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Soil microarthropods from the Chihuahuan Desert of New Mexico

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(With 1 plate and 1 figure in the text)

An account is given of the soil- and litter-dwelling microarthropods collected under three species of desert shrub in southern New Mexico. Particular attention is paid to the acarine component which represents 80% of the microarthropod fauna. Comparisons made with samples collected one hour after wetting show that only the Collembola respond rapidly to changes in the moisture content of the soil. The results of the study suggest that the depth and stability of the surface litter determine the degree to which microarthropod activity is affected by the application of water.

Contents

Page
Introduction 273
Study area and methods 274
Results 277
  Species richness and composition of the population 277
  Relationship to moisture, plant and depth 279
Discussion 282
Summary 285
References 285

Introduction

Very little information is available regarding the species composition of the microarthropod fauna of hot deserts (Wood, 1971; Wallwork, 1972; Franco *et al.*, 1979). Therefore, when an opportunity arose to undertake a short study in the Chihuahuan Desert, we decided to examine the soil and litter fauna under some of the comparatively species-rich thickets of shrubs lining the arroyos. Since we were able to take only one series of samples, we attempted to enhance the collection of species by wetting the litter and soil prior to sampling, since there is evidence to suggest that microarthropods respond rapidly to temporal changes in the soil moisture regime. In particular, Whitford *et al.* (1981), sampling creosotebush litter in the Chihuahuan Desert,

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reported higher numbers of microarthropods one hour after wetting than from dry controls. The application of water appears to act as a physiological 'trigger' in the sense of Noy-Meir (1973). According to Noy-Meir's 'trigger-pulse-reserve' principle, an environmental stimulation initiates a pulse of biological activity (such as emergence and dispersal, with an eventual peak in population density), the magnitude of which would be determined by the effect of the trigger on the reserve population.

In the present paper, populations of microarthropods from the soil and litter under three species of desert shrub have been examined before and after wetting. It is intended that later papers will deal with the taxonomy of the Cryptostigmata, both *Inferiores* and *Superiores*.

Study area and methods

Fieldwork was conducted in the northern part of the Chihuahuan Desert (Fig. 1(a)) on the New Mexico State University Experimental Range, 40 km north-north-east of Las Cruces, Dona Ana County, New Mexico (Fig. 1(b)). The Range covers an area of alluvial piedmont [bajada] (Plate I(a)) sloping from Mount Summerford on the west to the Jornada Basin on the east and north, and is drained by a large dry wash [arroyo] which flows south to north with several small arroyos (Plate I(c)) draining into it on both the east and the west side. The soil is a gravelly to sandy loam. Summer maximum temperatures reach 40 °C, while freezing temperatures have been recorded from October to mid-April. Mean annual rainfall for the area is about 230 mm, with most of the rainfall occurring between July and September as convectional storms (data from the Jornada Weather Station).

Differences in both soil type and drainage between the arroyos and the bajada have produced distinct assemblages of perennial vegetation. The low bajada has an essentially monotypic cover of *Larrea tridentata* (DC.)Cov. (the creosotebush) (Plate I(b)). The plants are generally less than 1 m in height and occur as individuals with relatively large uncovered areas in between. In contrast, the arroyo margins support a variety of large shrubs including, *Chilopsis linearis* (Cav.) Sweet (Desert willow), *Fallugia paradoxa* Endl. (Apache plume), *Celtis reticulata* Torr. (Hackberry), *Flourensia cernua* DC. (Tarbush) and *Prosopis glandulosa* Torr. (Mesquite). The Soaptree yucca (*Yucca elata* Engelm.) and the Banana yucca (*Yucca baccata* Torr.) also occur, although never in great abundance. While there were considerable accumulations of surface litter under the arroyo shrubs, the open areas beneath the creosotebushes were devoid of any litter.

The study area is located at the edge of a small arroyo (Plate I(d)) and consists of a monospecific thicket of each of the following 3 shrubs, namely *Celtis reticulata*, *Chilopsis linearis* and *Fallugia paradoxa*, the 3 forming a more or less uninterrupted sequence, with *Celtis* growing at the highest elevation on the arroyo and *Fallugia* at the lowest. This area offered an ideal experimental situation for a comparative study, unlike most of the nearby thickets, which comprised a mixture of 2 or 3 shrub species. At the time of sampling (21 June 1982), the soil had not received any appreciable rainfall for 6 months.

