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RESEARCH ARTICLE

DIVERSITY OF SOIL MESOFAUNA IN THE NEW VALLEY OASES, WESTERN DESERT, EGYPT.

Wafai Z. A. Mikhail.

Department of Natural Resources, Faculty of African Postgraduate Studies, University of Cairo.

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Abstract

This was conducted in four localities: Al-Kharga, Al Monira, Boulaq and Baris Oases in the New Valley Governorates, from the farmlands and the out skirting desert. Soil mesofauna was sampled by means of the pitfall trap method. Data of activity density of soil mesofauna families were treated by multivariate statistical methods; correspondence analysis and ascending hierarchic classification. A total of 499 individuals of soil mesofauna belonging to 35 families of 9 orders, were obtained. Based on the activity density of soil mesofauna, each of Al-Kharga and Boulaq are similar to each other at about 60% and each of Al-Monira and Baris are similar at about 56%, whereas, the four oases of the present study are similar at about 45%. The two indices of diversity used in this study indicated that families of soil mesofauna are nearly equal in both species richness and evenness. Composition and diversity of soil mesofauna families may differ in desert agro-ecosystems according to cropping patterns and type and intensity of agriculture practices.

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Introduction:-

Soil organisms are an integral part of agricultural ecosystems especially in desert areas. The presence of a range of soil organisms is essential for the maintenance of healthy productive soils. An excessive reduction in soil biodiversity, especially the loss of species with unique functions, may have catastrophic effects, leading to the long-term degradation of soil and the loss of agricultural productive capacity. As a consequence, more land would be needed for agricultural production to meet demands.

The overlooking and depletion of the beneficial functions performed by soil organisms in agricultural ecosystems as a result of inappropriate soil biological management is contributing to increased rates of land degradation, nutrient depletion, fertility decline, water scarcity, and yield reductions. All these factors have a negative impact on the livelihoods of people who depend directly on agriculture for their subsistence.

One of the main gaps in most agricultural management systems is their failure to consider the option of managing soil biological processes and, in particular, using practices that favour the activity of soil mesofauna as a means to maintain and improve soil fertility. Although not readily visible, relatively more attention has been placed in research and development on the functions of soil micro-organisms – both their positive effects on nutrient cycling and uptake, and the negative effects of soil borne pests, including nematodes (microfauna), and pathogens.

Corresponding Author:-Wafai Z. A. Mikhail.

Address:-Department of Natural Resources, Faculty of African Postgraduate Studies, University of Cairo.

The aim of the present study was conducted to survey soil mesofauna communities in such desert agro-ecosystems in the New Valley of the Western Desert of Egypt.

Material and Methods:-

The Study Sites

The New Valley Governorate is located on the south western part of the country, and shares the international borders of Libya to the west and Sudan to the south. As for its internal boundaries, it shares the borders with the Governorates of El Menia, Giza and Marsa Matrooh on the north and Assiut, Suhag, Qena and Aswan on the east.

The Governorate is divided up administratively into 4 centers, which comprise 4 cities, 37 local units and 164 villages in which approximately 187 thousand persons live. Water resources are considered the main factor for the distribution of the urban centers, as well as the availability of arable soil. Further, roads and transportation is considered the main factor for the urban activation and development of the centers and their sustainability.

The New Valley Governorate is considered the biggest Governorate in the country in terms of area, which amounts to approximately 440098 km², representing approximately 43.6% of the total area of the country.

The New Valley climate is dry desert climate, and the most important factors may be illustrated as follows: Rainfall is almost scarce throughout the year, not exceeding 4 mm/year. Average annual temperature is 23°C. Average relative annual humidity is 35.5% and average annual wind speed is 6 km/hour.

Soil mesofauna were sampled from four localities: Al-Kharga, Al Monira, Baris and Boulaq towns in the New Valley Governorates, from the farmlands and the out skirting desert. Each of Kharga, Al Monira and Boulaq were cultivated by the Egyptian clover or berseem (*Trifolium alexandrenum* L.) which is the main winter forage in Egypt and is the basic component of a sustainable cropping system (FAO, 2014). Baris Oasis is about 112 km to the south of Kharga Oasis. The area is dominated by the shrub, *Calotropis procera* (Madar): a medicinal plant of various therapeutic uses (Yogi et al., 2016), and some cultivated crops including the Egyptian clover.

