THE SPATIAL PATTERNS OF SELECTED SOIL ACARI AND COLLEMBOLA IN AN ECOLOGICALLY MANIPULATED ENVIRONMENT

Thesis for the Degree of Ph. D.
MICHIGAN STATE UNIVERSITY
James Henry Shaddy
1970

This is to certify that the

thesis entitled

THE SPATIAL PATTERNS OF SELECTED SOIL
ACARI AND COLLEMBOLA IN AN ECOLOGICALLY
MANIPULATED ENVIRONMENT

presented by

JAMES HENRY SHADDY

has been accepted towards fulfillment
of the requirements for

Ph.D.

Date

O-169

ABSTRACT

THE SPATIAL PATTERNS OF SELECTED SOIL
ACARI AND COLLEMBOLA IN AN ECOLOGICALLY
MANIPULATED ENVIRONMENT

By

James Henry Shaddy

The spatial patterns of three groups of soil arthropods (two Acari; Gamasides, and *Malaconothrus*, and a species of Collembola; *Mesaphorura granulata*) were studied in an ecologically manipulated old field environment. Cultivation and the addition of water were used to manipulate the conditions. Plots were established with the following characteristics: uncultivated-no water added, uncultivated-water added, cultivated-no water added, and cultivated-water added.

A high gradient extractor was used to remove the soil animals from the soil samples. Extraction efficiency estimates were as follows: Gamasides - 90%, *Malaconothrus* - 100%, and *Mesaphorura granulata* - 93%.

Cultivation had little effect on the time of peak density of the Gamasides but did result in a vertical redistribution with the largest population occurring at six inches (depth to which plots were plowed) and very few individuals present in the upper three inches of the soil. The spatial pattern of this group was mostly random except at the lower levels of the cultivated plots where aggregation occurred. A type II aggregation characterized this group. The addition of water had no conclusive effect.

The Malaconothrus was mostly aggregated in distribution exhibiting type II aggregation characteristics. Water had no apparent effect on seasonal abundance or aggregation characteristics.

Mesaphorura granulata was mostly random in distribution. Water had no apparent effect.

An initial reduction of numbers was observed in all groups in the cultivated plots.

The most common size of aggregation in all groups was two inches or less and eight inches.

THE SPATIAL PATTERNS OF SELECTED SOIL ACARI AND COLLEMBOLA IN AN ECOLOGICALLY MANIPULATED ENVIRONMENT

By

James Henry Shaddy

A THESIS

Submitted to
Michigan State University
in partial fulfillment of the requirements
for the degree of

DOCTOR OF PHILOSOPHY

Department of Entomology

1970

ACKNOWLEDGEMENTS

I wish to express my sincere appreciation to Dr. James Butcher for his encouragement and guidance throughout this study.

A special note of thanks is extended to Dr. William Cooper, Dr. Paul Rieke, Dr. Gordon Guyer, and Mr. Richard Connin for serving on my guidance committee. Each member contributed considerable assistance throughout my study.

Thanks is also extended to Mr. Richard Snider, Dr. James Truchan, Mr. Ernest Bernard, Miss Jacqueline Lorentzen, and others for their assistance during this study.

A special note of gratitude is extended to my parents for their encouragement and to my wife for her patience and labor in the preparation of this dissertation.

TABLE OF CONTENTS

LIST OF TABLES

Fig

LIST OF FIGURES

INTRODUCTION

The Arthropoda of the soil, of which Acari and Collembola are a major component, is an extremely diverse complex of animals. Generally, the greatest complexity and abundance is attained in undisturbed habitats such as forests and grasslands, especially where the climate, vegetation and soil type combine to supply adequate moisture, temperature and food (Burges and Raw, 1967). Their importance in this process of decomposition has been illustrated by Kubiena (1955), Edwards and Heath (1963), Ghilarov (1963), MacFadyen (1963), and Burges and Raw (1967), among others.

It is generally known that the horizontal patterns of animal populations are not random, but are aggregated or clumped (Glasgow, 1939; MacFadyen, 1952; Hairston and Byers, 1954; Haarlov, 1960; Poole, 1961; Block, 1966; and Gerard, 1966). Klopfer (1969), among others, has suggested that heterogeneity of the environment has resulted in reduced interaction between species consequently, permitting more species to coexist. If the environment was uniform, interspecific competition would be intensified resulting in a reduced number of different species. Other factors, both biotic and abiotic that may affect, in different degrees, the distribution and abundance of soil animals are (1) competition for food, (2) reproductive behavior (i.e. issuance from egg masses or clumped eggs with limited dispersion of immature stages and clustering of progeny around parents), (3) mutual attraction for other individuals of the same species, (4) response to daily and seasonal weather changes, and (5) increased survival of the species through clumping. Individuals in groups often experience a lower mortality rate during periods of stress (such as attacks by other organisms) than do isolated individuals, because the surface area exposed to the environment is less in proportion to the mass and because the group may be able to favorably modify the microclimate or microhabitat (Allee, 1931; Odum, 1959).

