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Impact of some Anthropogenic Activities on the Diversity of Ground Insects at the Southern Area of Port Said, Egypt

Abeer Shaban[1], Fayez M. Semida[2*], Mohamed A. Bedir[2], Ahmed H. Abo-Ghalia[2] and Iman M. Bahgat[1]
[1]Department of Biological and Geological Sciences, Faculty of Education (Port Said), Suez Canal University
[2]Department of Zoology, Faculty of Science, Suez Canal University, 41522 Ismailia, Egypt

ABSTRACT
The present study aims to assess the impact of some anthropogenic activities on the ground insects. Ground insects were sampled, by using pitfall traps in a nested design, from four different localities in the southern area of Port Said, Egypt, for 15 months (from July 2004 to September 2005). The localities represented three different human impact activities (industrial, animal rearing and cultivated localities) and one control locality. Each locality was represented by two separated sampling sites (20X20 meters), and each site had twenty individual traps distributed systematically. Habitat type and plant covers were clearly different among the four localities and to a less extent within localities. Species diversity varied spatially among the different localities. There was no significant difference in the diversity of ground insects among the study period. Nevertheless, the cultivated sites had the highest diversity, while animal rearing sites had the lowest one. In contrast, animal rearing sites recorded the highest species richness; while cultivated sites had the lowest one. The different localities had distinct and characteristic groups of species responding to anthropogenic activities.
Key words: Biodiversity, ground insects, anthropogenic activities, species abundance, species richness, Port Said.

INTRODUCTION

The extinction of many species has alerted the scientific communities with the drastic impacts of the irrational anthropogenic activities on Earth. Biodiversity might be affected by changes at various spatio-temporal scales, as well as biotic and abiotic conditions. A particular change in environmental conditions may increase the diversity of one subset of organisms within a community while decrease the diversity of a different group of organisms. Also, understanding diversity requires understanding the process that regulates the composition, the structure, and ultimately the diversity of communities (Semida *et al*., 2001). There may be strong habitat heterogeneity, and thus, different spatial locations may have quite different biodiversity. A high diversity within the plant and animal communities of a habitat is an important indicator of the overall quality of that system (Primack, 1993). Knowledge about spatial variation in habitat quality is important as the government develops its wildlife conservational programs (Zalat *et al.,* 2001).

Insects species represent more than three quarters of the total number of species of animal kingdom. They may have a greater impact on terrestrial ecosystems than any other type of animal (LaSalle and Gauld, 1991). So, they are essential to terrestrial ecosystem function, and play key roles in terms of both biomass and diversity (Soulé, 1991).

Understandably, most studies are on small spatial and temporal scales, necessitated by the intensive field work associated either with monitoring programs or field conducted for short time. For example, some studies were concerned with the Coleopterons species of Gabal Elba and the Red Sea (Fadl and Hassan,1997), human impact on the Mediterranean coastal desert habitats of Egypt (Aly *et al.,* 1998), species diversity in Wadi Allaqi in Upper Egypt (Ali *et al*., 2000), the effect of habitat heterogeneities on the diversity of beetles in South Sinai (Semida *et al.,* 2001), the spatial variation in the biodiversity of flying and ground insects in South Sinai (Zalat *et al*., 2001), insect diversity at the protected area of Wadi El-Assiuty (Mahbob, 2005), diversity of ants in some protactorates of Egypt (Sharaf, 2006), and temporal and spatial variation of darkling beetles (Ayal and Merkl, 1994; Krasnov and Shenbrot, 1997; Crist and Wiens, 1995).

Port Said area has witnessed major developmental activities during the last two decades such as industrial projects, rearing animals, fish cultures, and agricultural lands in the south and west areas. Such activities have caused drastic changes in the nature of landscape and the terrestrial environment of this region. Therefore, the current study aims to explore the effect of these activities on the biodiversity of this area, looking particularly at spatial and temporal variation in the diversity of ground insects in different study sites.

MATERIALS AND METHODS

The study was carried out at southern area of Port Said Governorate over a period of 15 successive months between July 2004 and September 2005. Four localities were selected for detailed study and each of them was represented by two sites to show the local habitat heterogeneities as followed: industrial (Ind.) sites at 2 Km. (A site: N 31º 13' 543" and E 32º 17' 679", and B

* Corresponding Author: fayezsemida@hotmail.com

site: N 31º 13' 586" and E 32º 17' 626"), animal rearing (Rear.) sites (A site: N 31º 06' 781"and E 32º 18' 253" at 17 Km., and B site: N 31º 05' 676" and E 32º 18' 326" at 19 Km), cultivated (Cultiv.) sites at 19 Km. (A site: N 31º 05' 694" and E 32º 18' 333", and B site: N 31º 05' 720" and E 32º 18' 372") and control (Cont.) sites at 18 km (A site: N 31º 06' 582" and E 32º 18' 159", and B site: N 31º 06' 569" and E 32º 18' 159"). The geographical position of each site was recorded using a hand-held GPS receiver.