Six sampling sites were selected at random beneath the overhang of each shrub type. At all sites the soil surface was covered by a loose litter layer which showed some variation in depth between the 3 different types of shrub; *Chilopsis*, approximately 1 cm, *Fallugia* 1·5 cm and *Celtis* 5 cm. There was a sharp boundary between the litter and the underlying soil which was a sandy loam. Before sampling, 3 of the sites under each shrub type received approximately 6 ml of water per square centimetre of litter, while the other 3 were left dry. At 07.00 h, water was applied through open-bottomed cylinders (15 cm diameter) situated on the soil surface, and samples of litter and soil were taken 1 h later. While a corer was used to remove the soil samples, the very loose structure of the litter made it impossible to remove an intact sample, and instead, the litter was collected using a small trowel. The litter from within the cylinder, together with the top 8 cm of soil and the underlying 8 cm of soil (8–16 cm), were removed separately, stored in polythene bags, and transported to the laboratory in an insulated container. At each of the wetted sites, water was able to penetrate throughout the 16 cm mineral soil column. Moreover, the wetting front expanded 15 to 20 cm away from the area directly enclosed by the cylinder. At each of the unwatered sites, litter and soil (0 to 8 cm and 8 to 16 cm) were sampled at 08.00 h. The total number of samples collected was 54.

