Pedobiologia 33, 79–86 (1989)
VEB Gustav Fischer Verlag Jena

[1]) Department of Biology, New Mexico State University, Las Cruces, New Mexico, U.S.A., and [2]) Departamento de Biologia y Quimica, Universidad de La Serena, La Serena, Chile

The relationships between abiotic factors and the abundance patterns of soil microarthropods on a desert watershed

JORGE G. CEPEDA[2]) and WALTER G. WHITFORD[1])

(Accepted: 88-09-14)

1. Introduction

A number of authors have reported the influence of abiotic parameters on the spatial and temporal distribution of soil microarthropods (REDDY, 1984; MALLOW *et al.*, 1984; STREIT, 1982; ANDERSON & HALL, 1977; USHER, 1976). It is clear from these studies that microarthropods respond differentially to the environmental factors. USHER (1976) and USHER *et al.* (1982) stressed the importance of the distribution of food resources and soil moisture. SCHENKER (1984), working in a mixed deciduous forest soil, found few statistically significant correlations; although the relations between microarthropods and soil features seemed apparent.

In deserts, the abiotic effects of climatic extremes of soil moisture and temperature are believed to drive many biotical processes taking place in the soil system (WALLWORK, 1982). The effect of these variables and organic matter on desert soil microfauna has been studied in different ways. SANTOS *et al.* (1987) reported highly significant correlations between mass of surface litter and density of microarthropods. STEINBERGER & WHITFORD (1984) found correlations between total microarthropods and soil moisture but the significance of these correlations depended upon site and season. Surveying a desert swale, STEINBERGER & WHITFORD (1985) observed that, whereas overall microarthropod abundance was correlated with soil moisture, some species-populations were not. WALLWORK *et al.* (1984), working with simulated rainfall, showed that a continuous irrigation regime caused changes in the reproductive patterns of some species of oribatids, but not in others. WHITFORD *et al.* (1981) observed an increase in numbers and diversity of microarthropods in surface litter within one hour after artificial wetting; nevertheless, a subsequent decrease followed in the still moist litter. STEINBERGER *et al.* (1984) concluded that water, in the absence of an adequate supply of organic matter, does not stimulate population increase of the soil fauna. McKAY *et al.* (1986) showed that soil temperature (or insolation) has a greater effect on overall microarthropod population densities than soil moisture. Thus most studies in deserts have focused on climatic variables and only marginally on soil properties. This study was designed to examine the relationships between abundance patterns of soil microarthropods and soil properties and climate in a northern Chihuahuan Desert ecosystem.

2. Study area

The work was conducted on the Jornada LTER site (30 °C 30′ N, 106° 45′ W) 40 km NNE of Las Cruces, New Mexico. The long-term[1]) average rainfall of the area is 225 mm $\times$ a^{-1}. Summers are hot with maximum air temperatures between 35–40 °C from mid-May to mid-September. Rainfall is predomminantly summer rainfall from convectional storms. Freezing temperatures frequently occur at night between October and March (HOUGHTON, 1972).

At the study site, two 3 km transects (nitrogen-treated and control), extend from the slopes of the Dona Ana Range downward into a playa, dry lake, crossing 7 vegetational zones (hereafter, sites). From the lower end of the transects to the upper end, these sites are named as: (1) playa, (2) playa fringe, (3) basin slope, (4) bajada, (5) lower piedmont, (6) upper piedmont, and (7) sotol rockland. Details of soil and vegetation patterns are in WIERENGA *et al.* (1987).

[1]) According SI the symbol a (for annus) is used instead of y (for year).

We studied abundance patterns of microarthropods along the control-transect both in mineral soil and in decomposing surface leaflitter of the following plant species: vine mesquite grass (*Panicum obtusum* H. B. K.), mesquite (*Prosopis glandulosa* TORR.), desert marigold (*Baileya multiradiata* HARV et GRAY), creosotebush [*Larrea tridentata* (DC) COVILLE], fluffgrass [*Erioneuron pulchellum* (H. B. K.) TAKEOKA], and black grama grass (*Bouteloua eriopoda* TORR.).

