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Species Diversity and Seasonal Population Dynamics of Terrestrial Insects in Saluga and Ghazal Protected Area, Aswan, Egypt

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ABSTRACT

Species diversity, relative abundance and population trends of terrestrial insects were studied in Saluga and Ghazal protected area, Aswan, Egypt for the first time during one year from November 2015 to October 2016. Three different methods of survey (aerial net trap, pitfall trap and yellow sticky trap) were used in different nine sites including all habitats in the area, sandy, rocky, vegetated and aquatic area. A total of 15151 individuals of 78 species belonging to 43 families from 11 orders were recorded using the previous three methods. The net trap collected 62 species from 59 genera belonging to 32 families in 11 orders among them Lepidoptera was the most abundant order followed by Hymenoptera and Odonata and pitfall traps collected 9 species belonging to 9 genera from 4 families and 3 orders, Hymenoptera and Coleoptera were the most abundant orders, while yellow sticky traps collected 10 species belonging to 10 genera, 9 families and 5 orders, Hemiptera and Coleoptera were the most abundant orders. The study indicated that the net trap was the most effective method for monitoring the largest number of orders, families and species and the highest population number was recorded in site 3, while the lowest number was in site (9). The relation between ecological factors and abundance of the most dominant species is discussed.

Keywords: terrestrial insects, diversity, abundance, protected area, methods of survey, Saluga and Ghazal.

INTRODUCTION

Insects represent the large proportion of all biodiversity on the planet (Daly *et al*., 1998). They represent 85% of the world animal diversity (Groombridge, 1992). They play different roles in ecosystem function such as plants propagation (Costanza *et al*., 1997), increasing soil fertility (Fittkau and klinge, 1973), predation and parasitism on other organisms in order to regulate their population (Greenwood, 1987 and Daily, 1997), food source for insectivorous vertebrates, such as many birds, mammals, reptiles, and fishes (Majer, 1987), play an important role in food webs as primary consumers of plants (Banko *et al*., 2002), providing commercial products such as honey and silk, treatment of several illnesses (Costa Neto, 2005) and indicator for environmental changes (Gullan and Granston 2010; Belamkar and Jadesh, 2014). All this increase the support for protection of these most varied and important organisms, specially the world has large global problem of biodiversity loss and study of insects diversity remains poorly especially for the sake of biodiversity conservation (Cowling *et al*., 1989), so we must focus on species diversity in order to evaluate species status, this being the explicit target of conservation (Medeiros *et al*., 2013).

Egypt also cares about the conservation of biodiversity through its protected areas as it has 30 protectorates covering about 15% from the total area (Salama, 2010) which aim to conserve the biological, natural and cultural features, to benefit contemporary and future generations (EEAA, 2015) as the biodiversity provides support in the development of agriculture, medicine industry and basic needs of local communities in addition to new industries like ecotourism which provides high economic return (EEAA, 2009).

MATERIALS AND METHODS

Study area

Saluga and Ghazal protected area locate at distance of about 3 km north of Aswan Dam in the middle of Nile as it is considered a part of the first cataract islands. It is about 0.5 km^2 approximately, so it is regarded as one of the smallest Egypt's 30 protectorates. It contains the remain of ancient Nile plants especially *Acacia* trees as it contains 4 species from 20 species of *Acacia* trees in the world and many other plants which have high medical importance. A total of nine sites representing the whole area of protectorate in a variety of habitat, including sandy, rocky, vegetated and aquatic area were choiced to survey, three sites of them in Ghazal Island and six sites in Saluga Island (Fig. 1).

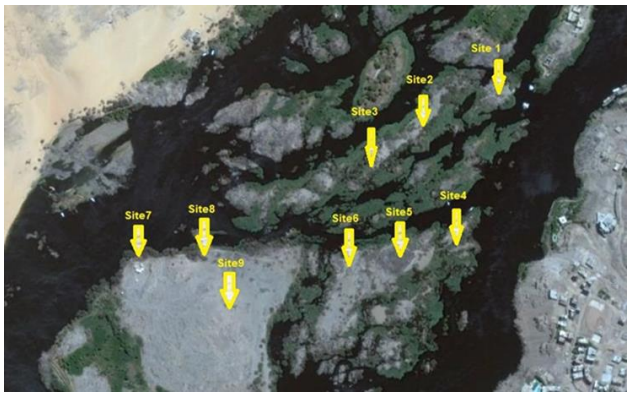

Figure (1): Map for Saluga and Ghazal protected area showing the nine sites.

