ACARINE FAUNA IN SOUTHEASTERN MANITOBA: I – FOREST SOILS

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INTRODUCTION

The acarine fauna of various soil and vegetation cover types have been reported from Europe (Drift, 1951; Evans, 1951; Macfadyen, 1952; Murphy, 1953; Evans, Sheals and Macfarlane, 1961; Hayes, 1965; Madge, 1965; Marcuzzi, 1965; Greenslade and Greenslade 1967) and North America (Hammer, 1952, 1955; Hirston and Byers, 1954; Wallwork, 1959; Woolley, 1960; Marshall and Kevan, 1964; Dowdy, 1965; Marshall, 1968). The reports in North America are from widely scattered localities and often the faunas are based on a few random collections rather than a systematic collecting method. Consequently it is difficult to make quantitative comparisons of the faunas and their seasonal fluctuations. Since the emphasis in biological science at present is on the ecosystem, it is desirable to know what species occur in each ecosystem and how the populations fluctuate under different conditions.

The present preliminary study is a comparison of the acarine fauna of 12 forest sites in Manitoba, Canada (Fig. 1). Some of the sites differ only in vegetation cover while others differ in soil type and moisture relations. Most of the collections have been identified at least to genus either by V.G. Marshall, Department of Fisheries and Forestry, Forestry Service, Chalk River, Ontario or by E.E. Lindquist, Department of Agriculture, Entomology Research Institute, Ottawa, Ontario.

MATERIALS AND METHODS

One core sample from each of the 12 sites (Table I) was taken every 4 weeks from 1 April 1968 to 6 January 1969. Heavy snow cover (approximately 45 cm) prevented sampling between February and April. A volumetric soil sampler designed by Vannier and Vidal (1965), modified by V.G. Marshall (personal communication) and built by Kraftsman Machine Co. Ltd., Winnipeg Manitoba with an area of 22 cm^2 and a volume of 330 cm^3 was employed. The core tube of the sampler was 15 cm long but cut transversally so that each core could be divided into two samples each 7.5 cm long. The temperature of each sample was recorded prior to sampling by placing a glass thermometer at depths of approximately 3 cm and 10 cm adjacent to the sampling sites. Each core tube with its sample was inverted into a Berlese funnel for extraction. A battery of 60-watt light bulbs was used to extract stages of mites from samples into vials. Seven days were allowed to dry the soil and complete the extraction. On every third collecting date the samples were extracted into 70% alcohol and the others into a saturated picric acid solution. Although alcohol is not as efficient for extraction purposes as picric acid, it does not discolor the mites and thus obscure some of the taxonomic characters. Mites submitted to specialists for identification were mounted on slides in Hoyer's medium (Baker and Wharton, 1952).

RESULTS

Seventy species of mites were identified consisting of 58.6% cryptostigmatids, 27.1% mesostigmatids, 12.9% prostigmatids and 1.4% astigmatids. Some additional forms, mostly larvae, could not be identified and are omitted from this report. In numbers of individuals the cryptostigmatids comprised 86% of the extracted fauna, the mesostigmatids 9%, the astigmatids 3%, and the prostigmatids 2%.

An annotated list of the species obtained in this study is presented in Table II. The sites from which each species was found and the site with the highest annual average of the species are indicted. Mites usually attain their highest densities in the surface layer but

