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Abundance and diversity of *Acacia tortilis* insects and araneids fauna in Wadi Mandar, Saint Catherine Protectorate, South Sinai, Egypt

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ABSTRACT

Due to the economic importance of *Acacia tortilis* trees in the desert ecosystem, a study was made concerning these trees in wadi Mandar, Saint Catherine Protectorate, South Sinai, Egypt. Thus, abundance and diversity of major insects and araneids species were searched. Collection was achieved by using pitfall traps technique in the trees area. Results indicate a total of 19467 individual insects and araneids. They belong to 68 species of which 58 species were identified. The collected species were included in 37 families belonging to 13 orders. The most abundant insect species was *Monomoriun niolticum* (O. Hymenoptera, F. Formicidae). On the other hand, the most abundant araneid species was *Stegodyphus dufori* (F. Eresidae). Separated curves for each insect and araneid order were constructed to determine the most abundant species in each order. Species diversity pattern of *Acacia* insects and araneids for the tree types was determined and the same was made among months of the study period. A detailed discussion was made to elucidate results of this research in relation to other authors.

Keywords: *Acacia tortilis*, insects and araneids fauna, abundance, diversity, Saint Catherine Protectorate, South Sinai, Egypt.

INTRODUCTION

Trees, in general, provide an excellent framework for insect community research, because they can be considered a discrete ecological unit (Southwood and Kenedy, 1983). Trees also have a great niche diversification because of structural complexity (Lawton, 1986). They are a stable resource (Southwood, 1978) and their inhabitants are more or less trophically interlinked (Moran and Southwood, 1982).

Acacia trees are of great importance to Bedouin life where they provide a stable browse for their flocks, especially for camels and goats; forage from these trees is available throughout most of the dry season when other sources are scarce (Goodman and Hobbs, 1988; Moustafa *et al*., 2001; Zalat *et al.*, 2001). The Bedouins in Sinai desert prohibit the cutting down of desert trees and bushes, especially *Acacia* trees. These severe rules are a result of the strict tribal laws and traditions on which Bedouins culture has been founded ; and that depend basically on the respect of nature (Abdel-Ghany, 2006).

In addition, the importance of *Acacia* trees in the rural economy lies in provision of a lot of useful products. Among these are the Arabic gum which is used in medicinal, culinary and confectionery purposes (Manniche, 1989), Fuel wood and charcoal, timber (where some *Acacia* species are highly resistant to termites) as well as contributing in environmental protection, sand dune stabilization and soil fertility (Fagg and Stewart, 1994; Springuel and Mekki, 1994; Gumaa *et al.*, 1998) .

The last 15 years have seen an immense increase in knowledge of insect communities associated with *Acacia* trees. However, insect communities of *Acacia* trees in arid and semi-arid habitats are still comparatively poorly studied. Although these trees are considered the most common and important ones in Egyptian deserts (Migahid *et al.*, 1959; Danin, 1983; El-Ghareeb and Abdelrazik, 1984), no large-scale study has yet been conducted anywhere in such habitat. Consequently, there are no virtual estimates of insect diversity in this habitat (Lewinsohn and Price, 1996). To assess habitats for their relevance for conservation, ecological inventories provide an essential tool for environmental management (Campbell, 1993) and insects are a major component in every habitat.

Krüger and McGavin, (1997, 1998) analysed in their study the insect community associated with *Acacia* trees in North-East Tanzania, but their study did not contain the effect of these insects on the studied trees. The occurrence and damage caused by two insect pests of *Acacia* was assessed by Montague and Woo (1999), revealing that, both insects caused damage to the main stem of the juvenile trees that reduced tree growth. Various species of herbivorous insects, dominated by species of Orders Coleoptera and Hemiptera, were found in beating samples from *Acacia mearnsii* in south-eastern Australia (Floyd *et al.*, 1997**)**. In this respect, Haojie *et al*. (1998) identified in their study a number of potentially serious pests of *Acacia mearnsii* and also presented some evidence for effective natural biological control agents.

