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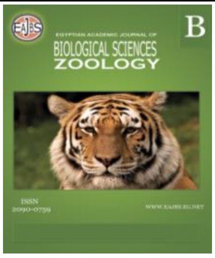


# Spiders Community Patterns in Native and Invaded Desert Habitats

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**ABSTRACT**

The rate of afforestation is increasing worldwide and has represented a common land use and a very important resource for centuries. The use of exotic species in the afforestation process may have a negative impact on ecosystem function and structure, including changes in shading, microclimate, nutrient cycles, and water balance, which may, in turn, affect biodiversity. The objective of this paper was to document and investigate the impact of forest plantations that use alien plants on the native ground-dwelling fauna, specifically using spiders as bioindicators. Spider species showed a great difference in both univariate measurements (diversity indices, richness and evenness) and multivariate analysis (species composition and indicator species). Five spider species were newly recorded in Egypt during this study; four of them were found in the forest habitat (*Micaria dives*, *Odontodrassus aravaensis*, *Pholcus opilionoides* and *Scytodes univittata*) while *Halodromus patellidens* was recorded in the control area. The experimental nature of this study confirmed that assessing the risks of forest plantation activities is urgently needed before introducing any species. It highlights the fact that the use of endemic trees is preferred in order to avoid altering native diversity.

## INTRODUCTION

Human populations have had a great impact on natural ecosystems and the biodiversity they support (Magurran, 2016). Together with vast population growth, the accelerated rapid urbanization and globalization of human technology, trade and transport are all increasing this impact. Our planet is becoming uniform in biological composition as a result of the intended and unintended movement of species. Growing rates of human trade and travel are known to increase the movement of organisms across the world, ranging from microorganisms and pathogens to plants, and from invertebrates to vertebrates. Among these., invasive alien species (IAS) are considered as one of the major and most quickly growing threats to biodiversity, animal health and human, security, and food.

The total area under forest plantations is growing throughout the world in order to meet up the demand for timber and the protection of natural forests (Verheyen *et al*., 2016). Forest plantations already account for up to 33% of the globe's total annual industrial Roundwood harvested and are expected to account for up to 50% of worldwide industrial Roundwood mass production by 2040 (Kanninen, 2010).

The use of alien species in forest plantations leads to the loss of natural habitats and the reduction of forage potential for many native insects, birds and other wildlife (Zevit, 2009). Major land changes are predicted to result in great changes in fauna and flora, so there is a need to assess the biodiversity value of habitats that could potentially be used in plantation forests. This will establish which habitats may be of less ecological or conservation importance, and hence should be more suitable for afforestation.

The introduction of non-native trees to a new ecosystem cannot be done without strategic planning, as the effect of habitat degradation, pollution and habitat fragmentation may be stabilized and reversed over time, although exotic invasions may become so entrenched that it may be impossible to completely remove them (Van Wyk *et al*., 2006). Several studies have investigated the effects of invasive plants on the soil properties (e.g., Farley & Kelly, 2004), vegetation (e.g., Souza *et al.*, 2013), bird diversity (e.g., Lachance *et al.*, 2005), spiders (e.g., Oxbrough *et al.*,2007), ground beetles and dung beetles (e.g., Gries *et al.*, 2011). Castro-Díez *et al*., 2019 reported key knowledge gaps from Africa and Asia that need attention as to how the effect of a non-native tree on ecosystem services. This is the first study from Egypt to assess the effect of afforestation in desert ecosystems.

The Egyptian government has adopted the approach of fuel and timber production in desert areas using treated sewage water. It has established new forests (man-made forests) in about 15,400,000 $m^2$ scattered all over the country in 24 areas. Ismailia is one of the Egyptian governorates that follow the National Programme for safe use of treated sewage water for afforestation, principally in the Serabium area. The Egyptian Environmental Affairs Agency (EEAA) had introduced many exotic timber trees to establish the Serabium forest (Hammad H.H., *et al*., 2020).

Spiders are realized as successfully bioindicators of forest management practices as they can be readily sampled, are affected by vegetation composition (Oxbrough *et al.*, 2007), and are differentially responsive to anthropogenic and natural disturbances (Mgobozi *et al.*, 2008). Moreover, they occupy a strategic functional position in terrestrial food webs as they regulate invertebrate populations and serve as a food source for higher organisms (Ferris & Humphrey, 1999). Communities of spiders are ubiquitous in forest ecosystems, being present from the litter layers to the canopy (Lafage *et al.*, 2019), and hence are ideal for study in forest environments.

This study aims to assess the environmental impact of a woody forest plantation in the Serabium region using spiders as a bioindicator. It assesses the spatial and temporal variation in the diversity of spiders at the study area, comparing them in terms of their abundance, species composition and diversity between native habitat and the newly established forest habitat and studying the relationship between the environmental variables at different studied sites and how these variables can affect the composition of species at each site.