Abundance patterns in decomposing leaf-litter were monitored with litter-bags (15mm × 15 cm) constructed from fiberglass mesh (1.5 mm), and filled with 10.35 ± 0.15 g of air-dried litter. 930 pairs of litter-bags were apportioned on the 6 lower sites (155 pairs per site). The pairs were formed by one litter-bag filled with creosotebush leaf-litter and one with site-dominant litter-type.

The pairs, fastened to the soil surface with 8 cm nails, were placed under the canopy or close to plants of the site-dominant species, i. e., vine mesquite (playa), mesquite (playa fringe), snakeweed (basin slope), creosotebush (bajada), fluffgrass (lower piedmont) and black grama grass (upper piedmont). The litter-bags were laid out on both sides of the transect and dispersed on a small area (no larger than 30 mm × 20 m).

Litter-bags were retrieved biweekly in the growing season (August through October) and monthly during the remaining time. On each sampling date, five randomly selected pairs of bags per site were collected within 3 h after sunrise, placed in plastic bags, and carried to the laboratory in insulated containers. Simultaneously, 5 soil cores (5 cm diameter × 10 cm depth) were taken from the mineral soil underlying the litter-bag filled with site-dominant litter-type.

Sampling covered a period of 17 months, from August, 1984 to December, 1985. A total of 22 sets of samples was collected throughout the study. Each set was comprised of 60 litter-bags and 30 soil cores. Microarthropods were extracted following the procedure described by SANTOS *et al.* (1978).

The micrometeorological and soil data along the transect were supplied by the LTER-Research Program. These were soil organic matter, soil nitrogen content, *p*H, calcium carbonate (caliche), sand: clay ratio, all considered as site factors; maximum air temperature, minimum air temperature, difference (maximum−minimum) air temperature, mean air temperature, weekly rainfall, and soil moisture (as measured at 30 cm depth) all considered as seasonal factors. To inspect the effect of seasonal factors the period was divided into five "seasons" according to rainfall predictability: summer-wet, 1984 (from August 6 to October 29), winter, 1984 (from November 26 to March 26, 1985) summer-dry, 1985 (from April 23 to July 9), summer-wet, 1985 (from July 23 to October 1), and winter, 1985 (from October 29 to December 22).

The relationships between abundance and abiotic variables were assessed with multiple linear regressions that were conducted with the $\log_{10}$ transformed abundance data and, in the case of seasonal factors, with the seasonal means.

3. Results

Variations in abundance of the most common higher taxa were partially explained by different combinations of environmental factors (table 1). Additionally, the multiple linear R^2 was relatively low, ranging from 41.2 % (prostigmatid mites) to 65.0 % (oribatid mites). In general, while the most important site factors were soil nitrogen content, *p*H, calcium carbonate, and the sand: clay ratio, the most important seasonal factors were soil moisture and minimum air temperature. Nevertheless, none of these factors were consistent as descriptors of the observed changes in abundance.

Air minimum temperature (seasonal mean) appeared as important for prostigmatid mites as a group in mineral soil, but not in litter where *p*H emerged as more important. Soil moisture was important for oribatid mites in mineral soil, but it was displaced by soil nitrogen in litter (table 1). For collembolans, the sand: clay ratio was important in mineral soil; however, calcium carbonate became the most important one in litter.

Changes in abundance of the most common species of soil microarthropods in the watershed were better described by the linear multiple regressions than those of higher taxa (table 2). Total R^2 ranged from 9.7 % to 90.2 % (*Tydeus sp.* mineral soil and litter, respectively). In general, higher total R^2's were observed in litter than in mineral soil.

As mentioned for higher taxa, a different set of abiotic variables partially explained the observed temporal changes in abundance of the most common species. The most important seasonal factors were air temperature and soil moisture (table 2). The most important site factors were soil organic matter, soil nitrogen, calcium carbonate and the sand: clay ratio.