Method of sampling soil fauna:-

Pitfall trap method

The soil fauna was collected from four localities of the study area by the pitfall trap method as described by Southwood and Henderson (2000) and Araújo et al. (2015). Pitfall traps consisted of 300 ml cups buried in the soil in such a way that the lip of the trap was ground level. The Pitfall were half filled with a detergent solution (1%) to ensure rapid sinking of animals and Pitfall traps were placed before sunset of day, kept open during the night, and the animals collected on the next morning. In this method, the number of individuals trapped is termed activity densities rather than population densities (Kromp, 1990; Mikhail, 1993; Araújo et al., 2015). The activity density cannot be related to the abundance per unit area (Kromp, 1990; Araújo et al., 2015), but is taken as number per trap (Mikhail, 1993; Araújo et al., 2015). The number of pitfall traps used in each of the four locality of the study area, was 25 traps, with a total of 100 pitfall traps in the study areas.

Treatment of data

Data of the activity density of the soil mesofauna taxa sampled in the present study were statistically analyzed by multivariate statistical methods: correspondence analysis CA and ascending hierarchical classification AHC. Simpson(S) and Shannon-Wiener (H) indices of diversity as well as Jaccard index of similarity were also calculated. All these calculations were done using PAST3 Programme, Version 1.94b (Hammer, 2009).

Results:-

Table (1) and Fig. (1) shows results of the sampled soil mesofauna families from the four localities, Al-Kharga, Al Monira, Boulaq and Baris of the present study at the New Valley Oases of the Western Desert of Egypt. A total of 499 individuals of soil mesofauna belonging to 35 families of 9 orders, were recrded.

Table 1:-Activity-density of soil mesofauna families in the New Valley,Western Desert, Egypt.

Taxa	Al-Kharga	Al-Monira	Baris	Boulaq	Total
Carabidae			1		1
Coccinellidae	4	33	19	6	62

Curculionidae				1	1
Dermestidae	2				2
Scarabaeidae			1		1
Tenebrionidae			11		11
Lycaenidae	11	5	5	6	27
Pieridae	1	1	2	1	5
Libellulidae	10	14	6	9	39
Agrionidae		5	1		6
Acrididae	7	9	34	10	60
Gryllidae		3		2	5
Tettigoniidae	3	2		3	8
Coreidae		2	3		5
Lygaeidae		1			1
Pentatomidae	3	8	11	17	39
Reduviidae			3		3
Chrysopidae	3	4	2	8	17
Myrmeleontidae		4			4
Mantidae		1	1		2
Nymphalidae	1			6	7
Asilidae	1				1
Muscidae	5		10	8	23
Bombylidae				1	1
Syrphidae				1	1
Conopidae	2		3		5
Tabanidae		1		2	3
Apidae	18	13	13	22	66
Sphecidae		8	14	13	35
Eumenidae	1	9	2	6	18
Formicidae			4		4
Vespidae		4	1		5
Pompilidae		2	1		3
Ischnumenidae			1		1
Scoliidae	6	5	1	15	27
Families	16	21	24	19	35
Individuals	78	134	150	137	499

Baris Oasis has the largest number of both families and individuals of soil mesofauna families, while Al-Kharga Oasis has the lowest numbers of both families and individuals whereas each of Al Monira and Boulaq are intermediate (Fig. 1).

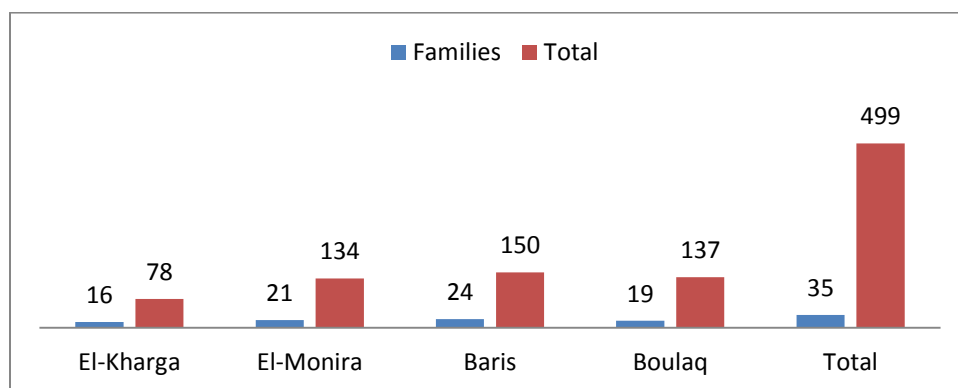


Fig 1:-Number of families and total number of individuals sampled in different localities in the New Valley Governorate

