ACAROFAUNA OF A NEGEV DESERT LOES PLAIN

BY Y. STEINBERGER [1]

SOIL MITES
NEGEV DESERT
ANNUAL AND PERENNIAL PLANTS
MOISTURE

ABSTRACT : The faunal composition and the changes in soil microarthropod populations associated with buried litter of perennial shrub *Hammada scoparia* and annual plant *Sasola inermis*, in the Negev desert, were described. Maximum population densities of soil microarthropods around *H. scoparia* occured in March (26,500 individuals m^{-2}) and around *S. inermis* occured in April (22,700 individuals m^{-2}). Lowest densities occured in September (446 m^{-2} and 223 m^{-2} near *S. inermis* and *H. scoparia*, respectively). These densities were 45 % to 50 % lower than those reported from a clay loam soil in a North American desert. Prostigmatid mites made up to 98 % of the total microarthropod population. Overall densities of microarthropod groups were correlated with soil moisture, but many individual taxa were not. The most numérous and frequently occuring taxa were tydeid and nanorchestid mites (Prostigmata), which are common in all North American deserts.

ACARIENS DU SOL
DÉSERT DU NEGEV
PLANTES ANNUELLES ET VIVACES
HUMIDITÉ

RÉSUMÉ : La composition faunistique et les variations de population des microarthropodes du sol associés à la litière enfouie de l'arbuste vivace *Hammada scoparia* et de la plante annuelle *Sasola inermis* dans le désert du Negev sont décrites. Les densités maxima de population des microarthropodes du sol se produisent en Mars (26,500 individus m^2) autour d'*H. scoparia* et en Avril (22,700 individus m^2) autour de *S. inermis* Les densités les plus faibles se produisent en Septembre (respectivement, 446 m^2 et 223 m^2 près de *S. inermis* et de *H. scoparia*). Ces densités sont de 45 % à 50 % plus faibles que celles relevées dans un sol d'argile et de glaise d'un désert Nord Américain. Les Prostigmates constituent 98 % du total de la population des microarthropodes. L'ensemble des densités des groupes de microarthropodes est en corrélation avec l'humidité du sol, mais de nombreux taxa pris individuellement ne le sont pas. Les taxa les plus nombreux et les plus fréquents sont les tydeides et les nanorchestides (Prostigmata), lesquels sont communs dans tous les déserts Nord Américains.

INTRODUCTION

There is limited data on soil microarthropod population in desert soils with most information on microarthropods in North American deserts (WOOD, 1971 ; WALLWORK, 1972 ; FRANCO *et al.*, 1979 ; SANTOS *et al.*, 1978 ; WALLWORK *et al.*, 1985 ; KAMILL *et al.*, 1985). Descriptive and experimental studies have shown that desert soils are dominated by prostigmatid mites and that population size variation is a function of soil organic matter more than water (SANTOS *et al.*, 1978 ; STEINBERGER *et al.*, 1984 ; WHITFORD *et al.*, 1986).

Because of the importance of degree of convergence in biota and processes for extrapolating data from one area to another of the world, we undertook a study of the microarthropods associated with decaying buried litter in the Negev Desert, Israel. The data from this study provides a direct comparison with that of SANTOS and WHITFORD (1981) and indirect comparisons with other studies of soil microarthropods in North American deserts.