Pitfall traps were used to sample the ground insects at the study localities. Each trap consisted of a rounded plastic bottle (13 cm deep with an opening of 5.7 cm. diameter) having one-third full of water with little detergent. Twenty replicated traps per site were fixed at five meter intervals in a regular distribution. Each individual trap remained in exactly the same position during the entire period of study, allowing comparable results in the cumulative catches per trap. Traps were closed except for 48-hour-period of trapping once per month throughout the study period. This period of 48 hours is considered adequate to minimize depletion of the ground insects (Southwood and Henderson, 2000).

The collected speciemens were identified to the species level whenever possible. Occasionally only generic or even family designations were possible but even though without a name, it was certain that each morphotype represents a separate species.

Speciemens identifications were done at collections of Plant Protection Institute, Ministry of Agriculture, and Entomology Department, Faculty of Science, Ain-Shams University, Cairo. Plants samples of each site were identified from specimens in the herbaria of Botany Department, Suez Canal University, Ismailia.

Three soil samples were collected from each site for physical and chemical analysis. The physical and chemical analyses were carried out in Lands and Water Department, Faculty of Agriculture, Suez Canal University, Ismailia according to the methods described in Page *et al.* (1982).

The diversity of each site was assessed using Simpson diversity index (D), since this is the most tractable and statistically useful calculation (Lande, 1996):

$$\lambda = \Sigma\, p_i^{\,2} \qquad D = 1 - \lambda$$

Where D is Simpson diversity index,
λ is an index of dominance, and
p_i is the proportion of the community occupied by the i^{th} species.

The species richness and total abundances were also calculated.

RESULTS

Habitat characteristics

Physical and chemical properties of the selected sites are shown in table (1). The highest values of organic matter (5.30%), organic carbon (3.07%), total nitrogen

Table (1): Soil characteristics at different study sites in southern Port Said area.

Variable		Ind-A	Ind-B	Rear-A	Rear-B	Cultiv-A	Cultiv-B	Cont-A	Cont-B
pH		8.21	8.22	7.57	7.97	7.95	8.10	8.18	8.17
Conductivity dSm^{-1}		20.2	72.1	130.5	90.0	35.3	19.7	31.1	47.8
Organic matter%		1.55	1.45	5.30	0.76	1.74	0.81	1.14	1.14
Organic C %		0.90	0.84	3.07	0.44	1.01	0.47	0.66	0.66
Total N %		0.086	0.072	0.31	0.044	0.103	0.057	0.057	0.057
Cations mgL^{-1}	**Na^+**	152	770	1282	878	260	130	322	430
	K^+	11.5	11.6	88	25.6	4.9	2.4	8.1	10.0
	Mg^{2+}	77	186	555	346	153	59	49	124
	Ca^{2+}	31	95	85	92	65	63	56	88
Moisture%		21.04	7.47	9.12	12.33	20.42	8.39	18.28	1.76
Sand%		92.0	91.2	81.1	79.0	66.8	88.0	94.0	92.5
Silt%		2.00	2.45	10.13	13.26	24.76	3.28	1.36	2.03
Clay%		6.00	6.35	8.77	7.74	8.44	8.72	4.64	5.47

(0.31%) were recorded in animal rearing site (Rear-A). The same site was also characterized by relatively high values of cations Na^{+} (1282 mgL^{-1}), K^{+} (88 mgL^{-1}), and Mg^{2+} (555 mgL^{-1}) which resulted in the highest level of conductivity (130.5 dSm^{-1}). On the other hand, industrial site B (Ind-B) was characterized by relatively higher pH value (8.22). Regarding the physical properties of the study sites, the Ind-A site had the highest percent of moisture (21.04%), the Control site (Cont-A) had the maximum value of sand (94.0%), the cultivated site A (Cultiv-A) had the highest value of silt (24.76%), and the animal rear-A site had a relatively high value of clay (8.77%).