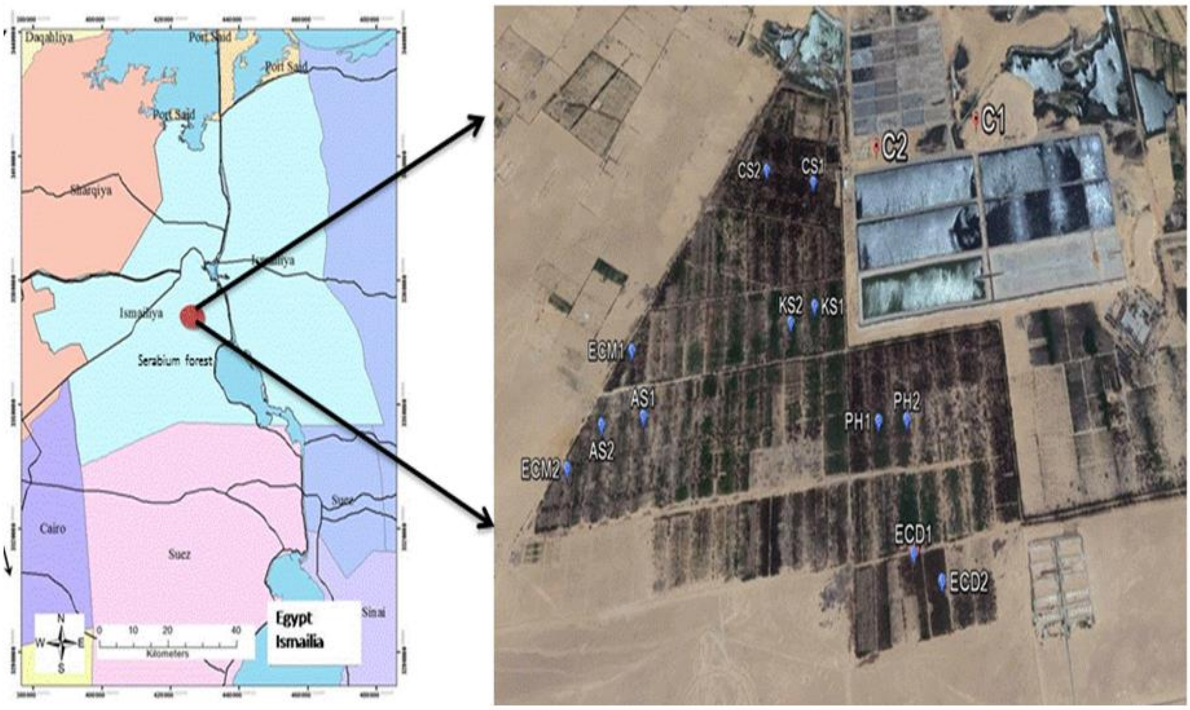
## MATERIALS AND METHODS

**Study Area:**

The study area is located in Serabium forest, 16 km south of Ismailia, northeastern Egypt (30°29'N, 32°14'E, elevation 10 m). Serabium forest is part of the national programs for the safe use of treated sewage water for afforestation. A semi-arid climate characterizes the region, with mean temperatures varying from 8.4 °C in the coldest month to 36°C in the warmest month. Annual rainfall is 35 mm. Serabium forest was established in 1998, and the cultivation process began in 2002 with many introduced tree species being introduced over nearly 2,520,000 $m^2$. All productive trees were cultivated as patches of monoculture. The most widely used species in the Serabium forest are *Agave sisalana*, *Cupressus sempervirens*, *Pinus halepensis*, *Khaya senegalensis*, *Eucalyptus camaldulensis* and *Eucalyptus citriodora*.

**Sampling Method:**

For each species, two sampling sites were established, along with two sites in the Serabium open desert to represent the natural ecosystem as control sites (Map 1) and (Table 1). Spiders were trapped by pitfall traps over a period of four successive seasons of 2010 (winter, spring, summer and autumn). The pitfall traps consisted of a plastic cup (5 cm diameter and 11 cm depth) flush with the ground and filled to the half with a preservative solution (45% water, 45% methanol, 10% glycerin). In each site, 45 pitfall traps were fixed; traps were arranged on a rectangular quadrat (50 m x 150 m) in three rows, with 25 m between lines and 10 m intervals among traps giving a total of 630 pitfall traps in 14 sites. Traps were active for one week and then collected. Specimens were stored, separated into morphospecies, counted and preserved in 70% ethanol alcohol with few drops of glycerin for further identification. The identification was performed by Hisham K. El-Hennawy (curator of Arachnid Collection of Egypt).




**Map 1:** Satellite photo showing the studied sites in forested area and deserted one in Serabium region, Ismailia governorate.

**Table 1:** Study sites abbreviation code.

| Code | Site name | Code | Site name | Code | Site name |
|---|---|---|---|---|---|
| **C1** | Control 1 | **PH2** | *Pinus halepensis* 2 | **ECM1** | *Eucalyptus camaldulensis* 1 |
| **C2** | Control 2 | **KS1** | *Khaya senegalensis* 1 | **ECM2** | *Eucalyptus camaldulensis* 2 |
| **CS1** | *Cupressus sempervirens* 1 | **KS2** | *Khaya senegalensis* 2 | **ECD1** | *Eucalyptus citriodora* 1 |
| **CS2** | *Cupressus sempervirens* 2 | **AS1** | *Agave sisalana* 1 | **ECD2** | *Eucalyptus citriodora* 2 |
| **PH1** | *Pinus halepensis* 1 | **AS2** | *Agave sisalana* 2 | | |

**Environmental Variables:**

The total percentages of the tree cover for each line were estimated and native plants were mostly identified in the field. Species that could not be identified in the field were collected and then identified in the laboratory at Suez Canal University. Four 1 m² quadrats were randomly laid out within each transect. Within each quadrat, the percentage of bare ground, the depth and percentage of ground covered by litter, the percentage of the woody debris (log) and the percentage of plant cover were recorded.

Three random soil samples from depth 0-30 cm were taken from each transect for physical and chemical analysis. The chemical variables included: pH, electric conductivity (EC), soil organic matter (SOM), total phosphorus (TP), nitrogen (N), and total soluble salts (TSS: $HCO_3$, $Cl^-$, $So_4^{-2}$, $Ca^{+2}$, $Mg^{+2}$, $Na^+$ and $K^+$). The physical variables included: soil texture (percentages of gravel, sand, silt, and clay) and water-holding capacity (WHC), Soil analysis was conducted at the Agricultural Research Center at Suez Canal University.

**Data Analysis:**

The data were analyzed using PC-ORD 4.10 package (McCune & Mefford, 1999), Canoco 4.5. (terBraak, 1988) and the SPSS for Windows 12 statistical software package (SPSS, Inc. 1996).