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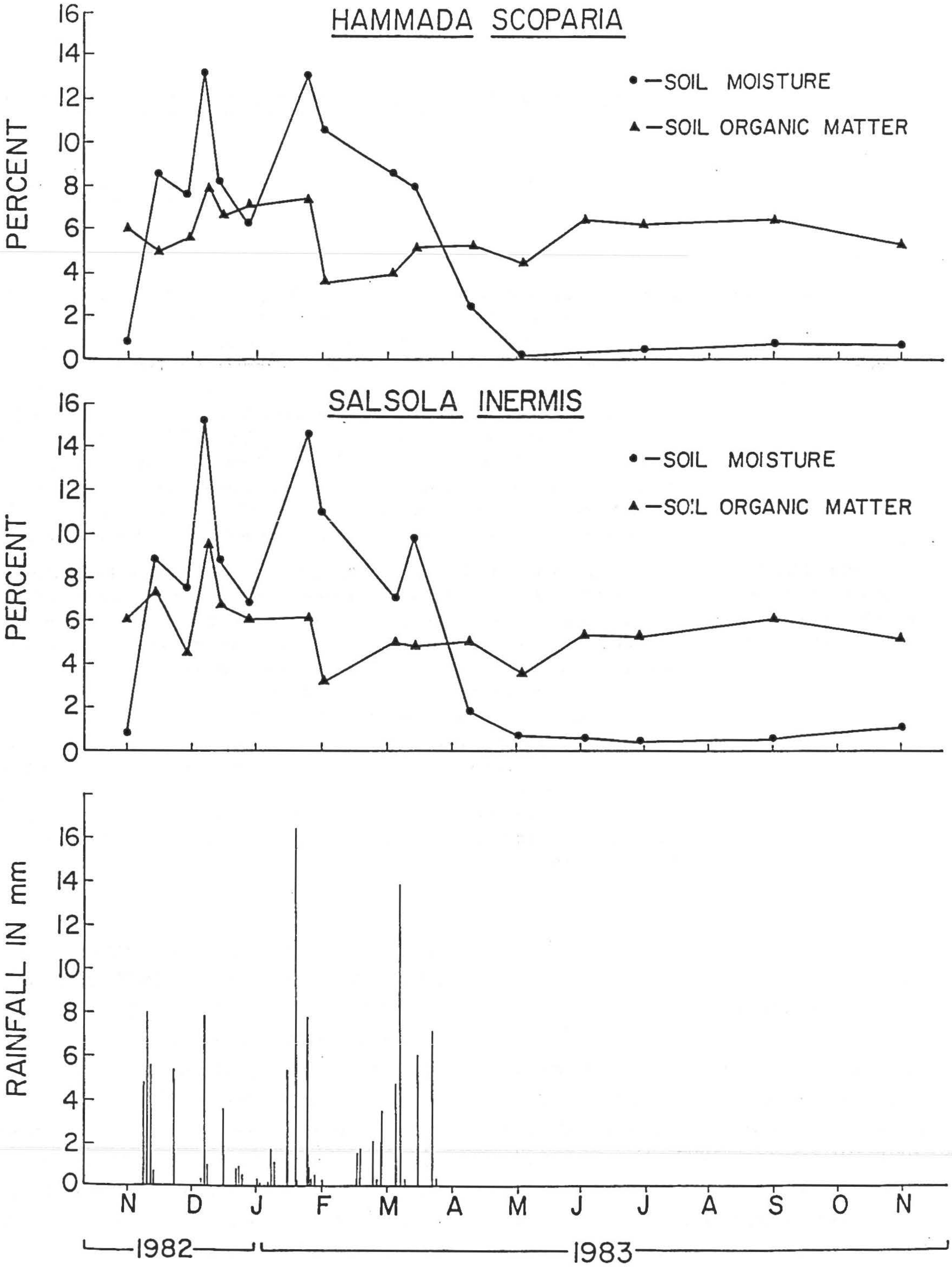

FIG. 1 : Rainfall distribution and percent soil water and organic matter content near the annual and perennial plants during the study period of 1982-1983.

Study site

The study area is located in the central Negev highland near the Avdat Farm (elevation about 600 m). The central Negev highland has a temperate desert climate, i.e., cool winters (mean/max 14.8°C ; mean/min 5.4° in January) and hot summers (mean/max 32.0°C ; mean/min 17.7° in June). Average annual rainfall is 89 mm (Avdat Station), fluctuating from 29 mm in an extreme drought year to 183 mm in a wet year. Rainfall occurs in scattered showers only during winter (November-April). An additional source of moisture in this desert is dew, which falls most heavily during the autumn months (September-November). Up to 37 mm of water from condensation can occur annually, but this figure is somewhat deceptive, since much of the dew evaporates as soon as the sun rises. The annual evaporation rate is 2615 mm (Evenari *et al.*, 1982).

The soils are brown, shallow rocky desert soils (" brown lithosols "), loessial, and gray desert soils (loessial serozems) (Dan *et al.*, 1962). These studies were conducted on a loess plain area. The dominant perennial shrubs found in the soil, although poor in organic matter and dry for much of the year, are the *Hammada scoparia* and *Zygophyllum dumosum*. Between these many different annual plants can be found.