Species/effort curve

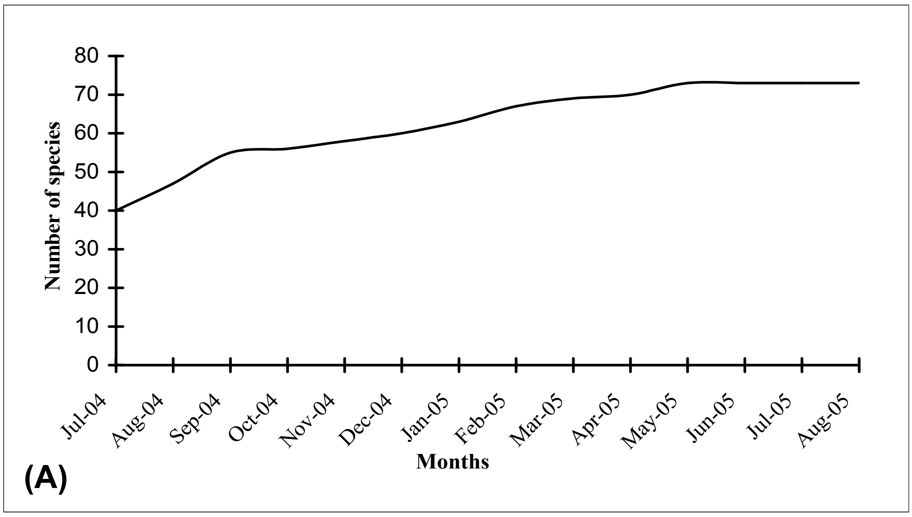
The number of recorded species during sampling depended on sampling efforts. As shown in figure (1A), the number of recorded species gradually increased with sampling effort (the number of species was about 73 species from May 2005 to the end of the study period). On the other hand, the number of recorded species gradually increased with increasing the number of traps to an asymptote nearly from trap 17 to trap 20 (Fig. 1B). From these curves it could be concluded that the sampling was enough to catch all the species available in the study area, and that the presented data showed an accurate reflection of the species diversity of the sampling sites.

Overall pattern of diversity

Traps were regarded as replicated samples for the insects collected from different sites. A total of 21435 individuals belonging to 69 species (about 34 families) were caught throughout the study period (Ind. Sites: 5991 individuals belonging to 51 species, Rear. Sites: 8984 individuals included in 61 species, Cultiv. Sites: 2147 individuals included in 44 species, and Contr. Sites: 4313 individuals included in 49 species).

Spatial and temporal patterns of variation in the diversity of the insect assemblages

To determine the spatial variation of ground insects' diversity in the study area, two different parameters



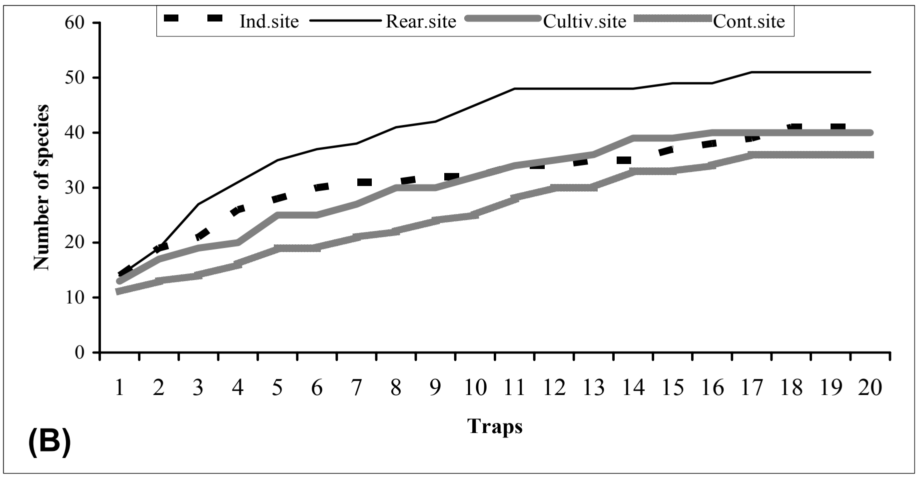
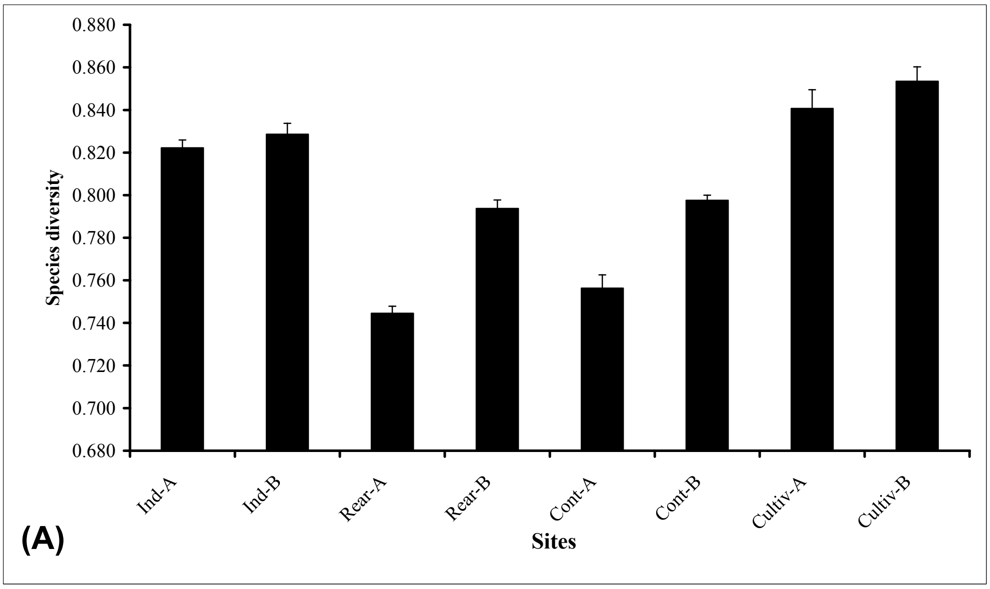