Fig. (2) shows results of the application of ordination methods, correspondence analysis(CA) and ascending hierarchic classification (AHC), to data of Table (1). Forty-four of the total variance is associated the first (horizontal) axis and 36% with the second (vertical) one. The first axis separates between each of Al-Kharga and Boulq Oases, which are cultivated with clover, at the right hand, from that of Baris Oasis, which experience mixed cultivation of different crops and the presence of *Calotropis procera* plant, at the left hand side of the ordination graph. The second axis separates between each of Al-Kharga, Boulq and Baris Oases at the top, from that of Al-Monira at the bottom of the ordination graph. Al-Kharga Oases is characterized more or less by two soil mesofauna families; Dermestidae and Asilidae. Four families are characteristic of Boulq Oasis. These are Curculionidae, Nymphalidae, Bombylidae and Syrphidae. Al-Monira is characterized by Lygaeidae and Myrmeleontidae. Baris is an oasis of different plants and dominated by *C. procera* shrubs. This condition creates suitable conditions for the presence of six families which can withstand in arid areas. These are Carabidae, Scarabaeidae, Tenebrionidae, Reduviidae, Formicidae and Ischnumenidae.

Eight taxa were present in the four oases; Coccinellidae, Lycaenidae, Pieridae, Libellulidae, Acrididae and Pentatomidae. Chrysopidae and Apidae are present in each of Al-Kharga, Al-Monira, Baris and Boulq. These families are appeared at middle of the ordination graph. Other families are scattered distribution in the ordination graph.

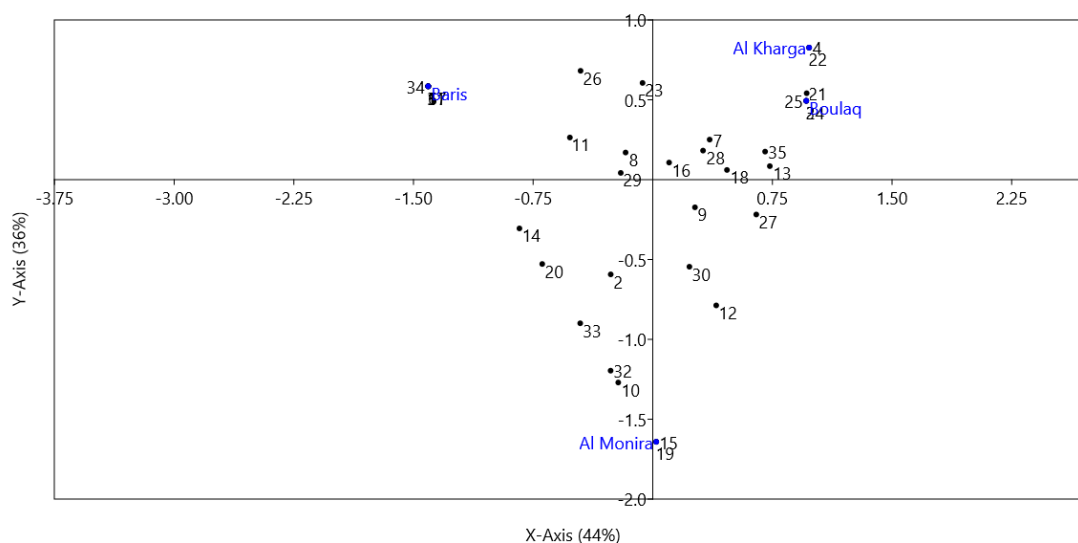


Fig 2:-Graphical representation of the application of CA and AHC methods to data of Table (1). Taxa: 1, Carabidae; 2, Coccinellidae; 3, Curculionidae; 4, Dermestidae; 5, Scarabaeidae; 6, Tenebrionidae; 7, Lycaenidae; 8, Pieridae; 9, Libellulidae; 10, Agrionidae; 11, Acrididae; 12, Gryllidae; 13, Tettigoniidae; 14, Coreidae; 15, Lygaeidae; 16, Pentatomidae; 17, Reduviidae; 18, Chrysopidae; 19, Myrmeleontidae; 20, Mantidae; 21, Nymphalidae; 22, Asilidae; 23, Muscidae; 24, Bombylidae; 25, Syrphidae; 26, Conopidae; 27, Tabanidae; 28, Apidae; 29, Sphecidae; 30, Eumenidae; 31, Formicidae; 32, Vespidae; 33, Pompilidae; 34, Ischnumenidae; 35, Scolidae.