Ecological factors

With regarded to geographical and natural features, this area characterized by hot and dry climate and its

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ecological factors (air temperature, humidity and wind velocity) were reported during the year of study.

Methods of survey

This work was carried out throughout one year (from November 2015 to October 2016) using different three methods

1. Aerial net

Standard entomological net (Borror *et al.*, 1989) was used for collecting flying insects and those resting on vegetation (Gray and Treloar, 1933).

2. Pitfall Trap

Circular small white plastic cups with a 6 cm diameter (Schirmel *et al.*, 2010) (27 traps, 3 traps in each site) were used to catch surface-dwelling insects.

3. Yellow sticky trap

Rectangular yellow plastic plates (20×30cm) (18 traps, 2 traps in each site) were used in the survey. These plates coated with a thin layer of special sticky material, motor oil (Soliman, 2001) on one side and hanged vertically at different heights above the ground according to the high of the different plants in each site.

The insect species which monitored by using the three methods were identified in Classification Department, Plant Protection Research, Institute Agriculture Research Center, Egypt.

4. Statistical analysis

Data analysis was performed using SPSS program version 20 (SYSTAT statistical program). Microsoft Excel 2010 was used to construct graphs.

RESULTS

The species diversity of terrestrial insects which monitored using aerial net included 62 species, 59 genera, 32 families belonging to 11 orders and the total density of these species was 3800 individuals (Table 1). The most dominant order was Lepidoptera included 1265 individuals represented 33.3% of the total density of all orders followed by Hymenoptera (1028 individuals) and Odonata (1000 individuals). Lycaenidae family was the most dominant family of order Lepidoptera (813 individuals) representing 64.3% of total surveyed Lepidopterous families followed by Nymiphalidae (372 individuals) which represent 29.4 %.T most dominant species of this order were *Anthene amarah*, *Azanus ubaldus*, *Danaus chrysippus*, *Vanessa cardui* with the total annual number of 609, 204, 222 and 150 individuals forming 48.2 %, 16.1 %, 17.6%, 11.9%, respectively of the total density of all Lepidopterous species. Gilbert and Zalat (2007) also recorded different species of butterflies in different protectorates in Egypt, in St Katherine, Gebel Elba mountains, Lake Burullus, Ashtum El Gamil, Zaranik and El Ahrash protectorates and These dominant Lepidopterous species in Saluga and Ghazal protectorate as a wet land system were also recorded in another wet land system by (Akite and Olanya, 2009).

Generally, these monitored species as pollinators reached their highest peaks and greatest activity in the blooming period of their host plants especially *Acacia* trees (Martins *et al*., 2013). These species reach its highest density in the month of April (Fig. 2A) as *Acasia seyal* and *Nilotica* reach flowering peak in this month. This results agree with many authers, (Schmitt, 1983) who revealed that butterflies increases with flowering plant density, (Willson and Rathcke, 1974; Willson and Price, 1977; Schaffer and Schaffer, 1979; Davis, 1981) who observed pollinators attracted to plants with a greater number of flowers, (Grindeland *et al.*, 2005 and Madson, 2015) who noticed increasing the number of pollinators with increasing in the flowers density and also with (Kunin, 1993; Waites and Ågren, 2004; Hegland and Boeke, 2006) who observed attraction more pollinators to abundant floral resources.

Table (1): Taxonomic list of insects monitored by aerial net in Saluga and Ghazal protectorate, Aswan during (November 2015 to October 2016).

