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Biodiversity of the Ground Spiders in Southern Area of Port Said Governorate, Egypt

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ABSTRACT

Ground spiders were sampled, by using pitfall traps, in a nested design from four different localities in the southern area of Port Said Governorate, through 15 months (from July 2004 to September 2005). The localities represented three different human impact activities (industrial, animal rearing and cultivated, in addition to control) through 15 months (from July 2004 to September 2005). Each locality was represented by two separated sampling sites (20X20 meters), and each site had twenty individual traps distributed systematically. Habitat characteristics and plant cover were clearly different among the four localities and to a less extent within localities. Species diversity did not significantly vary spatially; while it significantly varied temporally among the different localities during the study period. Both cultivated and animal rearing sites showed the highest diversity; while the industrial sites recorded the highest species richness. The different localities had distinct and characteristic groups of species responding to habitat characters.
Keywords: biodiversity, Arachnids, spiders, human activities, species abundance, Port Said.

INTRODUCTION

Changes in landscape structure which are driven by anthropogenic activities may affect the availability of habitats for particular species, especially those that are less acclimatized. Living species are the basis of the planet's biodiversity. This living basket of organisms is the base of human activities (Wilson, 1988; Pimentel *et al.,* 1992). Arachnida is a conspicuous and common animal group. They have diversified into virtually every terrestrial environment, with a few fresh water and marine representatives. Most spiders feed primary on insects and secondary on other spiders (Nyffeler, 1999). Because of their high abundance and predominantly insectivorous feeding habitats, spiders are suspected to play an important role in agro-ecosystems, woodlands and other terrestrial ecosystems (Nyffeler and Benz, 1987). They are one of the major groups of generalist predators that are needed in the development of efficient, sustainable, low-input agricultural systems (Ekschmitt *et al*., 1997). An over view of systematic taxonomy indicates that, there are three mega-diverse arachnid orders, Araneae (spiders), Parasitiforms and Acariforms (mites and tickes) which possess the bulk of arachnid diversity (Harvey, 2002).

Few studies have directly addressed year to year differences in spider communities (Norris, 1999). For example, some studies were concerned with the arachnological communities on census ground-active spiders in Tanzania and Namibia (Smith, 2000), marked annual differences in abundance of peat bog spider species (Relys *et al*., 2002), and spider populations in Europe field crops and US manual crops (Nyffeler and Sunderland, 2003). Otherwise, some studies assessed on the spider diversity in different regions such as South Sinai, Egypt (Abdelmoniem, 2003) and Boddington in Australia (Orabi, 2006).

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

MATERIALS AND METHODS

Study area:

The study was carried out at southern area of Port Said Governorate over a period of 15 successive months (July 2004 and September 2005). Four localities were selected for this study; and each of locality was represented by two sites to show the local habitat heterogeneities as follows: 1. industrial sites (Ind.) at 2km south of Port Said city (A site: 31? 13' 543" N and 32? 17' 679" E; and B site: 31? 13' 586" N and 32? 17' 626" E), 2. animal rearing sites (Rear.) at 17km (A site: 31? 06' 781" N and 32? 18' 253" E, and B site: 31? 05' 676" N and 32? 18' 326" E, 3. cultivated sites (Cultiv.) at 19Km. (A site: 31? 05' 694" N and 32? 18' 333" E, and B site: 31? 05' 720" N and 32? 18' 372" E); and 4. control sites (Cont.) at 18 km (A site: 31? 06' 582" N and 32? 18' 159" E, and B site: 31? 06' 569" N and 32? 18' 159" E). The geographical position of each site was recorded using a hand-held GPS receiver.

Sampling method:

Pitfall traps were used to sample the ground spiders during the study. Each trap consisted of a rounded plastic bottle 13 cm deep with an opening of 5.7cm

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diameter. The lower third of the trap was full of water with a little bit of 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.