Several studies on the vertical distribution patterns of soil micro-arthropods have shown that the majority of the organisms occur in the uppermost layers of the soil, particularly in forest and grassland regions (Glasgow, 1939; Nielsen, 1949; Kuhnelt, 1955; Murphy, 1955; and Poole, 1961).

There is some disagreement concerning the effect of cultivation on soil populations. Edwards (1929) and Gisin (1955) have concluded that there is relatively little effect, while others have observed a deleterious effect (Karg, 1956; Sheals, 1956; and Strebel, 1957).

Seasonal abundance of soil organisms have been correlated by numerous authors with such parameters as moisture and temperature (Ford, 1938; Weis-Fogh, 1948; MacFadyen, 1952; and Block, 1966). The effects of cultivation, moisture, temperature and many other factors have been reviewed thoroughly by Christiansen (1964) and Burges and Raw (1967).

The non-economic soil arthopod fauna of the United States, have received little attention from zoologists. This study is intended to provide information on seasonal abundance, horizontal and vertical distribution patterns of two groups of Acari (Gamasides and Malaconothrus) and one species of Collembola (Mesaphorura granulata).

Other Acari and Collembola were not present in sufficient numbers to allow a sophisticated analysis. Therefore this information has been placed in Appendix A.

The three above mentioned groups were studied in a cultivated and an uncultivated habitat which had water added during the driest part of the summer. These particular manipulations were studied since cultivation is a common practice in agricultural areas and its affect on the distribution of soil arthropods is poorly understood and at the same time, water may be an important limiting factor in their population growth and distribution (Christiansen, 1964; Knight and Chesson, 1966). Specifically, the research was designed to gain information on the following questions: (1) Does cultivation affect the horizontal aggregation pattern, the vertical pattern and seasonal abundance of the soil microarthropod fauna? (2) Does the addition of water during the summer affect the horizontal aggregation or vertical pattern, or the seasonal abundance?

MATERIALS AND METHODS

Plots

In the Spring of 1968, eight plots were established in an old field that had not been disturbed for approximately 15 years, on the farm of Ray L. Cook, Chairman, Department of Soil Science, Michigan State University, located approximately ten miles North of Lansing, Michigan. Each plot was 22 feet wide and 30 feet long. On May 22, the disrupted plots were plowed to a depth of six inches and double disced to insure a mixture of plant residue with the soil. Beginning July 17th and ending September 26th, one inch of water was added to specific plots at seven to nine day intervals. Water was procured from a nearby drainage ditch and applied to the plots using oscillating sprinklers. Actual rainfall was recorded with a universal recording rain gauge. Figure 1 indicates the location of the experimental manipulations in the different plots. The four western plots are referred to as Block I and the four eastern plots are referred to as Block II. Each block contains an undisturbed plot, a disrupted plot, an undisturbed plot with water added, and a disrupted plot with water added. A lettering system was devised to identify each plot. This system is explained in Figure 1.

The dominant plant fauna in the undisturbed plots consisted of *Agropyron repens*, *Solidago* sp., *Poa compressa*, and *Phleum pratense*.

