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FIRE AS MECHANICAL METHOD AFFECTING THE ABUNDANCE OF SOIL MITES AND SPIDERS

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ABSTRACT

The effects of fire on general abundance and distribution of soil mites and spiders at two study regions (El-Qaluobia and El-Menofia) Governorates of Egypt were recorded after wheat harvesting time during the season 2011/2012. A total of 18 mite species were collected and identified during the study period before and after fire. The collected mites were belonging to four suborders namely Astigmata (one family and one species), Prostigmata (six families and ten species), Mesostigmata (four families and six species) and Cryptostigmata (one species in one family). The collected spiders in this study were six species in five families, one of them identified in family level only (Philodromidae). Also, only one collected spider was identified as species level *Hogna ferox* (Lucas) (Family: Lycoseidae), and the rest of the collected families identified to genera level only. In general, mites and spiders were more abundant during two weeks before burning and reached to the lowest level during one day before and after burning. The ground layers after buring have significantly affected soil mites and spiders populations. Mites belonging to suborders Prostigmata and Mesostigmata were affected significantly by fire but Astigmata and Cryptostigmata were less affected. The abundance of spiders was significantly decreased after burning in the spider families Gnaphosidae and Lycosidae, but Oecobiidae was not affected after burning at the two regions.
Keywords: Mechanical fire – Wheat – Soil (Mites and Spiders) – Abundance.

INTRODUCTION

The soil is a unique habitat that supports rich and diverse life of many arthropods. It is a matrix of myriad solid mineral particles and pores filled by water, air, and decomposing organic matter. The penetration of light into the soil is limited. Soil animals generally avoid light; many of them do not possess specializes eyes, using instead well-developed tactile and chemical receptors and communication signals, Coy (1994). The soil atmosphere is saturated with water, poor in oxygen and rich in carbon dioxide. Most soil animals absorb and lose water through their integument and depend on water-saturated atmosphere for their existence. If the soil dries out, the animals in soil die, exist as cysts or eggs, or migrate away from unfavorable conditions. Mites and spiders comprise a huge and various groups of tiny arthropods in the calss Arachnidae, which belong to the subphylum Chelicerata.. Mites are free-living, saprophitic, parasitic and predator which are imortant in soil ecology and agriculture. Depending on the species and the circumstances, they can be either economically destructive pests or essential to the balance of biological systems. In Egypt, spiders constitute a considerable ratio (36.34%) of the total soil fauna, collected by pitfall-traps, in different agroecosystems (old lands) in Fayoum, Middle Egypt (Ghabbour and Mikhail, 1993). Mechanical fire or burning have probably been common

in Egyptian wheat and rice fields for removing the residues of the plantation after harvesting crops. As a result, fires are unlikely to constitute major disturbance in free-adapted communities. Furthermore, the distribution of some communities, including soil mites and spiders, is maintained by fire. Fire often appears to have little long-term effect on ordinal-level abundance of arthropods in temperate woodlands and open forests of southern Australia, Andersen and Muller (2000). Fire is also indicated in the development and maintenance of some faunal communities (Huhta, 1971; Recher *et al*., 1974). The impact of fire on soil and litter invertebrate communities in Egyptian fields has seldom been studied. The structure of soil and litter invertebrates' communities has traditionally been poorly studied because of the comlexity of organisms, a lack of knowledge of their ecology and the limitatios of techniques for examining the system as a whole (Usher *et al*., 1978). Each year many areas of Egyptian wheat and rice plantations burn, and it is important to understand the impact of fire on invetebrates as they are crucial to the stability, regulation and functioning of ecosystems, (Flinn *et al.,* 1983). On the other hand, workers interested in the ecology of soil fauna did not give enough attention to spiders, which are belived to be highly beneficial arthropods in biological control aspects (Tawfik, 1993). Survey of the mites and spiders occur in Egyptian wheat fields after harvesting time has not attracted the researchers, for what this investigation was carried out for this reason. So, the aim of the present study is focused on the impact of fire (burning) role on abundance of mites and spiders inhabiting wheat fields before and after harvesting period during 2011/2012 season at El-Qaluobia and El-Menofia Governorates.

MATERIALS AND METHODS

Experimental sites: Two sites were selected in wheat fields at two Egyptian governorates: El-Qaluobia (Toukh region) and El-Menofia (Ashmoun region); approximately 40 and 50 km North of Cairo, respectively with similarity in elevation, aspects and soil types.

