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Abundance and Diversity of Soil Mites (Acari: Gamasida & Oribatida) in Mango Orchards in Ismailia Region, Egypt

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ABSTRACT

The relative abundance of gamasid and oribatid mites inhabiting soil and litter in mango orchards was investigated in Ismailia region, Egypt. Soil and litter samples were collected from August 2008 to July 2009. Totally, 6057 individuals of gamasid and oribatid mites were found in the collected soil and litter samples. The collected mites belong to 34 mite species and 18 families. Gamasida was represented by 20 species of 2212 individuals, while Oribatida was represented by 14 species of 3845 individuals. Gamasid mites were generally dominated by *Parasitus zaheri* Hafez and Nasr in the soil samples, while in the litter, seven species were influent and the others were recedent. Oribatida comprised 63.48 % of total mites collected and dominated by six species in both soil and litter. The highest population density of soil mites was recorded in winter months compared with summer months. Biotic and abiotic factors affecting abundance of soil mites were discussed.

Key Words: Soil mites, Gamasida, Oribatida, Abundance, Diversity, Seasonal variations, Ismailia.

INTRODUCTION

Microarthropods living in litter and upper strata of the soil are an important component of the ecosystem, because of their relevant role in organic matter decomposition, mineralization, nutrient cycling and soil formation (Seastedt, 1984; Koehler, 1997; Parisi, *et al.*, 2005; Schneider *et al.*, 2007). Mites are major participants in soil food web. Some species feed directly upon decomposing plant materials; while others are fungivores. Other species are predators on small arthropods or their eggs and nematodes. Many species seem to be omnivorous.

Gamasid mites live in a wide range of terrestrial ecosystems under very different environmental conditions. Most are top predators and occupy a central position in the soil food web (Koehler, 1999). Thus, communities have significant role in regulating decomposition and nutrient cycling since they influence population growth of other organisms (Koehler, 1999). Soil gamasida communities are sensitive to changes in management practices and the type of land use is an especially critical parameter (Ruf and Beck, 2005).

Oribatid mites are usually the most abundant and diverse arthropods in soil. Its importance in ecosystem energy and nutrient dynamics is mostly indirect, and lies in its relationships with decomposer microorganisms (Seastedt, 1984). The density of soil mites is also considered as indicator of soil condition and quality (Usher, 1971). Population abundance of soil mites in soil vary in relation to various environmental factors i.e.; temperature, moisture, organic matter and nutrient availability (Hansen & Coleman 1998).

Several studies have been conducted to study the distribution and abundance of mites inhabiting soil and debris at different locations in Egypt (El-Kifl *et al.*, 1974; Zaher and Mohamed 1980; Hassan *et al.*, 1986; Zaki, 1992 and Kandeel, 1993). The main objective of this study is to work composition, density and seasonal changes of soil and litter mites (Gamasida and Oribatida) found in mango orchards in Ismailia region.

MATERIALS AND METHODS

Site description and sampling:

The present study was carried out on the experimental farm of Faculty of Agriculture, Suez Canal University, Ismailia Governorate. Ismailia is characterized by aridity with long hot rainless summer, mild winter and low amount of rainfall (50 mm). Three random samples of the top soil layer (0-20 cm) and litter layer in mango orchards, *Mangifera indica* L. were taken using a core from August 2008 to July 2009. Sampling was done four times monthly and a total of 720 samples were collected. Mites were extracted from the soil and litter samples by using modified Tullgren Funnel. Identification was carried out according to Karg, 1971 and Zaher, 1986). The specimens of each mite species were deposited in the mite collection of Department of Plant Protection, Faculty of Agriculture, Suez Canal University. pH, organic matter content, temperature and moisture content (% of dry weight) of soil and litter samples were recorded.

Data analysis:

The community structure of soil mites was analyzed using abundance and species number. For the quantitative categorization of the mites found, the criteria Dominance (D) were used, as suggested by (Kang *et al.*, 2001). 'Dominance' indicates the percentage of individuals of a given species compared to the individuals of all species found. Thus, a given species can be classified as 'Dominant' (>5%), 'Influent' (2-5%), and 'Resident' (<2%) of the community structure of soil arthropods. Total number of individuals, total number of species (species richness) and Shannon-Wiener index (H') and the evenness (J') Magurran, (1988) were assessed. Statistical analysis were carried out using the SAS package, and the Duncan multiple range test was used to compare the means of soil mite populations.