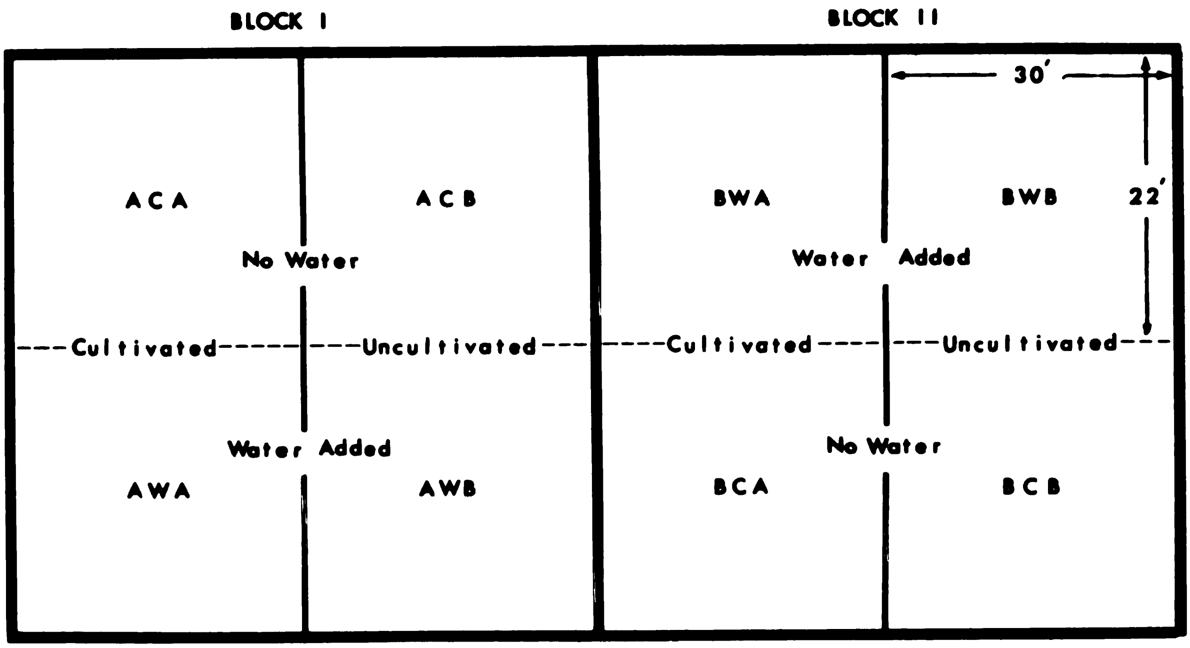

Figure 1.--Location and explanation of experimental manipulations.[1]

[1]ACA = Block I, no water, cultivated.
AWA = Block I, watered, cultivated.
ACB = Block I, no water, uncultivated.
AWB = Block I, watered, uncultivated.
BWA = Block II, watered, cultivated.
BCA = Block II, no water, cultivated.
BWB = Block II, watered, uncultivated.
BCB = Block II, no water, uncultivated.

Agropyron repens and *Ambrosia* sp. were the dominant plants on the cultivated plots later in the summer.

Soil samples were obtained from each plot for detailed chemical analysis to determine the homogeneity of the soil in the plots. Each sample consisted of 20 1-inch x 2-inch soil cores taken randomly over the plot. The cultivated plots were sampled to a depth of six inches with the two samples taken from each two inch interval. Two samples were taken from each uncultivated plot to a depth of two inches. The samples were analyzed by the Michigan State Soils Testing Laboratory at Michigan State University. The following methods were used in the analysis:

Potassium = extracted with neutral normal ammonium acetate and determined on a flame photometer.

Phosphorus = Bray P.

Nitrates = Brucine method.

Carbon = Leco Carbon Analyzer (combustion method).

A gas-liquid chromatograph (Beckman GC-4) was used to check the soil and water source for possible insecticide pollutants. None were found.

Sampling

The peripheral three feet of each of the plots was excluded from the sampling scheme to eliminate any possible edge effect. The remainder of each plot was divided into one square foot grids. Stakes were placed along the edge of each plot at one foot intervals. Strings were placed between any pair of longitudinal stakes to determine the exact location of any point on the grid. Points on the grid in each plot were selected at random from a table of random numbers with the restriction that a given point in any given plot could be sampled only once. Points chosen by this method determined the center of each sample location. Consequently, the center of each sample location was at least one foot from the center of the next closest sample.

The device used to obtain samples of the soil for arthropod analysis was constructed from stainless steel. The penetrating edges were sharpened. The sampler had dimensions of 4-inch x 4-inch x 2 1/2-inch (Figure 2). In the cultivated plots, samples were taken to a depth of six inches, but only the top two inches of the soil was sampled in the undisturbed plots. It is known that the majority of animals are in the first two inches of an undisturbed soil (Glasgow, 1939; Gisin, 1943; Nielsen, 1949; Kuhnelt, 1955; and Poole, 1961).

Since water was added to the uncultivated plots during this study, two samples were taken to a depth of six inches near the end of the sampling period to check the vertical distribution. It was found that over 75% of the Collembola and Acari were in the top two inches of the soil.

The living vegetation was clipped at ground level and along with the litter, removed from the four inch square sampling point. The sharpened side of the sampler was pushed into the ground to a depth of two inches, removed with the sample intact, and placed in a styrofoam container to minimize desiccation during transport back to the laboratory. The hole that was left in the ground by removing the sample was immediately filled with sand.

On specific dates (Table 1), four samples were taken adjacent to one another at various depths to gather information on samples of a

Figure 2.--The 4" x 4" x 2 1/2" stainless steel soil arthropod sampler.