Methods

Soils samples, 301.35 cm^3, (core diameter 6.3 cm, depth 10 cm), were collected near buried litter bags containing either *Salsola inermis* or *Hammada*

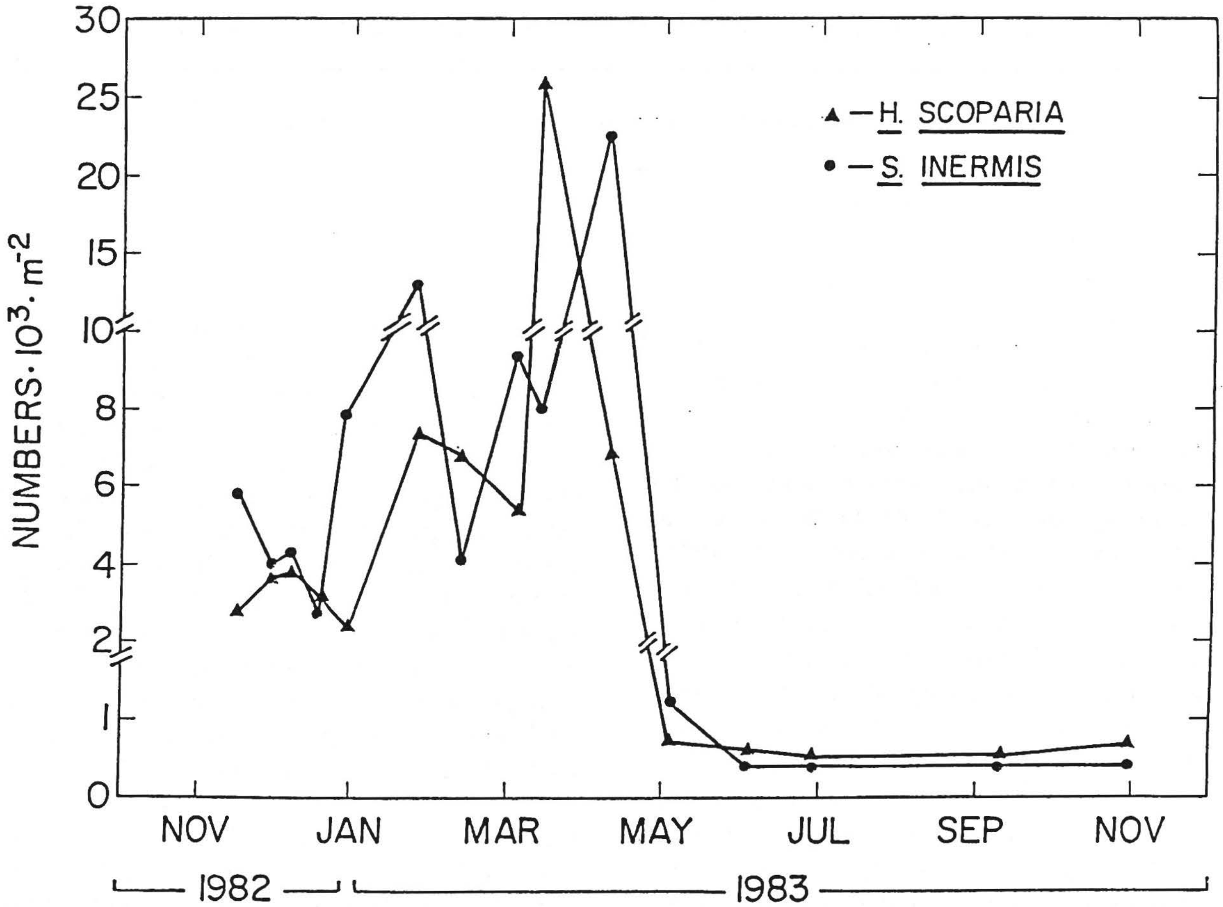

Fig. 2 : Annual variation in average population densities of mites in soil near *H. scoparia* and *S. inermis* in the Negev Desert.