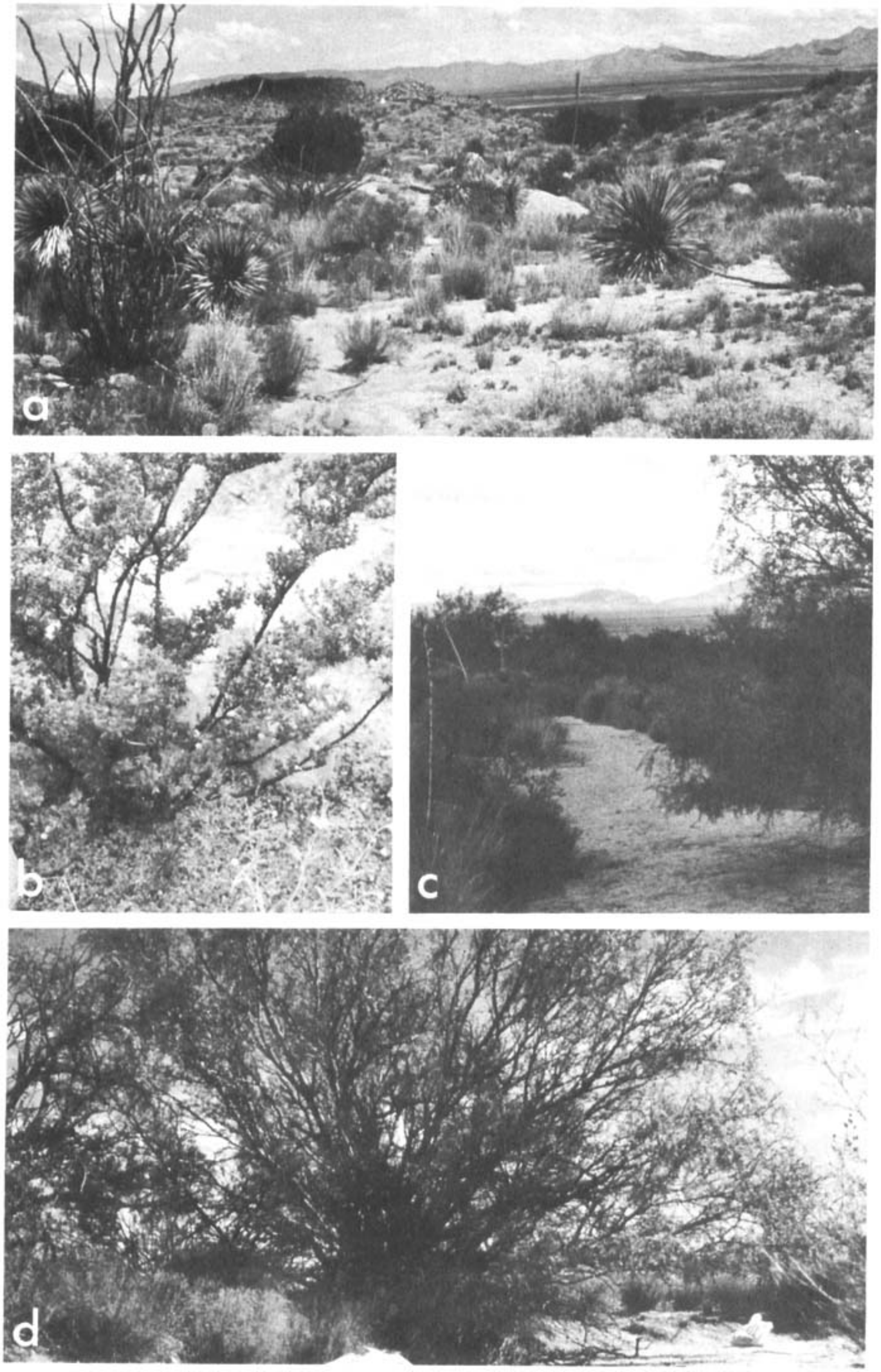

PLATE I. Experimental Range. (a) General view of high bajada. (b) Creosotebush on non-arroyo area. (c) Small arroyo lined with mixed vegetation. (d) Apache plume site on edge of arroyo, June, 1982.

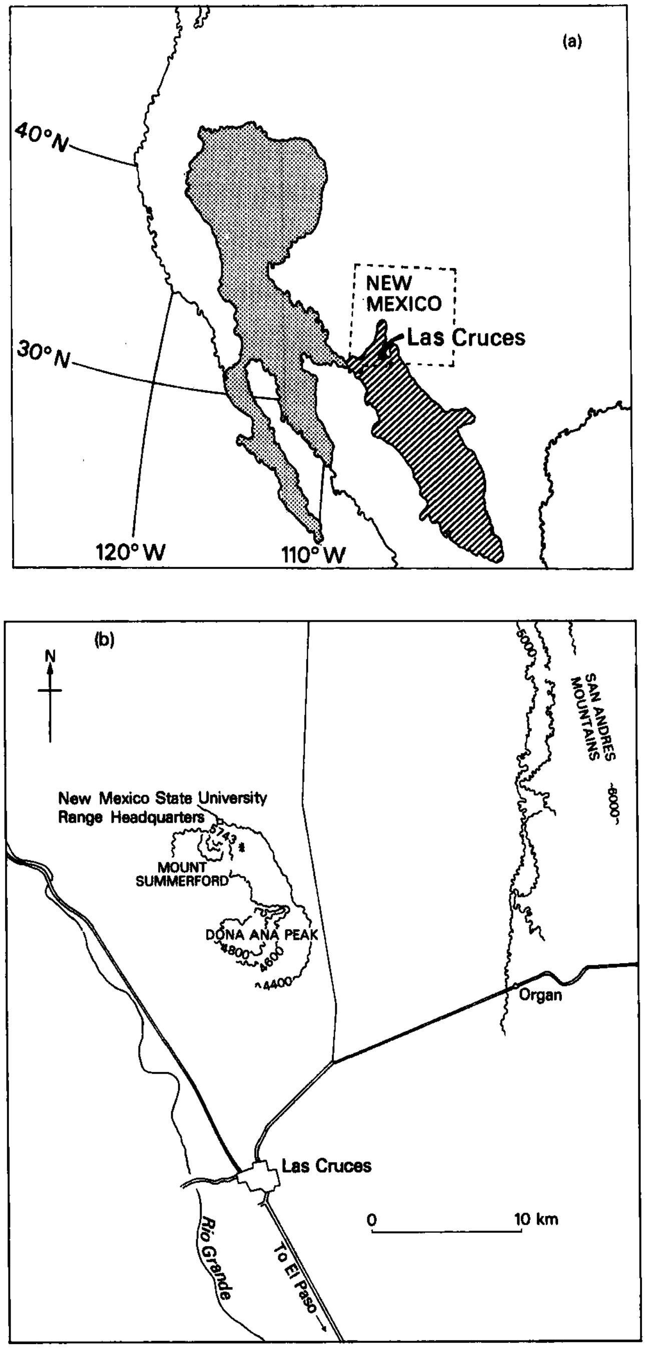

FIG. 1. (a) Map to show the desert areas of North America. ▨, indicates the Chihuahuan Desert; ☐, remaining desert. (b) New Mexico State University Experimental Range in relation to Las Cruces and vicinity. The position of the study area is shown by a star.

The microarthropod fauna was extracted by means of a funnel-desiccation technique, using water as a collecting medium (see Santos *et al.*, 1978) over a 48-h drying period. To ensure that extraction was complete, the collecting tubes were replaced after 48 h by fresh tubes of water which were removed after a further 48 h. The extracted material was sorted and the species that could be identified were counted and removed, while others, requiring more detailed studies, were cleared and mounted in lactic acid on cavity slides (see Evans *et al.*, 1961). Permanent preparations were made on plain slides in Hoyer's Medium. The litter and soil were dried for 72 h and then weighed. The percentage of organic matter in each of the 3 litter types was determined at Rothamsted Experimental Station.