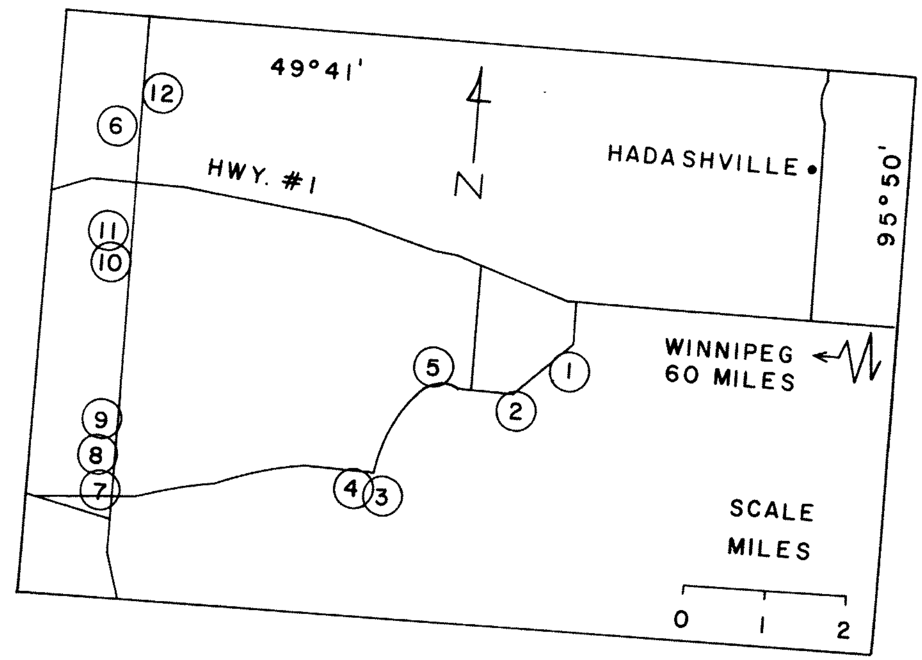

Figure 1. Map of study area showing the sites from which collections were made.

TABLE I

Description of Sampling Sites

Site No.	Moisture class *	Dominant vegetation	Subordinate vegetation type	Depth of organic matter	Soil type
1	dry	Jack Pine	discontinuous moss-lichen	2-4 cm	sand
2	dry	Jack Pine	continuous feathermoss	2-4 cm	sand
3	dry	Jack Pine	continuous feathermoss	2-4 cm	sand
4**	dry	ericaceous shrubs	continuous forbs	2-4 cm	sand
5	moist	White Spruce	discontinuous forb-moss	6-9 cm	loamy sand
6	moist	Aspen	continuous shrub-forb	5-7 cm	loamy sand
7	wet	Black Spruce	Sphagnum	50 cm	organic
8	wet	Black Spruce	Sphagnum	58 cm	organic
9	wet	Black Spruce	shrub-sphagnum	45 cm	organic
10	wet	Larch	Sphagnum-feathermoss	275 cm	organic
11	wet	Black Spruce	forb-moss	60 cm	organic
12	wet	Black Spruce	Sphagnum	45 cm	organic

* Dry- no free water in solum except for brief periods after rains and during snow melt; water table at about 120 cm in spring and 240 cm in autumn.
Moist- free water within 30 cm of surface for significant periods but not all of snow-free period; water table at about 25 cm in spring and 70 cm in autumn.
Wet- free water within 30 cm of surface for nearly all the snow free period; water table at about 5 cm in spring and 30 cm in autumn.

**This was a typical jack pine site but was clear-cut approximately ten years ago and there is essentially no arboreal regeneration.

Table II. Annotated List of Acarina: A - Sites, B - Site most Abundant and Annual Population Average, C - Layer, D - Population Peak. (See text for further explanation)

ASTIGMATA

Acaridae

Rhizoglyphus sp.
A. all
B. 3 (22,850/m^2)
C. surface & subsurface
D. December

PROSTIGMATA

Cunaxidae

Cunaxa setirostris Hermann
A. all except No. 6
B. 2 (620/m^2)
C. mostly surface
D. July & January

Rhagidiidae

Rhagidia sp.
A. all except Nos. 1 & 4
B. 6 (830/m^2)
C. mostly surface
D. none

Scutacaridae

Scutacarus sp.
Rare

Stigmaeidae

Ledermuelleria rhodomela Koch
A. 1, 3, 4, 6, 7, 9, 11, 12
B. 9 (540/m^2)
C. all surface
D. January

Ledermuelleria segnis Koch
A. 1, 2, 3, 7, 8, 9, 10, 11
B. 2 (500/m^2)
C. all surface
D. none

Stigmaeus scaber Summers and *S. sphagneti* Hull
A. all except No. 9
B. 3 (540/m)
C. all surface
D. none

Trombidiidae

Microtrombidium sp., near *parvum* Oudemans
A. all except Nos. 1 & 2
B. 5 (330/m^2)
C. mostly surface
D. May & November

Tydeidae

Lorryia sp.
A. 1, 2, 3, 4, 8, 9, 10, 11
B. 2 (200/m^2)
C. surface & subsurface
D. none

MESOSTIGMATA

Ascidae

Asca aphidioides L. and *A. garmani* Hurlbutt
A. all
B. 3 (2,110/m^2)
C. surface & subsurface
D. December

Cheiroseius sp.
A. 1, 6, 7, 8, 10, 11, 12
B. 8 (700/m^2)
C. mostly surface
D. none

Digamasellidae

Digamasellus angulosus Willmann
A. 5
B. 5 (860/m^2)
C. surface & subsurface
D. December