The four univariate parameters, namely Simpson's diversity index, Shannon's diversity index, species evenness and species richness were measured by PC-ORD. Differences in spider univariate measurements per plot were compared between sites using one-way analysis of variance (ANOVA) by the SPSS program (Zar, 1999).

Community composition was investigated using the two-way indicator species analysis (TWINSPAN) which separates similar groups of species and sites from dissimilar ones. This indicator species analysis (IV) provides a simple, intuitive solution to the problem of evaluating species associated with groups of sample units. This analysis was performed using PC-ORD statistical package.

Two ordination methods were applied, namely: detrended correspondence analysis (DCA) conducted by PC-ORD program (terBraak, 1988) and canonical correspondence analysis (CCA) performed by Canoco 4.5 program. These multivariate techniques arrange sites along axes based on data on species composition (Goodall, 1954). The points that are close together corresponded to sites that are similar in species composition, and points that far apart correspond to dissimilar sites.

DCA is an improved eigenvector ordination method that is based on reciprocal averaging. DCA corrects the two main faults of the ordination technique, namely violation and arch distortion of the orthogonality criterion. DCA is a multivariate technique that maximizes the correlation between species and sample scores along an assumed gradient (Gauch, 1982).

Associations of spider species and sites with environmental variables were investigated by CCA ordination using data for all 14 sites. CCA is a direct gradient ordination technique, whereby results are simultaneously based on species abundance and environmental variables (ter Braak, 1988). The technique selects the linear combination of environmental variables that maximize the dispersion of the species scores. This provides the first axis. Similarly, the second and subsequent axes also select the linear combination of environmental variables that maximize the dispersion of the species scores, but these are subject to the constraint of being uncorrelated with the previous axes. CCA differs from DCA in that the axes are constrained to optimize their relationships with a set of environmental variables. Arrows depict the direction (maximum change) of environmental variables in ordination space, while the length of arrows shows their degree of influence. The option of species scores as weight mean sample scores were used in choosing the scaling of CCA ordination scores.

The CCA was done in the forward selection mode of the CANOCO program (ter Braak 1988), and the significance of each variable was tested in a sequential fashion using a Monte-Carlo simulation algorithm before it was added to the final model. All variables that were significant at $p<0.05$ were included in the final model.

**Indicator Species Analysis:**

Indicator species analysis is a divisive polythetic method of numerical classification applicable to large sets of qualitative or quantitative data. This method provides a simple, intuitive solution to the problem of evaluating species associated with groups of sample units (Dufrêne and Legendre, 1997). This method combines information on the concentration of species abundance in a particular group and the faithfulness of occurrence of species in a particular group. It calculates the proportional abundance of a particular species in a particular group relative to the abundance of that species in all groups. It then calculates the relative abundance of certain species in a certain group and calculates the proportional frequency of the species in each group. These percentages represent the faithfulness of the occurrence of a species in a particular group. The two proportions were then multiplied to yield a percentage, which was used as an indicator value for each species in each group. Because the components' terms are multiplied, both indicator criteria must be high for the overall indicator value to be high. The highest indicator value for a given species in a cross-group is saved as a summary of the overall indicator value (IV) of that species. The IV was tested for statistical significance using a Monte Carlo technique.

## RESULTS

A total of 3217 spiders belonging to 106 species representing 26 families and 58 genera were identified; 351 (10.91 %) individuals were found in the control sites and 2866 (89.09 %) specimens in the afforested sites. Five species were found within the control area only; sixty-eight species were found in the afforested area only, and 33 species were common to both areas. Five spider species were newly recorded in Egypt during this study; four of them were found in the afforested habitat (*Micaria dives*, *Odontodrassus aravaensis Pholcus opilionoides* and *Scytodes univittata*), while *Halodromus patellidens* was recorded in the control area.

**Univariate Analysis:**

Site CS1 showed the highest value for species richness (39 species). The highest values for Shannon, and Simpson’s indices (H= 3.146 and D=0. 0.9388) were represented by the two afforested sites CS1 and CS2 respectively. For the species evenness, the maximum value (0.875) was recorded by afforested site CS2 Fig (1).

One-way ANOVA revealed a significant difference in Shannon’s diversity index ($F = 3.628$ and $P < 0.005$), Simpson’s diversity index ($F = 2.710$ and $P < 0.02$), richness ($F = 2.848$ and $P < 0.02$), and evenness ($F = 2.138$ $P < 0.05$.), between afforested and control sites.

**Multivariate Analysis:**

**Classification:**

The TWINSPAN analysis resulted in four groups by the three divisions (Fig. 2). The first division separates the two control sites C1 and C2 from the aforestated sites by the spider indicator species *Oxyopes* sp., which was present at the control sites only. The second division separated sites PH1and PH2, with their characteristic species *Gamasomorpha arabica*, from the rest of the planted forest sites. The third division separated the afforested sites ECD1, ECD2, AS1and AS2 from the other afforested sites CS1, CS2, KS1, KS2, ECM1, and ECM2 by the indicator species *Philodromus* sp., which was present in the first group only.