TABLE 1.--Sampling scheme showing the block, plots, number of replicates, and depth of each sample on each sample date

Date	Block	Plot	Replicates	Depth
6-7-68	I	ACA, AWA	I, II	1-6
	I	ACB, AWB	I, II	1-2
6-20-68	II	BCA, BWA	I, II	1-6
	II	BCB, BWB	I, II	1-2
7-2-68*	I	ACA	I, II, III, IV	3-4
	I	AWA	I, II, III, IV	3-4
7-17-68	I	ACA, AWA	I, II	1-6
	I	ACB, AWB	I, II	1-2
7-31-68	II	BCA, BWA	I, II	1-6
	II	BCB, BWB	I, II	1-2
8-14-68*	I	ACA	I, II, III, IV	5-6
	I	ACB	I, II, III, IV	1-2
8-28-68	I	ACA, AWA	I, II	1-6
	I	ACB, AWB	I, II	1-2
9-12-68	II	BCA, BWA	I, II	1-6
	II	BCB, BWB	I, II	1-2
10-16-68*	I	ACB	I	1-6
			II, III, IV	1-2
	I	AWB	I	1-6
			II, III, IV	1-2
11-11-68*	I	AWB	I, II, III, IV	1-2

*Set of four adjacent samples were taken to form an eight inch square sample.

larger size. Thus an eight inch square sample instead of the standard four inch square sample was taken on those dates. Replicate samples were taken from each plot and are explained in Table 1. The raw data for the total of 16,797 micro-arthropods from the sample dates are presented in Appendix A.

The moisture content of the soil was determined on each sampling date. Replicated samples were taken at a depth of four inches in each plot. The samples were brought back to the laboratory, weighed and dried in an oven at 100°C for 48 hours. The samples were then re-weighed to obtain per cent moisture.

Extraction

The arthropods were extracted from the soil samples by means of a modification of the Tullgren funnel described by MacFadyen (1961), Murphy (1962), and others. The extractor used by the author is similar to the high gradient extractor which Kempson, Lloyd, and Ghelardi (1963, p. 5, Figure 5B) have described in detail (Figure 3).

The extractor walls was constructed from 1/2-inch plywood. It differed from the extractor described by Kempson, Lloyd, and Ghelardi (1963) in the following respects: the baffle was built of 3/4-inch plywood as a separate unit which could be lifted out and replaced by a baffle of another design. The top side was covered with aluminum foil and the bottom covered with waterproof paint for insulation purposes. A total of 456 one inch holes were cut in the baffle in which the samples were placed (Figure 4).

Two 43 1/2-inch L x 22 1/2-inch W x 6-inch H cooling baths were constructed with galvanized metal. A 1/2 horse power circulating

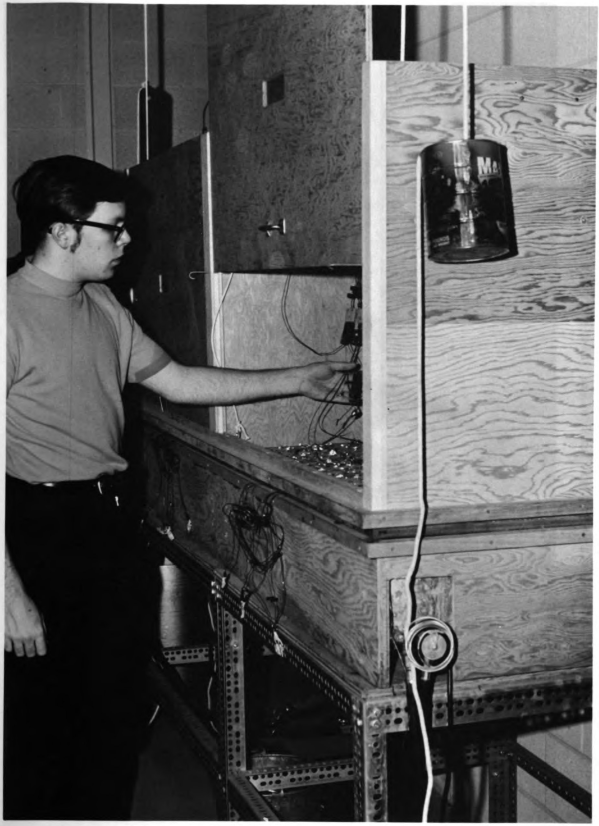

Figure 3.--The high gradient extractor used to extract arthropods from soil samples.

Figure 4.--Demonstration of how sample was inserted into the extractor.

ref:

ible

homc

wate

5°F

mete

time:

peric

once.

therm

coupl

the m

This a

sample

small

became

extrac

over]

days c

the ex

those

author

may al

refrigeration unit was installed for each cooling bath. One submersible water pump was then placed in each cooling bath to insure a homogeneous temperature throughout the water. The temperature of the water at the beginning of each extraction period was maintained about 5°F below that of the soil temperature. A Honeywell 24 point potentiometer was used to monitor temperatures within the extractor at all times.

A total of seven points were monitored during each extraction period, each point or area within the extractor was replicated at least once. Four soil samples, each specially drilled to receive three thermocouples, were monitored during the extraction period. One thermocouple was inserted near the top of the sample, one was inserted near the middle of the sample, and the third near the bottom of the sample. This allowed measurement of the temperature gradient through the soil samples throughout extraction. The gradient through each sample was small at the beginning of the extraction, usually about 4° - 6°F, but became more steep as extraction proceeded. At the end of the nine day extraction period, the temperature at the top of the soil sample was over 120°F while the temperature at the bottom was 85° - 90°F.