RESULTS AND DISCUSSION

Soil and litter characteristics:
Data of soil and litter pH, organic matter content and temperature are presented in table (1). The type of soil in the study area was sandy loam. The average value of pH ranged from 5.1 in litter to 7.7 in the soil. The mean values of total organic matter percentage were significantly higher in litter compared with soil. Soil temperature was relatively higher in litter. Organic matter content is a source for nutrient elements in the soil. It has appreciable influence on many soil properties, for its significance in maintenance of soil fertility. Litter of substrate can affect the rate of decomposition and the populations and community dynamics of soil fauna, partially explaining the increase in abundance of Gamasida and Oribatida.

Table (1): Means of general characteristics of soil and litter of the studied area.

Biotope	pH	Organic matter %	Temperature °C	Moisture %
Soil	7.7	0.87	19.8	3.1
Litter	5.1	46.2	27.2	15.7

Abundance and diversity:
A total of 6057 individuals of soil mites (Gamasida & Oribatida) were extracted from the litter and soil samples (Tables 2 and 3). The collected individuals belonged to 34 mite species. There was a significantly higher number of soil mites ($p < 0.05$) in litter samples than soil.

Gamasida: A total of 2212 Gamasida specimens were noted in the samples. 312 in litter and 900 in soil. Laelapidae was represented by the largest number of species (5 spp.) and individuals in both soil and litter (202 and 244 individuals, respectively). The Family Parasitidae dominated by *Parasitus zaheri* Hafez and Nasr in the soil samples only (D = 16.11%), followed by *Rhodacarus rosesus* (12.22%) (Family Rhodacaridae). The families Ascidae, Parasitidae and Macrochelidae were represented by more than one species (4, 2 and 3 species, respectively). However, Ascidae (104 individuals), Parasitidae (165) and Macrochelidae (113) were the families with the most numerous individuals (Table 2). In all samples the density of gamasid mites in litter was higher than in the soil ($p < 0.05$). Species diversity index (H') for gamasid mites were 2.64 and 2.84 at soil and litter, respectively and species evenness (J') was 0.88 and 0.95, respectively (Table 2).

Oribatida: The suborder Oribatida comprised 63.48 % of total mites collected. A total of 3845 individuals were obtained from the sampling areas. 1412 individuals from soil and 2433 individuals from litter. Oribatid mites were dominated by *Galumna tarsipennata* (Grandjean) (D = 19.83 %), *Oppiella nova* (Oudemans) (D = 13.46 %), *Oppia sticta* Popp (D = 8.29 %), *O. bayomi* Shereef and Zaher (D = 10.34 %), and *O. concolor* Koch (D = 8.49 %) in the soil. On the other hand, *Oppiella nova* was the most dominant species in the litter (D = 13.33 %) (Table 3).

The Oppiidae was a family represented by the largest number of species (4 species). It is also resulted in the largest number of individuals collected (1639) of which 573 from soil and 1066 from litter. This may be due to the increase of organic matter content in litter and supported by the findings of Urhan *et al.*, (2008) who reported that cryptostigmatid mites mostly dominate in soils that are rich in organic matter. Soil temperature exhibited strong negative correlation with the mite population. Such observations were made by El-Kifl *et al.*, (1974) and Zaher and Mohamed (1980).

The Oribatulidae (488 individuals), Galumnidae (474 individuals), Phthiracaridae (348 individuals) and Lohmannidae (320 individuals) were the families with numerous individuals (Table 3). *Ctenacarus araneola* (Grandjean) and *Aphilacarus acarinus* (Berlese) were classified as a resident species in both soil and litter (Table 3).

Oribatid mites density in the litter is nearly twice times as that in soil. Species diversity index (H') of oribatid mites was higher at litter (2.49) than soil (2.37), and species evenness (J') was 0.89 and 0.94 at soil and litter, respectively (Table 3).

