Available online freely at www.isisn.org

Bioscience Research

Print ISSN: 1811-9506 Online ISSN: 2218-3973

Journal by Innovative Scientific Information & Services Network

RESEARCH ARTICLE BIOSCIENCE RESEARCH, 2019 16(3): 3047-3053. **OPEN ACCESS**

Diversity of soil mesofauna in El-bahariya Oasis, Western Desert, Egypt

Wafai Z. A. Mikhail

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

***Correspondence:** wafai47@hotmail.com **Accepted:** 20 Aug. 2019 **Published online:** 04 Sep 2019

Soil mesofauna were sampled at El-Bawiti, Bahariya Oasis from the farmlands and the area around in desert. The area was divided into three parts: the eastern and western parts as well as area of El-Bawiti town itself. The eastern part was cultivated by Egyptian clover or berseem (*Trifolium alexandrenum* L.) is the main winter forage in Egypt and is a basic component of a sustainable cropping system. The western part was cultivated with maize (*Zea mays*), and called corn in several countries. Middle part is located in El-Bawiti town with small mixed cultivation of different crops and some trees. The soil fauna was collected from study area by means of the pitfall trap method. 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. Results show that the area cultivated with the Egyptian clover, *T. alexandrenum*, the eastern part, has more or less 25 families of soil mesofauna. On the other hand, the western part, which cultivated with maize, *Zea mays*, supports about 24 families. The two areas contain order Collembola with unidentified families. Each of crop density and crop type affect to great extent on the number of soil mesofauna families in each of the three sites of the present study. Thus, affect pitfall trap catches and consequently the two indices of diversity.

Keywords: Soil mesofauna, Dermestidae, Al-Bahariya Oasis, Diversity, Similarity

INTRODUCTION

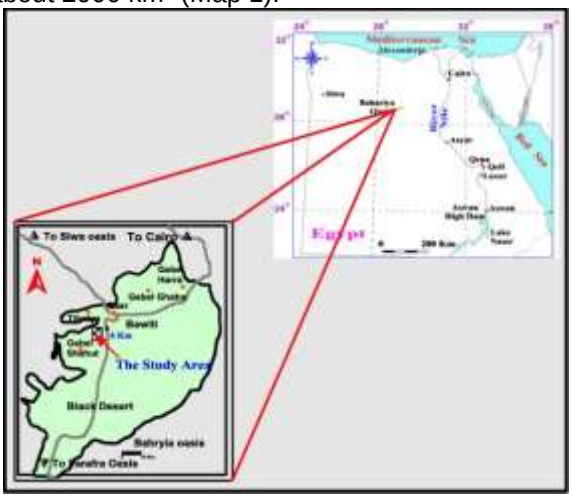
Invertebrate soil fauna are important group of invertebrate soil animals, and are key group of major heterotrophs in soil systems; facilitate bacterial and fungal structure and activity and diversity in soils. Many invertebrates regulate nutrient cycling by feeding directly on plant materials and organic substrates. The fragmentation or comminution of these materials enhances their decomposition. Comminution increases the surface area and exposes cytoplasm, thereby enabling greater access by microbes. Decomposition is further accelerated, as the feeding activity often results in the translocation of nitrogen from the soil to the substrate in the form of faecal material and through fungal hyphae. Grazing by invertebrates disseminates microbes from one organic source to another as many microbes adhere to invertebrate exoskeletons and cuticles and survive passage through their digestive tracts. Soil fauna have been found to have a consistent positive effect on litter decomposition at global and biome scales especially in desert agriculture. Soil animals exist in food webs containing several trophic levels. The structure of these food webs is complex, with many "missing links" poorly described or yet unknown, although tools such as stable isotope probing are revealing C and N transfer through trophic and species levels within the soil food web. The aim of the present is to know the major groups of soil mesofauna families

in the area of El-Bahariya Oasis, Western Desert of Egypt in one hand, and the effect of crop type and crop density on these groups in desert agro-ecosystem on the other.

MATERIALS AND METHODS

The Study Sites

El-Wahat el-Bahariya or El-Bahariya Oasis is a depression and oasis in the Western Desert of Egypt. It is approximately 370 km away from Cairo. The roughly oval valley extends from northeast to southwest, has a length of 94 km, a maximum width of 42 km and covers an area of about 2000 km² (Map 1).



