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Effect of different soil fungi on biological aspects of the oribatid mite *Nothrus silvestris* (Acari: Oribatida) in the laboratory

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Abstract:

Nothrus silvestris Nicolet (Acari: Oribatida: Nothridae) is a beneficial soil mite, considered as fungivorous grazer feeding on different kinds of soil fungi. In the present study, the feeding and reproductive biology of *N. silvestris* were recorded. Mites reared on nine different species of fungi isolated from tested soil under laboratory conditions in preequipped rearing vials. Data obtained showed that, *N. silvestris* preferred feeding on *Rhizoctonia solani* and *Alternaria alternate*. *Fusarium oxisporium* showed intermediate preferences, while rejected the other tested fungi as food items. Duration of development of *N. silvestris* extended to eight months when fed on young cultures of *R. solani* fungus, the average life span of adults reared on *R. solani* was 220.51±0.09. The longevity of females' *N. silvestris* was 145 days. All mites used in this experiment laid eggs, indicating that *N. silvestris* is thelytokous.

Introduction

Soil oribatid mites (Acari: Oribatida) are considered to be the most diverse and numerically the dominant group among soil micro-arthropods' mesofauna in all soil types. They have a great importance in improving the soil structure, they regulate decomposition rate (Walter and Behan-Pelletier, 1999), affect nutrient cycling and play an important role in soil fertility (Hartenstein, 1962). Finally, oribatid mites can control populations of pathogens which are related to their feeding habits (Crossley, 1977 and Enami and Nakamura, 1996). The development time for oribatid mites is long, lasting from several months to two years in temperate forests; they are characterized by low fecundity and low metabolic rates (Norton, 1994 and Behan-Pelletier, 1999).

Nothrus silvestris Nicolet (Acari, Oribatida, Nothridae) is a dominant oribatid species in Egyptian soils and considered to be a panphytophagous family feeding on decaying plant materials or fungi (Siepel, 1990). This species was classified as fungivorous grazer feeding on fungi, but its life cycle and developmental period still unknown due to its longitivity. Most species of Nothridae are parthenogenetic, sexual species are unknown (Siepel, 1990 and Norton *et al*., 1993).

From these perspectives, aims of the present study are to detecting the feeding biology of *N. silvestris* when reared on nine different species of soil fungi, and so monitoring its developmental period when feeding on the highly preferred food item.

Materials and methods

Soil samples were collected by steel corer of size (10 ×10 ×5 cm) from soil in Fesha-Sleem village, El-Gharbeia Governorate, Egypt vegetated with eggplants. Mites were extracted by Berleses' funnels and then mounted into lactic acid for identification for one to three weeks according to (Krantz, 1978). On the other hand, tested fungi were isolated from the same collected soil samples, purified on Potato Dextrose Agar (PDA) medium and identified according to Gilman (1957).

Isolated fungi were presented as food items as circular cuts on small agar discs of about (5 mm Ø) to five individuals of tested mite in plastic cups of (1.5 cm high x 2.5 cm in diameter) for five replicates to each fungus. The culture cups were pre-equipped; filled to their half by a layer of plaster of Paris "gypsum-charcoal" mix in a ratio (9:1). The surfaces of the medium were covered by filter paper perforated with non-deep hole. Finally, all culture vials were incubated in the dark at room temperature and moistened at 3-day intervals with 1 ml of distilled water to keep the humidity at a constant level (Schneider and Maraun, 2005).

Palatability of offered fungi to tested mite was examined daily by counting the number of fecal pellets deposited in close vicinity to each fungus. The breeding behavior and postembryonic development of tested oribatid mite were recorded weekly. The various developmental stages and total duration in days from egg to adult were monitored.

For statistical analysis, the relationship between preferability and suitability of the fungus for sustaining tested mite population growth was analyzed by (Pearson's correlation co-efficient). Developmental period of different stages and oviposition were determined.