Digamasellus sp.
A. 1, 2, 4, 7
B. 4 (620/m^2)
C. surface & subsurface
D. January

Laelaptidae

Hypoaspis nolli Karg
A. all except No. 9
B. 8 (2,190/m)
C. surface & subsurface
D. none

Neoparasitidae

Ololaelaps sp., near *venetus* Berlese
A. 2, 3, 6, 9, 10, 11, 12
B. 10 (290/m^2)
C. mostly surface
D. none

Parholaspidae

Neparholaspis swartae Marshall
Rare

Phytoseiidae

Typhlodromus sp.
A. 1, 2, 3, 4, 5, 6, 7, 9
B. 2 (1,610/m^2)
C. mostly surface
D. none

Rhodacaridae

Gamasellus bellavistae Emberson and *G. vibrissatus* Emberson
A. all except No. 4
B. 5 (2,020/m^2)
C. mostly surface
D. April & December

Sejidae

Sejus americanus Banks
A. 5, 6, 7, 8, 10, 11
B. 5 (620/m^2)
C. mostly surface
D. none

Uropodidae

Dinychus sp.
A. 5, 6, 7, 8, 9, 11, 12
B. 5 (580/m^2)
C. surface & subsurface
D. none

Trachytes sp., near *pyriformis* Kramer
A. 6, 7, 8, 9, 11, 12
B. 12 (660/m^2)
C. mostly surface
D. none

Veigaiidae

Veigaia mitis Berlese
A. 1, 5, 7, 8, 9, 11, 12
B. 8 (820/m^2)
C. surface & subsurface
D. October

Zerconidae

Parazercon radiatus Berlese and *Parazercon* sp., near *sarekensis* Willmann
A. all except No. 10
B. 5 (3,720/m^2)
C. surface & subsurface
D. May & December

Zercon alaskensis Sellnick and *Zercon* sp., near *peltatus* Koch
A. all except No. 5
B. 2 (1,690/m^2)
C. mostly surface
D. October

CRYPTOSTIGMATA

Achipteriidae

Achipteria sp., near *nitens* Nicolet
A. all except No. 11
B. 5 (6,080/m^2)
C. mostly surface
D. none

Brachychthoniidae

Eobrachychthonius latior Berlese
Rare

Liochthonius sp.
A. 3, 4, 5, 7, 8, 9, 10, 11, 12
B. 8 (2,330/m^2)
C. mostly surface
D. April & December

Camasiidae

Camisia sp.
A. 1, 2, 4, 8, 9, 10
B. 1 (660/m^2)
C. surface only
D. May

Heminothrus thori Berlese
A. 1, 3, 7, 9, 10, 12
B. 10 (4,510/m^2)
C. mostly surface
D. November

Uronothrus sp., near *kochi* Willmann
Rare

Carabodidae

Carabodes sp. 1
A. 1, 2, 3, 4, 5, 10, 12
B. 2 (8,970/m^2)
C. surface only
D. December & January

Carabodes sp. 2
A. all except Nos. 7 & 10
B. 1 (660/m^2)
C. surface only
D. June

Cepheidae

Cepheus sp., near *corae* Jacot
A. 3, 5, 6, 7, 9, 10, 12
B. 3 (290/m^2)
C. mostly surface
D. November & April

Ceratozetidae

Ceratozetes sp. 1
A. all
B. 12 (4,510/m^2)
C. surface & subsurface
D. none

Ceratozetes sp. 2
A. all
B. 8 (12,190/m^2)
C. surface & subsurface
D. April

Fuscozetes bidentatus Banks and *F. fuscipes* Koch
A. 2, 3, 4, 5, 6, 9, 12
B. 6 (4,830/m^2)
C. surface only
D. none

Propelops sp., near *pinicus* Jacot
A. 2, 4, 5, 6, 7, 8, 9, 10, 12
B. 6 (750/m^2)
C. surface only
D. April

Cosmochthoniidae

Trichthonius majestus Marshall & Reeves
Rare

Damaeidae

Belba sp., near *tatrica* Kulczynski
Rare

Eniochthoniidae

Hypochthoniella minutissimus Berlese
A. all except No. 1
B. 5 (5,910/m^2)
C. mostly surface
D. April

Eremaeidae

Eremaeus sp.
Rare

Euphthiracaridae

Euphthiracarus sp.
Rare

Rhysotritia ardua Koch
A. all except Nos. 2 & 7
B. 10 (1,530/m^2)
C. surface & subsurface
D. April