Map 1; Location map of Al-Bahariya Oasis, Western Desert, Egypt

A comparative study on the vegetation of Bahariya and Farafra Oases and Fayoum region was described by Abdel Ghani (1985). Soil mesofauna were sampled at El-Bawiti, Bahariya Oasis from the farmlands and the area around in desert. The area was divided into three parts: the eastern and western parts as well as area of El-Bawiti town itself. The eastern part was cultivated by Egyptian clover or berseem (*Trifolium alexandrenum* L.) is the main winter forage in Egypt and is a basic component of a sustainable cropping system (FAO, 2014). The western part was cultivated with maize (*Zea mays*), and called corn in several countries. Middle part is located in El-Bawiti town with small mixed cultivation of different crops and some trees.

Method of sampling soil fauna

Pitfall trap method

The soil fauna was collected from 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 at ground level. The pitfall traps were half filled with a detergent solution (1%) to ensure rapid sinking of animals. 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 the study area with the three sites was 25 traps for each site with a total of 75 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 stati**sti**cally 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) shows results of the sampled soil mesofauna from the three parts of the present study at El-Bahariya Oasis of the Western Desert of Egypt.

The area cultivated with the Egyptian clover, *T. alexandrenum*, the eastern part, has more or less 25 families of soil mesofauna. On the other hand, the western part, which cultivated with maize, *Zea mays*, support about 24 families. The two areas contain order Collembola with unidentified families (Fig. 1).

Fig. (2) shows results of the application of ordination methods, correspondence analysis CA) and ascending hierarchic classification (AHC), to data of Table (1). Seventy-six percent of the total variance is associated the first (horizontal) axis and 24% with the second (vertical) one. The first axis separates between each of the east side

which cultivated with clover and west side cultivated with maize, at the right hand, from that of the third site at El-Bawiti town which experience mixed cultivation of different crops at the left hand side of the ordination graph.

Table 1; Activity-density of soil mesofauna families in El -Bahariya Oasis, Western Desert, Egypt.

Families	Bawiti town	East of town	West of town	Total fauna
Araneidae	3	3	2	8
Anthicidae		3		3
Buperistidae			2	2
Carabidae		1	1	2
Coccinellidae		22	16	38
Curculionidae	7			7
Dermestidae		154		154
Scarabaeidae	1		1	2
Tenebrionidae		2		2
Collembola*		4	2	6
Mantidae			1	1
Muscidae	10	10	10	30
Sarcophagidae		2	2	4
Syrphidae		5	3	8
Tachinidae			4	4
Tipulidae	7	10	12	29
Cydnidae		1		1
Pentatomidae		2	2	4
Aphididae	5	2		7
Formicidae	3	6	4	13
Pompilidae		6		6
Scoliidae	2			2
Sphecidae			3	3
Danaidae		1	1	2
Lycaenidae		6	4	10
Noctuidae	4			4
Nymphalidae		1	2	3
Pieridae		1	2	3
Pyranstidae	2			2
Chrysopidae	3	3	3	9
Libellulidae		1	1	2
Agrionidae	1	1	1	3
Lestidae		1	1	2
Acrididae		6	4	10
Thripidae		3	2	5
Families	12	25	24	34
Total	48	257	86	391

*This is order not family.

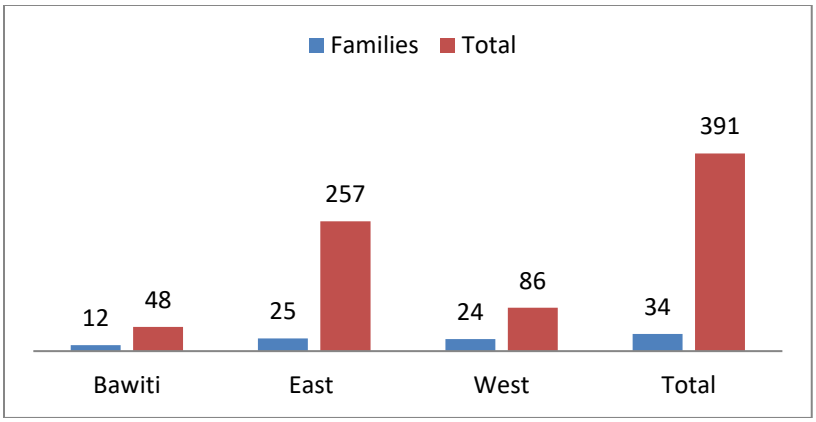


Figure 1 ; Number of each of families and total individuals in sites of the present study.