Specimens identifications

The collected specimens were identified to the species level whenever possible. Occasionally only generic or even family levels were possible. Specimens' identification was done at Arachnid Collection of Egypt (ACE), Cairo, and by experts.

Species diversity and species richness

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

$$\lambda = \Sigma p_i^2 \quad D = 1 - \lambda$$

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 evenness were also calculated.

RESULTS

Species/effort curve

The number of recorded species during sampling depended on sampling effort. As shown in figure (1-A), the number of recorded species gradually increases with sampling effort (the number of species was about 19 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 16 to trap 20 (Fig. 1-B). From these curves it could be concluded that the sampling was enough to sample the area of study and accurately reflected the species diversity of the sampling sites.

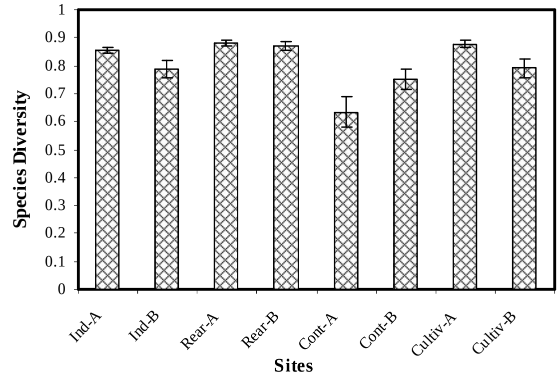

Figure (1-A): Species/effort curve during the study period.

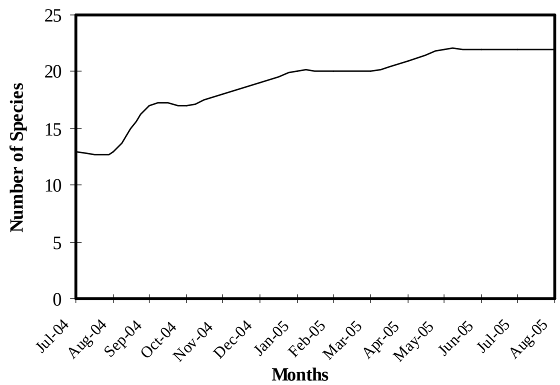

Figure (1-B): Species/effort area curve for the four study sites.

Overall pattern of diversity:

Traps were regarded as replicated samples for the spiders collected from different sites. A total of 1206 individuals belonging to 19 species (about 10 families) (Table 1) were caught throughout the study period (Ind. sites 449 individuals belonging to 17 species; Rear. sites 302 individuals of 15 species; Cultiv. sites 199 individuals of 12 species and Contr. sites 119 individuals of 9 species). The family composition of the ground active spider faunas revealed that Amaurobiidae accounted for the largest proportion of spider species,

Table (1): The similarity index between different study sites (Jaccard Index).

Sites	Ind-A	Ind-B	Rear-A	Rear-B	Cont-A	Cont-B	Cultiv-A	Cultiv-B
Ind-A	100%	97.7	97.2	94.7	93.7	98.1	98	97.7
Ind-B	97.7	100%	97.9	94.6	94.1	98.9	97.8	98.1
Rear-A	97.2	97.9	100%	99.7	93.4	98	99.1	97.4
Rear-B	94.7	94.6	99.7	100%	86.5	84.1	92.8	94.6
Cont-A	93.7	94.1	93.4	86.5	100%	97.3	90.5	83.1
Cont-B	98.1	98.9	98	84.1	97.3	100%	96.3	91.6
Cultiv-A	98	97.8	99.1	92.8	90.5	96.3	100%	97.8
Cultiv-B	97.7	98.1	97.4	94.6	83.1	91.6	97.8	100%

representing approximately 28% of all species at the study areas. Meanwhile, Oxyopidae was the lowest one (0.26%). The other families, which are well represented in the study areas included Linyphiidae (18%), Lycosidae (14.5%), Salticidae (13%) and Gnaphosidae (11%) of all families.