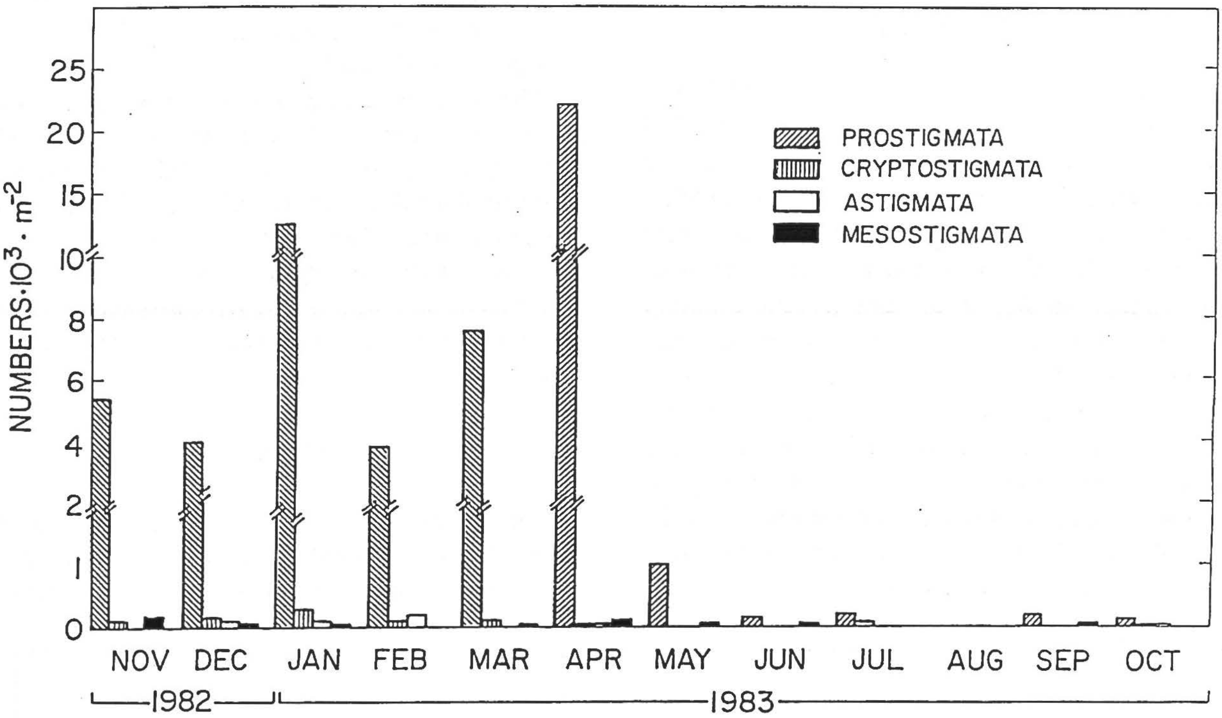

FIG. 3 : Annual variation in population densities of four orders of soil acari in soil in vicinity of *S. inermis*.

scoparia litter bags (STEINBERGER and WHITFORD 1988). During the winter following a rain of 5 mm or greater, soil samples were collected 10 and 20 days after the rain.

Fifteen soil samples were collected monthly. Samples were placed in plastic bags and transported to the laboratory in an insulated container.

Microarthropods were extrated into water in a modified Tullgren funnel. The extration provided a temperature gradient of 38-31°C in the soil column and a humidity gradient (SANTOS *et al.,* 1978). Samples were counted immediately after extraction. Representatives of each taxon were mounted in Hoyers and kept in reference collection.

The soil samples were weighed immediately upon return to the laboratory and afterwards they were dried at 60°C for a minimum of 72 h to measure water content gravimetrically. The oven dried samples k were then burned in a muffle furnace at 490°C for 8 h to estimate the organic matter. Rainfall was measured in standard rain guages. All the data were analyzed by analysis of variance.

RESULTS

There were significant temporal differences in soil moisture content near bags containing the *H. scoparia* and *S. inermis* litter. The soil water content between November and March was significantly higher (p. ?SO? 0.05) than between April and October (Fig. 1). There were no significant differences in organic matter content during the year. The organic matter content of the soil around the litter bags at a depth of 10 cm was x = 5,67 + 2.24 and x = 5.84 + 2.24 for *S. inermis* and *H. scoparia* respectively. The increase in soil water content corresponds with the rainy season period. During the November-April months, 37 rain events and a total rainfall of 122.9 mm occurred (Fig. 1).