Table (2): List of gamasid mites in Ismailia region during the study period.

Species	Abundance		Dominance (%)	
	Soil	Litter	Soil	Litter
Family: Ascidae				
Lasioseius aegypticus Afifi	30	35	3.33	2.67
Protogamasellus denticus Nasr	24	40	2.67	3.05
Blattisocieus keegani Fox	21	51	2.33	3.89
Gamasellodes sp	29	38	3.22	2.89
Family: Rhodacaridae				
Rhodacarus rosesus Oudemans	110	172	12.22	13.11
Family: Phytoseiidae				
Amblyseius cydnodactylon Shehata & Zaher	31	50	3.45	3.81
Family: Ologamasidae				
Gamasiphis denticus Hafez & Nasr	41	58	4.56	4.42
Family: Uropodidae				
Uroobovella (Fuscropoda) krantzi Zaher and Afifi	86	111	9.55	8.46
Trichouropoda patavina (Canestrini)	35	60	3.89	4.57
Family: Laelapidae				
Laelaspis zaheri Shereef & Soliman	51	56	5.67	4.27
L. volgini shereef and Afifi	37	43	4.11	3.27
Hypoaspis miles (Berlese)	58	60	6.45	4.57
H. baloghi shereefand Afifi	34	32	3.78	2.44
Androlaelaps casalis Berlese	22	53	2.44	4.04
Family: Ameroseiidae				
Amerosius aegypticus El-Badry, Nasr and Hafez	13	47	1.44	3.58
Family: Parasitidae				
Parasitus zaheri Hafez and Nasr	145	147	16.11	11.2
Vulgarogamasus burchanensis (Oudemans)	20	32	2.22	2.44
Family: Macrochelidae				
Macrocheles solimani Hafez, El-Badry&Nasr	65	104	7.22	7.93
M. glober Muller	38	60	4.22	4.57
M. muscaedomesticae (Scopoli)	10	63	1.11	4.8
Total individuals	900	1312		
No of dominant species			5	4
H'	2.64	2.84		
J'	0.88	0.95		
LSD 5%	82.1	125.3		

H' = Shannon's diversity index, J' = Pielou's evenness index.

Table (3): List of oribatid mites in Ismailia region during the study period.

Species	Abundance		Dominance (%)	
	Soil	Litter	Soil	Litter
Family: Galumnidae				
Galumna tarsipennata (Grandjean)	280	194	19.83	7.97
Family: Oribatulidae				
Scheloribates zaheri Yousef & Nasr	53	213	3.75	8.75
Zygoribatula tritici El-Badry & Nasr	58	164	4.11	6.74
Family: Oppiidae				
Oppiella nova (Oudemans)	190	324	13.46	13.32
Oppia sticta Popp	117	263	8.29	10.81
O. bayomi Shereef and Zaher	146	283	10.34	11.63
O. concolor Koch	120	196	8.49	8.05
Family: Epilohmanniidae				
Epilohmannia cylindrical Berlese	105	132	7.44	5.43
Family: Lohmannidae				
Lohmannia egypticus El-Badry & Nasr	47	113	3.33	4.64
Papillacarus aciculatus Kunast	38	122	2.69	5.01
Family: Cosmochthonidae				
Cosmochthonius lanatus (Michael)	25	86	1.77	3.53
Family: Ctenacaridae				
Ctenacarus araneola (Grandjean)	33	69	2.33	2.84
Family: Aphilacaridae				
Aphilacarus acarinus (Berlese)	28	58	1.98	2.38
Family: Phthiracaridae				
Phthiracarus sp.	172	216	12.18	8.89
Total individuals	1412	2433		
No of dominant species			7	10
H'	2.37	2.49		
J'	0.89	0.94		
LSD 5%	78.6	134.2		

H' = Shannon's diversity index, J' = Pielou's evenness index.

