطباق الأوساط الغذائية لفترة زمنية تصل إلى 15 دقيقة فى كل موقع. أما فطريات أسطح النباتات فقد تم عزل الفطريات بطريقة الغسيل لأسطح الأوراق والسيقان للنباتات محل الدراسة. أما فطريات الروث فقد تم تحضين العينات داخل علب بلاستيكية شفافة على ورق ترشيح مبلل بالماء المعقم بالقرب من مصدر ضوئي وتم متابعة الأنواع المتكونة لمدة وصلت إلى شهرين.***

***وقد استخدمت العديد من الأوساط الغذائية أثناء الدراسة منها وسط تشابكس مستخلص الخميرة المزود بكلورامفينيكول والروزبنجال (كمضادات لنمو البكتيريا) لعزل فطريات التربة وأسطح النباتات. وأنواع أخرى مثل بيئة مستخلص الشوفان والشعير ودكستروز البطاطس وأجار البطاطس والجزر وغيها لتنمية الأنواع والحفاظ عليها أثناء التعريف. وقد تم تعريف الفطريات حتى مستوى النوع بالاعتماد على مفاتيح تعريف عالمية مختصة بالأجناس والأنواع محل الدراسة.***

***ولوصف المجتمعات الفطرية للبيئات محل الدراسة تم استخدام العديد من القياسات التي تعبر عن درجة التواجد، التنوع ودلالاته والتماثل.***

***خلال هذه الدراسة تم عزل و/أو تسجيل 105 نوع تنتمي إلى 55 جنس من جميع البيئات محل الدراسة والمسماة (تربة، هواء، أسطح نباتات، روث). تصنيفيا تنتمي الأنواع المعزولة إلى خمس طوائف، سبعة رتب، عشرة فصائل. وكانت الفطريات الناقصة ممثلة بعشرين جنس و 52 نوع وتمثل 50% من نسبة الأنواع المعزولة، أما الفطريات الزقية فمثلت بتسعة عشر جنسا و 34 نوع ونسبة 32%، أما الفطريات الزيجوتية فقد حصلت على 16% من النسبة الكلية للفطريات المعزولة بينما حصلت الفطريات البازيدية على نسبة 2%.***

***وعلى أساس وفرة الأنواع داخل الأجناس فقد أحتل جنس الاسبرجيليس المركز الأول مسجلا 12 نوعا تبعه البنسيليوم (9 أنواع) والكيتوميوم (6 أنواع) والفيوزاريوم (5 أنواع) والأكريمونيم (3 أنواع) وتراوحت باقي الأجناس بين نوعين إلى نوع للجنس الواحد.***

***وعلى أساس وفرة الأنواع داخل البيئات المختلفة فقد احتل الروث المركز الأول مسجلا 54 نوعا بالمقارنة بالتربة التي سجلت 39 نوعا وأسطح النباتات التي سجلت 34 نوعا والهواء الذي سجل 17 نوعا.***

***وقد أظهرت التحاليل الإحصائية المختلفة أن بعض البيئات يمكن أن تكون مرتبطة مع بعضها البعض مثل الهواء وأسطح النباتات أما فطريات الروث فقد أظهرت التحاليل أن الروث يعد بيئة قائمة بذاتها ولا تشترك مع اى من البيئات الأخرى فى الأنواع التي تم عزلها أو تعريفها منه.***

***أما المفاجأة الكبرى فكانت بتحليل نتائج فطريات أسطح النباتات والتي أظهرت النتائج أن نبات الشيح لم يحمل اى فطر على سطحه بالإضافة إلى أن نبات الالكانا اورينتالس كان مميزا بفطرياته وانفصل عن باقي أنواع النباتات التي تجمعت فى مجموعات على أساس الفطريات التي تم عزلها منها ويرجع السبب فى هذا إلى تركيب هذه النباتات التشريحي ومحتواها من المواد الفعالة التي قد تحفز ظهور بعض الأنواع أو تثبطها.***

***وقد تم عزل بعض أنواع الفطريات الممرضة للنبات والتي سوف تؤثر بشكل كبير إن انتشرت على مزارع البدو فى المنطقة بالإضافة إلى بعض الأنواع التي لها القدرة على إنتاج السموم الفطرية والتي تعد من ملوثات الهواء والتي تتأثر إعدادها وأنواعها بحركة السياحة من وإلى الوادي وهى من الأنواع التي قد تؤثر فى الفترة القادمة بشكل كبير على صحة البدو.***