All the data were subjected to analyses of variance in order to assess the relative importance of wetting, litter type and sample depth on population size. The microarthropod densities have been expressed as the mean number per 100 grams of litter or soil sample. When significance was observed at the $P = 0{\cdot}05$ level in the overall analysis of variance, Tukey's Q test (Sokal & Rohlf, 1969) was used to make comparisons between pairs of means.

Results

Species richness and composition of the population

Table I lists the 32 species of microarthropod identified in the litter and soil under the three different shrubs, and their distribution between major taxonomic groups; Cryptostigmata (12 species), Prostigmata (11 species), Mesostigmata (three species), Collembola (four species), Psocoptera (one species) and Thysanoptera (one species). The Diptera and Coleoptera were only encountered as larvae and have been identified to family level. Table II shows the relative abundance of each of the major taxa. This Table represents the percentage composition of the populations in the combined litter and soil samples from all three shrubs and for both moisture regimes. The counts refer to adults only. It is interesting that the Acari comprise approximately 80% of all the individuals collected, and of these, the Cryptostigmata (2263) are considerably more numerous than either the Prostigmata (1511) or the Mesostigmata (63). The Astigmata have been excluded from the species list and from the analyses since they were represented only by single individuals in four samples.

The qualitative composition of the fauna under each of the three shrub types (and between the litter and soil) was remarkably similar, despite differences in litter depth and organic content. Twenty-nine species were collected under *Chilopsis*, and 27 under both *Celtis* and *Fallugia.* Under *Chilopsis* the Prostigmata represented 54% of the fauna (Table III), 45% of which was accounted for by the abundance of a species belonging to the family Tydeidae (Table IV). In the two other soils, this mite was outnumbered by larger, predatory species, such as those belonging to the genera *Spinibdella* and *Pachygnathus.* Relatively large numbers of a *Molothrognathus* species were recorded under *Chilopsis.* Also prominent under *Chilopsis* were the Collembola, the dominant species being a member of the genus *Sminthurides.* Under *Celtis* and *Fallugia* the population was dominated by the Cryptostigmata, which accounted for 65% and 85%, respectively, of the fauna.

Of the Cryptostigmata, the following six genera could be described as numerically 'dominant' at one or more of the three sites; *Plesiodamaeus*, *Trhypochthonius*, *Tectocepheus*, *Galumna*, *Joshuella* and *Scutovertex* (Table IV). However, the size of the population of each of the six 'dominants' appears to have been affected by the type of litter, the major differences occurring between *Fallugia* and the two other shrub species. While *Joshuella striata* and the *Scutovertex* species could be regarded as 'dominant' under *Fallugia*, these two represented less than 5% of the fauna

TABLE I

Microarthropods recorded in the litter and soil (0 to 16 cm) under the three species of desert shrub

Taxon	Recorded					
	Celtis		*Chilopsis*		*Fallugia*	
	Litter	Soil	Litter	Soil	Litter	Soil
Class Arachnida						
Subclass Acari						
Order Cryptostigmata						
Cosmochthonius plumatus Berlese	–	*	*	*	*	–
Camisia cf. *horrida* Hermann	*	*	–	–	*	–
Trhypochthonius tectorum (Berlese)	*	*	*	–	*	–
Plesiodamaeus sp.	*	*	*	*	*	*
Joshuella striata Wallwork	*	–	*	*	*	*
Tectocepheus velatus (Michael)	*	*	*	*	*	–
Oppia sp.	*	–	–	*	*	*
Passalozetes neomexicanus Wallwork *et al.*	*	*	*	*	–	–
Scutovertex sp.	–	–	*	–	*	*
Scheloribates cf. *pallidulus* (C. L. Koch)	–	*	*	*	*	*
Jornadia larreae Wallwork & Weems	–	*	*	–	–	–
Galumna sp.	*	*	*	–	*	–
Order Mesostigmata						
Asca sp.	–	–	*	–	*	–
Pseudoparasitus sp.	–	–	*	*	*	–
Macrocheles sp.	–	*	–	–	–	–
Order Prostigmata						
Pachygnathus nr *dugesi* Grandjean	*	*	*	–	*	–
Nanorchestes sp.	*	*	*	*	–	*
Speleorchestes sp.	*	*	*	*	–	*
Pediculaster sp.	*	–	*	–	–	–
Eupodes sp.	–	–	–	–	–	*
Protereunetes sp.	–	–	*	–	–	–
Tydeus sp.	*	*	*	*	*	*
Spinibdella cronini (Baker & Balcock)	*	*	*	*	*	*
Cunaxa cf. *capreolus* (Berlese)	–	–	*	–	*	–
Molothrognathus sp.	*	*	*	*	–	*
Microtrombidium sp.	*	–	–	–	–	–
Class Insecta						
Subclass Collembola						
Brachystomella sp.	*	*	*	*	*	*
Folsomides (*Subisotoma*) *angularis* (Axelson)	*	*	*	*	*	*
Pseudosinella sp.	*	*	*	*	*	*
Sminthurides (*Sphaeridia*) sp.	*	*	*	*	*	–
Subclass Pterygota						
Order Psocoptera						
Liposcelis sp.	*	–	*	–	*	–
Order Thysanoptera						
Frankliniella sp.	*	*	*	*	–	–
Order Diptera						
Ceratopogonidae (larva)	–	–	–	–	*	*
Order Coleoptera						
Cucujidae (larva)	*	*	*	*	*	*
Totals	23	22	28	19	23	16