Representative series of the temperature readings for different days during the extraction period along with the points monitored in the extractor are presented in Table 2.

Although the temperatures in this study correspond closely to those obtained by Kempson, Lloyd and Ghelardi (1963), studies by these authors and Nef (1962) indicate that desiccation along with gravity may also be very important stimuli in the extraction process. Because of the small size of the sample, it was impossible to monitor the moisture within the sample in this study.

TABLE 2.--Representative daily fahrenheit temperatures at points monitored in extractor during extraction period. Extraction began evening of day 0

Point of Thermocouple	1	2	3	4	5	6	7	8	9
Water bath	62	62	62	62	63	63	63	64	65
Air above bath	62	62	63	64	64	65	65	66	67
Air directly above sample	82	83	83	85	87	90	95	100	110
Air in extractor	82	83	83	86	87	89	91	92	99
Top of sample	75	76	77	83	86	94	100	111	120
Middle of sample	73	74	75	76	79	87	91	97	107
Bottom of sample	68	69	70	73	73	75	77	80	89

The samples were prepared for extraction by cutting each into 16 subsamples 1-inch x 1-inch x 2-inch in size or into 32 subsamples 1-inch x 1-inch x 1-inch (Figure 5) size. This allowed delineation of animal distribution patterns to a depth of six inches, in one inch increments in the cultivated plots. If the sample was dry and crumbly, distilled water was added to hold it together during the cutting process. Each subsample was placed in a polyethylene tube one inch in diameter and four inches long. This tube was then slipped over a 25 x 150 mm disposable culture tube with a three inch square piece of nylon netting placed between the culture tube and the polyethylene; thus, the sample was kept intact within the polyethylene tube (Figure 6). Each culture

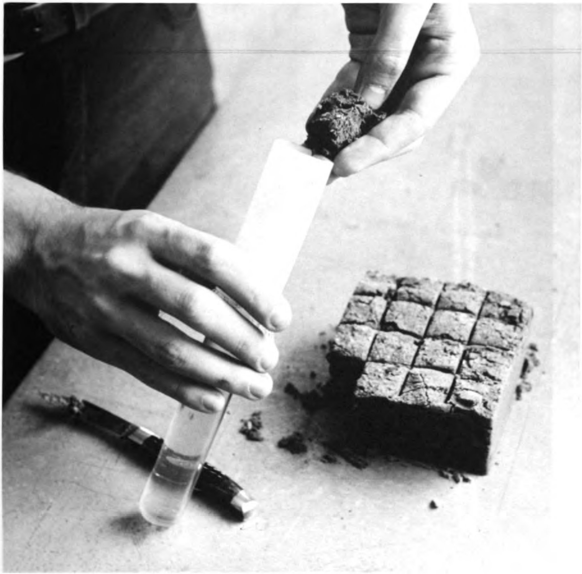

Figure 5.--Shows how sample was cut into subsamples and placed into container for extraction.

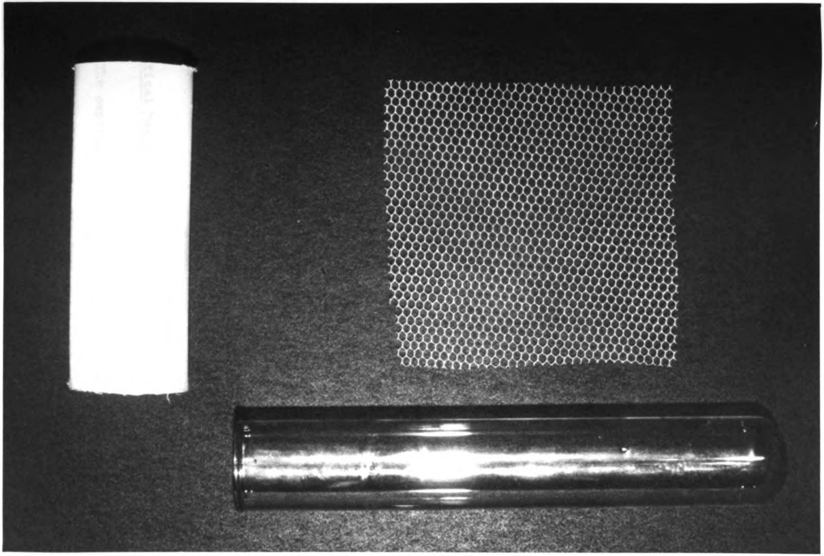

Figure 6.--Materials used to construct device to hold subsample for extraction: left - four inch polyethylene tube; right - nylon netting; and, below - a 25 x 150 mm test tube.

tube was filled to within 1 1/2 inches of the top with concentrated aqueous picric acid for collecting the soil arthropods.