The present investigation was designated to assess the association between the major insects and some of araneids species found in the microhabitat of *Acacia* trees in a well defined site at Saint Catherine protectorate (Wadi Mandar).

MATERIALS AND METHODS

Six acacia trees were chosen and tagged in wadi Mandar in a way that they include the two subspecies of *Acacia tortilis*: subspecies *tortilis* and subspecies

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raddiana. The trees were in the same area, beside a temporary tourists camp site, with an average distance of 50 meters apart. The selection of these trees was directed to be in the same area to fix one of the two important factors influencing insect communities found in the microhabitat of a particular tree, the two factors are: tree species and study area. This constancy offered the opportunity to study only the effect of the variation in tree species on insect communities (Krüger and McGavin, 1998).

Sampling, isolation and preservation of the specimens

Samples were collected monthly from April 2002 to June 2003. Five pitfall traps were placed under each of the selected trees in a way that they form a circle around its trunk. Each individual trap remained in exactly the same position during the entire period of study. Traps were kept closed throughout the study except for the period of trapping (Abdel-Ghany, 2006). Tarps covers were opened at dusk and kept open during two succeeding nights and insects were collected the next day. This period of 48 hours is considered adequate to minimize depletion of the insect fauna (Southwood and Henderson 2000). Contents of each trap were sieved by using suitable sieves to separate water from the samples and then transferred by using a delicate forceps to a labeled vial, containing 70% Ethanol to be preserved, separated and identified.

Identification of the samples

Contents of each trap were examined by means of binocular light microscope (Model ASZ45E), with magnification power from 10.5 to 45X (Bauch and Lomb USA). Identification of insects was achieved by specialists in insect and araneid taxonomy and the aid of certain Egyptian Entomological collections, such as the reference collection of the "Egyptian-British Biological Society, (EBBSoc)", Zoology department, faculty of Science, Suez Canal University and in the reference collection of the museum in Faculty of Science, Ain-Shams University. The specimens were identified to the species level, when possible. The majority of species of Order Lepidoptera could not able identified due to the distortion of their scales as a result of the effect of water added to traps.

Abundance and diversity

Seasonal and monthly abundance of the trapped insects and araneids determined, calculated and represented in tables and graphs. Species and orders importance curves were designed to show the highest and lowest records of individuals collected during the whole period of study. Similarity between the two tree subspecies according to the number of species was measured by using Jaccard index; this was in addition to calculating the similarity between the months of the studding period using the same index. Diversity of insects was measured by using Simpson diversity index (Lande, 1996).

RESULTS

Abundance of *Acacia* insects and araneids

A total number of 19467 individual insects and araneids were collected associated with acacia trees during the period of study. They were represented by 68 species of which 58 species could be identified. The collected species were included in 37 families belonging to 13 orders (Table 1). Seasonal distribution of collected insects and araneids indicated that they were most abundant during summer (48.95%), followed by autumn (27.58%), spring (16.68%) and then winter (6.79%). The peak of abundance occurred in August followed by September, July and then June. Their least abundance occurred in January (Fig. 1).

Summer was the most abundant season as the total insect and araneids count was 7940, autumn and spring came next to summer with 4473 and 2705 trapped insects and araneids, respectively. The lowest abundant season was winter in which only 1102 insects and araneids were collected. The insects and araneids trapped showed a small peak of abundance during April (845 individuals), then it increased till August that showed the highest abundance (4399 individuals), then decreased again to reach its lowest peak in January (166 individuals). From February until June, insects and araneids count recorded was 550 and 1420, respectively; which means an increasing tendency in their numbers (Fig. 1).