TABLE II

Numbers of individuals and relative abundance (%) of the major taxa for the combined 54 samples

Total number of microarthropods collected = 4594

Taxa

	Cryptostigmata	Prostigmata	Mesostigmata	Collembola	Diptera & Coleoptera	Psocoptera	Thysanoptera
Number of individuals	2263	1511	63	672	42	28	15
Relative abundance (%)	49·25	32·89	1·37	14·62	0·91	0·6	0·32
	Acari			Insecta			

under the other shrubs. Similarly, under both *Celtis* and *Chilopsis*, the 'dominant' taxa were *Tectocepheus* and *Plesiodamaeus*, together with *Trhypochthonius* under *Celtis* and *Galumna* under *Chilopsis*—these four taxa were recorded in very low numbers under *Fallugia*.

Relationship to moisture, plant and depth

There is no apparent relationship between species richness and the moisture status of the samples—30 species and 28 species were recorded from the dry and the wet samples, respectively. From Table V it is apparent that the only microarthropod group showing a positive response to wetting is the Collembola. The dry samples contained 106 individuals and the wetted samples 566 individuals.

Table VI shows the results of the analysis of variance designed to test overall differences between the 18 combinations of plant (3) × depth (3) × moisture (2), for each species separately. Each combination was represented by the mean of three observations and the Table shows the P value derived from the overall F test on 18 (one for an average replicate effect) and 35 degrees of freedom. Values of P less than 0·05 were observed only for the Cryptostigmata, Acari, Collembola, Psocoptera, Insecta and the total microarthropod fauna. With the exception of the species of Psocoptera, no individual species was found to be significantly different from any other for any of the three factors, or for any two- or three-factor interaction. Even when the effect of moisture was removed from the analysis, leaving plant, depth and the corresponding two-factor interaction, the effects remained non-significant. Anova (analysis of variance) tables of plant × depth × moisture are given for microarthropods (32 species), the Collembola (four species) and for the Psocoptera (one species) (Tables VII–IX). Three-way tables for the Acari, Cryptostigmata and Insecta have not been included since the data and their corresponding effects are mirrored by Table VII, in the case of both the Acari and the Cryptostigmata, and by Table VIII, in the case of the Insecta.

Table VII shows a very strong depth effect, with most microarthropods confined to the litter. A breakdown of the anova into main effects and interactions shows no other significant differences. In the case of the Collembola (Table VIII), there is again a very strong depth effect. However, there are, in addition, some other significant effects in the analysis of variance. These are as follows:

(1) Plant—the mean number for *Chilopsis* is significantly larger than for either of the other two plant species;

TABLE III

Numbers of individuals and relative abundance (%) of the microarthropod fauna. The data for sample depth and moisture have been pooled

	Shrub species					
	Celtis		*Chilopsis*		*Fallugia*	
Taxon	Number of individuals	Relative abundance (%)	Number of individuals	Relative abundance (%)	Number of individuals	Relative abundance (%)
Subclass Acari						
O. Cryptostigmata	764	65·57	507	22·35	992	85·44
O. Mesostigmata	12	1·03	50	2·20	1	0·08
O. Prostigmata	208	17·85	1237	54·54	66	5·68
Subclass Collembola	136	11·67	453	19·97	83	7·14
Subclass Pterygota	45	3·86	21	0·92	19	1·63
Totals	1165	100	2268	100	1161	100

TABLE IV

Numbers of individuals and relative abundance (%) of the Prostigmata and Cryptostigmata. The data for sample depth and moisture have been pooled