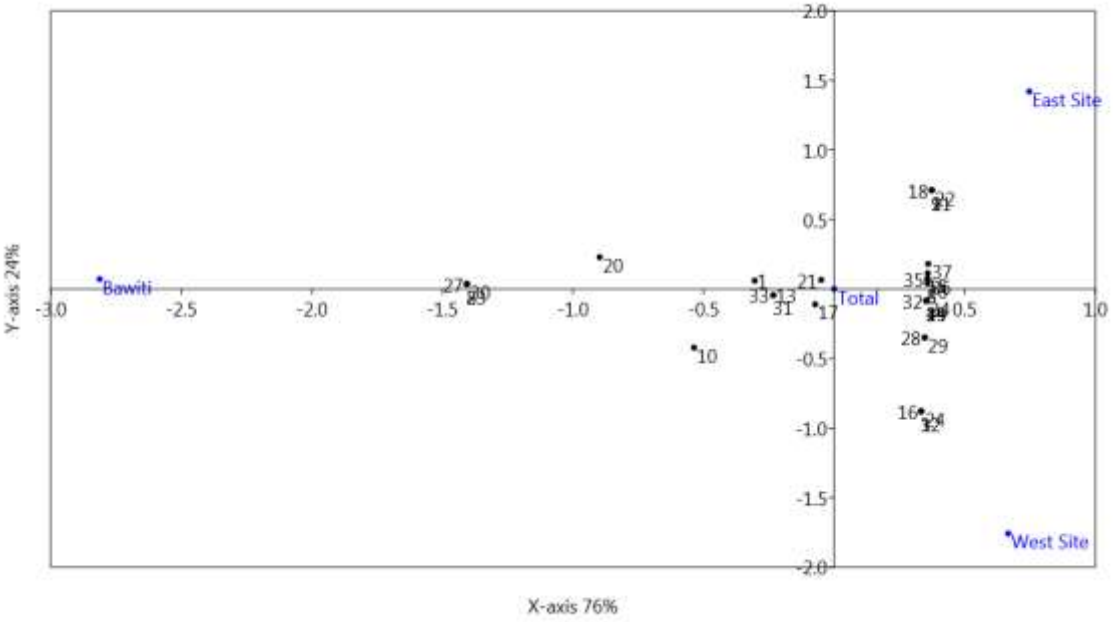


Figure 2; Graphical representation of the application of CA and AHC methods to data of Table (1).

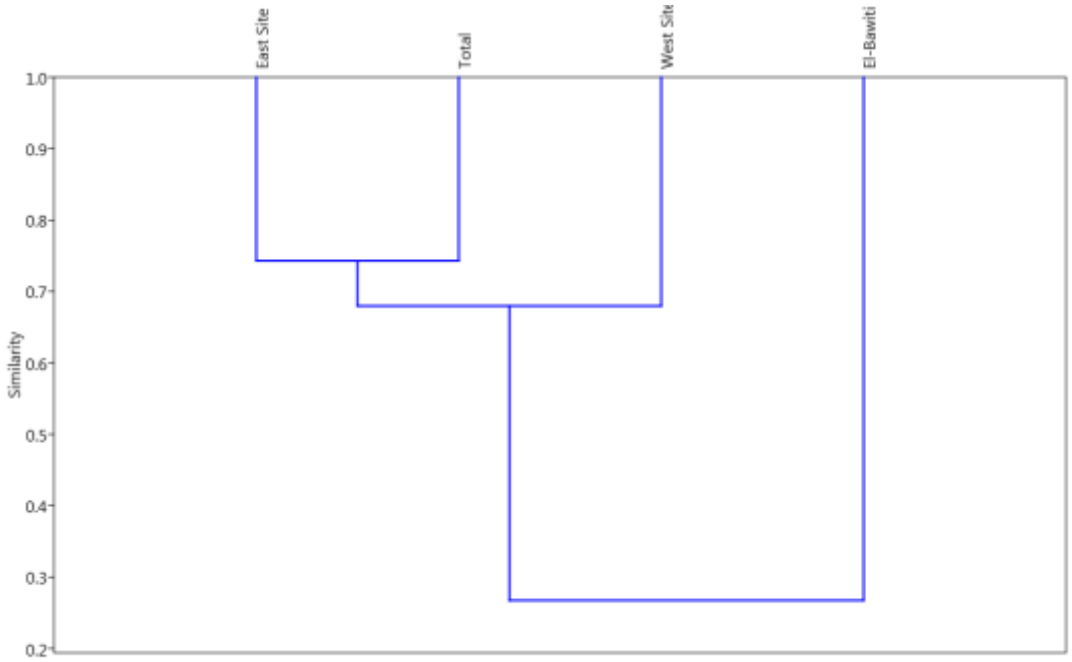


Figure 3; Similarity between El-Bawiti, East Site and West Site as well as total number of individual as base for comparison.