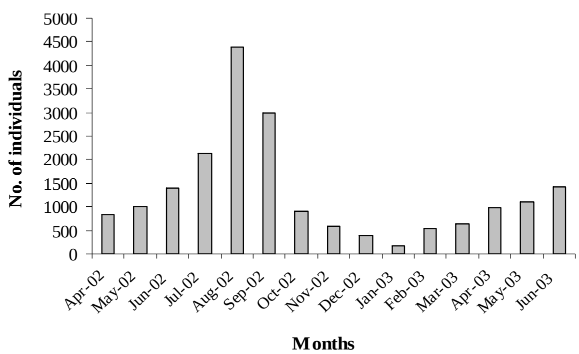

Figure (1): Monthly abundance of insects and araneids species attacking *Acacia tortilis* during the study period

Species abundance

The most abundant insect species was *Monomorium niloticum* (O: Hymenoptera, F: Formicidae), followed by *Bruchus rufimanus* (O: Coleoptera, F: Bruchidae), followed by *Cataglyphis niger* then *Cataglyphis sinaitica* (O: Hymenoptera, F: Formicidae). The lowest abundant species were *Deraeocoris addendus and Eurydema* sp (O: Hemiptera, Families: Miridae and Pentatomidae, respectively), *Saprinus* sp and *Aphodius* sp. (O: Coleoptera, Families: Scarabeidae and Histeridae, respectively).

Separated curves for each insect and araneid orders were constructed to determine the most abundant species in each order (Fig. 2). In O: Araneida, the most abundant species was *Stegodyphus dufouri* (F: Eresidae) and the lowest one was unidentified species of family Pseudoscorpionidae. While in order Coleoptera, the most abundant species was *Bruchus rufimanus* (F: Bruchidae) and the lowest one was *Aphodius sp.* (F: Scarabaeidae). On the other hand, in O: Dictyoptera, the most abundant species was *Blatella germanica* (F: Blattidae) and the lowest one was *Sphodromantis viridis* (F: Mantidae). In O: Hemiptera, the most abundant species was *Oxycarenus sp* (F: Lygaeidae) and the lowest one was *Eurydema sp.* (F: Pentatomidae). Moreover, in O: Hymenoptera, the most abundant species was *Mnomorium niloticum* (F: Formicidae) and the lowest one was *Pompilus plumbeus*(F: Pompilidae). Finally, in O: Orthoptera, the most abundant species was *Anacridium aegyptium* (F: Acrididae) and the lowest one was *Odiopoda germanica* (F: Acrididae). O: Lepidoptera and O: Diptera were excluded because the majority of their species were unable to be identified as