Results and discussion

1.Feeding behavior of tested mite:

Data obtained showed that, there are nine species of fungi inhabit tested soil samples including; *Rhizoctonia solani, Alternaria alternata, Fusarium oxisporium, Aspergillus fumigates, Penicillium italicum, Penicillium digitatum, Aspergillus niger, Trichderma viride and Verticellium lecanii.*

Results showed a remarked difference in the palatability of offered fungi (Figure, 1). However, culture cups containing *R. solani* and *A. alternata* showed the highest consumption rates to tested mite among all offered fungi as indicated by the number of fecal pellets excreted, while *F. oxisporium* showed intermediate preferences. Finally, species of *A. fumigates, P. italicum, P. digitatum, A. niger, T. viride* and *V. lecanii* respectively showed less or no palatability. Furthermore, culture vials containing *R. solani* and *A. alternata* food items were renewed twice a week with no starvation occurs under filter paper substrate. While the plastic vials containing less preferred fungi were no renewed for long time. Tested mite when obligated to feed on a certain type of fungi of less or no palatability; they showed more starvation under filter paper and some mortality occurred in culture jars of *T. viride* and *V. lecanii* where they captured in the fungal threads. These results are compatible with study of Hartenstein (1962) who reported that, *N. biciliatus,* markedly differ in their feeding reactions to different foods, however rejected feeding on *Penicillium* sp. and *Aspergillus fumigatus*. Furthermore Saichuae *et al.* (1972) reported that *N. biciliatus* preferred feeding on yeasts and *Alternaria* sp. during their study.

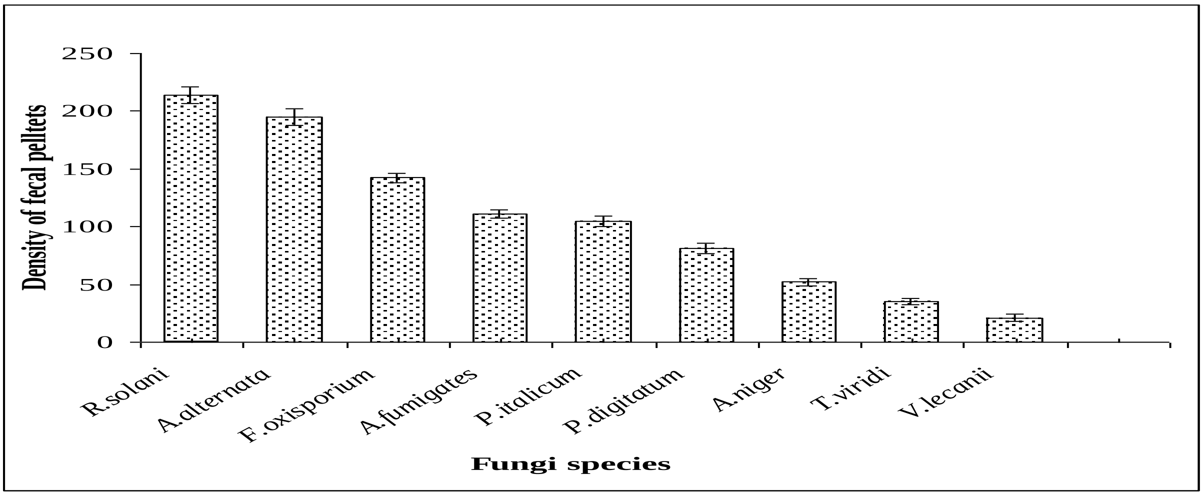

Figure (1): Numbers of fecal pellets deposited by *Nothrus silvestris* mite per day when feeding on nine different fungi in the rearing vials **(**Data are mean of five replicates ± standard deviation**)**

2. Developmental pattern of tested mite under different feeding guilds:

Some measure of the effect of suitable diets on the fecundity of *N. silvestris* was obtained in the following experiment, the palatable fungi *R. solani* and *A. alternata* showed high suitability for sustaining good growth of tested mite. Slight changes in developmental pattern may be observed among unpalatable fungi when concerned for sustaining growth of the tested mite. They showed low numbers of eggs and larvae and without any protonymphs, with respect to the mortality of some adults of mite in the rearing vials.