Tables 3 and 4 summarize the relative importance of the abiotic factors in explaining the observed changes in abundance. Calcium carbonate (caliche), minimum air temperature, and soil moisture appeared as the most important factors in mineral soil. In contrast, the most important

Table 1. Total and partial R^2 of linear multiple regression analysis (stepwise procedure) of microarthropod abundance (higher taxa) on seasonal and site variables, along the LTER Jornada Site (control-transect)[a].

Taxa	habitat	OM	CA	N	PH	SACL	TMAX	TMIN	WR	SM	TAVE	TDIF	Total R^2
Prostigmata	soil	–	–	–	–	–	–	41.18	–	–	–	–	41.18
	litter	–	5.00	–	30.00	–	6.20	–	–	–	–	–	41.20
Cryptostigmata	soil	–	–	–	8.00	–	–	–	–	57.00	–	–	65.00
	litter	–	–	44.00	–	–	–	–	4.66	–	–	–	48.66
Collembola	soil	–	9.05	–	–	36.64	–	–	–	–	4.89	–	50.27
	litter	–	21.05	–	–	–	10.00	–	11.00	–	–	–	42.00

[a] **Code:** OM: soil organic matter; CA: calcium carbonate; N: nitrogen content; PH: pH; SACL: sand-clay ratio; TMAX: maximum air temperature; TMIN: minimum air temperature; WR: weekly rainfall; SM: soil moisture (at 30cm depth); TAVE: average air temperature; TDIF: TMAX – TMIN. Litter corresponds to site-dominant litter-type. The analysis was conducted with the seasonal means. Criterion for variable selection: 10.0%.

Table 2. Total and partial R^2 of linear multiple regression analysis (stepwise procedure) of microarthropod abundance (most common species) on seasonal and site variables, along the LTER Jornada Site (control-transect)[a].

Taxa	habitat	OM	CA	N	PH	SACL	TMAX	TMIN	WR	SM	TAVE	TDIF	Total R^2
Siteroptes sp.	soil	–	–	10.57	–	44.09	–	–	–	–	–	–	54.66
	litter	5.39	5.84	38.64	1.73	17.00	13.69	–	–	–	–	–	82.30
Brachystomella sp.	soil	–	11.07	–	–	–	–	36.22	8.67	6.37	–	–	62.30
	litter	–	42.62	–	–	–	–	–	–	5.94	6.15	–	54.71
Joshuella sp.	soil	5.43	–	–	–	–	–	–	–	53.23	–	58.66	
	litter	–	–	61.92	5.82	3.37	2.97	–	–	–	–	–	76.60
Liposcelis sp.	soil	–	8.41	–	–	–	–	7.2	–	–	23.44	–	39.05
	litter	–	16.06	–	–	–	–	–	5.22	–	–	29.10	50.18
Tydeus sp.	soil	–	–	–	–	–	–	–	–	–	–	9.68	9.68
	litter	14.64	19.00	37.00	11.00	8.57	–	–	–	–	–	–	90.21
Speleorchestes sp.	soil	–	–	–	–	–	–	32.61	–	–	–	–	32.31
	litter	–	–	3.94	–	15.08	3.54	–	–	–	–	40.75	63.31
Immature oribatids	soil	11.51	–	–	–	–	–	–	–	14.51	–	7.10	33.12
	litter	24.21	–	–	–	4.30	8.83	–	–	–	–	20.62	57.96

[a] **Code:** as in table 1.

Table 3. Relative importance of abiotic variables on the abundance distribution patterns of higher taxa and the most common "species" of soil microarthropods present in mineral soil along the LTER-Jornada Site (control-transect).

habitat	environmental factors										
	site factors					seasonal factors					
	OM	CA	N	PH	SACL	TMAX	TMIN	WR	SM	TAVE	TDIF
soil	INORC	COLLE	–	CRYPT	COLLE	PMO1P	PROST	EO1CL	CRYPT	COLLE	TYO1P
	GDO1C	EO1CL	–	PMO1P	–	–	EO1CL	–	EO1CL	LIPOS	INORC
	–	LIPOS	–	–	–	–	NNO2P	–	INORC	–	–
	–	–	–	–	–	–	–	–	GDO1C	–	–

Survey covered a period of 17 months, from August, 1984 through December, 1985[a].