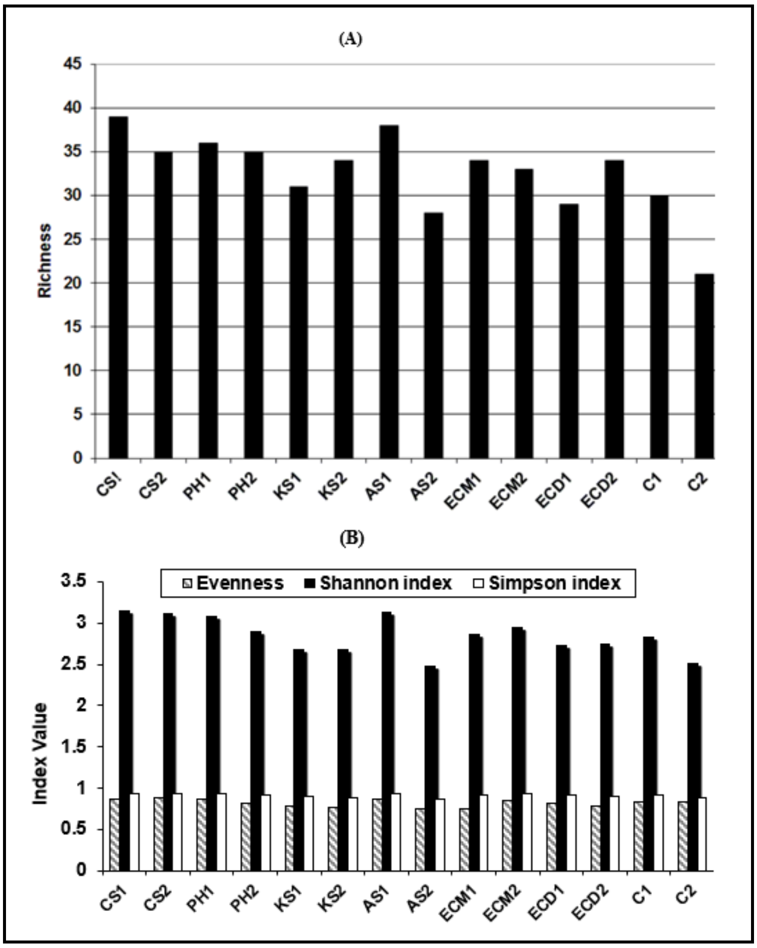



**Fig. 1 (A).** Species richness for spider species in each studied site and **(B)** Shannon Weiner (black histogram) and Simpson's (white histogram) diversity indices, plus evenness index (grey histogram)**.**

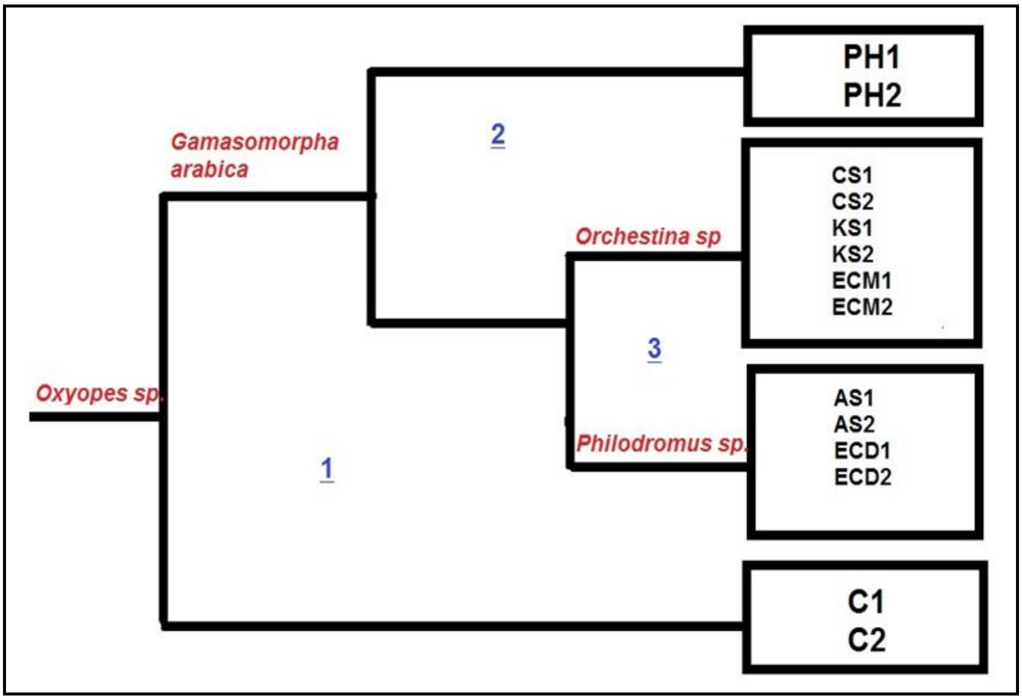



**Fig. 2:** Dendrogram showing the 14 studied sites grouped by the hierarchical cluster classification analysis.

**Ordination:**

In the DCA ordination (Fig. 3), the fourteen sites were spread out along the first and the second axis and tended to cluster in the same four groups obtained by TWINSPAN analysis. C1 and C2 sites clustered together near the right-hand at the end of the first axis, with their characteristic spider species *Oxyopes* sp., *Halodromus* sp. and *Yllenus tschoni*. Sites PH1 and PH2 were clustered separately around the top of the second axis with their own specialized species *Gamasomorpha arabica*, *Artema* sp., *Micaria* sp., *Gamasomorpha* sp. and *Pholcus* sp. from the rest of the forested sites, which by turn divided into two groups (AS1, AS2, ECD1 and ECD2) and (CS1, CS2, KS1, KS2, ECM1, ECM2). The first and the second axis of DCA showed the highest eigenvalues, which were 0.263 and 0.134 respectively.