Figure (2) showed the relationship [positive correlation (Pearson's correlation coefficient) R^2= 0.93, P < 0.005] between preferability of tested fungi as food items and their suitability for sustaining good growth of *N. silvestris* mite. That is evaluated when the number of fecal pellets deposited on each fungus and the number of emerged instars on each fungus after 30 days of rearing. Additional points should be noted. Firstly, some foods, such as *F. oxisporium, A. fumigates* did not support good mite growth and development in spite of being consumed.

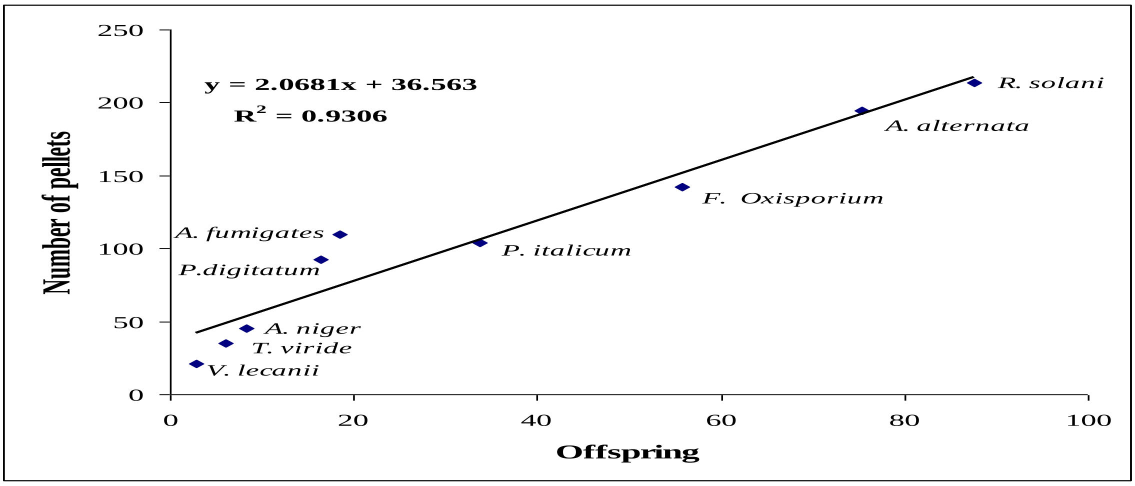

Figure (2): The relationship between preferabilty of nine tested fungi and their suitability to support growth of *Nothrus silvestris* mite (data the number of fecal pellets deposited from feeding on each fungus against the number of all offspring formed on each fungus after 30 days of rearing).

3.Immature survival and developmental times:

The developmental stages of *N. silvestris* include egg, larva, protonymph and deutonymph and tritonymph, each growth stage was determined by the presence of exuviae. The duration (in days) of egg and larval stage was the lowest, the deutonymphal and tritonymphal stages were the highest and are of approximately equal duration (Table, 1). The average life span of adults reared on *R. solani* was 220.51±0.09. The experiment was carried out at room temperature. The developmental period of *N. silvestris* was long to that reported for this species. No mortality was found on immature stages, which indicates the high possibility of survivorship of immature stages of *N. silvestris*. Some mortality of *N. silvestris* found on *A. niger T. viride and V. lecanii* due to starvation. A white colored integument on dorsal surface of *N. silvestris* was observed on *R. solani* food. This difference may be determined by variations on abiotic conditions, food intake and age.