Figure (1): Species/effort curve: (A) during the study period, and (B) for the four studied sites.

were analyzed: species abundance and species richness. Figure (2A) shows the spatial variation in Simpson diversity index at different study sites. The highest values of species diversity were recorded in Cultiv-B site, while the lowest one was recorded in Rear-A site. There was a significant difference in Simpson diversity index among locations (F = 4.35, df = 7, P≤ 0.0001). On the other hand, there was no significant differences among months of the study period (F = 1.27, df = 14, P = 0.23). August 2004, however, recorded the highest value of temporal variation in species diversity and April 2005 was the lowest (Fig. 2B). The highest species richness was recorded in Rear-A site, while the Cultiv-A site was the lowest one (Fig. 3A). On the other hand, September 2005 recorded the maximum species richness during the study period at different study sites but December 2004 recorded the minimum one (Fig.3B).

Species importance curve

Figure (4) shows the degree of abundance of species importance for the different study sites. Among the study sites, species 51 (*Pheidole sinaitica*, Hymenoptera: Formicidae (Myrmicinae) was the most important species while species 15 (*Oxacis carinicollis,* Coleoptera: Oedemiridae) was the lowest one (Appendix 1).



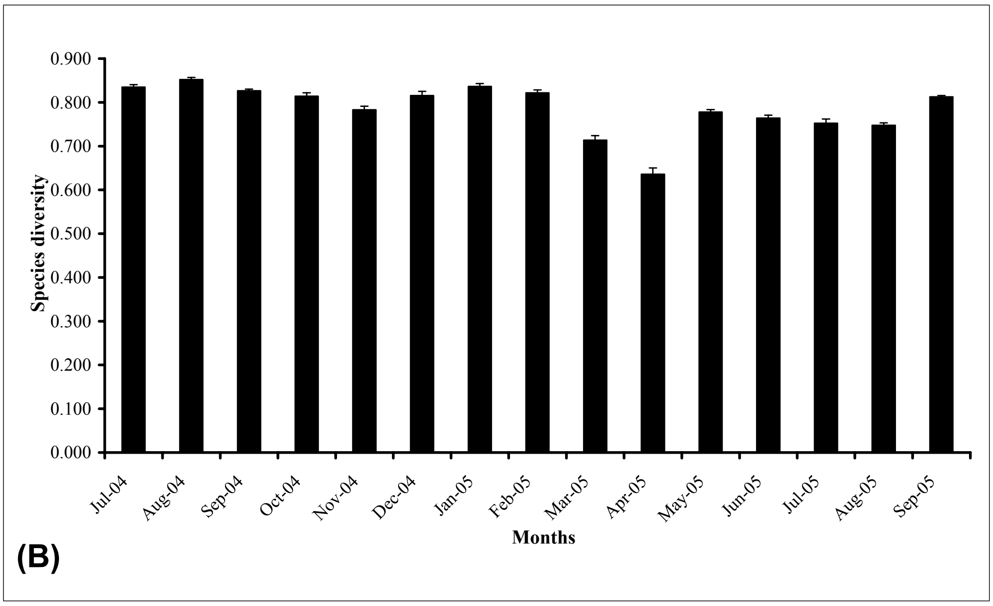
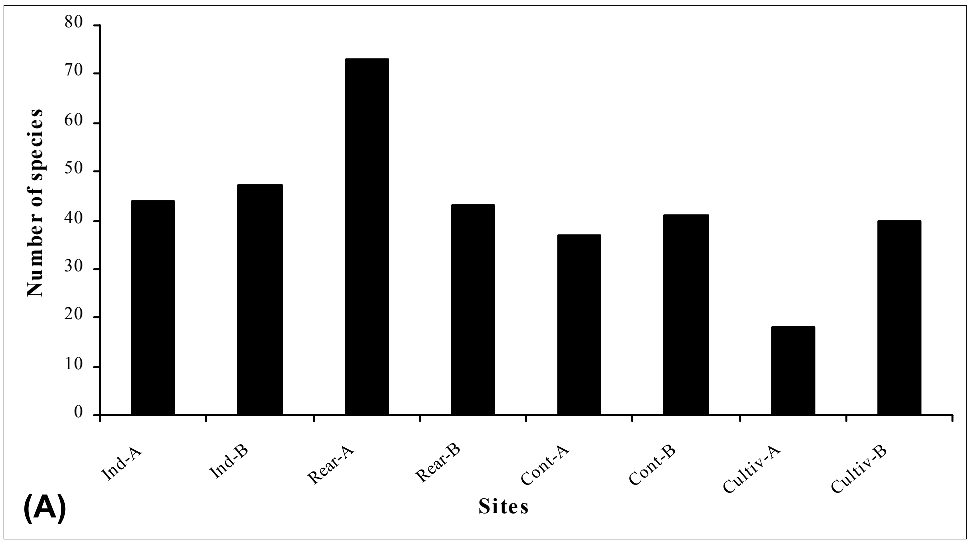


Figure (2): Spatial and temporal variation in Simpson diversity index at different sites of the study area: (A) spatial variation, and (B) temporal variation.