Spatial and temporal pattern of variation in diversity of the ground spiders assemblages

To determine the spatial variation of ground spider diversity of the study area, two different parameters were analyzed: species abundance and species richness. Figure (2-A) shows the spatial variation in Simpson diversity index at different study sites. The highest values of species diversity were recorded in Cultiv-A site and Rear-A site, while the lowest one was recorded in Cont-A site. There was no significant difference in Simpson diversity index among locations ($F_{(7,119)}$= 0.289, P $\geq$ 0.956). Comparable diversity indices were also recorded throughout the study period ($F_{(14,119)}$= 2.083, P $\geq$ 0.018). However, the highest value of temporal variation in species diversity was recorded in September-2005 and the lowest one was in August-2005 (Fig. 2-B).

The highest species richness was recorded in Ind-B site while the lowest one was recorded in Cont-B site (Fig. 3-A). On the other hand, September-2005 recorded the maximum species richness during the study period at different study sites while the minimum one was in August-2004 (Fig. 3-B).

Species importance curve

Figure (4) shows the degree of abundance of important species in the different study sites. Among the study sites, species 2 (Amaurobiidae) was the most important species; while species 6 (Gnaphosidae) and species 13 (*Oxyopes* sp., Oxyopidae) was the lowest one.

The similarity index between different studied areas (Jaccard index):

Table (1) shows the similarity between different species composition that were found in different localities. The Rear-A site was highly similar to Rear-B site (99.7%). On the other hand, the least similarity was between Cultiv-B site and Cont-A site (83.1%).

Species richness among the different ground spider families during the study period:

The abundance variation was among the different families of ground spiders, (Fig. 5) shows that there was a highly significant difference among families in the number of species during the study period ($F_{(10,42)}$=9.41, P $\leq$ 0.0001); while there was no significant difference between the study localities (F=3.72., df =3, P > 0.056). The most abundandant family was family Amaurobiidae at industrial, cultivated and animal rearing sites. On the other hand, family Linyphiidae was highly abundant at control sites. Family Pholcidae was the least abundant at industrial and control sites. Meanwhile, family Philodermidae recorded the least richness at cultivated and animal rearing sites.

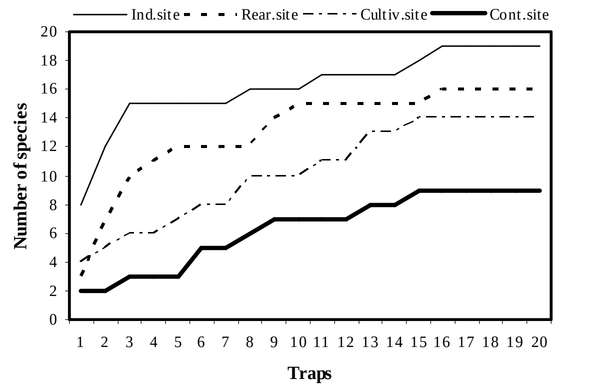

Figure (2-A): Spatial variation in Simpson diversity index at different sites of the study area.

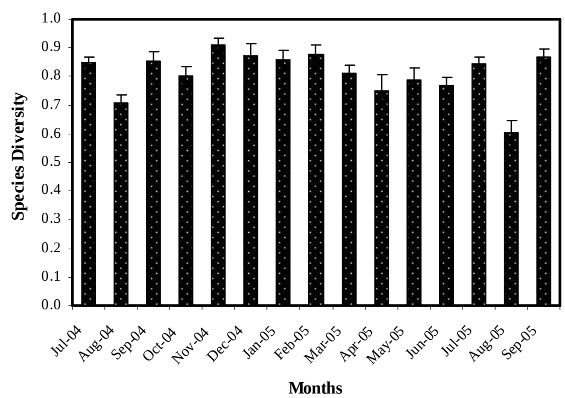

Figure (2-B): Temporal variation in Simpson diversity index at different sites of the study area.