	Shrub species					
	Celtis		*Chilopsis*		*Fallugia*	
	Number of individuals	Relative abundance (%)	Number of individuals	Relative abundance (%)	Number of individuals	Relative abundance (%)
O. Prostigmata						
Pachygnathus nr *dugesi*	63	30·28	41	0·10	21	31·81
Nanorchestes sp.	20	9·61	64	5·17	8	12·12
Tydeus sp.	84	40·38	1012	81·81	18	27·27
Spinibdella cronini	24	11·53	28	2·26	13	19·69
Molothrognathus sp.	12	5·76	89	7·19	1	1·15
Six other species	5	2·40	3	0·24	5	7·57
Totals	208	100	1237	100	66	100
O. Cryptostigmata						
Plesiodamaeus sp.	289	37·82	116	22·87	17	1·71
Trhypochthonius tectorum	238	31·15	2	0·39	1	0·10
Tectocepheus velatus	121	15·83	139	27·41	6	0·60
Galumna sp.	23	3·01	141	27·81	1	0·10
Joshuella striata	22	2·87	19	3·74	677	68·24
Scutovertex sp.	0	0·0	24	4·73	239	24·09
Six other species	71	9·29	66	13·01	51	5·14
Totals	764	100	507	100	992	100

TABLE V

Numbers of individuals and relative abundance (%) of the major taxa in the dry and wet samples. The data for shrub type and sample depth have been pooled

Taxon	Dry		Wet		
	Number of individuals	Relative abundance (%)	Number of individuals	Relative abundance (%)	Total number of individuals
Cryptostigmata	1094	57	1169	43	2263
Prostigmata	634	33	877	32·7	1511
Mesostigmata	38	1·9	25	0·9	63
Collembola	106	5·5	566	21·1	672
Diptera & Coleoptera immatures	16	0·8	26	0·9	42
Psocoptera	21	1·0	7	0·3	28
Thysanoptera	8	0·4	7	0·3	15
Totals	1917	100	2677	100	4594

TABLE VI

*Results of the analysis of variance for the major taxonomic groups. *Significant at 0·05*

Taxon	*P* value for differences between all 18 factor combinations plus an average replicate effect	*P* value for differences between the three depths averaged over the levels of all the other factors
Cryptostigmata	0·0089*	0·0001*
Prostigmata	0·3411	0·0705
Mesostigmata	0·0952	0·0327
Total Acari	0·0024*	0·0001*
Collembola	0·0006*	0·0003*
Psocoptera	0·0001*	0·0001*
Thysanoptera	0·5709	0·0385
Diptera & Coleoptera	0·1411	0·0216
Total Insecta	0·0004*	0·0001*
Total microarthropods	0·0001*	0·0001*

(2) Moisture—within the litter there is a strong moisture effect for each of the plant species;

(3) Plant × depth—there is some suggestion that the depth effect differs for the three plants, largely due to the mean number of 6·63 in the upper 8 cm of soil under *Celtis*.

Table IX for the Psocoptera shows that depth is again significant. Moreover, it is apparent that the moisture effect differs between the three plant species in the surface litter. Psocopterans occurred in the dry, but not in the wetted litter under *Celtis* and *Fallugia*, whereas the density of these insects was higher in the wetted *Chilopsis* litter than in the dry. However, the numbers recorded were low in all cases and little importance can be attached to these findings.

TABLE VII

The effects of wetting on mean numbers (n = 3) of microarthropods per 100 grams of litter or soil (0 to 8 cm and 8 to 16 cm) under the three different shrubs

	Shrub species								
	Celtis			*Chilopsis*			*Fallugia*		
	Dry	Wet	Mean	Dry	Wet	Mean	Dry	Wet	Mean
Surface litter	147·28	317·45	232·36	372·05	453·52	412·78	125·37	215·46	170·41
Soil 0 to 8 cm	6·21	15·64	10·92	1·13	17·17	9·15	6·48	2·95	4·71
Soil 8 to 16 cm	5·51	7·73	6·62	3·12	10·28	6·70	0·58	4·27	2·42
Mean	53·0	113·60		125·43	160·32		44·14	74·22	

TABLE VIII

The effect of wetting on mean numbers (n = 3) of Collembola per 100 grams of litter or soil (0 to 8 cm and 8 to 16 cm) under the three different shrubs

