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Predaceous and Parasitic, Ground-dwelling Arthropods in Different Ecosystems in Western Saudi Arabia

A.A. FARAGALLA and M.O. TAHER
Department of Biological Sciences, Faculty of Science, King Abdulaziz University, Jeddah, Saudi Arabia

ABSTRACT. Populations of predaceous and parasitic ground-dwelling arthropods have been investigated in three ecosystems: a) natural ecosystem of uncultivated land, b) a continuously cultivated vegetable agroecosystem and c) a permanent agroecosystem of date palm-citrus orchard during an 8 months period starting October 1985 through May 1986 by pitfall trapping to determine their species composition and abundance. Araneae, Formicidae, Histeridae and Carabidae were consistently the most abundant of the predaceous-parasitic arthropod complex. From data analysis Chi square (X^2) the ratio of the arthropod taxa present in the three ecosystems showed high significant differences at 1% level of probability. The composition of this complex did not vary in the three ecosystems, but their respective numbers have declined at the onset of winter (November to December). True Spider (Araneae) represented a distinct group averaged 39.4% and one family of them, the Lycosidae, has amounted for 72.1% of all true spiders, harvestmen and sunspiders put together.

Introduction

Ground-dwelling arthropods are an integral component of the fauna of any natural ecosystem and/or agroecosystem[1-4]. These feed on a variety of pests present in the ecosystem, but sometimes fall as prey to other predators. Hence, knowledge of the exact composition of the predator/parasite complex coupled with that of the exact numbers of each category is of greatest importance in the implementation of sound pest control measures. Such knowledge is not available for the fastly mushrooming agricultural development of Saudi Arabia.

Hence, the present study is an effort to determine the components of the predaceous and parasitic ground-dwelling arthropod fauna in three different ecosystems in Western Saudi Arabia.

Material and Methods

Pitfall traps suffer from the disadvantage that the catch depends on the population density and activity of the individuals, but often are the only methods available for the studies of ground-dwelling populations[5]. They are used in a variety of ways to determine population densities, species composition, and measure the effect of insecticides on ground-dwelling arthropods[6-12].

In this study, the area chosen for conducting the survey – during October 1985 through May 1986 – was in Khulais valley 80 km northeast the city of Jeddah. This area was selected as it is a traditional valley for agricultural production in the first place, together with the recent expansion of new agricultural projects. Three sites were chosen including a traditional farm with a natural ecosystem comprising basically an uncultivated land (fallow) covered with sparse vegetation; bushes, trees and desert weeds. These include *Tamarix* sp., *Tribulus terresteris, T. pentandrus, Abutilon* sp., *Calatropis procera, Zrozophora obliqua, Acacia* sp., *Caparis spinosa, Heliotropium arabainense, Schouwia thebaica, Corchorus depressus* and *Launaeae capitata.* An area continuously used for vegetable production throughout the year was chosen and designated as an annual agroecosystem. The other was a date palm-citrus orchard selected to represent a permanent agroecosystem. In each of the 3 sites a catching grid of 0.75 ha. was selected where 8 pitfall traps were distributed. The contents of the traps were removed weekly on Thursdays to the laboratory for record of weekly collection and subsequent identification. Spiders, phalangids and sunspiders were identified by the American Museum of Natural History at New York, U.S.A.

Results and Discussion

To test the homogeneity of the three ecosystems Chi square (X^2) was used to compare the ratio of the different taxa of the predaceous/parasitic complex with the supposition :

H_o $P_{i1} = P_{i2} = P_{i3}$ for every i (1-18) homogeneous
H_i At least one of P_{ij} is different (j = 1, 2, 3) not homogeneous

Data analysis showed that for every level of we reject H_o.

In the natural ecosystem (fallow uncultivated land) the predator/parasitic taxa reported were Formicidae (31.0%), Araneae (29.1%), Histeridae (13.2%) and Carabidae (10.1%) comprising 83.3% of the total captured (Table 1). In the continuously cultivated agroecosystem (vegetable field) these were Araneae (53.0%), Formicidae (15.2%), Carabidae (10.7%) and Histeridae (7.6%), comprising 86.5% of the total captured (Table 2), and in the permanent agroecosystem (date palm-citrus

orchard) these were Araneae (36.0%), Formicidae (22.2%), Histeridae (16.3%) and Carabidae (11.2%) comprising 85.7% of the total captured (Table 3).

TABLE 1. Taxonomic composition of pitfall trapped predaceous and parasitic arthropods in a natural, fallow or uncultivated land ecosystem.