Microarthropod population density increased during the winter between November 1982 and April 1983 to a mean maximum size of 26,477 m^{-2} under the perennial shrub *H. scoparia* and 22,723 m^{-2} under the annual *S. inermis* (Fig. 2). Over the dry

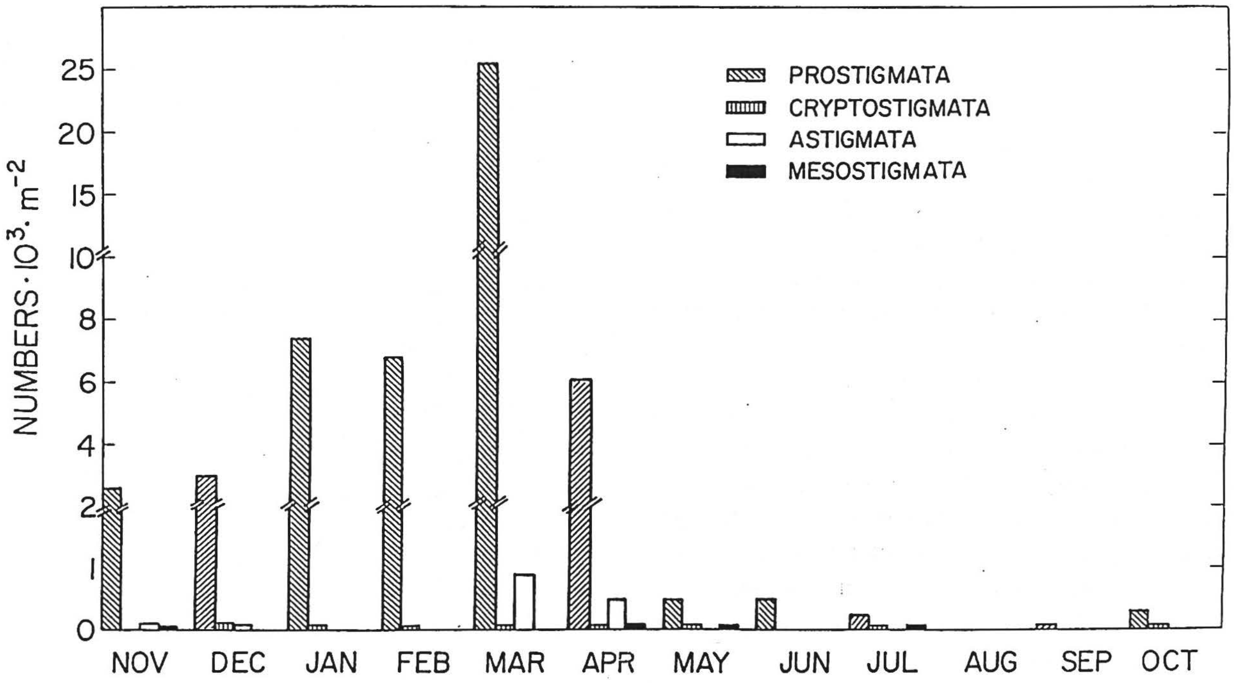

FIG. 4 : Annual variation in population densities of four orders of soil acari in soil in vicinity of *H. scoparia.*

summer the population densities declined markedly to a range of 200 to 400 microarthropods m^{-2}. There were no significant différences in population densities association with litter type. There was a significant water — total microarthropod populations being most affected by the soil water content during the season ($F = 8.14$ $p < 0.005$).

The soil microarthropod fauna of the Negev is dominated by prostigmatid mites. Prostigmatid mites in soil near the annual and pernnial plant litter bags made up 97 % of the total population (Fig. 3,4). Near the annual plant *S. inermis* a peak population density of 12,700 to 22,100 m^{-2} between January and April (Fig. 3) was obtained. Cryptostigmatids, mesostigmatids and the astigmatids accounted for 6%, 1%, and 5 % of the total population respectively. In the vicinity of *H. scoparia* the highest prostigmatid mite population of 26,000 individuals m^{-2} occurred in March (Fig. 4).

There was a significant correlation between the population densities of cryptostigmatids, and astigmatid mites and the soil water content $p < 0.05$ in the vicinity of *S. inermis* litter bags (Tab. 1). In the vicinity of *H. scoparia* litter bags there was a significant correlation between the prostigmatid mites and the soil water content ($p < 0.01$) (Tab. 1).