Fig. (3) shows results the hierarchical classification of oases of the present study based on Jaccard similarity index (sometimes called the Jaccard similarity **coefficient**) compares members for two sets to see which members are shared and which are distinct. It's a measure of similarity for the two sets of data, with a range The Jaccard index will always give a value between 0 (no similarity) and 1 (identical sets), and to describe the sets as being "x% similar" you need to multiply that answer by 100. So a Jaccard index of 0.73 means two sets are 73% similar. The higher the percentage, the more similar the two populations. Although it's easy to interpret, it is extremely sensitive to small samples sizes and may give erroneous results, especially with very small samples or data sets with missing observations.

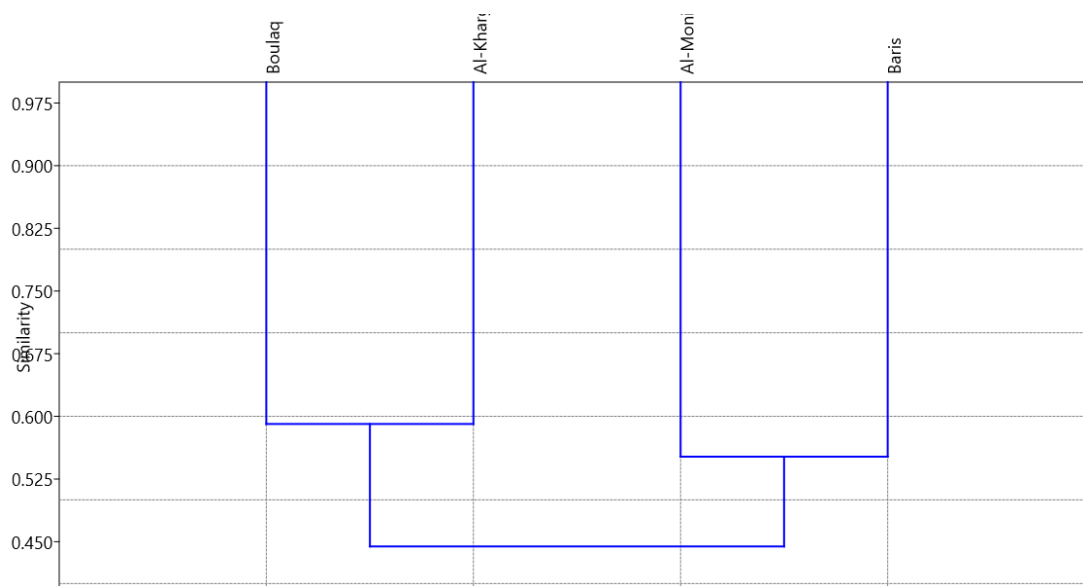


Fig 3:-Hierarchical classification of El-Kharga, Al-Monira, Baris and Boulq based on Jaccard similarity coefficient.

Based on the activity density of soil mesofauna, each of Al-Kharga and Boulq are similar to each other at about 60% and each of Al-Monira and Baris are similar at about 56%, whereas, the four oases of the present study are similar at about 45%.

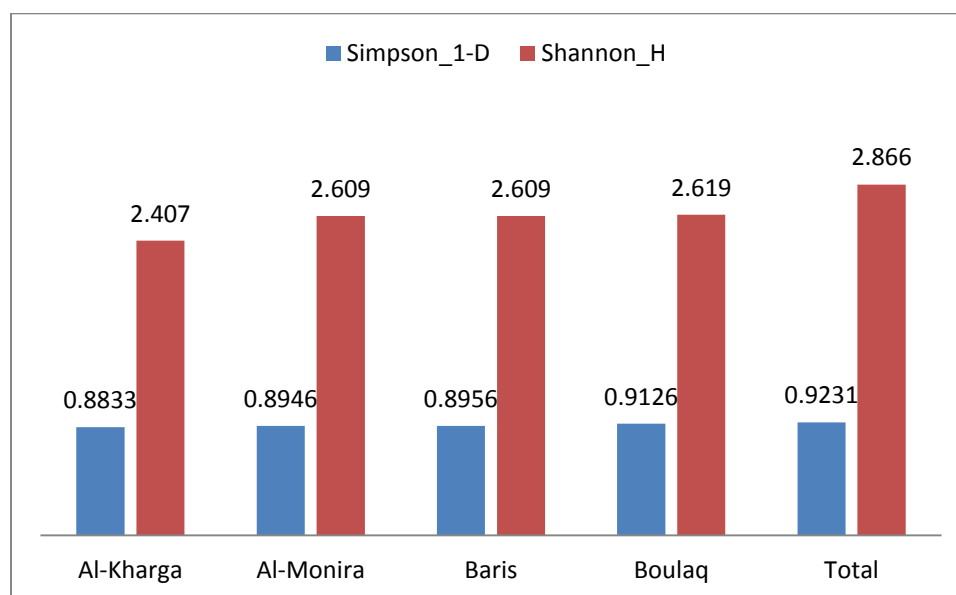


Fig 4:-Simpson and Shannon-Wiener Indices of diversity in different localities of the New Valley Governorate.