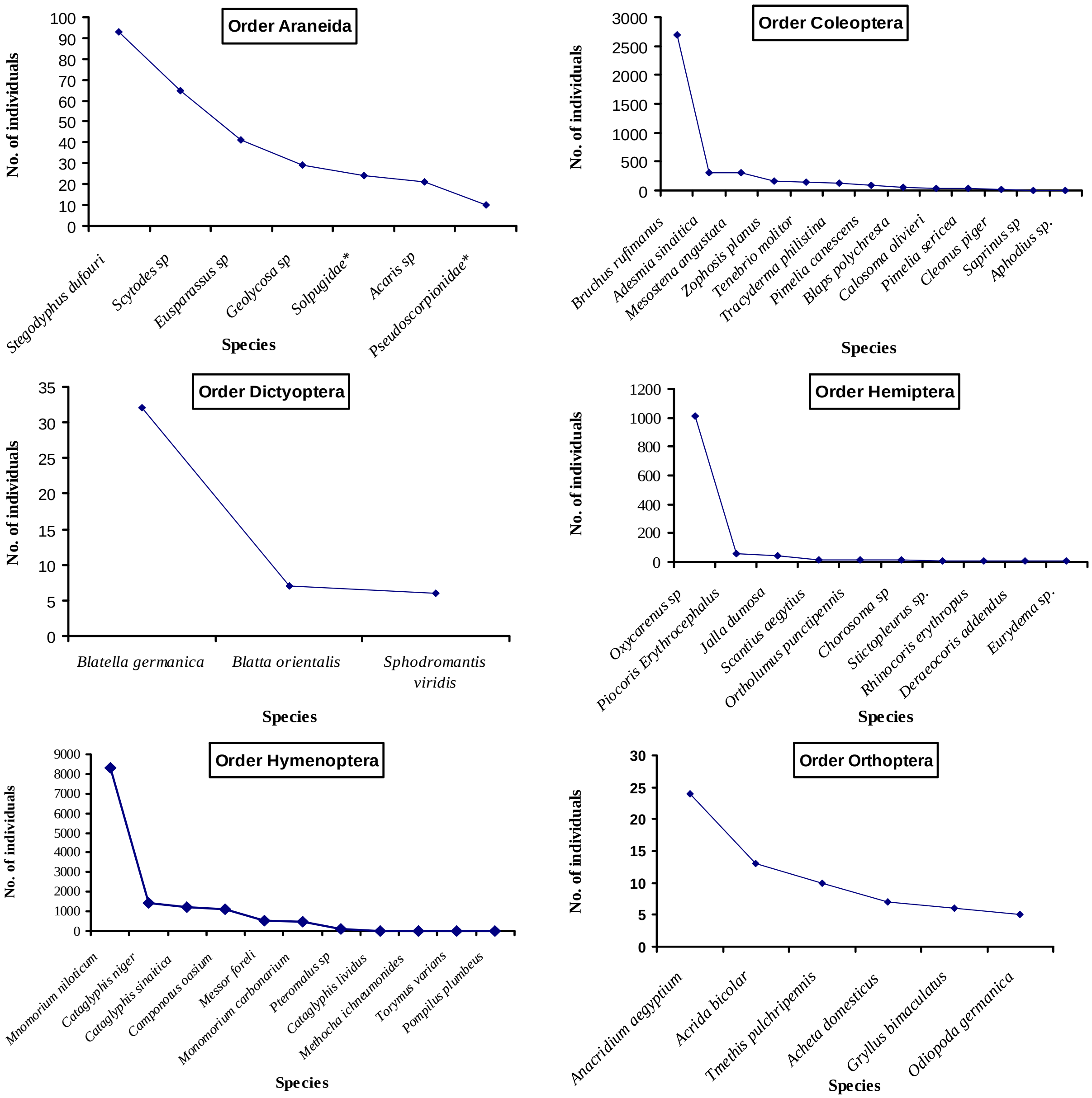

Figure (2): Relative abundance of collected araneids and insects associated with *Acacia tortilis* trees in wadi Mandar, St. Catherine Protectorate.

mentioned before. Also, Orders represented by only one species were not included. These were Orders Collembola, Mycoptera, Neuroptera and Phasmida.

Similarity between two tree types

The similarity index for the two tree types showed a high similarity (81.65) between the two *Acacia tortilis* subspices *tortilis* and *raddiana* according to number of insects recorded per each species during the study period. One way ANOVA test, showed no significant difference between the two *Acacia tortilis* subspecies according to number of insects collected through the period of study (F = 2.26, df = 1, $P > 0.05$). The average insects collected from *Acacia tortilis* sub-species *tortilis* and *raddiana* were 3.727 ± 0.603 and 2.589 ± 0.456, respectively.

Diversity of *Acacia* insects and araneids

(1) Species diversity pattern of Acacia insects and araneids for the two tree types

A slight difference in Simpson diversity index was recorded, as it was 0.335 ± 0.012 for *Acacia tortilis* subspecies *tortilis* and 0.388 ± 0.014 for *Acacia tortilis* subspecies *raddiana* (Fig. 3). ANOVA test shows no significant difference in the mean diversity per trap among the two tree types (F = 7.93, df = 1, $P > 0.05$).

(2) Species diversity pattern of Acacias insects and araneids during months of the study period

The highest diversity occurred during January 2003, followed by June 2002, as their Simpson diversity indices were 0.479 ± 0.054 and 0.467 ± 0.035, respectively. While the lowest diversity calculated was for April 2003, where its Simpson diversity index was 0.272 ± 0.36 (Fig. 4). The one-way ANOVA test showed a very high significant difference in the species diversity among months, (F = 31.577, df =14, $P < 0.01$) (Fig. 4).