Table (1): Duration (in days) of developmental stages of *Nothrus silvestris* feed on *Rhizoctonia solani*

Developmental stages	Number	Development time (days)
Egg	3.1±0.05	2.30±0.15
Larva	4.3±0.19	8.26±0.17
Protonymph	13.2±0.11	14.19±0.21
Deutonymph	20.05±0.12	23.12±0.34
Tritonymph	26.04±0.09	27.31±0.09
Life cycle		75.18±0.093
Life span		220.51±0.09

4. Adult life parameters:

The biological parameters of adults, preoviposition period together with other female adult periods and longevity are shown on (Table, 2). Preoviposition lasted for 9-11 days. Oviposition occurring approximately 5 weeks, and oviposited 4 months after emergence of the adult. The longevity of females' *N. silvestris* was 145.33± 0.34 days. The first eggs were laid approximately within the fifth or sixth day of rearing. The average number of eggs laid per female was 2-4 eggs per time. Adult of *N. silvestris* reached the highest rate of egg lying on the tenth day. All mites used in this experiment laid eggs, indicating that *N. silvestris* is thelytokous. The average pre-oviposition, oviposition and post-oviposition periods were 9.55±0.34, 121.78 ± 0.85and 14 ± 0.18 days, respectively. Survival rates of adults were very high; the longest-lived individual died at 145 day.

Table (2): Duration (in days) of preoviposition, oviposition and postoviposition periods, longevity (days) of adult *Nothrus silvestris* on *Rhizoctonia solani*.

Stage	Mean ± SD
Preoviposition	9.55±0.34
Oviposition	121.78 ± 0.85
Postoviposition	14 ± 0.18
Longevity	145.33± 0.34
Generation period	84.73± 0.17

In a brief description of the general features of *N. silvestris* adults; they have a strong and dark exoskeleton with distinct ventral marks and plates (Photo, 1). The newly emerged instars are dramatically different than adult and appear to vary in size. Larva is having small body, which is creamy white in color, body is soft and without any sclerotization, it also possessed three pairs of legs and is very sluggish in movement (Photo, 2). Protonymph is easily distinguished from larva by its larger body size, body is creamy in color, and integument is ornamented with some punctations and possessed four pairs of legs (Photo, 3). Deutonymph is distinguished by its slightly bigger size with four pairs of legs, integument is provided with more punctations and possessed long notogastral setae (Photo, 4). Finally, Tritonymph is characterized by its larger body size, the notogastral setae is longer and body is more turgid and colored pale brown (Photo, 5). Fecal pellets of *N. silvestris* deposited from feeding on *R. solani* within feeding cups were examined in (Photo, 6) consisted of crushed hyphae of fungus, fungal propagules within food bolus and mucoid substance. Photo (7) showed the adult and immatures of *N. silvestris* mite while wondering on the filter paper substarate of the feeding vials. Emerged immature of *N. silvestris* emerged from feeding on fungal food cut were showed in Photo (8).

That is important to understand the niche differentiation between oribatid mite species according to the availability of their preferred food in their habitat and the influence of oribatid mite species on the dispersion of its relative soil fungi. Binding the relationship between palatability of the fungus as food item and its suitability to support mite's population growth is important in regulating the soil ecosystem and improving soil quality.

It is concluded that the present work about the biology and feeding behavior of *N. silvestris* has contributed to increase knowledge about this mite and its potential as a beneficial mite in soil fertility, but many aspects need further study to fully use its potential in soil improvement. The effect of palatability and suitability of a fungus for sustaining mite population growth is an important issue to elucidate the possible high species richness of tested oribatid mite in soil in relation to availability of their preferred fungi in their niche

Photo (1): Microscopic photo of adult *Nothrus silvestris* mite.

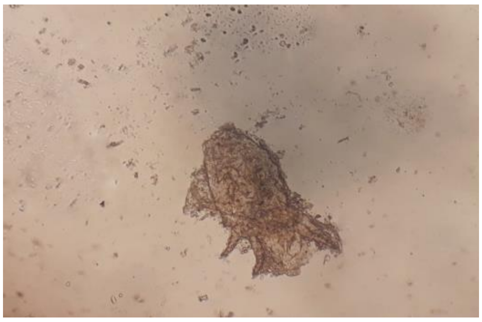

Photo (2): Newly emerged hexapod larva of *Nothrus silvestris* at 20x magnification