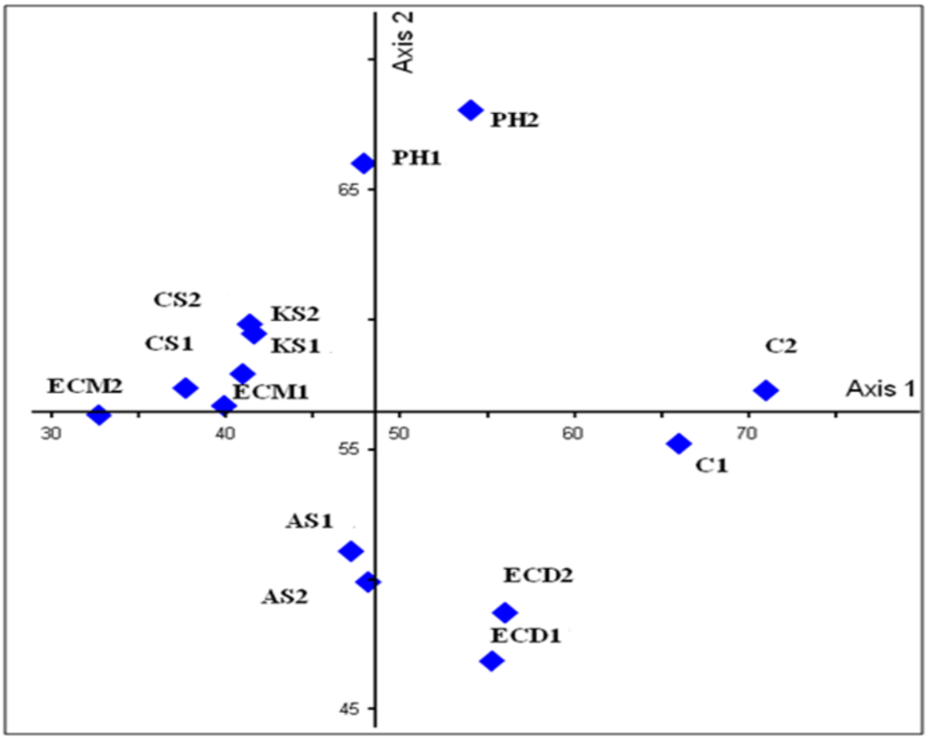



**Fig. 3:** Detrended Correspondence Analysis (DCA) of the spiders for the 12 afforested sites and the two control sites.

**1-Land Cover:**

The scatter plot of the CCA ordination of the 14 studied sites in relation to five variables represented by bare ground%; litter cover %; litter depth "cm"; wild plant cover% and log% is shown in Fig. (4). The log% variable (dead wood) was the most important factor (P= 0.010) followed by litter cover (P= 0.012). The sites are distributed along the first two CCA axes, with the environmental factors referring to the relationship between communities and the factors controlling their distribution. The two control sites (C1 and C2) are located at the right-hand side and are more closely associated with the log% variable. The forest sites are closely associated with the litter cover and litter depth.

**2-Flora:**

The forward selection procedure of the CCA resulted in the retention of 6 from 11 flora variables (Fig. 5). The first axes show a strong positive correlation with the percent cover of *Pinus halepensis*, which was highly significant ($p<0.02$). There was a strong positive correlation between the two floral factors, *Bassia* sp. and *Phragmites australis* and the two control sites (C1and C2), separating them at the positive end of the first axis. On the other hand, *Pinus halepensis* sites (PH1and PH2) clustered at the top of the second axis. The first CCA axis separates the two sites forested by *Eucalyptus citriodora* (ECD1 and ECD2) away from the other sites (KS1, KS2, CS1, CS2, ECM1 and ECM2), which were scattered around the left hand of the first axis. The eigenvalues for the two CCA axes were 0.296 and 0.202.

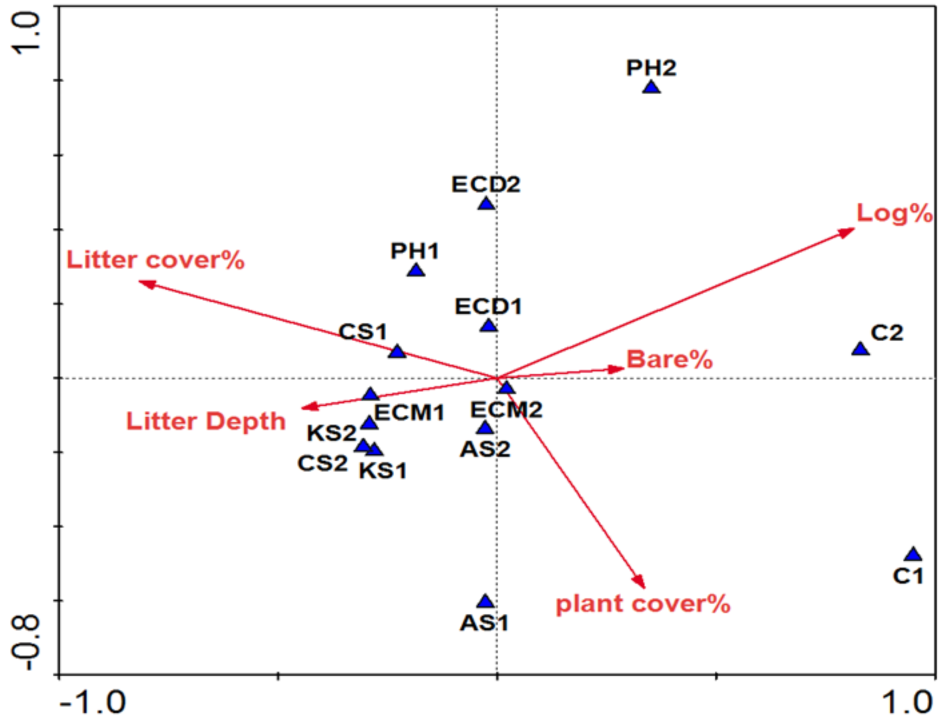



**Fig. 4:** Ordination diagram for the first two axes of the CCA showing the contribution of the five land cover variables as represented by arrows**.**