(3) Species richness

A slight difference between in species richness was recorded between tree types; as 67 species were recorded associated with *Acacia tortilis* subspecies *tortilis* and 65 species with *Acacia tortilis* subspecies *raddiana*. Among months, species richness varied greatly, where the highest richness was recorded during April (45 spp.). On the other hand, the lowest month in the number of species recorded was January with only 14 species (Fig. 5).

Discussion

A well known fact is that the method of sampling is an important factor affecting results. On the other hand, the type of soil of the studied area determines to a great extent the method of sampling. As the compactness of the soil increased, soil insects and animals in this case

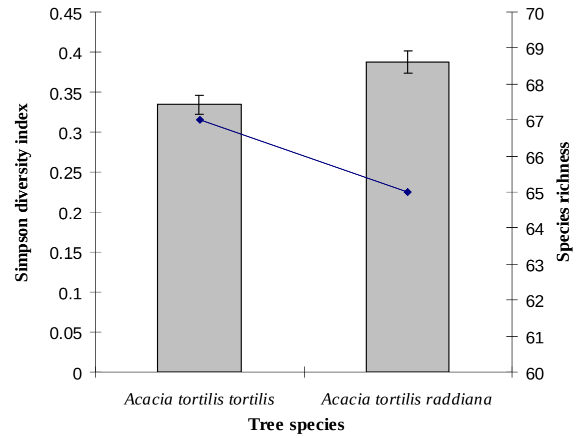

Figure (3): Variations between *A. tortilis tortilis* and *A. tortilis raddiana* in insect and araneids species diversity (measured by Simpson diversity index), mean diversity per trap and species richness during the study period.

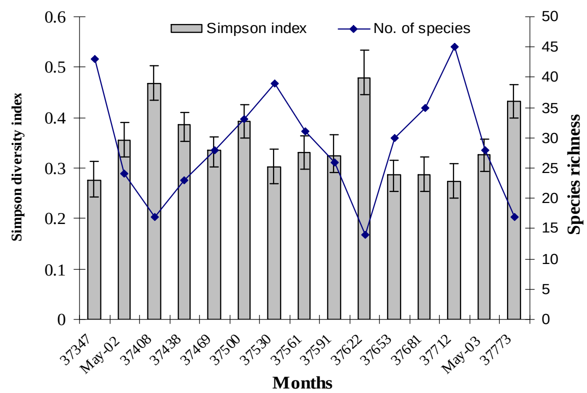

Figure (4): Variations between months in insect species diversity (measured by Simpson diversity index), mean diversity per trap and species richness during study period.

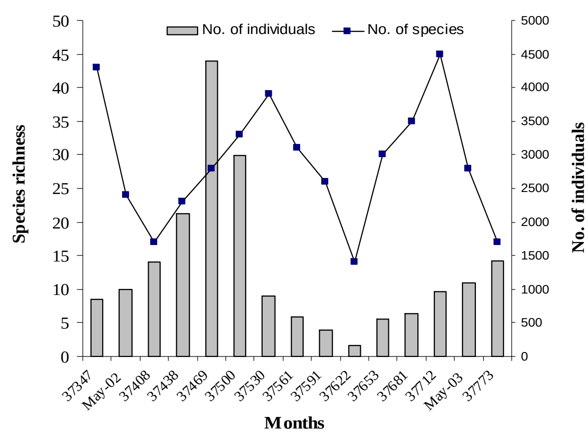

Figure (5): Variations between months in insects' species richness (measured by Simpson diversity index) and number of individual insects collected in each month during study period.

would be found under stones or small retreats. In the present study, the pitfall trap method described by Southwood (1978) and Slingsby and Cook (1986) is the most adopted method. Pitfall traps method is a routine technique for investigating local and temporal changes of arthropods fauna. In such areas, the composition and size of catches may be influenced by a number of factors including surrounding plant cover (Honek, 1988), land use pattern (Wallwork, 1976) and soil structure (Mikhail, 1993).