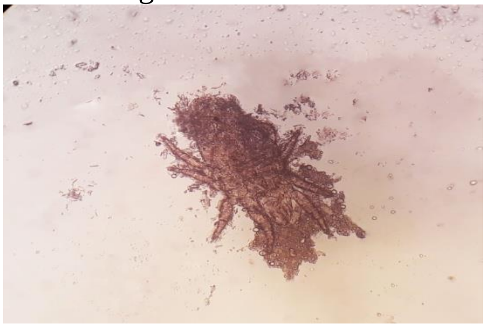

Photo (3): The octapod protonymph stage of *Nothrus silvestris*. At 20x magnification**.**

Photo (4): The octapod deutonymph stage of *Nothrus silvestris* at 20x magnification

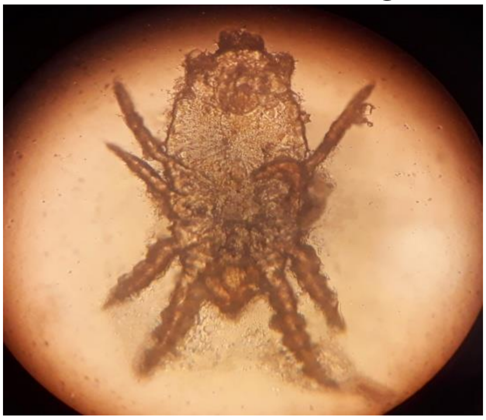

Photo (5): The octapod tritonymph stage of *Nothrus silvestris* at 20x magnification

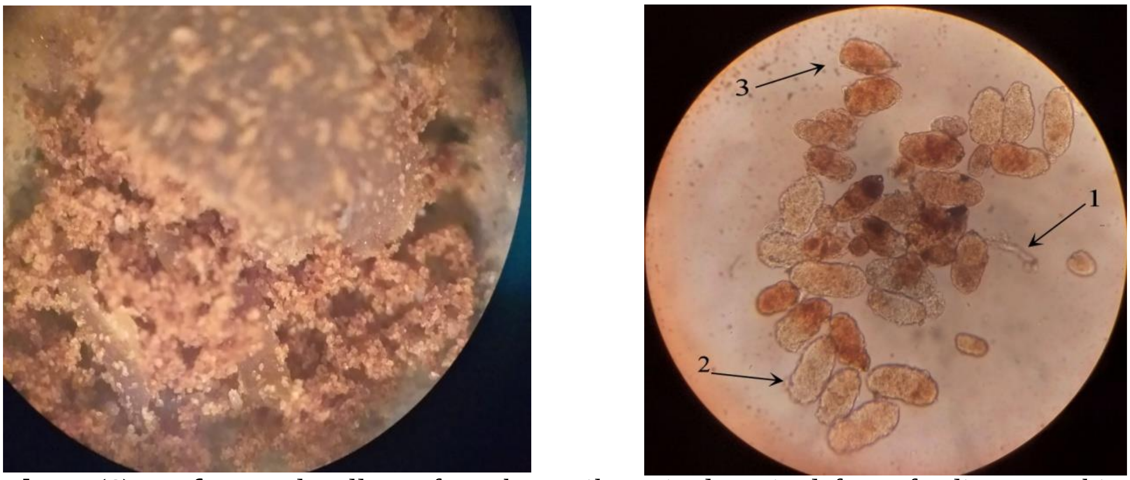

Photo (6): Left: Fecal pellets of *Nothrus silvestris* deposited from feeding on *Rhizoctonia solani,* consisted of (1) crushed hyphae (2) food bolus consisting of fungal propagules (3) mucoid substance at 20x magnification. **Right:** Fecal pellets of *Nothrus silvestris* deposited on *Rhizoctonia solani* within feeding cups, at 4x magnification

Photo (7): Adult and immature of *Nothrus silvestris* mite while wondering on the filter paper substarate of the feeding vials at 4x magnification