Collection and identification of mites and spiders:

1- **Mites**:

Berlese-**Tullgren apparatus:** Is a great tool for separating mites from the soil they inhabit. A soil sample about (500 gm) is placed on the sieve at the top of a funnel. A small lamp with a lower-power light bulb heats the soil from above, which stimulates the soil mites to move downwards (positive geotaxis in response to dryness).This downwards movement evantually cause the soil mites to fall through the sieve into a container (Petri-dish) with preservatives material. This method gives a biassed sample of soil fauna, because it is based on specific avoidance behavior triggered by dryness and thus best mites that are mobile and do not desiccate easily. Collected mites were put in Nesbitt´s clearing agent, then mounted on glass slide using Hoyer's medium for examination. Identification of mounted species was identified according to review given by Griffiths 1960, Hughes 1961 & 1976, Lindquist and Evans 1965, Summers and Price 1970, Karg 1971, Zaher 1986 and Krantz and Walter 2009)**.**

2- **Spiders**:

Pit-fall traps method: Samples of the soil spiders fauna were collected from the study regions by pit-fall traps method described by Slingsby and CooK (1986) and Southwood and Henderson (2000).In this study, the number of spiders trapped in primarily depend on their location activity (Greenslade and Greenslade, 1983).The traps were used in each sampleling date in different plots. The number of spiders collected is the total number of individuals/10 traps to avoid decimal fraction.Traps (plastic containers) (10 cm diameter) were filled with detergent and water were embedded in the soil at the soil surface. Ten traps were collected and the old traps placed by new once at the same place. For comparing spiders' abundance during the pre-and post-burning periods of the study, only data collected in from each period were included in analysis. Identification of the collected spiders followed the systems used by Petrunkevitch 1939, Kaston, 1978 and El-Henawy 1990. In most cases, identification of spiders was possible only to the genus level.

RESULTS AND DISCUSSION

I- Mites: Eighteen species were collected during the study period, Table (1). Collected mites belonging to suborders Astigmata, Prostigmata, Mesostigmata and Cryptostigmata.The astigmatid mite *Tyrophagus putrescentiae* (Schrank) of family Acaridae was the only species collected in this study. Prostigmata (the most common suborder) was represented by nine species under six families, *Acaropsellina docta*, *Cheyletus badryi, C. malaccensis* (Cheyletidae); *Orthotydeus kochi, Tydeus aegyptiaca* (Tydeidae), *Spinibdella bifurcata* (Bdellidae), *Cunaxa capreolous*, *Cunaxa sitirostris* (Cunaxidae), *Eupodes aegyptiacus* (Eupodidae) and *Raphignathus niloticus* (Raphignathidae).However, the surveyed mesostigmatid mites in the current study were, *Proctolaelaps aegyptiaca* and *Laesioseius lindquisti* (Family Ascidae), *Androlaelaps casalies* and *Hypoaspis orinetalis* (Family Laelapidae), *Uroobovella krantzi (*Family Uropodidae) and *Parasitus consanguineus* (Family Parasitidae). On the other hand the only mite species *Oppiia sticta* (Family Oppiidae) oif suborder Cryptostigmata was recorded. Three of the collected mites in this study can be regard as fungivorous (*Tyrophagus putrescentiae, Urobovella krantzi* and *Oppiia sticta*), thirteen species are feeding as predators (*Acaropsellina docta*, *Cheyletus badryi, C. malaccensis*, *Spinibdella bifurcata*, *Cunaxa capreolus, C. sitirostris, Eupodes aegyptiaca, Raphignatrhus niloticus, Proctolaelaps aegyptiaca, Laesioseius lindquisti* , *Androlaelaps casalies, Hypoaspis orinetalis H. orinetalis* and *Parasitus consanguineus* while, two mite species uncertain in their feeding behaviour (*Orthotydeus kochi* and *Tydeus aegyptiaca*). From the same mentioned table, it can be noticed that the mites *T. aegyptiaca, S. bifurcata.*, *C. capreolus*, *C. sitirostris E. aegyptiacus*, *A. casalis* and *P. consanguineus* were appeared in the study before burning and dissappeared after fire. On the other hand, the cheyletid mite *C. badryi* and the raphignathid *R. niloticus* were the only collected two mites which observed after burning and not surveyed before fire process. On the other hand, the mites which appeared

before and after burning were *T. putrescentiae*, *A. docta*, *C. malaccensis* (Cheyletidae); *O. kochi, P. aegyptiaca* and *L. Lindquisti*, *U. krantzi* and *O. sticta*.