Galumnidae

Pergalumna sp.
A. all
B. 2 (1,240/m^2)
C. mostly surface
D. April

Gustaviidae

Gustavia sp.
A. all except No. 4
B. 6 (1,290/m^2)
C. mostly surface
D. December

Gymnodamaeidae

Allodamaeus sp.
A. 4, 6, 7, 12
B. 4 (910/m^2)
C. surface only
D. January

Gymnodamaeus gildersleeveae Hammer
A. 1, 2, 4
B. 4 (1,940/m^2)
C. surface only
D. May & January

Haplozetidae

Peloribates sp.
A. all
B. 1 (10,870/m^2)
C. mostly surface
D. June & December

Hypochthoniidae

Hypochthonius rufulus Koch
A. 7, 8, 9, 10
B. 7 (2,890/m^2)
C. surface & subsurface
D. January

Malaconothridae

Malaconothrus sp.
A. 5, 8, 9, 10, 11, 12
B. 12 (2,210/m^2)
C. surface & subsurface
D. April & September

Mesoplophoridae

Archoplophora laevis Jacot
A. all except Nos. 1, 4, 10
B. 12 (14,170/m^2)
C. surface & subsurface
D. April & December

Metrioppiidae

Ceratoppia bipilis Hermann
A. 1, 2, 3, 7, 10, 11, 12
B. 12 (210/m^2)
C. surface only
D. none

Ceratoppia sp.
A. 2, 3, 4, 5, 7, 12
C. surface only
Scarce

Nanhermanniidae

Nanhermannia elegantula Banks
A. 5, 6, 7, 8, 9, 10, 11, 12
B. 10 (6,080/m^2)
C. surface & subsurface
D. December

Nothridae

Nothrus silvestris Nicolet
A. 3, 7, 8, 9, 10, 11, 12
B. 12 (3,470/m^2)
C. surface & subsurface
D. July & January

Oppiidae

Oppia minus Paoli and
Oppiella nova Oudemans
A. all
B. all (17,930-67,390/m^2)
C. surface & subsurface
D. none

Oribatulidae

Scheloribates sp., near *pallidulus* Koch
A. all except Nos. 7, 10, 11
B. 3 (2,270/m^2)
C. mostly surface
D. April & December

Pelopidae

Eupelops sp.
A. 1, 2, 3, 4, 7, 9, 10, 11
B. 1 (6,030/m^2)
C. mostly surface
D. April & November

Phthiracaridae

Hoplophorella sp.
Rare

Phthiracarus sphaerulus Banks
A. all except No. 2
B. 5 (4,750/m^2)
C. surface & subsurface
D. April & December

Steganacarus diaphanum Jacot
Rare

Tectocepheidae

Tectocepheus velatus Michael
A. all
B. 2 (7,690/m^2)
C. mostly surface
D. none

Trhypochthoniidae

Trhypochthonius tectorum Berlese
A. all except Nos. 6, 11
B. 2 (2,900/m^2)
C. mostly surface
D. none

The time of annual population peaks are also indicted for each species. In some cases two very similar species could not be distinguished under a dissecting scope and were counted together.

The most common species, comprising 71% of the acarine fauna, were *Archoplophora laevis, Ceratozetes* spp., *Nanhermannia elegantula, Oppia minus, Oppiella nova, Parazercon* spp., *Peloribates* sp., *Phthiracarus sphaerulus, Rhizoglyphus* sp., and *Tectocepheus velatus.* These were all cryptostigmatids except *Parazercon* and *Rhizoglyphus.* Species represented by very few individuals included *Belba* sp., *Eobrachychthonius latior, Eremaeus* sp., *Euphthiracarus* sp., *Hoplophorella* sp., *Neparholaspis swartae, Scutacarus* sp., *Steganacarus diaphanum, Trichthonius majestus* and *Uronothrus* sp.

There was no clearcut separation to habitat preference at the suborder level, however, a marked preference was often observed by some species. The species restricted to dry sites were *Gymnodamaeus gildersleeveae* and *Uronothrus* sp., and those relatively most abundant in dry sites were *Belba* sp., *Carabodes* spp., *Camisia* sp., *Digamasellus* sp., *Eupelops* sp., *Peloribates* sp., *Scheloribates* sp., *Trhypochthonius tectorum* and *Typhlodromus* sp. These latter species when found in wet sites most frequently occurred in the surface samples. The species restricted to wet sites were *Hypochthonius rufulus* and *Trichthonius majestus,* and those relatively most abundant there were *Archoplophora laevis, Ceratozetes* sp. 2, *Cheiroseius* sp., *Eobrachychthonius latior, Malaconothrus* sp., *Nanhermannia elegantula, Nothrus silvestrus, Achipteria* sp., *Sejus americanus, Trachytes* sp., and *Veigaia mitis. Digamasellus angulosus* was the only species confined to moist sites.