Fig. (4) shows results of the calculation of each Simpson and Shannon-Wiener indices of diversity. Both of Simpson and Shannon-Wiener indices of diversity are nearly equal, and slightly differ from those of the total of the area sampled. Al-Kharga appear to be slightly smaller in the two indices than the other three sites, Al-Monira, Baris and Boulq. The total number of individuals of each different family was summed and the two indices of diversity were calculated for comparison with the three sites.

Discussion:-

The soil mesofauna of each of the four sites of the New Valley area seems to be distinct. However, the ordination and classification techniques used serve to give better illustrations of these data sets. Correspondence analysis (CA) is a multivariate graphical technique designed to explore the relationships among categorical variables. Ecologists frequently collect data on multiple categorical variables with the goal of examining associations among these variables. Nevertheless, CA appears to be an underused technique in ecological data. The total variance among these categorical data is 80% (Fig. 2), and is good enough to explain the data matrix in dual low dimensional vector space and gives a better visualization of the data set of the present study (**Mikhail, 1996**).

In the present study, the activity density of the surface active families of soil mesofauna in each of Al-Kharga, Al-Monira, Baris and Boulaq Oases of the New Valley, Western Desert, Egypt are investigated using pitfall trap sampling method. Pitfall trapping is commonly used for capturing invertebrates that are active on the ground. As the name suggests, the trap works on the principle that an invertebrate moving on the ground simply falls into an open (usually circular) container dug into the ground (**Sherley and Stringer, 2016**). Pitfall trapping can provide a consistent, and therefore reliable, method for accurately assessing insect assemblages. **Pawson et al. (2008)** demonstrate how pitfall trapping can be used to understand beetle communities over a range of exotic habitat types. This can be applied to other invertebrate assemblages. In this context, **Sinclair et al. (2005)** show that pitfall trapping can be a major tool in understanding invertebrate population changes over time and space of different habitats. There many factors affect pitfall trap catching. Among these factors: trap fluid type, length of time the trap is operating and the surface texture (**Topping and Luff, 1995**). On the other hand, **Mikhail (2019)** mentioned that the composition and diversity of soil mesofauna families may differ in desert agro-ecosystems according to cropping patterns and type and intensity of agriculture practices.

The Egyptian clover *Trifolium alexandrinum* is main crop cultivated in each of Al-Kharga, Al-Monira and Boulaq. Generally, conventional no-tillage and tillage practices, crops types, and pattern of cultivation, are the most effective factors that affect activity density of soil mesofauna families (**Rizk and Mikhail, 1999; Coleman et al., 2004; Masood et al., 2019; Mikhail, 2019**). Agriculture practices being minimal in fields cultivated with the Egyptian clover, this may explain the moderate numbers of each soil mesofauna families and total number of individuals in three oases previously mentioned. On the other hand, Baris area has higher numbers of each of soil mesofauna families and total number of individuals than the other three sites. The aridity in Baris area supports a moderate population of soil mesofauna families that withstand this aridity.

Many different measures (or indices) of biodiversity have been developed, and whole books have been written explaining and comparing them (**Magurran, 2013**). Here, we explore two measures of biodiversity Simpson and Shannon indices of diversity. Biodiversity is one of the primary interests of ecologists, but quantifying the species diversity of ecological communities is complicated. In addition to issues of statistical sampling, the rather arbitrary nature of delineating an ecological community, and the difficulty of positively identifying all of the species present, species diversity itself has two separate components: 1.) the number of species present (species richness), and 2.) their relative abundances (termed dominance or evenness) (**Gotelli and Colwell, 2011**). The two indices of diversity used in this study indicated that families of soil mesofauna are nearly equal in both species richness and evenness.

Conclusion:-

The soil mesofauna of each of Al-Kharga, Al-Monira, Baris and Boulaq of the New Valley area seems to be distinct. The statistical method used; ordination and classification techniques, are efficient methods in comparing data assemblages of soil mesofauna of different localities. Composition and diversity of soil mesofauna families may differ in desert agro-ecosystems according to cropping patterns and type and intensity of agriculture practices.

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Author Contributions

This is an article done by the author itself.

Conflict Of Interest

The author declared that the present study was performed in absence of any conflict of interest.

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