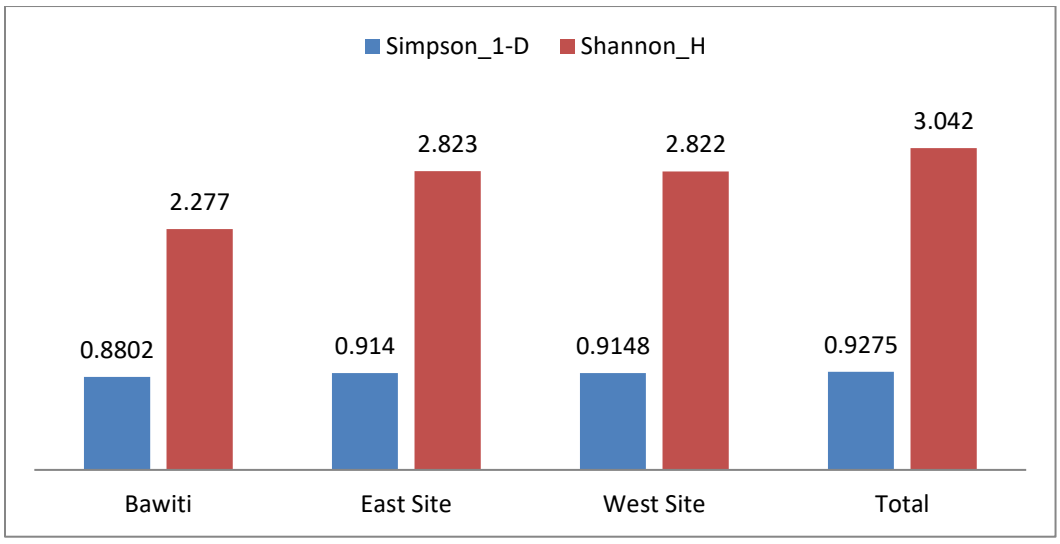


Figure 4; Simpson and Shannon-Weiner Indices of diversity.

The second axis separates between the cultivation of clover at the top from that of maize at the bottom of the graph. The total number of individuals of the families of the present study is included in this analysis and appears at the middle of the ordination graph. Taxa of soil mesofauna families were distributed according to their numbers in different sites. Curculionidae, Scoliidae, Noctuidae and Pyranstidae were sampled from El-Bawiti area, and Anthicidae, Dermestidae, Tenebrionidae, Cydnidae and

Pompilidae were sampled from the Eastern Site, whereas each of Buperistidae, Mantidae, Tachinidae and Sphecidae were sampled from the Western Site. It is noticed that family Dermestidae has higher number of individuals in the Eastern Site.

Fig. (3) shows results the 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.

Six taxa were present in the three site; Araneidae, Muscidae, Tipulidae, Formicidae, Chrysopidae and Agrionidae. Aphididae is present in each of El-Bawiti and the Eastern site while Scarabaeidae present in El-Bawityi and the Wesren site. These explain lower similarity between each of the Eastern and Western sites in one hand and El-Bawiti site on the other (Fig. 3). Fourteen families were present in each of the Eastern and Western sites. These are: Carabidae, Coccinellidae, Sarcophagidae, Syrphidae, Pentatomidae, Danaidae, Lycaenidae, Nymphalidae, Pieridae, Libellulidae, Lestidae, Acrididae, Thripidae and Collembola. This also, explains the higher similarity between each of the Eastern and Western Sites (Fig. 3).

Fig. (4) shows results of the calculation of each Simpson and Shannon-Weiner indices of diversity. Both of Simpson and Shannon-Weiner indices of diversity are nearly equal, and slightly differ from those of the total of the area sampled. El-Bawiti appear to be smaller in the two indices than the other two sites. 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

Since agro-ecosystems are differing in age, diversity and management, there is great variability in the basic ecological and agronomic patterns among different agro-ecosystems. The composition and diversity of soil mesofauna families may differ in agro-ecosystems according to cropping patterns and type and intensity of agriculture practices.

In the present study, the activity density of the surface active families of soil mesofauna associated with each of Egyptian clover *T. alexandrinum*, cultivated in eastern plots and the maize *Z. mays*, cultivated in the western area as well as the mixed cultivation of field crops in El-Bahariya Oasis, Western Desert of Egypt were investigated. Generally, conventional no-tillage and tillage practices, crop types, and pattern of cultivation, are the most effective factors that affect activity density of soil mesofauna families (Rizk and Mikhail, 1999; Masood et al., 2019). On the other hand, pitfall traps have limited usefulness for assessing population sizes, because catches reflect both density and mobility of arthropod, however, pitfall traps are a valuable method for comparing habitats, assessing seasonal shifts in macro arthropod communities, and evaluating species richness (Coleman et al., 2004; Masood et al., 2019).