The abundance of insects and araneids fauna gathered during the period from April 2002 to June 2003 varies greatly among months; with as the highest abundance in August and the in January with only 166 sampled insects. The above mentioned observation leads to the suggestion that the climatic conditions play an important role in determining the activity and abundance of insects; as high abundance is directly related with warm weather and versa. This suggestion agrees with Kasperi *et al*. (2000) who found that temperature affects species abundance, density and distribution, as the temperature in this case acts as an estimate of activity and productivity. Both habitat diversity and size of an ecosystem influence the number of species supported; but other variables are also important. Current ecological researches suggest that a moderate degree of stress or disturbance tends to maximize species diversity (Ali *et al.* 2000).

In the present study, 68 species of insects and araneids were collected from the ground soil underneath the selected *Acacia* trees using the pitfall trap method, the most abundant species belong to orders Hymenoptera, Coleoptera, and Hemiptera. Ten genera were recorded as the most dominant in this study, namely: *Monomorium niloticum*, *Cataglyphis niger, Cataglyphis sinaitica, Camponotus oasium*, *Messor foreli,* and *Monomorium carbonarium* (Hymenoptera, Formicidae); *Bruchus rufimanus* (Col., Bruchidae); *Aedesmia sinaitica* and *Mesostena angustata (*Col., Col., Tenebrionoidae) and *Oxycarenus sp.* (Hemiptera, Ligaeidae) .

Similarly, Krüger and Mc Gavin (1997) indicates that the abundance of ants and the diversity of Coleoptera were at the highest levels as compared with other taxa. The same observation is shown in other tropical areas studies (Adis *et al*., 1984, and Stork, 1991) and also, in rain forest communities (Alison *et al*., 1993 and Basset, 1991). On the other hand, the diversity of chewing species, mainly of O: Orthoptera and certain plant sapsuckers (O: Hemiptera) came in the second level. This observation has been recorded in the approach by (Basset and Arthington, 1992). Moreover, Basset (1996) found that ants are the main predators in insects' communities. Finding in this study support this view where ants' biomass had a significant existence comparing with the abundance of other taxa. A number of both empirical and theoretical studies have found that predation is a very important process in local communities (Cornell and Lawton, 1992). On the other hand, in his approach, Jamal (1994) listed hundreds of insect species considered as major insects pests of *Acacia senegal* and *Acacia seyal* trees collected from their canopy and trunk. The most important insect pests found in the region were Coleoptera.

The clear presence of large amounts of Diptera species, especially the house fly, *Musca domestica,* could be referring to the area from which samples were collected; as it was near a tourist's temporary camping site made for Bedouin dinner; and this conclusion also leads to the relatively high number of spiders that may feed on these flies.

The similarity between the two subspecies of *Acacia* trees according to the number of insects collected from the pitfall traps located under each tree shows that there is a low level of host specificity between the gathered insects and the two tree sub-species with a recorded total similarity 81.65%. Stork (1987) reported that closely related tree species have a similar insect fauna, and Basset (1992) also found low host specificity between tree species and their arboreal and free-living insect herbivores in rain forests. Otherwise, Erwin (1983) reported in his approach high host specificity between tree types and associated insect communities in tropical forests in South America. This parallels the result of Moran and Southwood (1982) and Lawton (1986) who found a correlation between the architectural complexity of the host plant and the number of phyto-phagous species.

The above mentioned correlation between trees and insects affecting the types of species composition could not be found in the present study, leading to the suggestion of high similarity between the two tree types faunas. This could be explained probably because all sampled trees belong to the same species, where the differentiation between the subspecies level may have a neglected effect on the variability in the association insects and araneids fauna.