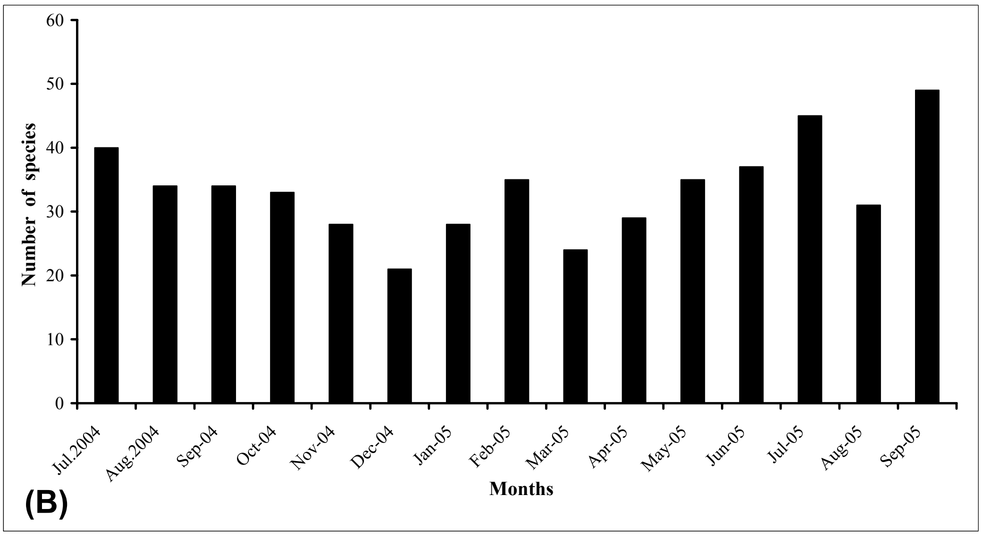


Figure (3): Species richness: (A) at the four sites of the study area, and (B) during the study period.

The similarity between different studied areas (Jaccard index)

Table (2) shows the similarity between different numbers of species that found in every two sites at the same time. The Ind-A site was highly similar to Ind-B site (99.9%) and Cultiv-A site (99.7%). On the other hand, the least similarity was between Ind-B site and Cont-B site (79.5%).

Species richness among the different insect orders during the study period

The abundance variation was studied among the different orders of insects. Figure (5) shows that there was a highly significant difference among orders in the number of species during the study period (χ^2 = 45.82, df = 14, P $\leq$ 0.0001) and there was no significant difference between the study localities (χ^2= 2.57, df =3, P = 0.067). The most abundant order was Hymenoptera at industrial, cultivated, and control sites. On the other hand, order Coleoptera was the most abundant one at animal rearing sites. Order Mantodea was the least one at industrial, animal rearing, and control sites. Otherwise, Blattoidae, Embioptera, and Neuroptera were the least in richness at cultivated and control sites.

DISCUSSION

The spatial and temporal patterns of biodiversity are considered good indicators of ecosystem quality (Primack, 1993). In the south region of Port Said, there is a habitat heterogeneity, and thus, different sites may have quite different biodiversities. A high diversity within the insect communities in this habitat is an important factor reflecting the richness of the overall quality of that ecosystem (Semida *et al.*, 2001). This, in turn, may be a useful monitoring tool in determining the