After all of the samples had been inserted into the baffle of the extractor, it was then lowered onto the extractor base. This allowed the culture tubes containing the picric acid to be immersed in the cooling bath.

The extraction efficiency was determined by hand sorting 42 randomly selected subsamples after complete extraction in the extractor. This is one of the methods of determining extraction efficiency and although time consuming, has been used by many authors (Forsslund, 1949; MacFadyen, 1953; Hughes, 1954; Murphy, 1962).

At termination of the extraction period, the samples were removed from the extractor and the culture tubes containing the animals were sealed with corks and stored. These were later counted and sorted under a binocular dissecting microscope.

The Collembola in the samples were sorted to the species level using the classification of Snider (1967). The mites were identified to genus or family whenever possible. Other specimens were grouped under unidentified. The remaining arthropods were identified to genus, family, order, or class.

Mathematical Manipulations

The experimental design, sampling program, and extraction techniques were specifically designed for the use of Morisita's (1959) index of dispersion of individuals and analysis of distributional patterns. This index is:

$$I = N \frac{\sum_{i=1}^{N} n_i(n_i-1)}{x(x-1)}$$

Where N = total samples, n_i = numbers in the i^{th} sample and x = the sum of the numbers of individuals found in all the samples. This index has the advantage of being relatively independent of the type of distribution, the number of samples, and the size of the mean (Southwood, 1966). When the distribution of the population is Poisson (random) the index will exhibit a value of unity. When the distribution is contagious (negative binomial) the index will be greater than one and if the distribution is regular (binomial) the index is less than one. Morisita (1962) has defined the exact mathematical relationship between the index and the parameters of these distributions. An F test developed by Morisita (1959) was used to test the significance of the departure from a random distribution indicated by the index:

$$F = \frac{I(x-1) + N-x}{N-1}$$

The size of aggregations within samples can also be determined by using Morisita's (1959) I value. The formula is I(s)/I(2s), where I(s) is the I value of the quadrat size s, and I(2s) is that of the quadrat size 2s. When these computed values are plotted, the peak or peaks of the curve will determine the aggregation size.

Usher (1969) has developed a method of defining the type of aggregation exhibited by a soil animal. Type I aggregation is characterized by having a positive and significant correlation coefficient between the population density and the number of aggregated samples while the correlation between the population density and the mean number of individuals per aggregated sample is either non-significant or negative and significant. Such an aggregation could result from some fixed attribute of the species such as the size of the egg cluster. A Type II aggregation is characterized by a non-significant correlation between population density and the number of aggregated samples and a positive and significant correlation between population density and mean number of individuals per aggregated sample. This type of aggregation would result from the aggregations being located either in particularly suitable microenvironments or in relation to food supply, with the individuals moving there. A Type III aggregation would be characterized by both correlations between population density and the number of aggregated samples, and population density and the mean number of individuals per aggregated sample being positive and significant.

This method has been employed in this study where sufficient data were available.

An analysis of variance was used to test for significant differences among the ecological manipulations discussed earlier.

RESULTS

Extraction

Generalizations concerning extraction efficiency of soil arthropods cannot be made since they are an extremely diverse group of animals. Such factors as behavior, size, and age, only to mention a few, will affect their egress from a soil sample. For example, it is known that Oribatid nymphs tend to be slower than adults in leaving the sample which results in their exposure to deleterious conditions for a longer period of time; this may increase the ratio of nymph to adult mortality (Haarlov, 1947; Murphy, 1958; Murphy, 1962). Other factors such as mineral and organic matter content of a soil will also influence extraction efficiency (Nef, 1960; Murphy, 1962).

In determining the extraction efficiency in this study, distinction was not made between adult and immature forms of the Acari and Collembola.

Forty-two dried soil samples were placed in 70% alcohol after extraction was finished and later searched through for corpses of soil animals. The extraction efficiency estimates for all arthropods are presented in Table 3.

Among the Acari, *Malaconothrus* was extracted with 100% efficiency. *Oppia*, Gamasides, and Scutacaridae were extracted with efficiency of 100, 90, and 89% respectively. *Tetocepheus* and unidentified Prostigmata groups were lowest with 75 and 73% efficiency.