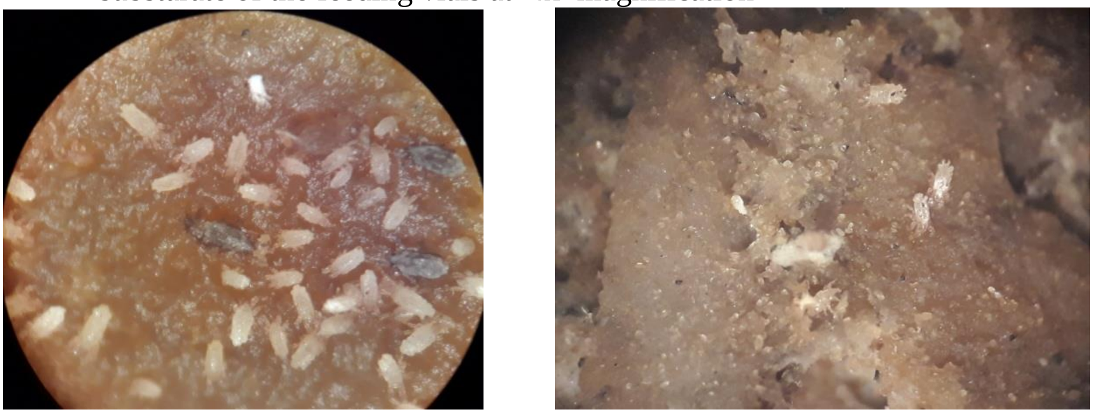

Photo 8): Emerged immature of *Nothrus silvestris* on fungal food cut at 4x magnification.

References

Behan-Pelletier, V.M. (1999): Oribatid mite biodiversity in agro-ecosystems: role for bioindication. Agriculture, Ecosystems and Environment, 74**:** 411-423.

Crossley, D.A. Jr. (1977): Oribatid mites and nutrient cycling. In: Dindal, D.L. (Ed.), Biology of Oribatid Mites. State University of New York, Syracuse, 71 pp.

Enami, Y. and Nakamura, Y. (1996): Influence of *Scheloribates azumaensis* (Acari: Oribatida) on *Rhizoctonia solani*, the cause of radish root rot. Pedobiol., 40**:** 251-254.

Gilman, J.C. (1957): A manual of soil fungi. The Iowa State College Press, Iowa, USA, 450 pp.

Hartenstein, R. (1962): Soil Oribatei. V. Investigation on *Platynothrus peltifer* (Acarina; Camisiidae). Annals of the Entomological Society of America, 5**:** 709-713.

Krantz, G.W. (1978): A Manual of Acarology 2[nd]. Edition. Oregon State University Book Stores, Inc., Corvallis, 509 pp.

Norton, R.A. (1994): Evolutionary aspects of oribatid mite life histories and consequences for the origin of the Astigmata. In: Houck, M. (Ed.) Mites Ecological and evolutionary analyses of lifehistory patterns. Chapman and Hall, New York, 99–135pp.

Norton, R.A.; Kethley, J.B.; Johnston, D.E. and Connor, B.M.O. (1993): Phylogenetic perspectives on genetic systems and reproductive modes in mites. In Wrensch and Ebbert, 8-99.

Saichuae, P.; Gerson, U. and Henis, Y. (1972): Observations on the Feeding and Life History of the Mite *Nothrus Biciliatus* (KOCH). *Soil Biol. Biochem*. Vol. 4, pp. 155-164. Pergamon Press. Printed in Great Britain.

Schneider, K. and Maraun, M. (2005): Feeding preferences among dark pigmented fungi (“Dematiacea”) indicate trophic niche differentiation of oribatid mites. Pedobiol., 49**:** 61 – 67.

Siepel, H. (1990): Niche relationships between two panphytophagous soil mites, *Nothrus silvestris* Nicolet (Acari: Oribatida, Nothridae) and *Platynothrus peltifer* (Koch) (Acari: Oribatida, Camissidae). Biology Fertility Soils, 9:139–144.

Walter, D.E. and Behan-Pelletier, V. (1999): Mites in forest canopies: filling the size distribution shortfall. Ann. Rev. Entomol., 44:1–19.