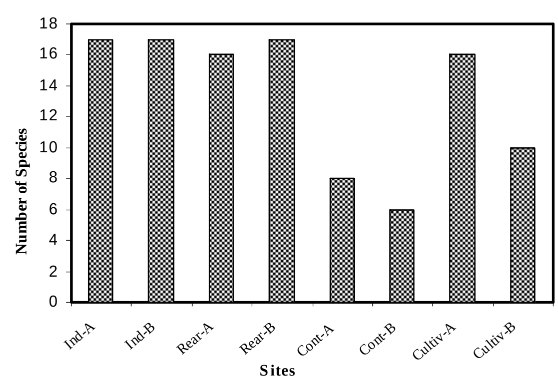

Figure (3-A): Species richness at different study.

DISCUSSION

Habitat edges influence species distribution, genetic structure and predation (Risser, 1995). In the southern area of Port Said Governorate, there is habitat heterogeneity; consequently, different sites may have quite different biodiversities. This is in turn may be a useful monitoring tool in determining the conservation and management programs of this ecosystem. By preserving spider diversity, the numbers of pest species that can be consumed by spiders increase. The preservation of the diversity of spiders in cultivated areas using different methods may not only increase their efficiency against one particular pest, but also results in the capture of more pest species; thus, mitigating overall crop damage (Marc and Canard, 1989). Not only local habitat features determine local diversity, but other processes acting at coarse scales are also influential. Human factors are important in managed or semi-natural habitats (Caley and Schulter, 1997).

In the current study, the four different studied localities were spatially isolated and each locality has its own different habitat features in plant cover, soil proparties and species composition. On the other hand, there was no significant spatial difference in their overall biodiversity of spider communities. Habitat heterogeneities extend also to the level of sites within locality. Soil type, soil moisture, organic matter and other ground animals may be one of the main factors which determne the composition of the spider assemblage within the different types of habitats.

The habitats within the Ind-B site were more heterogeneous than the other localities. This was reflected in its higher species richness; while Cont-B site has the lowest species richness. In contrast, Cultiv-A and Rear-A sites have almost equivalent species diversity, higher than other sites; while Cont-A site was the lowest species diversity.

Throughout the study period, diversity did vary significantly among different months of the year, with maximum value at September-2005 and minimum value during August-2005. Moreover, the species richness varied significantly among the study period reaching its maximum value during September-2005 and minimum value during August-2004. This may be explained by climatic changes.

In the present work, there is a great similarity between Cultiv-A and Rear-A. This may be due to the similarity in some plavegetation cover and animals present in these areas. Amaurobiidae accounted for the largest proportion of spider species, representing approximately 28% of all species at the study area while Oxyopidae was the lowest one (0.26%). Other families that considerably represented in the studied area including Linyphiidae (18%), Lycosidae (14.5%), Salticidae (13%) and Gnaphosidae (11%) of all families

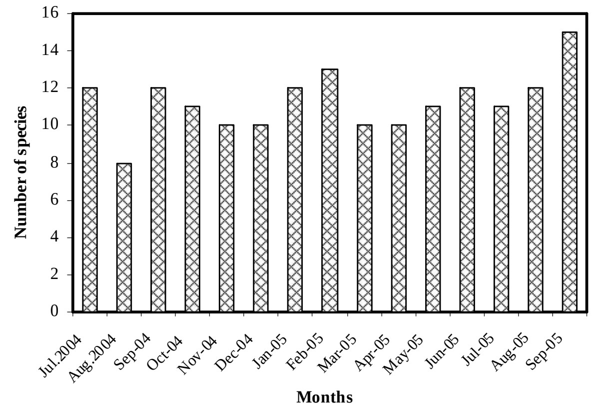

Figure (3-B): Species richness at different months during the study period.