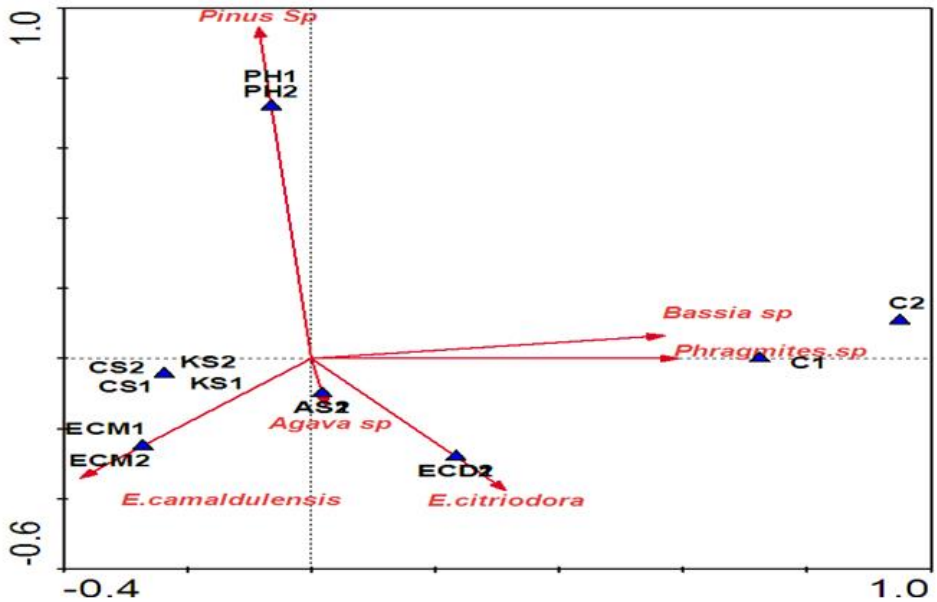



**Fig. 5:** Ordination diagram for the first two axes of the CCA showing the contribution of the flora variables as represented by arrows**.**

**3-Soil Variables:**

Figure 6 represents the scattered CCA ordination plot of the 14 studied sites and the most important soil environmental variables (8 from 18). These variables were located between the first two axes which had the highest eigenvalues (0.289 and 0.226). Afforested sites ECM2 and CS1 were strongly correlated with organic matter while PH1, PH2, KS2 and CS2 sites were mainly affected by nitrogen, clay and gravel% variables.

*Eucalyptus citriodora* canopy sites (ECD1 and ECD2) and (KS1) sites were affected by sand% and nitrogen. It was clear that the sand variable was the most effective variable on these sites. The pH variable was shown to most effective on ECM 1 andAS1 sites. AS2 sites were found in the core axes and were affected by all soil environments in an equal way. The control sites (C1 and C2) were separated at the right hand of axes 1.

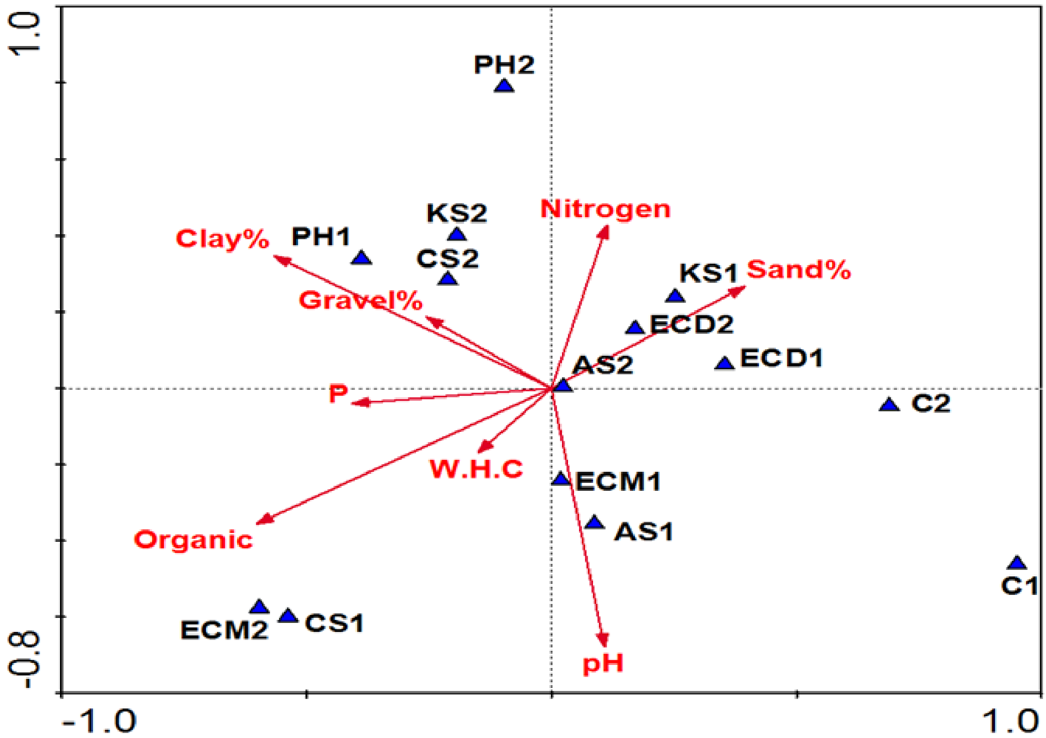



**Fig. 6:** Ordination diagram for the first two axes of the CCA showing the contribution of the most important chemical and physical soil variables (8 from 18 variables) as represented by arrows.

**4-All environmental variables:**

Figure 7 represents the distribution of sites and their associated species on the CCA diagram. The most important environmental variables' procedure resulted in the retention of nine variables from the 34 variables. The arrow shows the direction of the gradient, and the length of the arrow is proportional to the correlation between the variable and the ordination. The analysis revealed four groups. The two control sites (C1 and C2) were separated at the right hand of the first axes associated with the two plant species (*Bassia* sp. and *Phragmites* sp.) and the log% variable. The eight forested sites (ECM1, ECM2, CS1, CS2, KS1, KS2, AS1 and AS2) together with their characteristic species were separated by the four environmental variables, namely organic matter, clay%, litter cover% and the plant species *E. camaldulensis* variables at the left hand of the first axis. The second axis separated the two sites (ECD1 and ECD2) with *E. citriodora* variable at the negative side while the two sites PH1 and PH2 sites were clustered separately around the top positive of the second axis by the environmental variable *Pinus halepensis*.