[a] Code for abiotic variables as in table 1. Code for microarthropods as follows: PROST: Prostigmata; CRYPT: Cryptostigmata; COLLE: Collembola; INORC: Immature oribatids; TYO1P: *Tydeus sp.*; NNO2P: *Speleorchestes sp.*; PMO1P: *Siteroptes sp.*; GDO1C: *Joshuella sp.*; EO1CL: *Brachystomella sp.*; LIPOS: *Liposcelis sp.*

Table 4. Relative importance of environmental factors on the abundance distribution patterns of higher taxa and the most common "species" of soil microarthropods present in decomposing leaf-litter along the LTER-Jornada Site (control transect).

habitat	environmental factors										
	site factors					seasonal factors					
	OM	CA	N	PH	SACL	TMAX	TMIN	WR	SM	TAVE	TDIF
litter	TYO1P	PROST	CRYPT	PROST	TYO1P	PROST	GDO1C	CRYPT	EO1CL	EO1CL	NNO2P
	PMO1P	COLLE	TYO1P	TYO1P	NNO2P	COLLE	–	COLLE	–	–	INORC
	INORC	TYO1P	NNO2P	PMO1P	PMO1P	NNO2P	–	LIPOS	–	–	LIPOS
	–	PMO1P	PMO1P	GDO1P	INORC	PMO1P	–	–	–	–	–
	–	COLLE	GDO1C	–	GDO1C	INORC	–	–	–	–	–
	–	LIPOS	–	–	–	GDO1C	–	–	–	–	–

Survey covered a period of 17 months, from August, 1984 through December, 1985[a].

[a] Code for environmental factors as in table 1. Code for microarthropods as in table 3.

factors in litter were calcium carbonate, soil nitrogen, maximum air temperature and the sand: clay ratio.

5. Discussion

Three general patterns emerged from the analyses. Different combinations of abiotic variables partially explained the variations in abundance associated with decomposing litter and the underlying mineral soil. Similarly, different sets explained the numerical fluctuations of higher taxa and species-populations. Seasonal and site factors were equally important in mineral soil; but site factors were more important than seasonal factors in litter.

In mineral soil, minimum air temperature (seasonal mean) was the only factor explaining the observed numerical changes of total prostigmatid mites. This finding compares with that reported by MacKay *et al.* (1986) who experimentally found an increase in microarthropod population density (mostly Prostigmata) in plots with reduced soil temperature. In our study, *p*H appeared as the most important site factor in litter, accounting for 30.0 % of the total variation. Reports on the direct and indirect effect of *p*H on soil microarthropods are conflicting. Luxton (1967), surveying a salt marsh, found negative correlations between microarthropod numbers and *p*H in all groups of mites; whereas Edwards & Lofty (1969) observed that an increase in *p*H increased the population density of some species of collembolans, but decreased the density of others. Hazra (1982, cited by Reddy 1984) recorded higher numbers in sites with approximately neutral *p*H. Soil acidity seems to affect fecundity, longevity, and development of several species of microarthropods (Hutson, 1978; Hågvar & Abrahamsen, 1980; Hågvar & Amundsen, 1981). We suggest that the effect of *p*H on desert soil prostigmatids are indirect, primarily affecting their food resources (e. g., fungi, bacteria, and algae).

At the species-population level, abiotic variables accounted for more of the variation of *Tydeus sp.* associated with surface litter than with mineral soil. In litter, the most important factors were soil organic matter, calcium carbonate, nitrogen content, and the sand: clay ratio. Soil organic matter and nitrogen were probably related to the food resources of tydeids. This finding supports the suggestions made by Kamill *et al.* (1985) that distribution of prostigmatids is food regulated. Additionally, Whitford *et al.* (1981) documented the daily vertical movement of tydeid populations. The effect of the sand: clay ratio detected in this study may be related to that phenomen. For *Speleorchestes sp.*, the results of this study agree with those reported by MacKay *et al.* (1986, 1987) and Steinberger and Whitford (1984). Air temperature accounted for most of the variation observed in *Speleorchestes sp.* populations both in surface litter and in the underlying mineral soil. Two abiotic factors (*p*H and maximum air temperature) explained almost 55.0 % of total variation of *Siteroptes sp.* in mineral soil. In litter, the most important factors were the sand: clay ratio, maximum air temperature, and soil nitrogen content. *Siteroptes sp.*, *Tydeus sp.*, and *Speleorchestes sp.* are in the prostigmatid families numerically well represented in desert soils. Thus, it is not surprising that basically the same array of abiotic parameters may affect their abundance patterns. Those parameters related to food distribution and vertical movements of the populations appear as the most important ones.