Four families (Tydeidae, Nanorchestidae, Caligonellidae and Raphignathidae) of the 12 prostigmatid families, one family (Aphelacaridae) from a total of four cryptostigmatid families and only one family (Rhodararidae and Acaridae) from the mesostigmatids and astigmatids respectively occurred at a frequency between 0.5-1.0 (Table 1) in the soil in the vicinity of *S. inermis.* The population densities of the prostigmatid families, Tydeidae, Nanorchestidae and Raphignathidae, were significantly related to the soil water content as were the cryptostigmatic *Oribatula* and the astigmata Acaridae.

Near the perennial shrub *H. Scoparia* only three (Tydeidae, Nanorchestidae and Raphignatidae) from the total of 12 families of prostigmatids occurred at a frequency between 0.5-1.0 (Tab. 1).

Discussion

The seasonal fluctuations in population sizes of the soil microarthropods were similar to the data reported by STEINBERGER and WHITFORD (1984, 1985) for soil microarthropod populations in sandy soils on a desert watershed and for a desert tabosa grass *Hilaria mutica* swale in the Chihuahuan Desert.

Microarthropod population densities are large and in the range of those reported in the Mohave and Chihuahuan desert in the U.S. (FRANCO *et al.*, 1978, STEINBERGER and WHITFORD 1984). In the North American deserts mesostigmatids and cryptostigmatids frequently account for 30 % or more of the total microarthropod population, but in the Negev soils they rarely account for such a large fraction of the populations. Additionally, the populations of prostigmatids exhibited marked seasonal fluctuations while the population densities of mesostigmatids and cryptostigmatids remained relatively constant.

When we examined the percent composition of the microarthropod fauna in the soil adjacent to the decaying litter, we found some general patterns that are comparable to those described by SANTOS and WHITFORD (1981) in buried litter (Tab. 1). The soil microarthropod fauna was dominated by tydeid, group that appears to be important as initial colonizers of organic materials in North American deserts (SANTOS *et al.*, 1983). By day 133, there had been an average mass loss of about 30 % in the litter types and treatments (see STEINBERGER and WHITFORD 1988).

The correlation of population size and soil moisture present a universal pattern similar to that reported by STEINBERGER and WHITFORD (1985) for the desert tabosa swale with a summer and winter rainfall. The data completely supports the hypotheses concerning responses of total microarthropods during the drying following the rain, but no correlation was obtained between the total soil microarthropod population and soil water content for either plant litter type.

TABLE 1 : Frequency of occurrence of soil mite taxa in soil taken near *Hammada scoparia* and *Salsola inermis* in the Negev Desert. Pearson Correlation coefficients, are given for taxa in which there was a significant correlation between population densities and soil water content over the one year sampling.

TAXON	FREQUENCY	
ACARI	*S. inermis*	H. scoparia
PROSTIGMATA		$p < 0.01$
Tydeidae - *Tydeus* sp.	0.9 $p < .0002$	0.0 $p < .002$
Nanorchestidae	0.8 $p < .0001$	0.8 $p < .008$
Speleorchestes sp.		
Nanorchestes sp.		
Raphignathidae - *Raphignathus* sp.	0.6 $p < .04$	0.8
Pygmephoridae - *Bakerdania* sp.	0.3	0.4
Linotetranidae - *Linotetranus*sp.	0.3	0.2
Anystidae -Erythracarinae	0.3	0.2
Tarsonemidae - *Tarsonemus* sp.	0.3	0.1
Scutacaridae	0.1	
Caligonellidae - *Molothrognathus.*	0.7	0.3
Cunaxidae - *Cunaxoides* sp.	0.2	0.3
Nematalcyidae - *Gordialycus* sp.	0.2	0.4 $p < .04$
Bdellidae	0.3	0.3
Spinibdellinae		
Cytinae		
CRYPTOSTIGMATA	$p < 0.007$	
Aphelacaridae -*Aphelacarus* sp.	0.5	—
Passalozetidae - *Passalozetes.*	0.1	0.1
Oribatulidae - *Zygoribatula* sp.	0.3 $p < .004$	0.3
Haplochthoniidae		
Haplochthonius sp.	0.1	—
Cosmochthonius.	0.2	—
MESOSTIGMATA		
Rhodacaridae	0.6	0.3
ASTIGMATA		
Acaridae	0.6 $p < .05$	0.3

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