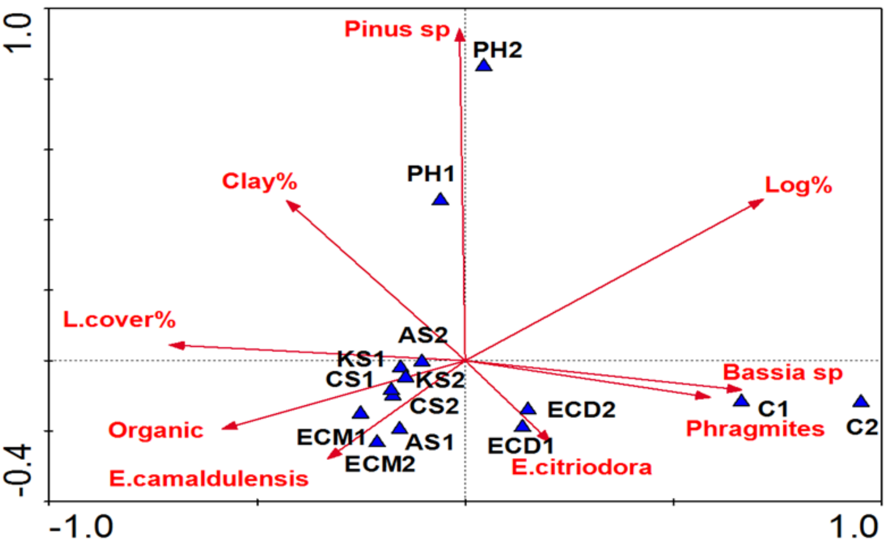



**Fig. 7:** ordination diagram for the first two axes of the CCA showing the contribution of the most important environmental variables (9 from 34 variables) as represented by arrows**.**

**Indicator Species:**

The indicator species analysis showed that 12 spider species were significantly correlated with the studied sites (Table 2). There was an association between control sites (C1, C2) with *Yllenus tschoni* (IV=97.8, P<0.02), *Oxyopes* sp. (IV=90.9, P<0.02) and *Halodromus* sp. (IV= 80, P<0.05). There were five spider species that prefer *Pinus halepensis* canopy sites (PH1, PH2). These spiders were *Gamasomorpha* sp. (IV=93.3, P< 0.003), *Pholcus* sp. (IV=95.2, P< 0.01), *Artema* sp. (IV=89.2, P< 0.02), *Gamasomorpha arabica* (IV=100, P<0.02), Micaria sp. (IV=94.7, P<0.03). Two spider species showed their preference to *Agave sisalana* and *Eucalyptus citriodora* canopy sites (AS1, AS2, ECD1, ECD2), these species were *Micaria dives* (IV=90.9, P<0.01) and *Zelotes* sp. (IV=52.9, P<0.05). *Cupressus sempervirens*, *Eucalyptus camaldulensis* and *Khaya senegalensis* sites (CS1, CS2, ECM1, ECM2, KS1, KS2) were characterized by two spider species *Cheiracanthium* sp. (IV=51.2, P<0.05) and *Orchestina* sp. (IV=66.7, P<0.005).

**Table 2:** Statistically significant indicator species at each site grouping.

| Indicator species | Indicator value | P value | Group code |
|---|---|---|---|
| *Orchestina* sp. | 66.7 | 0.005 | 0 |
| *Cheiracanthium* sp. | 51.2 | 0.05 | 0 |
| *Gamasomorpha* sp. | 93.3 | 0.003 | 1 |
| *Pholcus* sp. | 95.2 | 0.01 | 1 |
| *Gamasomorpha arabica* | 100 | 0.02 | 1 |
| *Artema* sp. | 89.2 | 0.02 | 1 |
| *Micaria* sp. | 94.7 | 0.03 | 1 |
| *Micaria dives* | 90.9 | 0.01 | 2 |
| *Zelotes* sp. | 52.9 | 0.05 | 2 |
| *Yllenus tschoni* | 97.8 | 0.015 | 3 |
| *Oxyopes* sp. | 90.9 | 0.02 | 3 |
| *Halodromus* sp. | 80 | 0.05 | 3 |

| **Sites** | **CS1** | **CS2** | **KS1** | **KS2** | **ECM1** | **ECM2** | **PH1** | **PH2** | **AS1** | **AS2** | **ECD1** | **ECD2** | **C1** | **C2** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Group Code | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 2 | 2 | 2 | 2 | 3 | 3 |
| | | | | | | | | | | | | | | |

## DISCUSSION

Our results indicate that the plantation of the forest using introduced woody tree species does alter and radically change spider assemblages that are normally native to this region, as each habitat supported distinct spider assemblages that reflect major differences in both environmental conditions and management. Similarly, Greenwood *et al*. (2004) showed distinct differences between the invaded and the native habitats, which indicated that the invasion had a strong overall effect on terrestrial arthropods composition. The alien plant species modify the ecosystems functioning by altering the soil-nutrient cycling, habitat structure and quality available to other organisms in undesirable ways that are difficult or impossible to reverse (Shackleton *et al*., 2018). Also, the alien plant species can change the physical properties of the soil environment directly, leading to changes in environmental variables that may control the composition and function of soil community (Duda *et al*., 2003). Numerous vegetation studies document the retreat of native species from invaded plant communities indicating that this can dramatically shift vegetation structure and displace native herbs and tree seedlings (Flory & Clay, 2009). In accordance, the analysis for the environmental variables, flora, and soil nutrients showed the importance of plant species as one of the main factors driving the recolonization of the spider fauna. This result is consistent with the widely held view that vegetation structure is of primary importance in determining the composition of spider assemblages (Langellotto & Denno, 2004). Vegetation structure is important because it provides web-attachment sites (Rypstra, 1986) and foraging perches of spiders (Döbel *et al*., 1990). It can also provide protection from predators (Morrison & Lindell, 2012). This is particularly important for the larger active hunters (such as lycosids and clubionids), which may be at greater risk of predation from birds (Böhm *et al.*, 2011).