Variation in overall crytostigmatid mites in mineral soil was accounted for by *p*H (8.0 %) and by soil moisture (57.0%). Wallwork *et al.* (1986) and Kamill *et al.* (1985) experimentally documented the effect of soil moisture on oribatids. With few exceptions, these authors found that overall densities were higher in the rainfall amended plots than in the controls. They concluded that the most important effect of improved moisture conditions was to modify the leaf litter microclimate and the extent of egg production of the "seasonal breeders".

In our work, the proportion of R^2 accounted for by the abiotic parameters decreased in litter. Soil nitrogen was the most important variable, explaining 44.0 % of the total variation. Choudhri & Pande (1981 cited by Reddy 1984) reported a positive correlation between nitrate content and acarine populations in both upper and lower soil layers, but their results were inconsistent among sites. Usher (1976) and Koskenniemi & Huhta (1986) have suggested that a nitrogen effect may be related to microbial activity. Therefore the relationships between soil nitrogen and changes in oribatid numbers observed in this work may be due to a reflection of the relationship between nitrogen and food resources rather than to a direct effect.

Two factors (soil organic matter and soil moisture) accounted for almost 59.0% of total variation of *Josuella striata* in mineral soil. In litter, 6 parameters explained almost 77.0 % of that variation, with soil nitrogen and *p*H being the most important ones. As aforementioned, both factors might represent possible relations with the food resources of this species.

Soil organic matter, soil moisture, and the difference between maximum and minimum air temperature were the most important factors for the oribatid immatures (a group formed mainly by *J. striata, Jornadia larrea, Hemileius sp.,* and *Peloribates sp.*) in mineral soil. In litter, the same factors plus the sand: clay ratio and maximum air temperature played a role. Noticeably, soil moisture emerged as a relatively important factor in mineral soil, but not in surface litter, where temperature was apparently more important. This discrepancy may be interpreted in terms of the moisture content of the litter and the vertical movements of oribatids, particularly immatures given their unsclerotized cuticles. For the Jornada Site, WHITFORD *et al.* (1981) reported that leaf-litter moisture was higher during early morning than at midday. Following this pattern, oribatid populations moved up from deeper soil layers into the litter in early morning and then back down into the soil layers at midday. Because our sampling was conducted within 2–3 h after sunrise, litter moisture and oribatid populations may have been at their optima. Nevertheless, litter moisture conditions at the time of sampling were not recorded and, consequently, were overlooked during our analyses. Our results, however, support the contention of MACKAY *et al.* (1987) that soil temperature is more important than soil moisture in this desert habitat.

Linear multiple regressions provided a better account for the observed changes in abundance of *Brachistomella arida,* the most common collembolan, than for the whole group. This clearly suggests that responses to the abiotic factors are species-specific rather than a group's property. The results of this work partially agree with those of MACKAY *et al.* (1987) who found that a combination of shade and increased soil moisture greatly increased the population density of collembolans. In this study, minimum air temperature was found to play a role, but not soil moisture. Instead we found that calcium carbonate was an important factor both for the collembolans as a group as for *B. arida.* A growing body of evidence (WHITFORD *et al.,* 1981; STEINBERGER & WHITFORD, 1984; STEINBERGER *et al.,* 1984 KAMILL *et al.,* 1985) supports earlier contentions that collembolans are very responsive to moisture conditions. Field observations conducted during our work agree with that. Nevertheless, the effect of the increased soil moisture in field conditions was probably hidden by the other parameters included in the regressions.