Taxon	Total no. captured/month								Mean (X)	% of total captured
	Oct.	Nov.	Dec.*	Jan.	Feb.	Mar.	Apr.	May		
Insecta										
Formicidae	92	70	15	32	55	38	13	12	40.9	31.0
Histeridae	5	4	4	40	31	33	9	13	17.4	13.2
Carabidae	1	3	0	37	16	29	13	8	13.4	10.0
Hymenoptera[a]	7	6	7	3	4	2	3	0	4.0	3.0
Diptera[b]	4	3	4	4	4	4	2	0	3.1	2.4
Staphylinidae	0	3	0	5	1	3	0	0	1.5	1.1
Anthicidae	0	2	0	1	1	2	4	2	1.5	1.1
Pentatomidae	1	0	0	1	0	2	1	1	0.8	0.6
Syrphidae	1	0	0	1	1	2	0	0	0.6	0.5
Myrmeleontidae	1	1	0	0	0	1	0	0	0.4	0.3
Dermaptera (Labiduridae)	0	1	0	0	0	1	0	0	0.3	0.2
Cicindelidae	0	1	0	0	0	0	0	0	0.1	0.1
Other Arthropods										
Araneae	84	72	22	27	18	41	21	22	38.4	29.1
Phalangida	7	3	0	1	0	2	0	0	1.6	1.2
Solifugae	4	0	0	3	1	3	0	3	1.8	1.3
Scorpionida	3	4	0	0	0	1	2	0	1.3	1.0
Chilopoda	0	0	0	0	0	0	0	0	0.0	0.0
Acari	15	10	1	7	7	0	1	0	5.1	3.9
Total No.	225	183	53	162	139	164	69	61	1056	100.0

*Data for December is for 2 weeks only, due to a natural run-off.
[a]Hymenoptera included: Vespidae, Eumenidae, Sphecidae, Mutilidae and Braconidae.
[b]Diptera included: Asilidae, Cecidomyiidae, Sarcophagidae, Tachinidae and Bombyliidae.

TABLE 2. Taxonomic composition of pitfall trapped predaceous and parasitic arthropods in a continuously cultivated agroecosystem (vegetable field).

Taxon	Total no. captured/month								Mean (X)	% of total captured
	Oct.	Nov.	Dec.*	Jan.	Feb.	Mar.	Apr.	May		
Insecta										
Formicidae	81	0	29	48	84	11	115	0	46.0	15.2
Histeridae	26	54	8	12	19	25	24	17	23.1	7.6
Carabidae	15	10	2	48	11	91	67	16	32.5	10.7
Hymenoptera[a]	8	6	4	4	3	3	2	1	3.9	1.3
Diptera[b]	6	5	0	3	1	0	4	0	2.4	0.8
Staphylinidae	7	3	0	7	9	1	1	3	3.9	1.3
Anthicidae	0	1	0	1	3	4	5	1	1.9	0.6

Table 2. (Continued).

Taxon	Total no. captured/month								Mean (X)	% of total captured
	Oct.	Nov.	Dec.*	Jan.	Feb.	Mar.	Apr.	May		
Pentatomidae	1	1	0	1	0	0	1	0	0.5	0.1
Syrphidae	1	2	0	1	2	1	0	0	0.9	0.3
Myrmeleontidae	3	0	0	3	2	3	1	0	1.5	0.5
Dermaptera (Labiduridae)	0	3	0	0	1	3	3	0	1.3	0.4.
Cicindelidae	0	0	0	0	0	49	0	0	6.1	2.0
Other Arthropods										
Araneae	226	391	110	156	140	99	142	20	160.5	53.0
Phalangida	44	8	0	20	11	1	3	0	10.9	3.6
Solifugae	15	2	0	1	1	1	5	0	3.1	1.0
Scorpionida	2	2	0	1	2	0	2	0	1.1	0.4
Chilopoda	0	0	0	0	0	0	2	0	0.3	0.1
Acari	10	5	0	4	3	4	0	0	3.3	1.1
Total No.	445	493	153	310	292	296	377	58	2424	100.0

[b]) same as in Table 1

TABLE 3. Taxonomic composition of pitfall trapped predaceous and parasitic arthropods in a permanent agroecosystem (date palm-citrus orchard).