Orders	Families	Species	No. of individuals	% of species	No. of individuals of
Blattodea	Blattidae	*Blattella germanica*	6	100	6
Coleoptera	Buprestidae	*Juloidis caillaudi*	4	8.5	47
		Steraspis squamosa	10	21.3	
	Coccinellidae	*Sternocera castanea*	4	8.5	
	Scarabaeidae	*Coccinella septempunctata*	1	2.1	
	Asilidae	*Pachnoda saviqnyi*	28	59.6	
	Bombyliidae	*Stenopogon junceus*	13	25.5	
	Calliphoridae	*Aphoebantus wadensis*	4	7.9	
Diptera	Muscidae	*Lucilia cuprina*	3	5.9	51
	Syrphidae	*Musca domestica*	22	43.1	
		Eristalis jugorum	3	5.9	
		Eristalis taeniops	4	7.9	
		Eristalis quinquelineatus	2	3.9	
Hemiptera	Alydidae	*Xyonysius sp*	4	11.4	35
	Coccidae	*Waxiella mimosae*	24	68.6	
	Lygaeidae	*Spilostethus pandurus*	7	20	
Hymenoptera	Apidae	*Apis Mellifica*	78	7.6	1028
		Xylocopa pubescens	288	28	
	Chrysididae	*Chrysis lincea*	2	0.2	
	Eumenidae	*Chlorodynerus chloroticus*	30	3	
		Delta campaniforme	10	1	
		Eumenes maxillosus	3	0.3	
		Rhynchium oculatum	2	0.2	
	Halictidae	*Halictus luridipes*	4	0.4	
		Halictus pollinosus	1	0.1	
	Pompilidae	*Ctenagenia vespiformis*	2	0.2	
	Scoliidae	*Dielis collaris*	542	52.7	
	Sphecidae	*Bembix chopardi*	28	2.7	

Orders	Families	Species	No. of individuals	% of species from orders	No. of individuals of orders
Hymenoptera	Sphecidae	*Prionyx crudelis*	8	0.8	1265
		Sceliphron spirifex	8	0.8	
		Sphex pennsylvanicus	15	1.5	
	Vespidae	*Odynerus cyanopterus*	4	0.4	
		Philanthus coarctatus	2	0.2	
		Vespa orientalis	1	0.1	
Lepidoptera	Geometridae	*Rhodometra sacraria*	40	3.2	
	Lycaenidae	*Anthene amarah*	609	48.2	
		Azanus ubaldus	204	16.1	
	Nymiphalidae	*Danaus chrysippus*	222	17.6	
		Vanessa cardui	150	11.9	
	Pieridae	*Catopsilia florella*	4	0.3	
	Crambidae	*Nomophila noctuella*	36	2.9	
Mantodea	Mantidae	*Calidomantis savignyi*	3	33.3	9
		Sphodromantis viridis	6	66.7	
Neuroptera	Chrysopidae	*Chrysoperla carnea*	7	53.9	13
	Myrmeleontidae	*Myrmeleon formicarius*	6	46.2	
Odonata	Coenagriidae	*Ischnura senegalensis*	489	48.9	1000
	Libellulidae	*Brachythemis Leucostica*	17	1.7	
		Crocothemis erythraea	36	3.6	
		Orthemis ferruginea	453	45.3	
		Sympetrum danae	5	0.5	
Orthoptera	Acrididae	*Acrida nasuta*	63	22	286
		Acrotylus insubricus	27	9.5	
		Aiolopus thalassinus	23	8.1	
		Anacridium aegyptium	9	3.2	
		Calliptamus coelesyriensis	20	7	
		Duroniella fracta	14	4.9	
		Euprepocnemis plorans	21	7.4	
		Oxycoryphus	25	8.8	
		Schistocerca gregaria	43	15	
		Thisoicetrus littorali	20	7	
		Truxalis annulata	21	7.4	
Thysanura	Lepismatidae	*Thermobia domestica*	60	100	60
Total			3800		

According to Hymenoptera, Scoliidae and Apidae were the most abundant families including 542 and 366 individuals representing 52.7% and 35.6% from the total density of all families and *Dielis collaris*, *Xylocopa pubescens* and *Apis Mellifica* were the most abundant species with a total annual number of 542, 288 and 78 forming percentage of 52.7%, 28% and 7.6%, respectively of the total species density. (Fig. 2B) illustrated that *Dielis collaris* started with two highest peaks during December and November. Two equal peaks for *Xylocopa pubescens* occurred in the months of July and August, so these results accept with (Ben Mordechai *et al*., 1978; Gerling *et al*., 1983; Sugiura, 1995; Steen and Schwarz, 2000) who illustrated that *X. pubescens* hibernate during the cold season in temperate areas but emerge on warm days in winter. The highest monthly peak of *Apis Mellifica* was in March. All peaks for these Hymenopterous species occurred also during the blooming period of *Acacia* species like (Shebl and Farag, 2015) who found Hymenopterous species associated with different plants, peaked during the flowering period of these plants. Most of these surveyed species (*Xylocopa pubescens*, *Anthophora sp*, *Delta sp*., *Rhynchium sp*., *Sphex sp*., *Bembix sp*., *Dielis collaris*and *Vespa orientalis*) were recorded in St Katherine Protectorate, Egypt (Zalat *et al.*, 2008).