With respect to the effect of temperature on collembolans, reports are conflicting (REDDY, 1984). Based on laboratory experiments, VAN STRAALEN & JOOSSE (1985) suggested that temperature sensitivity represents an adaptation to life at the soil surface. This may also be the case with desert collembolans. The highest percentage of total variation was, however, accounted for by soil calcium carbonate. Its concentration in the top 10 cm increases from the upper piedmont down to the playa site (NASH, 1985). Collembolans exhibit species-specific response to calcium concentration (USHER 1976). WALLWORK (1983) indicated that calcium is important for several species of oribatids and for some prostigmatids. But the relationships between calcium carbonate and the distribution and abundance of collembolan remain unclear.

Thus the data show that several soil parameters are important variables affecting microarthropod population densities. The relative importance of the soil parameters varies seasonally in some cases, hence generalizations concerning the relative importance of climatic and soil variables must be made with caution. The study only covered the taxa associated with surface litter and the top 10 cm of the underlying mineral soil; therefore, generalizations to deeper soil layers are not possible. Additionally, significant correlation coefficients may be the result of the level of significance chosen, and they do not show cause and effect relationships. However, the work has proved the need of further experimental work, particularly at the species level, if true patterns or finer regulatory processes are expected to be unveiled in the desert soil.

6. Acknowledgements

We thank MELIHA und MOHAMMAD NASH, and STEVE WONDZELL for allowing us to use their data on physical and chemical characteristics of the LTER Jornada Site (control-transect). We extend our thanks to ILIANA VILLAGRAN for her field assistance. The study was supported by research grant from the U.S. National Science Foundation: the Jornada LTER BSR 8114466 and BSR 821539 to W. G. WHITFORD.

7. References

Anonymous, 1985, SAS User's Guide: Statistics. Version 5 edition. Cary, NC. SAS Inst. inc.

ANDERSON, T. M, & H. HALL, 1977. Cryptostigmata: species diversity and soil structure. Ecol. Bull. 25, 15–23. Proc. IV Int. Soil Zool. Coll. Int. Soc. Biol Sci. (ISSS).

HÅGVAR, S., & G. A. ABRAHAMSEN, 1980. Colonization by Enchytraeidae, collembola, and Acari in sterile soil samples with adjusted *p*H levels. Oikos **34**, 245–258.

– 1981. Effects of liming and artificial acid rain on the mite (Acari) fauna in coniferous forest. Oikos **37**, 7–20.

HAZRA, A. K., 1982. Soil and litter arthropod fauna of Silent Valley, Kerala: A preliminary report. J. Soil Ecol. **2**, 73–77.

HUTSON, B. R., 1978. Influence of *p*H, temperature and salinity on the fecundity and longevity of four species of Collembola. Pedobiologia **18**, 163–179.

HOUGHTON, F. E., 1972. Climatic Guide, New Mexico State University, Las Cruces, NM, 1851–1972. New Mexico State University, Agric. Research Report **230**, 1–20.

KAMILL, B. W., Y. STEINBERGER & W. G. WHITFORD, 1985. Soil arthropods from the Chihuahuan Desert of New Mexico. J. Zool. London **205**, 273–286.

KOSKENNIEMI, A., & V. HUHTA, 1986. Effects of fertilization and manipulation of *p*H on mite (Acari) populations of coniferous forest soil. Rev. Ecol. Biol. Sol. **23**(3), 271–286.

MACKAY, W. P., S. SILVA, D. C. LIGHTFOOT, M. I. PAGANI, W. G. WHITFORD, 1986. Effect of increased soil moisture and reduced soil temperature on a desert soil arthropod community. Amer. Midl. Nat. **116**(1), 45–56.

– W. G. WHITFORD, 1987. Diurnal activity patterns and vertical migration in desert soil microarthropods. Pedobiologia **30**, 65–71.

MALLOW, D., D. LUDWIG, D. A. CROSSLEY JR., 1984. Microarthropod community structure in a coastal dune ecosystem on Jekyl Island, Georgia, USA. Pedobiologia **27**, 365–376.