Taxon	Total no. captured/month								Mean (X)	% of total captured
	Oct.	Nov.	Dec.*	Jan.	Feb.	Mar.	Apr.	May		
Insecta										
Formicidae	66	360	0	42	41	28	54	5	74.5	22.2
Histeridae	69	137	41	33	79	46	25	8	54.8	16.3
Carabidae	106	56	23	18	12	51	20	14	37.5	11.2
Hymenoptera[a]	8	9	6	8	6	4	3	2	5.8	1.7
Diptera[b]	7	4	4	3	4	4	4	4	4.3	1.3
Staphylinidae	3	0	0	16	14	10	7	0	6.3	1.9
Anthicidae	5	3	0	3	4	5	3	2	3.1	0.9
Pentatomidae	0	2	0	3	1	2	2	2	1.5	0.4
Syrphidae	1	2	1	4	3	3	2	1	2.1	0.6
Myrmeleontidae	2	1	0	2	0	3	9	2	2.4	0.7
Dermaptera (Labiduridae)	0	0	0	0	1	0	1	0	0.3	0.1
Cicindelidae	0	9	0	0	1	0	0	0	1.3	0.4
Other Arthropods										
Araneae	192	145	79	107	44	124	54	20	120.0	36.0
Phalangida	37	10	2	4	4	0	1	0	7.3	2.2
Solifugae	23	1	1	4	0	3	2	3	4.6	1.3
Scorpionida	5	11	2	4	0	0	1	0	2.9	0.9
Chilopoda	2	0	0	5	1	1	0	1	1.3	0.4
Acari	5	8	4	15	3	1	0	4	5.0	1.5
Total No.	731	758	163	271	218	285	188	68	2682	100.0

[b]) same as in Table 1

It is very striking to observe that with all differences in vegetation cover, plant and animal communities, density, diversity, crop species in the three ecosystems investigated, the predaceous/parasitic arthropod complex composition was almost similar and ranges between 83-86%. The highest percentage was in the permanent agroecosystem followed by the continuously cultivated agroecosystem. The permanency of the former system together with its characteristics of appreciable diversity of plant and animal species, its greenery throughout the year coupled with adequate moisture, humidity, shade, shelter and modified temperature might have contributed to the greatest presence of these predaceous/parasitic arthropod complex through presenting the most favorable niches for them.

True spiders (Araneae) outnumber all other groups of arthropods and together with harvestmen (Phalangida) and sunspiders (Solifugae) are well represented in the three ecosystems (Table 4). Moreover, five families of true spiders have been collected in adequate numbers that warrant family comparisons. Of these, the Lycosidae is the most predominant and outnumber the other true spider families together with the rest of the arachnids put together. Their highest prevalence was in the continuously cultivated agroecosystem followed by the date palm-citrus orchard agroecosystem and the natural agroecosystem (Table 4). It could be stated from these results that Araneae do represent a dominant group in the three agroecosystems investigated compared to predaceous/parasitic hexapod families.

Though sampling was not carried out over June to September, yet it is evident from the results that the peak of prevalence of the predaceous/parasitic arthropod

TABLE 4. Pitfall trapped spiders, harvestmen and sunspiders fauna in a ground-dwelling arthropod complex of three ecosystems.

Taxa	% of all Arachnids captured		
	Natural ecosystem	Vegetable field	Date palm-citrus orchard
Order: Araneae			
Family:			
Lycosidae	8.9	36.8	26.4
Zodariidae	0.6	4.2	3.3
Theridiidae	0.4	4.2	3.3
Gnaphosidae	0.9	2.9	3.0
Salticidae	0.1	0.9	0.1
Order: Opiliones or Phalangida (Harvestmen or Daddy Longlegs)	0.5	3.1	2.3
Order: Solifugae (Sunspiders or Wind Scorpions)	0.5	0.9	1.1

complex in the three ecosystems studied is during October. Thereafter, there is evidence of decline in numbers over November and December, possibly due to temperature drop in winter. The numbers then fluctuate before reaching their lowest point by May (Tables 1-3, Fig. 1). Presumably, the numbers increase steadily over June to September to peak by October.

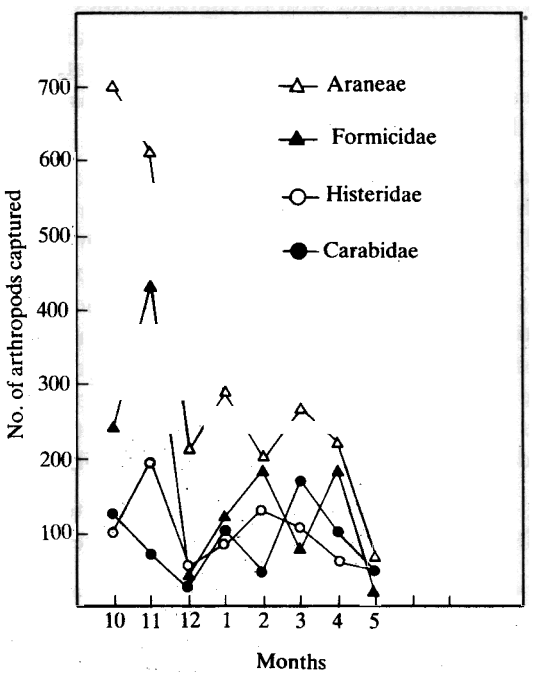

FIG. 1. Total number of major pitfall trapped predaceous/parasitic arthropods from the three ecosystems investigated.