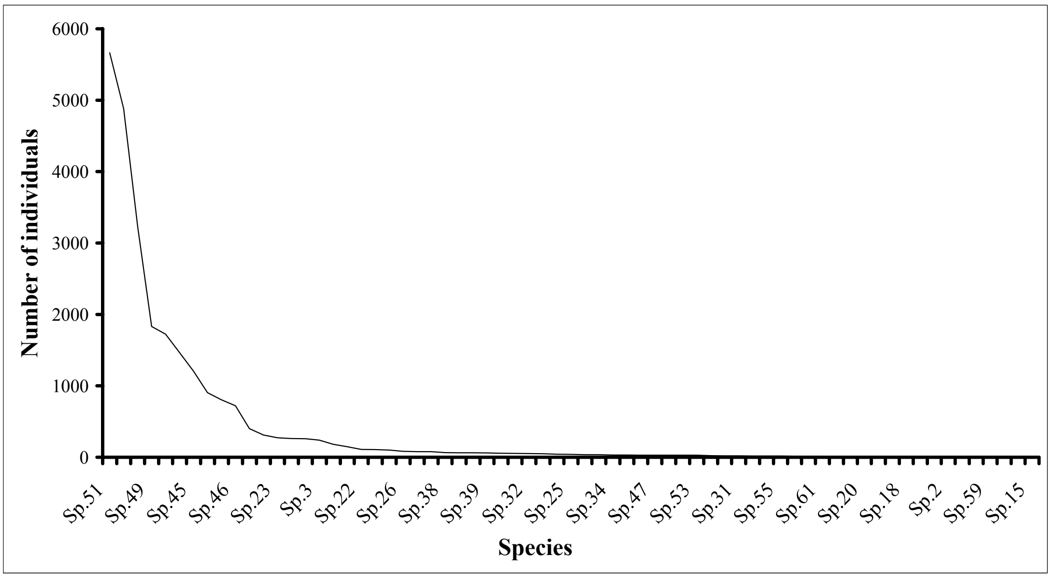


Figure (4): Species importance curve for the different sites of the studied area.

Table (2): The similarity between different studied areas (Jaccard Index).

Sites	Ind-A	Ind-B	Rear-A	Rear-B	Cultiv-A	Cultiv-B	Cont-A	Cont-B
Ind-A	100%							
Ind-B	99.9	100%						
Rear-A	92.5	92	100%					
Rear-B	96.1	96.2	97.3	100%				
Cultiv-A	99.7	99.6	98.2	97.3	100%			
Cultiv-B	93.9	93.6	91.6	91.6	97.6	100%		
Cont-A	96	95.5	90.7	90.7	96.4	92.7	100%	
Cont-B	93.3	79.5	90.9	90.9	96.8	93.4	99.2	100%

conservation and management programs of this ecosystem. Ground insects play an important role in food webs and nutrient cycling. They have a significant effect on the habitat, especially when locally abundant. The overall biological diversity at the regional scale and different diversities within a region are closely related (Remero-Alcaraz and Avila, 2000). Local diversity is generated and maintained by multifaceted factors such as productivity, climatic variability, age of ecosystem predation, competition, spatial heterogeneity and human factors (Fjelsa and Lovett, 1997).

In the current study, the four different studied localities were spatially isolated and each locality had its own different habitat features. This led to the existence of significant differences in their overall biodiversities. Habitat heterogeneities extend also to the level of sites within locality. Soil type, soil moisture, and organic matter may be the main factors which determine the composition of the insect assemblage within the different types of habitats.

The habitats within the Rear-A site are more heterogeneous compared to other localities, as it is reflected by its higher species richness. Cultiv-A site, on the contrary, has the lowest species richness. Cultiv-A and B sites, however, have almost equivalent species diversity, significantly higher than other sites, whereas Rear-A site has the lowest species diversity.

Throughout the study period, diversity did not vary significantly. However, maximum value during August 2004 and minimum value during April 2005 were recorded Species richness, however, varied significantly during the study period, reaching its maximum value during September 2005 and its minimum value during December 2004, which may be explained by climatic changes.

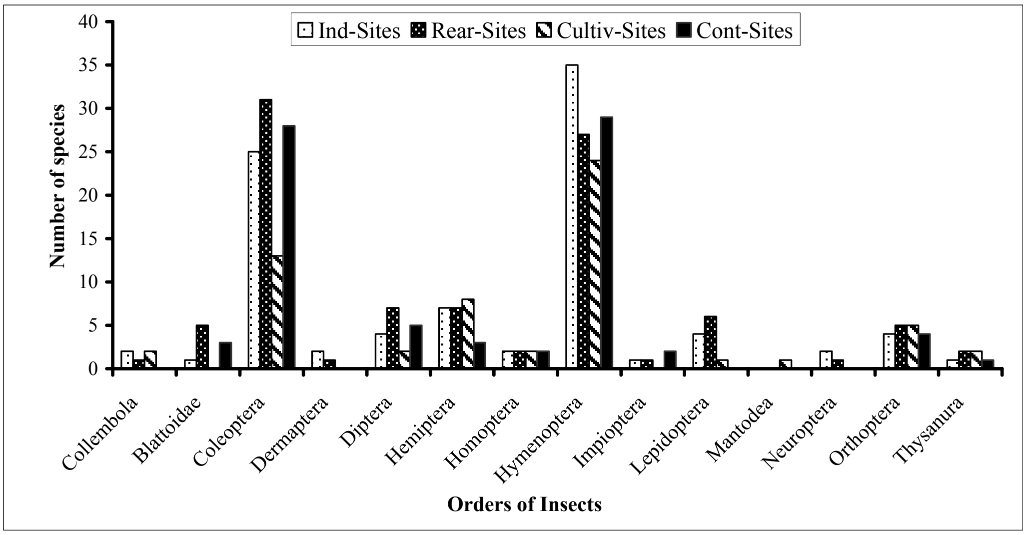


Figure (5): Species richness among different orders during the study period.