The biodiversity of arthropod population is generally influenced by a complex of many factors such as: altitude, climatic variability, vegetation composition, soil structure and human intervention. Human factor is one of the most important effects on managing natural and semi-natural habitats. However, not only local habitat features determine local diversity, but other processes acting at coarse scales are also influential (Caley and Schutter, 1997). The diversity and richness of sampled insects from pitfall traps located under the two *Acacia* tree subspecies, showed no significant differences. This leads to the same conclusion, that insects and araneids faunas of the same tree genus reveal a high degree of resemblance.

Insects and araneids diversity and richness vary greatly among months of study; where the highest diversity was recorded during January, while the lowest

Table (1): List of insects and araneids taxa collected by pitfall traps during the study period.

No.	Order	Family	Genus & Species
1	Araneida	Eresidae	*Stegodyphus dufouri*
2	Araneida	Ixodidae	*Acaris* sp.
3	Araneida	lycosidae	*Geolycosa* sp.
4	Araneida	Pseudoscorpionidae	-
5	Araneida	Scytodidae	*Scytodes* sp.
6	Araneida	Solpugidae	-
7	Araneida	Sp.arassidae	*Eusparassus* sp.
8	Coleoptera	Bruchidae	*Bruchus rufimanus*
9	Coleoptera	Carabidae	*Calosoma olivieri*
10	Coleoptera	Curculionidae	*Cleonus piger*
11	Coleoptera	Histeridae	*Saprinus* sp.
12	Coleoptera	Scarabaeidae	*Aphodius* sp.
13	Coleoptera	Tenebrionidae	*Tenebrio molitor*
14	Coleoptera	Tenebrionidae	*Tracyderma philistina*
15	Coleoptera	Tenebrionidae	*Mesostena angustata*
16	Coleoptera	Tenebrionidae	*Blaps polychresta*
17	Coleoptera	Tenebrionidae	*Adesmia sinaitica*
18	Coleoptera	Tenebrionidae	*Zophosis planus*
19	Coleoptera	Tenebrionidae	*Pimelia canescens*
20	Coleoptera	Tenebrionidae	*Pimelia sericea*
21	Collembola	Neelidae	-
22	Dermaptera	Labiidae	*Labia minor*
23	Dictyoptera	Blattidae	*Blatella germanica*
24	Dictyoptera	Blattidae	*Blatta orientalis*
25	Dictyoptera	Mantidae	*Sphodromantis viridis*
26	Diptera	Muscidae	*Musca domestica*
27	Diptera	Muscidae	*Eudasyphora cyanella*
28	Diptera	Ptychopteridae	*Ptychoptrea contaminta*
29	Diptera	Rhinophoridae	*Stevenia angustifoms*
30	Diptera	Sarcophagidae	*Sarcophaga carnaria*
31	Diptera	Tachinidae	*Gonia divisa*
32	Diptera	Tephritidae	*Ceratitis* sp.
33	Diptera	-	-
34	Hemiptera	Pyrrhocoridae	*Scantius aegytius*
35	Hemiptera	Lygaeidae	*Ortholumus punctipennis*
36	Hemiptera	Lygaeidae	*Piocoris Erythrocephalus*
37	Hemiptera	Miridae	*Deraeocoris addendus*
38	Hemiptera	Pentatomidae	*Eurydema* sp.
39	Hemiptera	Pentatomidae	*Jalla dumosa*
40	Hemiptera	Lygaeidae	*Oxycarenus sp.*
41	Hemiptera	Reduvidae	*Rhinocoris erythropus*
42	Hemiptera	Rhopalidae	*Chorosoma sp.*
43	Hemiptera	Rhopalidae	*Stictopleurus sp.*
44	Hymenoptera	Formicidae	*Mnomorium niloticum*
45	Hymenoptera	Formicidae	*Cataglyphis niger*
46	Hymenoptera	Formicidae	*Camponotus oasium*
47	Hymenoptera	Formicidae	*Cataglyphis sinaitica*
48	Hymenoptera	Formicidae	*Monomorium carbonarium*
49	Hymenoptera	Formicidae	*Messor foreli*
50	Hymenoptera	Formicidae	*Cataglyphis lividus*
51	Hymenoptera	Methochidae	*Methocha ichneumonides*
52	Hymenoptera	Pompilidae	*Pompilus plumbeus*
53	Hymenoptera	Pteromalidae	*Pteromalus sp.*
54	Hymenoptera	Torymatidae	*Torymus varians*
55	Lepidoptera	Noctuidae	*Heluthus nubigera*
56	Lepidoptera	-	-
57	Lepidoptera	-	-
58	Lepidoptera	-	-
59	Lepidoptera	-	-
60	Mycoptera	-	-
61	Neuroptera	Ascalaphidae	-
62	Orthoptera	Acrididae	*Odiopoda germanica*
63	Orthoptera	Acrididae	*Tmethis pulchripennis*
64	Orthoptera	Acrididae	*Acrida bicolar*
65	Orthoptera	Acrididae	*Anacridium aegyptium*
66	Orthoptera	Gryllidae	*Acheta domesticus*
67	Orthoptera	Gryllidae	*Gryllus bimaculatus*
68	Phasmida	Phasmatidae	*Bacillus sp.*