Table (1): List of the collected mites in harvested wheat fields at El-Qaluobia and El-Menofia Governoartes during 2011/2012 season.

Family	Species	Behavior	Appearance time	Region
Suborder Astigmata Family : Acaridae Ewing and Nesbitt	*Tyrophagus putrescentiae* (Schrank)	F.	Before and after burning	Q. & M.
Suborder Prostigmata F.: Cheyletidae Leach	*Acaropsellina docta* (Berlese)	P.	Before and after burning	Q.
	Cheyletus badryi Zaher & Hassan	P.	After burning	M.
	C.malaccensis (Oudemans)	P.	Before and after burning	M.
F.: Tydeidae (Kramer)	*Orthotydeus kochi* Oudemans	U.	Before and after burning	Q. & M.
	Tydeus aegyptiaca Rasmy & El-Bagoury	U.	Before burning	M.
F.: Bdellidae Duges	*Spinibdella bifurcata* Atyeo.	P.	Before burning	Q.
F.: Cunaxidae Thor	*Cunaxa capreolous* (Berlese)	P.	Before burning	Q. & M.
	Cunaxa sitirostris (Hermann)	P.	Before burning	Q. & M.
F. : Euopodidae Koch	*Euopodes aegyptiacus* Abou Awad & El-Bagoury	P.	Before burning	M.
F.: Raphignathidae Kramer	*Raphignathus niloticus* Rakha and Mohamed	P.	After burning	M.
Suborder Mesostigmata F.: Ascidae (Voigts & Oudemans)	*Proctolaelaps aegyptiaca* Nasr	P.	Before and after burning	Q. & M.
	Laesioseius lindquisti Nasr and Abou -Awad	P.	Before and after burning	Q. & M.
F.: Laelapidae (Berlese)	*Androlaelaps casalis* (Berlese)	P.	Before burning	Q.
	Hypoaspis orinetalis Hafez, El-Badry and Nasr	P.	Before burning	Q.
F.: Uropodidae Berlese	*Urobovella krantzi* Zaher and Afifi	F.	Before and after burning	Q. & M.
F.:Parasitidae Oudemans	*Parasitus consanguineus* Oudemans & Voigts	P.	Before burning	M.
Suborder Cryptostgimata F.:Oppiidae Grandjean	*Oppiia sticta* Popp.	F.	Before and after burning	M.

F. = Fungivorous P. = Predator U. = Uncertain Q. =El-Qaluobia M. = El-Menofia

II-Spiders: As show in Table (2), six species of spiders collected from area under study belong to five families as follows: *Zelotes* sp. (Gnaphosidae), *Erigone* sp. and *Prinerigone* sp. (Linyphiidae), *Oecobius* sp. (Oecobiidae), (??) Philodromidae and *Hogna ferox* (Lycoseidae). One of these spiders was identified at the family level only (Philodromidae). Also, only one spider was identified as species level *Hogna ferox* (Lucas) (Family Lycoseidae), and the rest of the collected families identified to genera level only. The collected four

genera were *Zelotes* (Gnaphosidae), *Erigone* and *Prinerigone* (Linyphiidae), and *Oecobius* (Oecobiidae).

Table (2): List of the collected spiders in harvested wheat fields in El-Qaluobia and El-Menofia Governoartes during 2011/2012 season.

Family	Species	Appearance time	Region
Gnaphosidae Pocock	*Zelotes* sp.	Before and after burning	Q. & M.
Linyphiidae Blackwall	*Erigone* sp.	Before burning	M.
	Prinerigone sp.	After burning	Q. & M.
Oecobiidae Blackwall	*Oecobius* sp.	Before and after burning	Q. & M.
Philodromidae Thorell	??	After burning	Q.
Lycoseidae Sunderval	*Hogna ferox* (Lucas)	Before and after burning	Q. & M.