In the present work, great similarities were recorded between Ind-A and B sites, Cont-A and B sites and Cultiv-A with Ind-A and B. This may be due to similarities in plant cover and animals present in these areas. These results are similar to those of (El-Moursy *et al.*, 1999; and Semida *et al.*, 2001) who studied the similarity between several habitats in Zaranik and St. Katherine protectorates, respectively.

The current study showed that different localities had distinctive assemblages of insects. Most of these differences may be due to habitat heterogeneities and different human activities in the studied area. Thus, industrial sites are characterized by the presence of Isotoma sp. (Isotomidae: Collembola). Animal rearing sites are characterized by larvae of *Erastalis* sp. (Syrphidae: Diptera), *Cataglyphis sinaitica* (Formicinae: Formicidae) and *Messor foreli* (Myrmicinae: Formicidae). Cultivated sites are characterized by the presence of *Formicomus coeruleiipennis* Laf (Anthicidae: Coleoptera), *Nyssius cymoidus* (Lygidae: Hemiptera) and *Gryllus bimaculatus* De Geer (Gryllidae: Orthoptera); while the control are characterized by *Blattella arundinicola* Wera (Blattidae: Blattoidae), *Catablyphis lividus* (Andre) (Formicinae: Formicidae) and Mutillinae (Multillidae: Hymenoptera).

This study shed some light on one of the most important regions in Egypt. The habitat heterogeneities that caused by human activities, and management clearly affect species diversity and community composition very strongly. It illustrates the fact that this area of land needs more attention in order to promote its conservation via a suitable management program.

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Appendix (1): Insect species collected from the study area using pitfall traps at south Port Said area during 2004-2005.

Order	Family	Species Name	Species No.
Collembola	Isotomidae	*Isotoma sp.*	Sp.1
Blattoidae	Blattidae	*Blata orientalis*	Sp.2
Blattoidae	Blattidae	*Blata orientalis*.(nymph)	Sp.3
Blattoidae	Blattidae	*Blattella arundinicola* Wera	Sp.4
Coleoptera	Anthicidae	*Anthicius larvipennis* (Merseul)	Sp.5
Coleoptera	Anthicidae	*Anthicus tobias*	Sp.6
Coleoptera	Anthicidae	*Formicomus coeruleiipennis*Laf.	Sp.7
Coleoptera	Coccinellidae	Larvae	Sp.8
Coleoptera	Curculionidae	*Mesites cunipes var. cribratus* Frm.	Sp.9
Coleoptera	Elateridae	*Drasterius bimaculatus* Rossi.	Sp.10
Coleoptera	Filistatidae	*Megacephala euphratica.*Latr.	Sp.11
Coleoptera	Histeridae	*Saperinus chalcites* Ill.	Sp.12
Coleoptera	Histeridae	*Saperinus gilvicornis* Er.	Sp.13
Coleoptera	Dytiscidae	Larvae	Sp.14
Coleoptera	Oedemiridae	*Oxacis carinicollis* Lew.	Sp.15
Coleoptera	Scarabaeidae	*Heteronychus licas* Klug	Sp.16
Coleoptera	Staphylinidae	*Bledius andresi* Brnh.	Sp.17
Coleoptera	Staphylinidae	*Philonthus turbidus* Erichson.	Sp.18
Coleoptera	Tenebrionidae	*Alphitobius diaperinus.*Panzer	Sp.19
Coleoptera	Tenebrionidae	*Blaps polychresta*Forsh.	Sp.20
Coleoptera	Tenebrionidae	*Mesostena angustata.*Fabricus	Sp.21
Coleoptera	Tenebrionidae	*Oterophloeus haagi* Kraaatz	Sp.22
Coleoptera	Tenebrionidae	*Pimelia subquadrata* Sturm.	Sp.23
Coleoptera	Tenebrionidae	*Scelosodis castaneus* Esch.	Sp.24
Coleoptera	Tenebrionidae	*Trachyderma (Ocnera) philistina* Reiche	Sp.25
Coleoptera	Tenebrionidae	Adults	Sp.26
Dermaptera	Labiduridae	*Euborella annulpes*	Sp.27
Diptera		Coccon	Sp.28
Diptera	Therevidae	*Cliorisma frauenfeldi* (Loew)	Sp.29
Diptera	Sciaridae	*Sciara kairensis* Becker	Sp.30
Diptera	Syrphidae	*Erastalis sp* (larvae).	Sp.31
Hemiptera	Sculeridae	Larvae	Sp.32
Hemiptera	Cydnidae	*Cydnus hispidulus* Klug.	Sp.33
Hemiptera	Lygidae	*Nyssius cymoidus*	Sp.34
Hemiptera	Miridae	*Orthotulus pusillus* Reuter.	Sp.35
Hemiptera	Miridae	*Lygus conspurcatus* Reuter.	Sp.36
Homoptera	Aphidae	*Myzus persicae* Sulz.	Sp.37
Hymenoptera	Bethylidae	*Farasierola sp.*	Sp.38
Hymenoptera	Crabronidae(Craboninae)	G.1	Sp.39
Hymenoptera	Eumenidae	*Katamens dimidiativentris*	Sp.40
Hymenoptera	Formicidae	*Tetramorium brevicorne* Brondroit	Sp.41
Hymenoptera	Formicidae(Formicinae)	*Cataglyphis lividus* (Andre)	Sp.42
Hymenoptera	Formicidae(Formicinae)	*Cataglyphis sinaitica*	Sp.43
Hymenoptera	Formicidae(Myrmicinae)	*Camponotus oasium* Forel	Sp.44
Hymenoptera	Formicidae(Myrmicinae)	*Camponotus sp.*	Sp.45
Hymenoptera	Formicidae(Myrmicinae)	*Camponotus thoracicus* (Fabricius)	Sp.46
Hymenoptera	Formicidae(Myrmicinae)	*Messor ebininus* Santschi.	Sp.47
Hymenoptera	Formicidae(Myrmicinae)	*Messor foreli*	Sp.48
Hymenoptera	Formicidae(Myrmicinae)	*Monomorium carbonarium*	Sp.49
Hymenoptera	Formicidae(Myrmicinae)	*Pheidole sinaitica*	Sp.50
Hymenoptera	Ichneumonidae	*Netelia pharaonum*	Sp.51