record was during April. In contrast, it was found that the highest species richness was recorded during April and the lowest record was during January. These results proved that, although January had the lowest number of insects and araneids species; this month showed the highest diversity level.

This result leads to the suggestion of homogenous distribution of numbers of insect and araneids through the sampled species (high degree of evenness), which consequently leads to the obtained elevated level of diversity. This homogeneity could be explained to be due to the very low number of insects and araneids that make the competition between the individuals at its lowest degree, thus giving the opportunity to all species to be found and live peacefully with each other.

On the contrary, the highest species richness recorded in April was accompanied with the lowest diversity throughout the whole period of study; and this is result thought to be due to the high heterogeneity (low degree of evenness) in the samples distribution in each species recorded along this month. This heterogeneity may be due to that not all the species were expressed during that month and this could be explained that some insects and araneids species don't have the ability to bear the crowded ecosystems, where they prefer to feed during quiet periods, avoiding the aggressive competition on place and food resources.

Our study agrees in many aspects to that by Semida (2006). In fact, the latter study was carried out an in area near to that of ours (wadi Feiran in Saint Catherine protectorate) and was also concerned with *Acacia* trees and insects interaction. For both studies, some of these insects are visitors, some are insect predators and some others are seed feeders.

In conclusion, *Acacia* trees have a very high diversity of insects and araneids fauna and this probably indicates that these trees may work as unique ecosystem by themselves to accommodate the high diversity of insects and animals in this harsh environment and possibly may work as an island to harbor these entomo-fauna and other animal species.

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وفرة وتنوع حشرات وعناكب أشجار السيال بوادى مندر بمحمية سانت كاترين جنوب سيناء - مصر

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الملخص العربـــى

تمت دراسة فونا الحشرات والعناكب لأشجار السيال ذات الأهمية الإقتصادية للنظام البيئى الصحراوى فى أحد وديان منطقة سانت كاترين وذلك بإستخدام المصائد الأرضية. ولقد أوضحت النتائج جمع 19467 فرد من مختلف أنواع الحشرات والعناكب والتى تنتمى إلى 37 فصيلة من 13 رتبة تم تعريف 58 منها إلى مستوى النوع. وبالنسبة للحشرات وجدنا أن حشرة ال "مونوموريم نيلوتيكم" هى الأكثر إنتشاراً أما عنكبوت "ستيجودفيس ديفورى" فهو الأكثر انتشارا مقارنة بباقي العناكب. ولقد تم عمل منحنيات تبين إنتشار كل نوع من أنواع الحشرات والعناكب. وتم أيضاً عمل أنماط تنوع أنواع الحشرات والعناكب المصاحبة لأشجار السنط محل البحث. ولقد ناقش البحث نتائجه فى ضوء الدراسات السابقة للعديد من الباحثين.