	Shrub species								
	Celtis			*Chilopsis*			*Fallugia*		
Sample depth	Dry	Wet	Mean	Dry	Wet	Mean	Dry	Wet	Mean
Surface litter	2·96	34·20	18·58	31·87	137·69	84·78	4·60	30·00	17·3
Soil 0 to 8 cm	0·0	6·63	3·31	0·0	4·48	2·24	0·20	0·84	0·52
Soil 8 to 16 cm	0·0	1·11	0·55	0·24	2·90	1·57	0·0	0·14	0·07
Mean	0·98	13·98		21·32	48·35		1·6	10·32	

TABLE IX

The effect of wetting on mean numbers (n = 3) of Psocoptera per 100 grams of litter or soil (0 to 8 cm and 8 to 16 cm) under the three different shrubs

	Shrub species								
	Celtis			*Chilopsis*			*Fallugia*		
Sample depth	Dry	Wet	Mean	Dry	Wet	Mean	Dry	Wet	Mean
Surface litter	2·11	0·0	1·05	1·35	2·37	1·86	2·27	0	1·13
Soil 0 to 8 cm	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0	0·0
Soil 8 to 16 cm	0·0	0·20	0·10	0·27	0·0	0·14	0·17	0	0·08
Mean	0·70	0·06		0·54	0·79		0·81	0	

Discussion

Under the arroyo shrubs, the accumulated leaf material was buffered from the effects of extremes in the physical environmental conditions. It was not surprising, therefore, to record relatively large numbers of Cryptostigmata, since mites of this order are known to have a preference for highly organic soils with an appreciable litter layer. However, in terms of numbers of species, the Cryptostigmata on the arroyo (12 species) represented an impoverished fauna compared to that in, for example, a temperate forest soil where just under 50 species have been recorded in mixed oak and hornbeam litter (Lebrun, 1965). The deficiency of large Mesostigmata collected was not unexpected since these predatory mites are generally associated with moist, surface litter and with the underlying fermentation layer. Although organic matter accumulates in undisturbed desert areas to form a litter layer, the latter remains distinct from the underlying mineral soil, with the absence of an intermediate F-layer (Wallwork, 1972). It is surprising, however, that the smaller, weakly sclerotized euedaphic Mesostigmata, such as *Rhodacarus* and *Rhodacarellus*, were not present in the mineral soil samples. While this could have been due to a loss during extraction, this explanation is not entirely adequate, for a similar loss was not evident in the collections of Prostigmata which included many small and delicate forms. The collembolan population on the arroyo was also dominated by hemiedaphic forms. However, the time of sampling may be influential, for the euedaphic Isotomidae were seen by Wallwork *et al.* (In press) to be particularly abundant on the Jornada after heavy August rains. Since prostigmatic mites are known to form a significant component of microarthropod communities in dry soils (Loots & Ryke, 1967), it was not unexpected to record a fairly diverse fauna under desert conditions.

The most comprehensive study available for comparative purposes is that of Wallwork (1972), who investigated the microarthropod communities in the litter and soil under juniper (*Juniperus monosperma*) in the southern part of the Mojave Desert. Wallwork recorded a remarkably similar fauna and, as at the arroyo, the Cryptostigmata were the dominant component, and *Joshuella striata* one of the 'dominant' species. However, Wallwork recorded the highest numbers of individuals in the mineral soil, unlike the arroyo samples which showed a pattern of vertical distribution closely similar to that occurring in cool, temperate soils where microarthropods are concentrated in the surface litter and in the underlying F-layer. Moreover, 33% of the mite fauna under juniper was accounted for by the presence of a species of *Glycyphagus*. Astigmatic mites were encountered in very small numbers on the arroyo.

Another comparable study (Wood, 1971) has been made in Australian desert soils where the microarthropod fauna was found to be dominated by prostigmatic mites and Collembola and, as on the arroyo, very few Astigmata were recorded. Moreover, Wood emphasized a relationship between the relative abundance of the Cryptostigmata and the organic matter of the soil, noting an increase in the numbers of Cryptostigmata with increasing amounts of organic matter. Similar conclusions were reached by Loots & Ryke (1967) as a result of their study of South African soils. These authors also noted an inverse relationship between the numbers of Prostigmata and the quantity of organic matter in the soil.

The fact that cryptostigmatic mites are extremely numerous in highly organic soils, while the Prostigmata appear to favour somewhat poorer, less structured soils, could, in part, be an indication of their different food preferences. Most Cryptostigmata have rather generalized feeding habits and will consume a great variety of plant material (Luxton, 1972). Less is known concerning the food habits of soil-dwelling Prostigmata, but genera such as *Spinibdella* and *Pachygnathus* are known to be predatory, while many of the smaller forms, for example, *Tydeus*, are probably more specialized mycophages. Theoretically, the different organic matter contents of *Celtis*, *Chilopsis* and *Fallugia* litter (29·4%, 83·2% and 57·8%, respectively) should be reflected by differences in the population densities of the mite fauna. However, while the level of organic matter in the *Fallugia* litter gave relatively good correlations with the sizes of the pro- and cryptostigmatic communities, there is no evidence to suggest a possible relationship between food availability and microhabitat requirements in the two other shrub species.