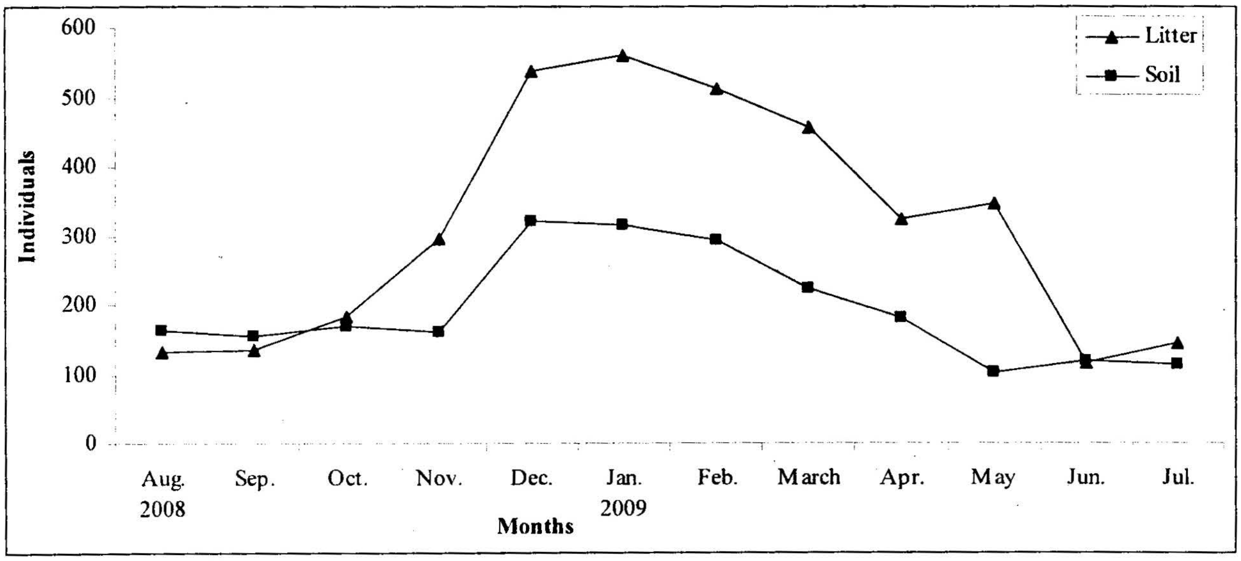

Fig.1: Seasonal variations of total soil mites in soil and litter in Ismailia region