With regarded to Odonata, It was represented by 2 families (Coenagriidae and Libellulidae) which had the same abundance with a total of 511 and 489 individuals forming 51.1% and 48.9%, respectively. The most abundant species of this order were *Ischnura senegalensis* and *Orthemis ferruginea* which calculated 453 and 489 individuals with a percentage of 48.9% and 45.3%, respectively of the total density of Odonata species. The same Odonatous species (*Crocothemis erythraea*, *Ischnura sp.* and *Sympetrum sp.*) were recorded in St Katherine Protected area (Power and Gilbert, 2014). The highest monthly peak of *Ischnura senegalensis* occurred during July, while the highest peak for *Orthemis ferruginea* was during August (Fig. 2C) because the period of water level increasing in the protectorate start from the end of May to the end of August. These results are in full agreement with (Villanueva and Mohagan, 2010; Saha and Gaikwad, 2014; Rohmare *et al*., 2016) who reported that the diversity and abundance of Odonata species depends on some factors among them they mention the presence or absence of water bodies, size of the water bodies, flooding period.

9 species belonging to 8 genera from 4 families and 3

orders were monitored using pitfall traps and the total density of these species was 929 individuals (Table 2).

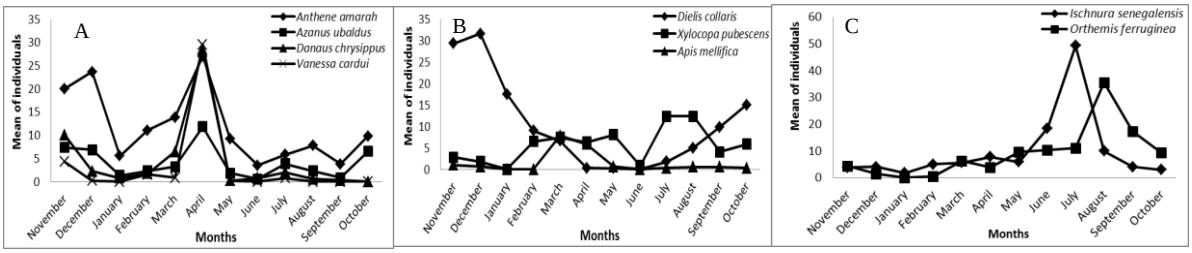

Figure (2): Population fluctuation of the most dominant species monitored by aerial net (A) Lepidopterous species, (B) Hymenopterous species and (C) Odonatous species.

Table (2): Taxonomic list of insects monitored by pitfall traps in Saluga and Ghazal protectorate, Aswan.

Order	Family	Species	No. of individuals of species	% of species from orders	No. of individuals of orders
Coleoptera	Melyridae	*Melyris oblonga*	1	0.4	
	Tenebrionidae	*Blaps schweinfurthi*	4	1.5	264
		Pimelia angulata	228	86.4	
		Trachyderma hispida	31	11.8	
Hemiptera	Lygaeidae	*Spilostethus pandurus*	3	100	3
Hymenoptera	Formicidae	*Camponotus sp.*	20	90.9	
		Cataglyphis bombycinus	39	5.9	662
		Cataglyphis oasium	602	0.2	
		Crematogaster melanogaster	1	3	
Total					929

Hymenoptera and Coleoptera were the most abundant orders with individual including 662 and 264 individuals represented 71.3% and 28.4%, respectively of the total density of all orders. Formicidae was the only monitored family of Hymenoptera. The most abundant species of this family was *Cataglyphis oasium* (602 ants) represented 90.9% of the total species density forming its highest peak in May (Fig. 3). Different *Cataglyphis* species were recorded in Zaranik protected area (El-Moursy *et al.*, 2001) and in St. Catherine protectorate (Orabi *et al.*, 2011). The most dominant family of Coleoptera was Tenebrionidae which listed 263 individuals representing 99.6% of the total density of Coleopterous families. The most abundant Coleopterous species was *Pimelia angulate* (228 beetles) with a percentage of 86.4% of the total species density. It also recorded in Zaranik protectorate (El-moursy *et al.*, 2001). The highest number of this species was during the months of Winter because the adults begin mating in this period, so this species formed the highest peak in December (Fig. 3) because this species in North Africa emerge in January to begin mating, synchronously with floral bloom (Schulze, 1964).