Our data suggest that the depth of the litter layer may be a more useful indicator of favourable conditions for the establishment and accumulation of mite communities. In temperate forest soils, the composition of the mite community varies considerably from one organic layer to another. In general, the larger species tend to congregate in the litter while the smaller species are found in the F- and H-layers. Although in the desert there was an apparent similarity in the cryptostigmatic fauna of the three litter types regardless of available litter depth, certain of the larger species, such as a heavily sclerotized galumnid, tended to favour the shallow *Chilopsis* litter (1 cm), while the smaller, weakly sclerotized *Trhypochthonius tectorum* apparently preferred the greater depth of litter available under *Celtis* (5 cm) (Table IV). The distribution of the Prostigmata was in complete contrast to that of the Cryptostigmata. The larger species (*Spinibdella cronini* and *Pachygnathus dugesi*) were more numerous in the deep litter, while the smaller *Tydeus* and *Molothrognathus* species attained their greatest numbers in the shallowest litter—under *Chilopsis* (Table V). This suggests that for the Prostigmata, food, rather than available living space, is a more important factor limiting distribution.

It would appear from the analysis of variance that the soil moisture status has little significant effect on the size of the microarthropod fauna. However, given that the total number of individuals recorded was highest in the wetted samples, we must ask the source of these additional animals. While one explanation is that wetting perhaps enhanced microarthropod extractability, this suggestion cannot be confirmed, since we have no data on inactive individuals. The comparatively broad wetting front around the cylinder suggests a movement of individuals in relation to moisture conditions.

Only the Collembola exhibited a significant moisture effect in that there were more in the wetted, than in the dry samples. A growing body of evidence suggests that Collembola are able to survive during periods of drought in a dehydrated state [anhydrobiosis], from which they become active only after rainfall (Greenslade & Greenslade, 1973; Poinsot-Balaguer, 1976; Whitford *et al.*, 1981). Our data, although limited to a one-hour wetting period, would appear to confirm such suggestions. However, there are no signs of upward migration into the litter as a result of wetting, as shown by Whitford *et al.* for creosotebush litter. On the arroyo, the Collembola appear to hydrate either within the surface litter, or within the mineral soil. While the larger populations in the wetted litter may have been due, in part, to anhydrobiosis, it must be noted that Collembola were also recorded in the dry litter.

The lack of any appreciable response to wetting by the rest of the microarthropod fauna could be attributable to the time that the water was allowed to permeate the mineral soil. Whitford *et al.* recorded a marked increase, both in the numbers and in the species diversity of the microarthropod fauna in creosotebush litter, just one hour after wetting, and suggest that activity is a direct response to rainfall. Few individuals were recorded in the dry litter and none in the dry soil. Such results conflict with those recorded on the arroyo, and appear to be directly attributable to differences in the type and density of the vegetation and, in turn, to the organic matter content of the arroyo and non-arroyo soil. Under creosotebush, there was very little accumulated litter, the soil surface was subjected to great fluctuations in temperature and moisture, and the soil was essentially mineral in character (less than 10% organic matter content). Under the arroyo shrubs, the dense 'ground cover' of overhanging branches enhanced water retention within the surface litter and, at the same time, moderated the temperature. In view of these differences, it was perhaps not surprising that a 'pulse' of wetting failed to produce a significant burst of biological activity by the microarthropod fauna.

Summary

(1) The litter and soil were sampled under three species of desert shrub in southern New Mexico before and after wetting, and the microarthropod fauna extracted.

(2) Thirty-two species were identified—species richness was not correlated with depth, litter type, or with moisture.

(3) Cryptostigmatid mites composed 50% of the microarthropods collected—the numbers of Astigmata were insignificant.

(4) There were significantly higher numbers of microarthropods in the litter than in the underlying mineral soil under all three shrub species.

(5) The *Chilopsis* community consisted of more small prostigmatid mites than *Celtis* or *Fallugia*, and tended to harbour more of the larger species of Cryptostigmata.

(6) While the numbers of Collembola were increased by the application of water, the other microarthropods failed to exhibit a clear response.

(7) There is evidence that, in a hot desert, the depth and stability of the surface litter determine the size of the microarthropod community.

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