TABLE 3.--Estimates of extraction efficiency for all arthropods in forty two hand sorted samples

Animal	No. Extracted	No. Not Extracted	Per Cent Efficiency
	Acari		
Malaconothrus	28	0	100
Oppia	4	0	100
Gamasides	56	6	90
Scutacaridae	8	1	89
Oribatei	5	1	83
Tectocepheus	3	1	75
Prostigmata	16	6	73
Average			89
	Collembola		
Mesaphorura granulata	52	4	93
Isotoma notabilis	36	5	88
Protaphorura armata	14	2	88
Pseudosinella violenta	6	1	86
Megalothorax albus	5	1	83
Average			90
	Other Arthropods		
Ants	8	0	100
Psocoptera	1	0	100
Hymenoptera	1	0	100
Pauropus	1	0	100
Campodea	1	0	100
Coleoptera	9	3	75
Heteroptera	21	9	70
Diptera	2	3	40
Average			75
Overall Average			87

The average efficiency for all Collembola was 90%. Mesaphorura granulata was extracted with an efficiency of 93% while Megalothorax albus exhibited the lowest efficiency at 83%. A total of 26 species of Collembola were identified in this study (Table 4). Many of these did not occur in sufficient numbers to obtain an efficiency estimate.

The average efficiency for arthropods other than Acari and Collembola was 75%.

Soil and Soil Moisture

The results of the chemical analysis of the soil (Table 5) indicated that no important differences existed between plots with respect to percent carbon, potassium, phosphorous, nitrates, or pH. All of the above elements are present in minimal amounts[1] which may explain the low populations of some soil arthropods. Based on these results, it is assumed the study plots are homogeneous, although it is not possible to obtain complete homogeneity in any natural soil.

The mechanical analysis indicated the soil was 55 percent sand, 27 percent silt, and 18 percent clay. This represents a Washtenaw sandy loam soil type which is approaching a loam.

A total of 13.9 inches of rainfall was recorded in the area of the experimental plots from June 1st through September 30th. Nine inches of water was added artificially making a total of 22.49 inches of water on the watered plots (Table 6). Because of environmental and mechanical complications, it was impossible to begin adding the water to the plots earlier. If the additional water had been applied at a

---

[1]Personal communication from Dr. Paul Rieke, Professor of Soils, Michigan State University.

TABLE 4.--List of Collembola species identified during study

Arrhopalites benitus Folsom
Arrhopalites pygmaeus (Wankel)
Bourletiella juanitae Maynard
Entomobrya multifasciata (Tullberg)
Entomobryoides purpurascens (Packard)
Folsomia candida Willem
Isotoma notabilis Shaffer
Isotoma viridis Bourlet
Lepidocyrtus lignorum (Fabricius)
Lepidocyrtus paradoxus Uzel
Lepidocyrtus violaceus (Geoffroy)
Megalothorax albus Maynard
Mesaphorura granulata (Mills)
Metakatianna macgillivrayi (Banks)
Neanura muscorum (Templeton)
Neelus minutus Folsom
Orchesella ainsliei Folsom
Proisotoma minuta (Tullberg)
Protaphorura armata (Tullberg)
Pseudosinella rolfsi Mills
Pseudosinella sexoculata Schott
Pseudosinella violenta (Folsom)
Sinella curviseta Brook
Sminthurinus elegans (Fitch)
Tomocerus flavescens (Tullberg)
Willowsia platani nigromaculata (Lubbock)

TABLE 5.--Results of soil analysis from each plot. Each figure represents an average of two samples

Plot	Depth	Block I					Block II				
		C%	K*	P*	NO_3*	pH	C%	K*	P*	NO_3*	pH
Cultivated	2	2.43	66	5	7.6	6.4	2.18	54	5	8.3	6.3
No Water Added	4	2.45	66	2	12.8	6.3	2.37	55	3.5	7.1	6.4
	6	2.45	74	4.5	9.4	6.4	2.45	66	5.5	12.0	6.6
Cultivated	2	2.00	54	4	9.6	6.3	2.41	63	9	7.7	6.5
Water Added	4	2.25	55	1	6.6	6.1	2.59	55	5.5	6.2	6.6
	6	2.19	84	4.5	10.4	6.1	2.72	70	7.5	14.2	6.6
Uncultivated No Water Added	2	3.34	133.5	16.5	11.6	6.2	2.26	121	15.5	6.4	6.3
Uncultivated Water Added	2	2.45	144	10	5.1	6.3	2.78	85	16	12.3	6.4

*Parts per million.

different time, the response by these animals could have been different.

TABLE 6.--Total rainfall and water added to plots during this study

	June	July	August	September	Total
Rain	5.54	1.90	2.85	3.20	13.49
Added Water		2.00	4.00	3.00	9.00
Total	5.54	3.90	6.85	6.20	22.49

The moisture content of the soil can depend greatly on the depth of the sample, and when the sample was taken in relation to the last rainfall as well as many other factors. Figure 7 presents the relationship between soil arthropod and moisture sample dates and the application of water and rainfall. The soil moisture on each sampling date is presented in Table 7. A two-way analysis of variance was applied to the moisture data from July 31st through September 12th because this was where treatment actually began (Table 8).

In the cultivated plots there was no significant difference between soil moisture values in the watered and unwatered plots. There was a significant difference in moisture content between dates in the cultivated plots which was expected.