Generally the various acarine groups were more abundant in winter and spring and scarce in late summer and early autumn (Fig. 2). Similar trends in seasonal fluctuations among forest soil mites were also observed by Madge (1965) and Block (1966) in England. The temperatures of the samples generally attained a high of about 18°C in July and were frozen from mid November to early April (Fig. 2); the lowest temperature recorded was minus 9°C in January. From late April to mid-October the surface temperatures were consistently higher than the subsurface temperatures but the only appreciable difference occurred during late April. From November to April the surface temperatures were slightly lower than the subsurface temperatures.

DISCUSSION

Although most of the species found in this investigation have been reported from various parts of North America or Europe (Woolley, 1960; Marshall and Kevan, 1964; Madge, 1965; Marshall, 1968) some have not previously been reported from Canada and others may be new to science. *Archoplophora laevis, Digamasellus angulosus, Fuscozetes bidentatus, Ledermuelleria rhodomela* and *Sejus americanus* were among those not listed by Hammer (1952), Marshall and Kevan (1964) or Marshall (1968) as occurring in Canada; however most of their work was on the cryptostigmata and only two of these mites are in that suborder. *Trichthonius majestus* was recently described by Marshall and Reeves (1970). Several genera including *Cepheus, Euphthiracarus, Gustavia, Hoplophorella, Ledermuelleria,* and *Rhizoglyphus* contain undescribed species.

The number of mites per square meter varied seasonally and from site to site. The undisturbed dry sandy sites had a yearly average of 75,032 mites/m^2 in the top 15 cm with 78% of these being in the surface 7.5 cm. The highest average at one collecting period, combining surface and subsurface samples, was 152,577 mites/m^2. The wet sites had the highest yearly average, 79,593 mites/m^2 in the top 15 cm with 73% in the top 7.5 cm and a peak collection period of 145,480 mites/m^2. The cut over jack pine site had the smallest population with an annual average of 40,992 mites/m^2. The moist sites had a yearly average of 74,615 mites/m^2 and a peak collection average of 160,907 mites/m^2. It is difficult to compare these figures with studies conducted in other areas and sites because of the differences in techniques used by the researchers. Macfadyen (1955, 1961, 1962) and