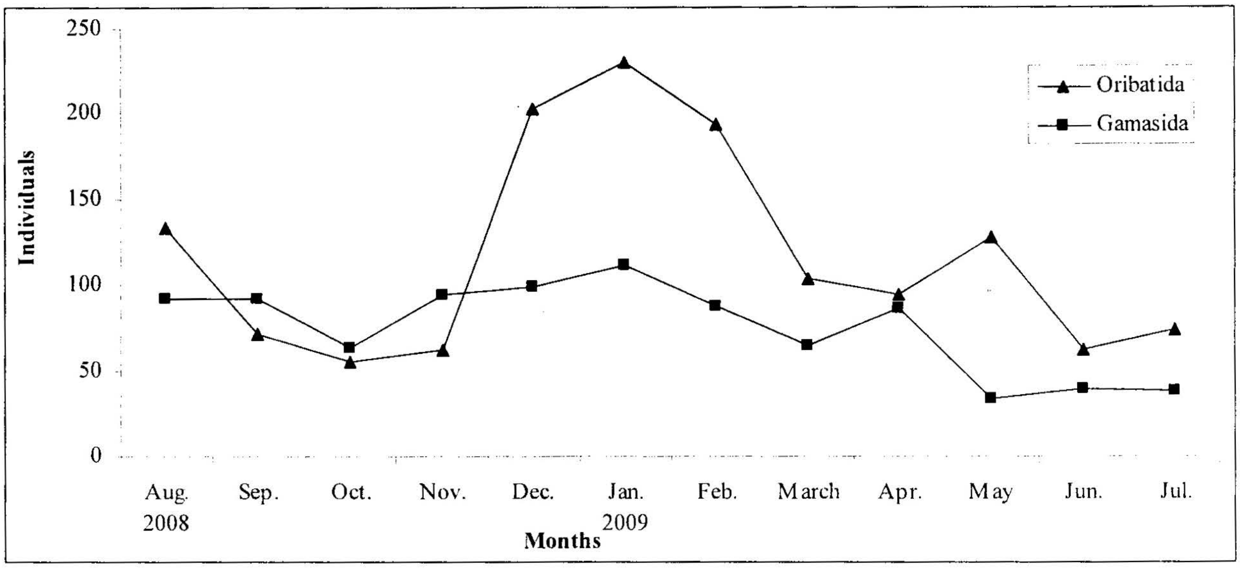

Fig.2: Density pattern of soil mites in the soil during the study period

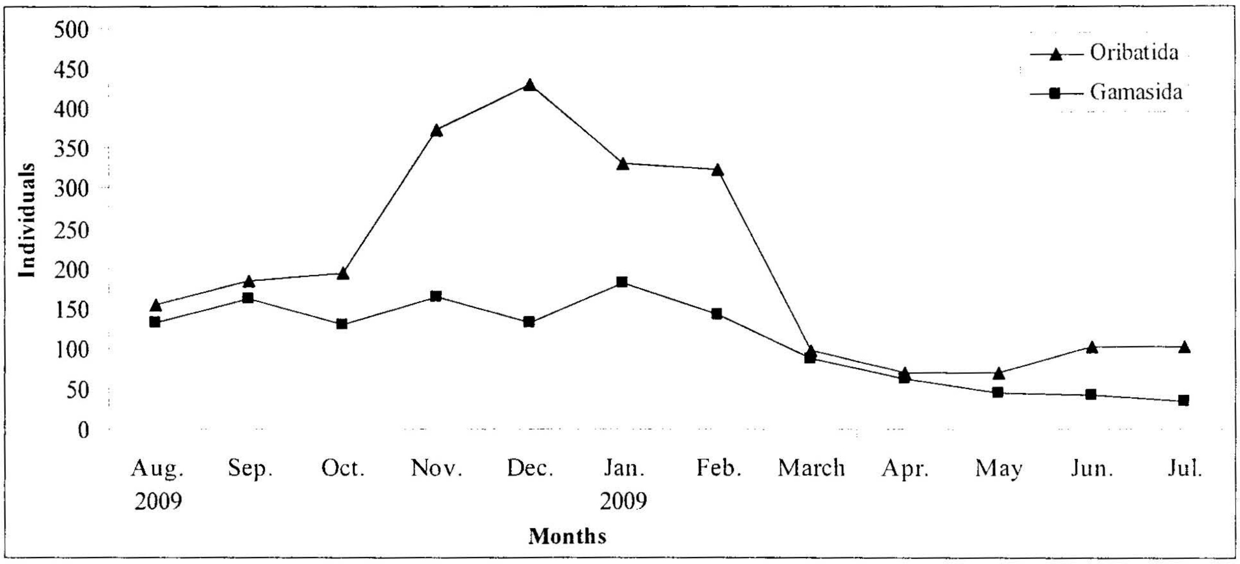

Fig.3: Density pattern of soil mites in litter during the study period

Seasonal variation of population density:

Fig. (1) illustrates the seasonal variations of gamasid and oribatid mites inhabiting soil and litter. Soil mites were more abundant throughout the year in litter than in soil. The highest population density was recorded in December – February in both litter and soil, while the lowest density was in May- July. El-Kifl *et al.*, (1974) found oribatid mites tended to decrease during summer months. They found that the minimal means were noticed in June.

It is clear that gamasid individuals were less abundant compared to oribatids. The highest population of gamasida was recorded in January (Fig. 2). On the other hand, the lowest was recorded during summer months. High temperature and low water moisture seem to be unsuitable soil environmental factors resulting in decreasing the population of soil mites.

The oribatid mites were more abundant throughout the year in soil than in litter. Its population density was higher during November – January compared to other months (Fig. 3). Its highest density was recorded in December and January in soil and litter, respectively. On the other hand, lowest density of oribatids was recorded in May and June in soil and litter. The distribution is affected by two factors which are classified into direct and indirect. The direct ones are the environmental factors (air, soil temperature, soil moisture and rainfall) and soil quality, while the indirect factors are those corresponding to choice of microhabitat, food and the relation between individuals (Zaki, 1992).

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