NASH, M. H. H., 1985. Numerical classification, spatial dependence and vertical krigging of soil sites in Southern New Mexico. Master Thesis. New Mexico State Univ, Las Cruces, N. M., 194 pp.

REDDY, M. V., 1984. Ecology of soil and litter inhabiting arthropods. Indian Rev. Life Sci. **4**, 169–217.

SANTOS, P. F., E. DEPREE & W. G. WHITFORD, 1978. Spatial distribution of litter and microarthropods in a Chihuahuan Desert Ecosystem. J. Arid Environ. **1**, 41–48.

SCHENKER, R., 1984. Spatial and seasonal distribution patterns of oribatid mites (Acari: Oribatei) in a forest soil ecosystem. Pedobiologia **27**, 133–149.

STEINBERGER, Y., & W. G. WHITFORD, 1984. Spatial and temporal relationships of soil microarthropods on a desert watershed. Pedobiologia **26**, 275–284.

STREIT, B., 1982. Microarthropod populations gradients and aggregations in the soil of a mixed temperate deciduous forest. Rev. Swisse Zool. **89**(4), 993–1004.

USHER, M. B., 1976. Aggregations responses of soil arthropods in relation to the soil environment, pp 61–94. *In:* ANDERSON, J. M., & A. MACFADYEN (eds). The role of terrestrial and aquatic organisms in decomposition processes. The 17th Symp. British Ecol. Soc. (1975). Blackwell Scientific Pub. 474 pp.

– R. G. BOOTH & K. E. SPARKS, 1982. A review of progress in understanding the organization of communities of soil microarthropods. Pedobiologia **23**, 126–144.

WALLWORK, J. A., 1982. Desert soil fauna. Praeger Pub., New York, 296 pp.

– B. W. KAMILL & W. G. WHITFORD, 1984. Life styles of desert soil microarthropods: A re-appraisal. South African J. Sci. **80**, 163–169.

– M. MACQUITTY, S. SILVA & W. G. WHITFORD, 1986. Seasonality of some Chihuahuan Desert soil oribatid mites (Acari: Cryptostigmata). J. Zool. London **208**, 403–416.

WHITFORD, W. G., D. W. FRECKMAN, N. Z. ELKINS, L. W. PARKER, R. PARMALEE, J. PHILLIPS & S. TUCKER, 1981. Diurnal migration and response to simulated rainfall in desert biota microarthropods and nematodes. Soil Biol. Biochem. 13, 417–425.

WIRENGA, P. J., J. M. H. HENDRICKX, M. H. NASH, J. LUDWIG & L. A. DAUGHERTY, 1987. Variation of soil and vegetation with distance along a transect in the Chihuahuan Desert. J. Arid Environ. **13**, 53–63.

Synopsis: *Original scientific paper*

CEPEDA, G. J. & W. G. WHITFORD, 1988. The relationships between abiotic factors and the abundance patterns of soil microarthropods on a desert watershed. Pedobiologia **33**, 79–86.

An exploratory analysis was conducted on the relationships between temporal abundance patterns of soil microarthropods associated with decomposing leaf-litter and the underlying mineral soil, and the most prevailing abiotic variables along a transect in a northern Chihuahuan Desert ecosystem. Different combinations of variables partially explained the temporal variations in abundance of soil microarthropods associated with decomposing leaf-litter and the mineral soil. Similarly, different sets explained variations of higher taxa and the most abundant species. Seasonal and site factors were equally important as descriptors of numerical fluctuations in mineral soil; but site factors predominated over seasonal factors in decomposing leaf-litter. The data suggest that those factors related to food resources and vertical movements of soil microarthropod populations are the most important abiotic variables present in the watershed.

Key words: Acarina, Collembola, Psocoptera, abundance patterns, desert soil, abiotic parameters, air temperature, soil moisture, soil nitrogen, Chihuahuan Desert, watershed, LTER-Research Program.

Address of corresponding author: Prof. Dr. W. G. WHITFORD, Department of Biology, New Mexico State University, Las Cruces, New Mexico 88003, U.S.A.