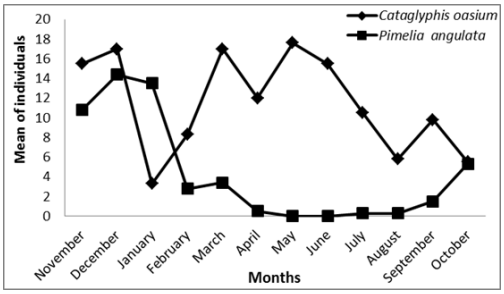

Figure (3): Population fluctuation of the most dominant species monitored by pitfall traps.

Yellow sticky traps collected 10 species belonging to 10 genera, 9 families and 5 orders with a total density of 10422 individuals (Table 3). Diptera, Hemiptera and Coleoptera were the most abundant orders which listed 8012, 1344 and1007 individuals forming 76.9% 12.9% and 9.7% of the total density of all orders. Culicidae was the richest Dipterous family with 7514 individuals representing 93.8% from all families density. The most abundant species was *Culex sp*. which was the only species representing to Culicidae family reaching its highest peak during August (Fig. 4). Cicadellidae was the most dominant Hemipterous family listing 1338 individuals forming 99.5% of the total families density. *Batrachomorphus sp.* was the most dominant Hemipterous species and the only species belonging to the Cicadellidae family forming its highest peak in October (Fig. 4). The most dominant Coleopterous family was Dermestidae with a total number of 661 individuals forming a percentage of 65.7% of the total families density. The most abundant species was found belonging to this family, *Attagenus fasciatus* which also recorded in in Zaranik protectorate (El-Moursy *et al.*, 2001). It had 65.7% of the total species density and formed its highest peak in August (Fig. 4).

According to these results, the net trap was considered the most effective method for monitoring the largest number of orders, families and species in the protectorate followed by yellow sticky traps then pitfall traps. On the contrary, the yellow sticky trap method was efficient in the monitoring largest number of individuals followed by aerial net trap then pitfall trap. The highest population number was recorded in site 3 (3240 individuals) as this site included a high density of *Acacia* trees that distinguish the protectorate, while the lowest number (108 individuals) was in site 9 because it empty of plants.

Table (3): Taxonomic list of insects monitored by yellow sticky traps in Saluga and Ghazal protectorate, Aswan.

Order	Families	Species	No. of individuals of	% of species from orders	No. of individuals of
Coleoptera	Buprestidae	*Anthaxia angustipennis*	8	0.8	
	Chrysomelidae	*Bruchidius incarnatus*	204	20.3	1007
	Chrysomelidae	*Caryedon gonagra*	134	13.3	
	Dermestidae	*Attagenus fasciatus*	661	65.7	
Diptera	Chironomidae	*Tanytarsus sp.*	498	6.2	8012
	Culicidae	*Culex sp.*	7514	93.8	
Hemiptera	Aleyrodidae	*Trialeurodes sp.*	6	0.5	1344
	Cicadellidae	*Batra chomorphus*	1338	99.5	
Hymenoptera	Vespidae	*Odynerus cyanopterus*	56	100	56
Neuroptera	Chrysopidae	*Chrysoperla carnea*	3	100	3
Total					10422

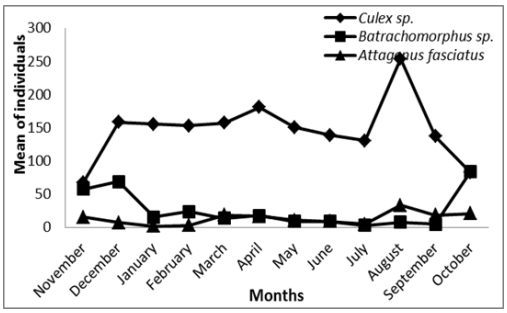

Figure (4): Population fluctuation of the most dominant species monitored by yellow sticky traps.