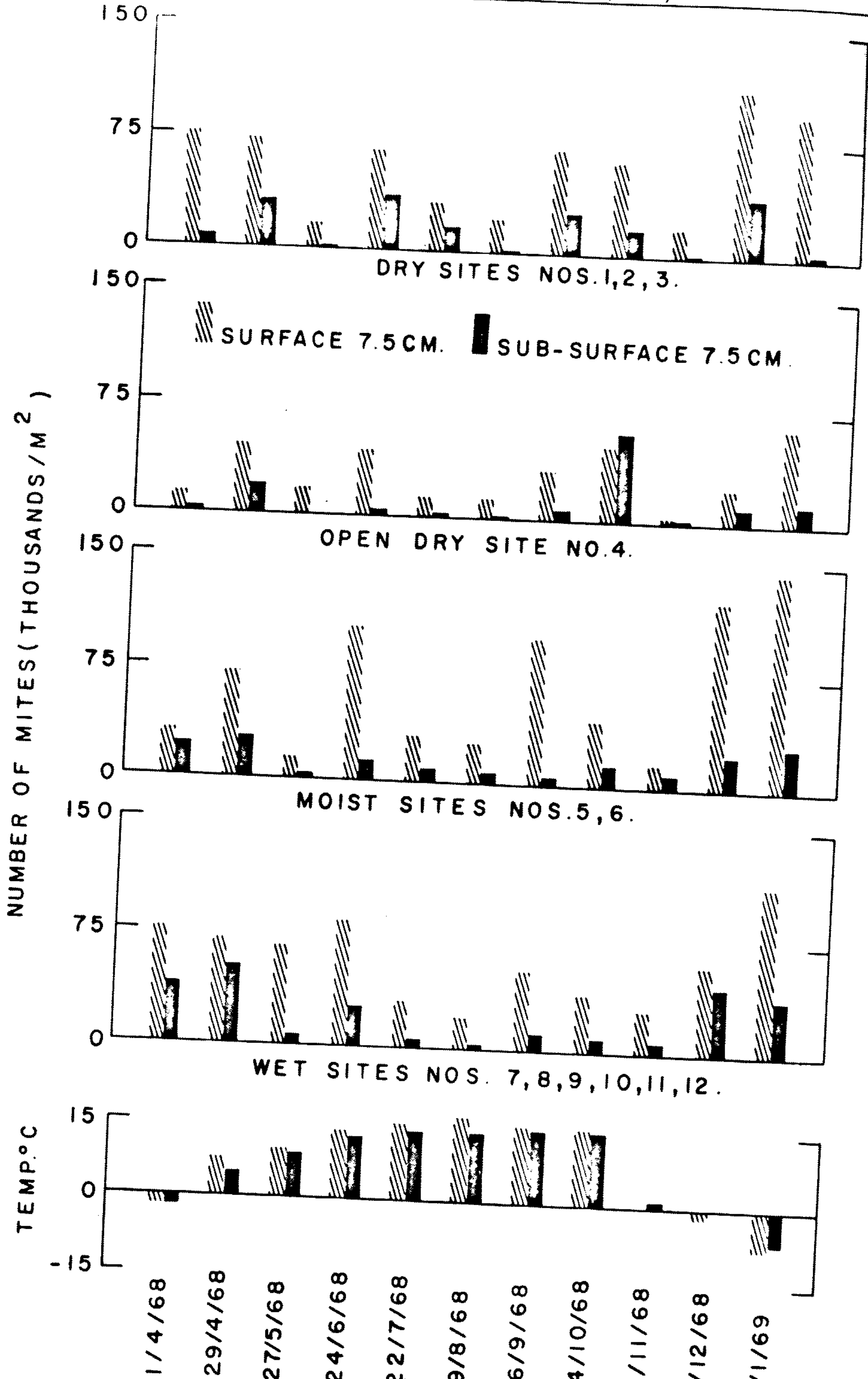

Figure 2. Average populations in surface and subsurface samples for each site type on 11 collecting dates and the average temperature of the samples.

Murphy (1962) have evaluated several extraction techniques and found the number of species and individuals to vary with the method but that different methods were better for different soil types. Other factors influencing the number of mites extracted include the depth, area, and phenological time of sampling, the disturbance of the sample, and the collecting medium employed. Hairston and Byers (1954) reviewed the number of mites obtained in several studies of various sites and indicated the lack of comparative estimations of population size among different studies. The reported number of mites in forest communities varies between 20,000/m^2 and 341,000/m^2 (Marshall and Kevan, 1964; Dowdy, 1965; Madge, 1965; Block, 1966; Marcuzzi, 1966; Berg and Ryke, 1967; Greenslade and Greenslade, 1968). The degree of variance that can be ascribed to habitat difference in these studies can not be evaluated because the techniques employed in each case differ.

The ecology of soil mites is not well known but a few studies, mostly in the last few years, have been made on their importance to the soil community. One of the greatest hinderances appears to be the difficulty to rear single species from field populations in the laboratory so that life history and other biological studies can be conducted in detail. Often nymphal stages require a specific food material and perhaps environmental conditions that differ from the adult (Sengbusch, 1954; Hartenstein, 1962; Murphy and Jalil, 1964; and Rodriquez, 1964). Indications are that the feeding habits of soil mites vary considerably among species but much of the specific data has been obtained through inconclusive laboratory analysis. Fungi, algae, protozoa, insect larvae, and raw organic matter are among the materials that soil mites have been found to feed upon (Evans *et al.*, 1961; Kevan, 1962; Crossley and Witkamp, 1964; Wallwork, 1967). They have also been found to serve as intermediate hosts for some cestodes (Freeman, 1952; Allred, 1954) and as vectors of various plant diseases (Sengbusch, 1954). Dowdy (1965) found species of *Allodamaeus, Tectocepheus, Trhypochthonius* and *Zercon* to be more abundant on the vegetation than in the soil during at least part of the year. It is perhaps worth noting that the mites associated with stored cereal products, including grain, (Sinha, 1963; 1964) constitute an entirely different fauna than those found in the soil. From the stand point of numbers of individuals and species diversification the roles performed by soil mites must be quite variable but important to the ecosystem.

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