The CCA analysis for spiders showed also that percentage log and litter cover are highly significant variables in grouping the sites, the logs being associated with the control sites and increased litter cover in afforest sites. Spiders were proven to be very sensitive to litter cover and depth, which is consistent with studies in other ecosystems (e.g. Uetz, 1979; Smith *et al.*, 2008). The litter layers add habitat architecture to the forest floor and so, enhance prey species diversity (Lafage *et al.*,2019).

The CCA results for soil variables and spider fauna showed that the percentage of organic matter was the most significant factor in the analysis. While Shabaan (2009) indicated that the most important variables for spiders fauna were $K^+$, pH value and the percentage of silt. Many studies from other ecosystems (e.g., Hore & Uniyal, 2008; Petillon *et al*., 2008) documented the influence of moisture content on spider communities. This structural heterogeneity may probably be related to the variation in the chemical structure of soil such as the value of the organic matter, which may cause differences in the ground arthropod communities (Bot & Benites, 2005).

Both the TWINSPAN and the DCA analysis separated the two open desert control sites with their characteristic spider species from the forest sites. The forest sites were separated into three groups. The closed canopy sites *Pinus halepensis* (PH1 and PH2) were separated into one group and the open canopy sites (AS1, AS2, ECD1 and ECD2) were separated together away from the rest of the forested sites (CS1, CS2, KS1, KS2, ECM1 and ECM2). The result of the TWINSPAN, DCA and CCA was supplemented by the indicator species analysis where many sun-seeking species were found in the control area and absent from the densely shaded afforested environments. Of the 12 spider species shown to be significantly responsible for the separation of the sites, in the control sites (C1 and C2), three spiders species show their preferential and associations for open habitat (*Yllenus tschoni*, *Oxyopes* sp. and *Halodromus* sp.) while five spider species (*Gamasomorpha arabica*, *Gamasomorpha* sp., *Pholcus* sp., *Artema* sp., *Micaria* sp.) were characteristic of the *Pinus* *halepensis* closed-canopy sites. The separation of (AS1, AS2, ECD1 and ECD2) sites from (CS1, CS2, ECM1, ECM2, KS1 and KS2) was due to the presence of *Micaria dives* and *Zelotes* sp. in the first group while the other group is characterized by the presence of *Orchestina* sp. and *Cheiracanthium* sp.

The weaknesses of using richness as a measure of restoration, or indeed any other type of disturbance, has already been pointed out by Andersen and Majer (2004) and others, suggesting that more focus on the composition of the assemblages might be a more appropriate approach. Many studies have focused on changes in species composition rather than changes in indices of diversity (Talley & Levin, 2001; Cobbold & MacMahon, 2012), especially regarding the effects of anthropogenic disturbance. In the current assessment, there was a great difference in species composition by TWINSPAN, DCA and CCA analysis between the studied sites, this was due to spider assemblages' sensitivity to habitat structure and microclimate.

**Conclusion:**

Our study confirmed the importance of using the endemic species in afforestation programs to avoid altering native diversity. We demonstrated that the introduced woody tree in Serabium region does alter and radically change spider assemblages native to this habitat. Our data indicate that the most successful species was *Eucalyptus citriodora* which was established many years ago in Egyptian habitat rather than the newly introduced species. Our results highlight the importance of establishing a risk assessment plan for all expected introduced species in native habitat before planting and considering how it may affect native biodiversity.

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## ARABIC SUMMARY

أنماط مجتمع العناكب في البيئيات الطبيعية والغازية الصحراوية.

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معدل التشجير آخذ في الازدياد في جميع أنحاء العالم، وقد مثل استخداماً مشتركاً للأراضي ومورداً بالغ الأهمية لعدة قرون .وقد يكون لاستخدام الأنواع الدخيلة في عملية التشجير أثر سلبي على وظيفة النظام البيئي، بما في ذلك التغيرات في التظليل، والمناخ المحلي، ودورات المغذيات، والتوازن المائي، مما قد يؤثر بدوره على التنوع البيولوجي . وكان الهدف من هذا البحث هو توثيق أثر المزارع التشجيرية التي تستخدم النباتات الدخيلة على الحيوانات المحلية التي تعيش في الأرض، وعلى وجه التحديد استخدام العناكب كدلائل حيوية .وأظهرت أنواع العنكبوت اختلافا كبيرا في كل من القياسات أحادية المتغيرات مؤشرات التنوع، والثراء، والوفرة النسبية (والقياسات المتعدد المتغيرات) مثل (الأنواع المتواجدة والمؤشرات) .وقد سُجلت خمسة أنواع من العنكبوت تواجدت حديثاً في مصر خلال هذه الدراسة؛ تم العثور على أربعة منها في الغابات التشجيرية
في ( (*Micaria dives*, *Odontodrassus aravaensis*, *Pholcus opilionoides* and *Scytodes univittata* حين تم تسجيل (*Halodromus patellidens*) في المنطقة الصحراوية. وأكدت الطبيعة التجريبية لهذه الدراسة أن تقييم مخاطر البيئية للمزارع التشجيرية أمر ضروري على وجه السرعة قبل إدخال أي نوع من الأنواع الغازية كما إنه يُضيء حقيقة أن استخدام الأشجار المتوطنة هو الأفضل من أجل تجنب التغيير للأنواع الأصلية.