Hymenoptera	Multillidae(Mutillinae)	Adults	Sp.52
Hymenoptera	Pompilidae(Pompilinae)	G.1	Sp.53
Hymenoptera	Pompilidae(Pompilinae)	G.2	Sp.54
Impioptera		Adults	Sp.55
Lepidoptera		larva1	Sp.56
Lepidoptera		larvae2	Sp.57
Lepidoptera		larvae3	Sp.58
Lepidoptera		larva4	Sp.59
Lepidoptera		larva5	Sp.60
Mantodea	Mantidae	Larvae	Sp.61
Neuroptera	Myrmeleontidae	Larvae	Sp.62
Orthoptera	Acrididae	Nymph	Sp.63
Orthoptera	Chrysididae(Cleptinae)	Adults	Sp.64
Orthoptera	Gryilidae	*Acheta domesticus*	Sp.65
Orthoptera	Gryllidae	*Gryllus bimaculatus* De Geer.	Sp.66
Thysanura	Lepismatidae	*Thermobia aegyptiaca*	Sp.67

تأثير بعض النشاطات البشرية على التنوع البيولوجي للحشرات الأرضية في المنطقة الجنوبية لمحافظة بورسعيد - مصر

عبير شعبان[1]، فايز محمد صميده[2]، محمد أحمد بدير[2]، احمد حسن أبوغاليه[2]، إيمان بهجت[1]
[1]قسم العلوم البيولوجية- كليه التربية ببورسعيد- جامعة قناة السويس- مصر
[2]قسم علم الحيوان- كليه العلوم بالإسماعيلية- جامعة قناة السويس- مصر

الملخص العربــي

تم حصر الحشرات الأرضية من أربع أماكن مختلفة في المنطقة الجنوبية لمحافظة بورسعيد وذلك باستخدام المصائد الأرضية. وتشمل تلك المناطق مواقع تمثل تأثير ثلاثة أنشطه بشرية مختلفة: منطقه صناعية، منطقه تربيه حيوان، منطقه زراعية بالإضافة الى منطقة بدون أنشطة(تجربة ضابطة). ولقد تم اختيار موقعين منفصلين بكل منطقة (20X 20 م) بحيث كان بكل موقع 20 مصيدة أرضية منفصلة و موزعة بانتظام.

وقد أظهرت الدراسة اختلافاً للموائل والغطاء النباتي باختلاف المناطق الأربعة وبدرجة أقل داخل المواقع. وقد أدى ذلك إلى اختلاف التنوع من حيث المكان. وعلى الرغم من ذلك لم يوجد فرق معنوي في التنوع البيولوجي للحشرات الأرضية خلال فترة الدراسة. أوضحت الدراسة أن المنطقة الزراعية تحتوى على أعلى تنوع بينما كانت منطقه تربيه الحيوانات الأقل احتواء على التنوع وعلى العكس، كانت منطقه تربيه الحيوانات الأعلى غنى من حيث الأنواع، بينما المنطقة الزراعية الأقل غنى. ويمكن القول أن المناطق المختلفة تميزت بمجموعات مميزة الأنواع من الحشرات الأرضية إستجابة للأنشطه المختلفة للانسان.