The association between ecological factors and abundance of the most dominant species monitored using aerial net, pitfall traps and yellow sticky traps

The reported data of ecological factor in the study area indicated that temperature ranged between (44°C) in June and (21.5°C) in January, the highest percent of humidity was recorded during December (61.4%), while the lowest percent was recorded during June (20.8%) and the mean value of wind velocity ranged from (27.3 km/h) in August to (15.5 km/h) in October. By applying the correlation analysis in SPSS program between total number of species and ecological data (air temperature, humidity and wind velocity) (Table 4), it is cleared that the abundance of *Xylocopa pubescens* was positively correlated with temperature (r = 0.597), *Dielis collaris* showed negative correlation with temperature (r = -0.905) and was in positive relation with humidity (r = 0.801). The abundance of *Pimelia angulata* was negatively correlated with temperature (r = -0.804) while it was positively correlated with humidity (r = 0.88)

Table (4): Correlation coefficients for the association between ecological factors and the most dominant species monitored by using aerial net, pitfall traps and yellow sticky traps during the present study.

Species	Temperature		Humidity		Wind	
	r	Sig.	r	Sig.	r	Sig.
Anthene amarah	-0.424	NS	0.375	NS	-	NS
Azanus ubaldus	-0.193	NS	0.165	NS	-	NS
Danaus chrysippus	-0.064	NS	-0.145	NS	0.004	NS
Vanessa cardui	0.059	NS	-0.28	NS	0.092	NS
Dielis collaris	-0.905	**	0.801	**	-	NS
Xylocopa pubescens	0.597	*	-0.503	NS	0.363	NS
Apis Mellifica	0.216	NS	-0.447	NS	0.037	NS
Ischnura	0.45	NS	-0.399	NS	0.376	NS
Orthemis	-0.067	NS	0.245	NS	0.022	NS
Cataglyphis oasium	-0.02	NS	0.038	NS	-	NS
Pimelia angulata	-0.804	**	0.88	**	-	NS
Culex sp.	0.046	NS	-0.204	NS	0.446	NS
Batrachomorphus	-0.395	NS	0.575	NS	-	NS
Attagenus fasciatus	0.407	NS	-0.296	NS	0.094	NS

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تنوع الأنواع والديناميات السكانية الموسمية للحشرات الأرضية في محمية سالوجا وغزال ، أسوان ، مصر

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الملخص العربي

تمت دراسة تنوع الأنواع والوفرة النسبية والديناميكية التعادية لأنواع الحشرات الأرضية، في محمية سالوجا وغزال - أسوان - مصر، لأول مرة خلال عام واحد (نوفمبر 2015 إلى أكتوبر 2016). ولقد تم إستخدام ثلاث طرق مختلفة للرصد (مصيدة الشبكة الهوائية، ومصايد الشراك الأرضية والمصايد اللاصقة الصفراء) في تسعة مواقع مختلفة؛ تغطى جميع البيئات فى المنطقة الرملية، والصخرية، والنباتية، والمائية. ولقد تم جمع إجمالى 15151 من الأفراد، من 78 نوعاً، تنتمي إلى 43 عائلة، من 11رتبة، باستخدام الطرق الثلاث السابقة.ولقد جمعت مصيدة الشبكة 62 نوعًا، من 59 جنسًا، تنتمي إلى 32 عائلة، في 11 رتبة؛ وكانت رتبة حرشفية الأجنحة، الرتبة الأكثر وفرة، تليها غشائيات الأجنحة، والرعاشات، وجمعت مصايد الشراك الأرضية 9 أنواع، تنتمي إلى 9 أجناس، من 4 عائلات، و 3 رتب؛ كانت رتبتاغشائيات الأجنحة وغمدية الأجنحة أكثر الرتب وفرة؛ في حين أن المصايد اللاصقة الصفراء جمعت 10 أنواع، تنتمي إلى 10 أجناس، و 9 عائلات، و 5 رتب؛ كانت رتبتا نصفية الأجنحة وغمدية الأجنحة الرتبتين الأكثر وفرة. ولقد أشارت الدراسة الى أن مصيدة الشبكة هى الطريقة الأكثر كفاءة لرصد أكبر عدد من الرتب، والعائلات، والانواع؛ وسجل اعلى عدد للأفراد فى موقع 3، بينما كان اقل عدد فى موقع 9. واخيراً تمت مناقشة العلاقة بين العوامل البيئية وفرة الأنواع الأكثر هيمنة.