The Dermestidae family was present in higher numbers in the Eastern Site. This family is one of order Coleoptera that are commonly referred to as skin beetles. Other common names include larder beetle, hide or leather beetles, carpet beetles, and khapra beetles. Dermestids have a variety of habits; most genera are scavengers that feed on dry animal or plant material, such as skin or pollen, animal hair, feathers, dead insects and natural fibers. These beetles are significant in forensic entomology, and some species are known to be associated with decaying carcasses, which helps with criminal investigations (Hall et al., 2012).

Comparisons indicated that higher activity densities of soil mesofauna families were generally associated with no-tillage practices, crop types, density of the cultivated crop and, pattern of cultivation (Rizk and Mikhail, 1999; Merlim et al., 2005). The effect of crop density, affect to great extent on the number of families in Eastern site cultivated with Egyptian clover, and in the Western site which cultivated with maize in the present study. This may be due to the great palatability of clover which attracts more animals, especially invertebrate soil mesofauna, on one hand, and the density of maize plants on the other. Agricultural practices being minimum in both clover and maize, since density of these two plants are high; this may explain the higher activity density of soil mesofauna families in these two sites. El-Bawiti site is consisted of mixed

sparse cultivations which affect to great extent the number of soil mesofauna to be lower than the other two sites. Consequently, all these factors affect the two indices of diversity.

CONCLUSION

Each of crop density and crop type affect to great extent on the number of soil mesofauna families in each of the three sites of the present study. Thus, affect pitfall trap catches and consequently the two indices of diversity.

CONFLICT OF INTEREST

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

ACKNOWLEGEMENT

The author would thank all participants and their parents.

AUTHOR CONTRIBUTIONS

This is an article done by the author itself.

REFERENCES

Abdel Ghani, M. (1985): Comparative study on the vegetation of Bahariya and Farafra Oases and Fayoum region. Ph.D. Thesis, Fac. of Sciences, University of Cairo.

Araújo, A. S. F.; Eisenhauer, N.; Nunes, L. A. P.; Leite, L. F. C. and Cesarz, S. (2015): Soil surface-active fauna in degraded and restored lands of northeast Brazil. *Land Degrad. Develop*., 26: 1–8.

Coleman, D. C. and Crossley, D. A. (1996): Fundamentals of soil Ecology. Academic Press,New York, 205 pp.

FAO (2014): Egyptian Clover (*Trifolium alexandrenum* L.): King of Forage Crops. Food and Agriculture Organization of the United Nations, Regional Office for the Near East and North Africa, Cairo: 127 pp.

Hall, M.; Whitaker, A. and Richards, C. (2012): Forensic entomology. In: N. M´arquez-Grant and J. Roberts (Editors), *Forensic Ecology Handbook: From Crime Scene to Court.* John Wiley & Sons, Ltd.: 111-140.

Hammer, Ø. (2009): Paleontological Statistic Software Package, Version 1.94b, Natural History Museum, University of Oslo. 175 pp.

Kromp, B. (1990): Carabidae Beetles (Coleoptera, Carabidae) as dioindecators in biological and conventional farming in Austrian potato. *Bio. Fert. Soils*, 9: 182- 187.

Masood, M. F.; El-Gayar, E. A.; Sobhy, H. M. and Mikhail W. Z. A. (2019): Impact of crop type on the diversity of soil fauna populations. *Bioscience Research*, 16 (2): 1961-1965.

Merlim, A. O.; Guerra, J. G. M; Junqueira, R. M. and de Aquino, A. M. (2005): Soil Macrofauna in cover crops of Figs grown under organic management. *Sci. Agric. (Piracicaba, Braz.)*, 62 (1): 57- 61.

Mikhail, W. Z. A. (1993): Effect of soil structure on soil fauna in a desert wadi in Southern Egypt. *Journal of Arid Environments*. 24: 321-331.

Rizk, M. A. and Mikhail, W. Z. A. (1999): Impat of no-tillage agriculture on soil fauna diversity. *Zoology in the Middle East*, 18: 113-120.

Southwood, T. R. E. and Henderson, P.A. (2000): Ecological Methods. 3rd Edition, Blackwell Science Ltd, Oxford: 524 pp.

Wallwork, J. A. (1976): The Distribution and Abundance of Soil Fauna. Academic Press, London: 355 pp.