Q. = El-Qaluobia M. = El-Menofia ?? = not identified to genus and species level

Abundance of soil mites and spiders: Abundance of mites and spiders collected from two sites (El-Qaluobia and El-Menofia Governorates) was compared to investigate similarity or differences arising from site differences. Similarity of mites and spiders abundance at the two sites before the fire, coupled with a significant difference between them after the fire, implicates fire intensity as affecting the response to post-fire conditions, Tables (3 & 4). Before the fire, the abundance was obviously differed at the two sample sites of the current study. The apparent increase in astigmatid mites in El-Qaluobia Governoarte (from 24 to 39 mites) and cryptostigmatid mites (from 7 to 13 mites), Table (3). However, in El-Menofia Governoarte, the astigmatid, prostigmatid and mesostigmatid mites changed from (25 to 36), (43 to 17) and (35 to 22) mites, respectively, Table (4) following fire in the current study and these results could not be conclusively attributed to the effects of fire, but may have been entirely affected by biotic, climatic or other environmental conditions independent of fire as increasing the number of fungi abundance in the two tested regions in this period. On the other hand, the abundance of mites belonging to suborders Prostigmata and Mesostigmata was observed significantly decreased at the two tested regions from 43 to 16 mites and from 31 to 18 mites, respectively. Most of the Prostigmata and Mesostigmata individuals collected belonged families, which are predaceous mites, and these decreased in abundance after fire. Habitat simplification immediately after fire have masked the extent of abundance decline in these groups. In general the results suggest that fire or post-fire conditions are deleterious to predatory mites' populations at least in the short term. Excessive heat is a constant problem for all mites because it increases the rate of water loss and increase the volume of body fluid contained within their hard exoskelton causing increased internal pressure.

Table (3): The number of collected mites and spiders before and after wheat residues burning at El-Qaluobia Governorate during 2011/ 2012 season.

Arthropod		Treatment	The number before burning				The number after burning			
			Two weeks	One week	One day	Total	One day	One week	Two weeks	Total
Mites / 500 gram	Astigmata	Fired	10	8	6	24	3	16	20	39
		Control	17	12	8	37	8	6	4	18
	Prostigmata	Fired	22	14	7	43	2	4	10	16
		Control	20	13	6	39	5	6	9	20
	Mesostigmata	Fired	16	10	5	31	2	7	9	18
		Control	14	10	6	30	5	4	10	19
	Cryptostigmata	Fired	6	1	0	7	0	3	10	13
		Control	10	4	2	16	3	5	7	15
Spiders / 10 traps	Gnaphosidae	Fired	13	12	6	41	0	6	14	20
		Control	16	14	8	38	5	6	22	33
	Oecobiidae	Fired	10	8	4	22	1	6	13	20
		Control	8	6	4	18	2	5	16	23
	Lycoseiidae	Fired	19	25	7	51	0	0	10	10
		Control	18	16	9	43	6	8	6	20

Table (4): The number of collected mites and spiders before and after wheat residues burning at El-Menofia Governorate during 2011/ 2012 season.

Arthropod		Treatment	The number before burning				The number after burning			
			Two weeks	One week	One day	Total	One day	One week	Two weeks	Total
Mites / 500 gram	Astigmata	Fired	14	7	4	25	6	11	19	36
		Control	12	8	5	25	4	4	33	41
	Prostigmata	Fired	18	15	10	43	3	5	9	17
		Control	15	14	12	41	11	9	8	28
	Mesostigmata	Fired	18	10	7	35	3	8	11	22
		Control	16	7	9	32	7	6	10	23
	Cryptostigmata	Fired	10	2	2	14	0	6	13	19
		Control	13	6	4	23	4	9	16	29
Spiders / 10 traps	Gnaphosidae	Fired	15	10	3	28	1	5	10	16
		Control	18	13	6	37	5	7	6	18
	Oecobiidae	Fired	11	9	3	23	2	5	15	22
		Control	14	12	10	36	8	8	10	26
	Lycoseiidae	Fired	22	11	5	38	1	2	16	19
		Control	20	14	9	43	5	6	13	24

The spiders' abundance in the current study was decreased after burning in comparison with before this process. In El-Qaliobia Governorate, the gnaphosid spiders dcreased from 41 to 20 individuals, oecobiids were not significantly affected decreased from (22 to 20 spiders), and the individuals of the family Lycoseidae were noticed decreased from 51 to 10 spiders), Table (3). On the other hand, these spider families decreased from 28 to 16 gnaphosid spiders, 23 to 22 oecobiid spiders and from 38 to 19 glycoside spiders in El-Menofia Governoarte, Table (4). The survival of these species subsequent to fire is affected by a variety of biotic and edaphic factors.