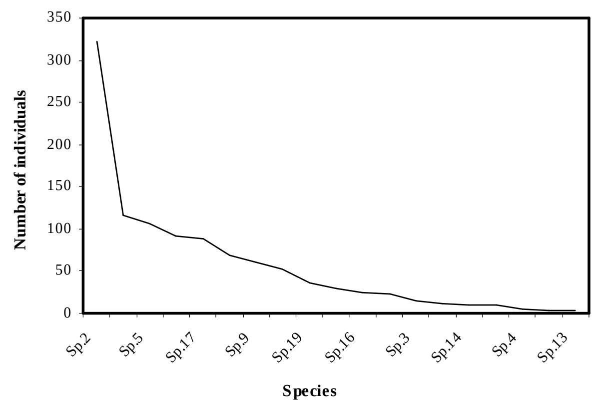

Figure (4): Species importance curve for the different study area.

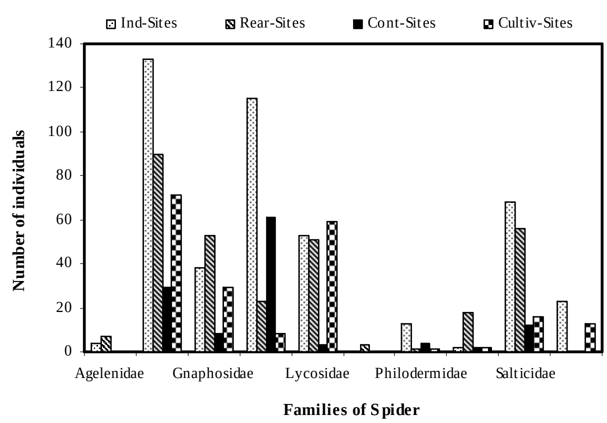

Figure (5): Species richness among different families during the study period.

The different localities show distinctive assemblages of spiders. Most of these differences may be due to habitat heterogeneities and different human activities in the studied area. Industrial sites are characterized by the presence of *Micaria sp.* (Gnaphosidae) and

Philodromus sp. (Philodermidae); Animal rearing sites are characterized by *Oxyopes sp.* (Oxyopidae); Cultivated sites are characterized by the presence of *Pardosa injcunda* (Lycosidae); while the Control sites are characterized by adults of sp.2 (Linypiidae).

The study area is an important region in Egypt that may play an important role in future projects. The habitat heterogeneities caused by human activities and management clearly affect species diversity and community composition very strongly. It illustrated 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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التنوع البيولوجي للعناكب الأرضية في المنطقة الجنوبية لمحافظة بورسعيد، مصر

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الملخص العربـــى

تم جمع عينات العناكب الأرضية من أربعة أماكن مختلفة في المنطقة الجنوبية لمحافظه بور سعيد وذلك باستخدام المصائد الأرضية لمدة 15 شهرا (ابتداء من يوليو 2004 وحتى سبتمبر 2005) وكانت المناطق تمثل تأثير ثلاثة أنشطة بشرية مختلفة : منطقه صناعية، منطقه تربيه حيوانات، منطقه زراعية. وأخيراً كان هناك موقع بدون أنشطة (تجربة ضابطة). وقد مثلت كل منطقة بموقعين منفصلين (20X 20 م) بحيث تم تثبيت 20 مصيدة أرضية منفصلة وموزعة بإنتظام فى كل موقع.

وقد أظهرت الدراسة إختلافاً للموائل والغطاء النباتى بإختلاف المناطق الأربعة وبدرجة أقل داخل الموقع الواحد. وعلى الرغم من ذلك وجد أنه لا يوجد إختلاف فى التنوع البيولوجى للعناكب الأرضية من حيث مكان الدراسة. بينما وجد إختلاف معنوى بين شهور الدراسة المختلفة. بالمقارنة مع المواقع الضابطة. وكانت المنطقة الزراعية ومنطقه تربية الحيوانات الأكثر تنوعاً بينما كانت المنطقة الصناعية الأغنى من حيث عدد الأنواع . ويمكن القول أن المناطق المختلفة تميزت بمجموعات مميزة من العناكب الأرضية استجابة لخصائص الموائل.