The predominant presence of Araneae in the cultivated agroecosystem (vegetable field) and the permanent agroecosystem (date palm-citrus orchard) may be related to the availability of preys and our results are in agreement with those previously reported[3,4,7-9] that the dominant presence and the predatory role of Araneae (specially the family Lycosidae) on a variety of cropping systems. The prominent abundance of the litter-dwelling predatory arthropods, Formicidae and Carabidae make our results in conformity with those reported on soybean agroecosystem by Bechinski and Pedigo[13]. Low abundance in the members of family Formicidae was observed in vegetable agroecosystem (15.2%) when compared with natural and date palm-citrus orchard agroecosystem (31.0% and 22.2% respectively) which might be related to the normal activities of weeding and insecticides used to curb pest populations in this particular agroecosystem. The predominant presence of Histeridae in the date palm-citrus the agroecosystem (16.3%) could be attributed to the high organic matter and detritus covering the floor of this agroecosystem which might be related to dung and dropping of grazing animals, while vegetable agroecosystem got the lowest abundance (7.6%).

This study is the first documentation of the occurrence and abundance of predaceous and parasitic ground-dwelling arthropods in the ecosystems studied. However, further investigations are needed to generate more data to enable comparison between natural ecosystems and those agroecosystems that receive various insecticide treatments for pest control. Such comparison should take in account the conservation of ground-dwelling beneficial biological control agents, the predaceous/parasitic arthropods in order to develop sound pest management strategies in various agroecosystems.

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المفترسات والطفيليات من مفصليات الأرجل التي تقطن التربة في أنظمة بيئية مختلفة بالمنطقة الغربية من المملكة العربية السعودية

عبد الرحمن فرج الله و محمد عمر طاهر
قسم علوم الأحياء ، كلية العلوم ، جامعة الملك عبد العزيز
جـــدة ، المملكة العربية السعودية

المستخلص . تمت دراسة حقلية لمدة ثمانية شهور مابين أكتوبر ١٩٨٥م ومايو ١٩٨٦م على المفترسات والطفيليات من مفصليات الأرجل التي تقطن التربة في ثلاثة أنظمة بيئية تشتمل على نظام طبيعي (أرض خلاء غير مزروعة) ، ونظام بيئي زراعي يدار طول العام (حقل لإنتاج الخضار) ، ونظام بيئي ثابت (بستان لنخيل البلح والموالح) باستخدام الفخاخ الأرضية بهدف التعرف على مجموعات المفصليات السائدة ، وتركيبها ووفرتها . ولقد اتضح أن رتبة العناكب الحقيقية ومن الحشرات فصائل النمل الأسمر الحقيقي ، وخنافس المستروي والخنافس الأرضية تقطن التربة . وتتوافر بصفة مستمرة .

إن تحليل البيانات بإستخدام مربع كاي (X^2) لنسب المجموعات التي توجد في الأنظمة الثلاثة قد أوضح فروقا معنوية عالية . واعتمادا على تركيبة المفصليات التي تم حصرها وبالنظر للاختلافات الخاصة التي يتميز بها كل نظام بيئي ، فإن المركب الكلي لمجموع المفصليات لا يختلف كثيرا في الأنظمة الثلاثة التي تحت الدراسة . ولقد اتضح أن العدد الكلي لكل مجاميع الطفيليات والمفترسات ينخفض تدريجيا ابتداء من نوفمبر إلى ديسمبر وذلك يتزامن مع انخفاض درجة الحرارة وبداية فصل الشتاء ، أما قمة وجودها فتكون خلال شهر أكتوبر . فالعناكب الحقيقية هي المفصليات السائدة ؛ إذ كان متوسط وجودها ٣٩,٤٪ وأن فصيلة العناكب الذئبية تمثل ٧٢,١٪ من كل فصائل العناكب الحقيقية ، طويلات الأرجل والمعتزلات مجتمعة .