Important biotic components include food source (plant or prey), competition, predation and the relationship between species. Edaphic factors important to soil organisms include weather, microclimatic (soil moisture, humidity and temperature), chemical (nutrients), and physical (soil texture and structure). Savory (1977) and Chandler *et al*., (1983), in a review of the effects of fire on soil and litter invertebrates states all investigators agree with that acarina populations are reduced by burning. The apparent increase in mite abundance after fire in the current study may have been even greater during the same period had the sites out been burnt. This suggestion is supported by the site composition. No difference in abundance of this group was recorded between sites during the pre-fire period but a significantly lower abundance was recorded at the two sites after the fire. Astigmatid mites may have an advantage in surviving fire as these small mites normally inhabit the lower soil strata. The small size of these mites enhances movement through the soil profile and many are tolerant of dry conditions, Spain and Huston (1983). An increase in soil pH following fire (Coy, 1994) reflects changes in chemical properties such as cation exchange capacity. The chemical composition of soil often determines the abundance and the distribution of invertebrates. Furthermore, vegetation growth and therefore the food source of some invertebrates can be affected by the chemical composition of soil. Studies using pitfall tarpping for spider collection recorded far higher numbers; however, most studies to report a decreased abundance following fire (O'Dowd and Gill, 1984 and Huhta, 1971). Other research has also reported that species richness and species composition were affected by fire, different guilds of spiders respond according to their biologies and behavioral patterens (Koch and Majer, 1980 and Huhta, (1971). The concentration of mite survivors in the soil and on its surface may be responsible for the increased number of other invertebrates in samples immediately after fire. Decreased abundance of invertebrates after fire has been reduced in most Australian researches (e.g. Majer, 1980 and O'Dowd & Gill, 1984). Only one study (Whelan *et al.*, 1980) reported increased invertebrate abundance following fire, which was attributed to habitat compression. Bornemissza (1969) reported the speed of reinvasion by soil invertebrates following fire was associated with the accumulation of leaf litter under trees and with the regeneration of herbs and shrubs in exposed areas. Campbell and Tanton (1985) similarly concluded that environmental conditions preceding fire may affect subsequent survival and recovery patterns in soil invertebrate fauna. Long-term studies of the species composition of communities, and their response to fire, are urgently required, management decision can then be based on a sound understanding of the ecological imlification of fire in wheat field.

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تأثير الحرائق الميكانيكية على اكاروسات وعناكب تربة نباتات القمح بعد الحصاد

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تم دراسة تواجد كل من الاكاروسات والعناكب في تربة نباتات القمح قبل وبعد موسم الحصاد لدراسة دور الحرائق لبقايا هذه النباتات في محافظتي القليوبية والمنوفية فى موسم 2012/2011 حيث تم حصر 18 نوع اكاروسى فى فترات الدراسة تنتمي الى تحت أربعة رتب اكاروسية وهى رتبة عديمة الثغر Astigmata ورتبة الثغر الامامى Prostigmata والتي كانت أعلى المجاميع الاكاروسية انتشارا وتحت رتبة الثغر المتوسط Mesostigmata وتحت رتبة الحلم الخنفسى Cryptostigmata. أما بالنسبة للعناكب فقد تم جمع 6 أنواع تنتمي إلى خمسة فصائل وأتضح من خلال الدراسة ان أعلى تواجد لهذه الاكاروسات والعناكب فى الفترة (أسبوعين قبل موسم الحصاد) واقل تواجدا كان بعد (يوم واحد من حرق بقايا القمح) وذلك فى كلا المنطقتين ولقد كان هناك تأثيرا واضحا على تعداد هذه المفترسات عند تعرض الطبقة الخارجية من الأرض الى الحرائق فى مناطق الدراسة حيث تأثرت وقل عدد الاكاروسات المنتمية الى تحت رتبتى الثغر الامامى والمتوسط بصورة واضحة ولم تتاثر أعداد كل من الاكاروسات التى تنتمي الى تحت رتبتى عديمة الثغر والحلم الخنفسى بهذه الحرائق فى كلا المنطقتين وربما يرجع السبب فى ذلك في أن فطريات التربة التى تتغذى عليها هذه الاكاروسات قد ذاد تواجدها بعد الحرائق أما بالنسبة للعناكب الأرضية فقد تأثرت أعداد فصيلتي Gnaphosidae و Lycoseidae بوجود الحرائق حيث قل عددها بصورة واضحة بعد عملية الحريق اما بالنسبة الى فصيلة Oecobiidae فلم تتأثر أعدادها بوجود الحرائق فى كلا المنطقتين.

قام بتحكيم البحث

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