In the uncultivated plots the results were identical in that there was no difference between the watered and unwatered plots while a significant difference existed between dates.

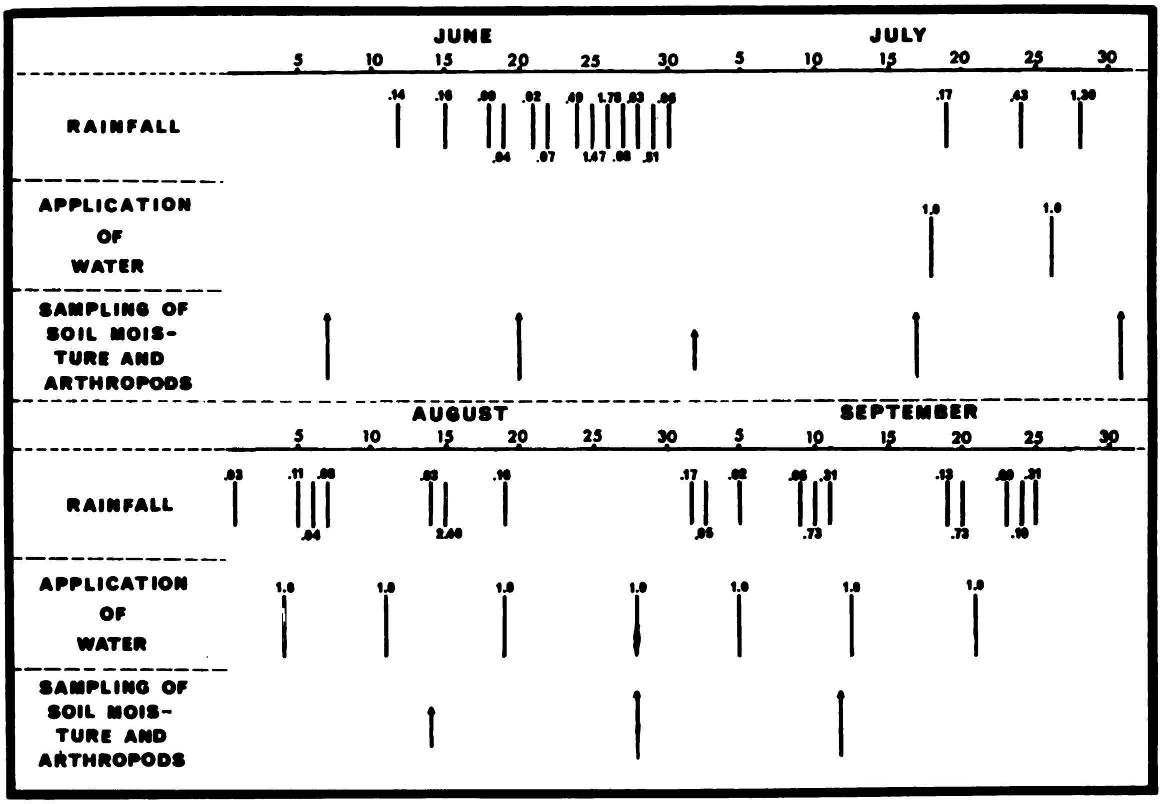

Figure 7.--Time relationship of rainfall and water application to arthropod and soil moisture sampling.

TABLE 7.--Soil moisture at a depth of four inches in each plot on each sample date. All figures represent an average of at least four samples

	June		July		August	September
	7	20	17	31	28	12
Cultivated No Water Added	16.75	14.39	8.12	9.00	10.75	13.18
Cultivated Water Added	16.35	15.01	8.10	9.79	10.27	14.87
Uncultivated No Water Added	9.50	10.94	9.79	11.98	13.54	13.57
Uncultivated Water Added	9.35	11.77	9.22	11.77	15.40	15.33

TABLE 8.--Results of a two way analysis of variance of soil moisture with watered and unwatered treatments in cultivated and uncultivated plots

Source	d.f.	SS	MSS	F
		Uncultivated		
Treatment	1	7.578	7.577	4.389
Dates	2	36.794	18.397	10.659**
Interaction	2	5.814	2.906	1.684
Error	18	31.067	1.726	
Total	23	81.254		
		Cultivated		
Treatment	1	2.633	2.633	1.381
Dates	2	91.472	45.736	23.983**
Interaction	2	4.888	2.443	1.281
Error	18	34.329	1.907	
Total	23	133.322		

**Significance at the .01 level.

Seasonal Abundance and Vertical Pattern

The seasonal abundance or fluctuations and vertical distribution of both groups of Acari and the species of Collembola are presented in Figures 8-11. Estimates of the standard error are given for those samples with the largest variance in each figure.

Gamasides.--Numerically, the Gamasides gradually increased approximately four fold over the summer, reached a peak abundance on August 28, and declined thereafter in both the watered and unwatered cultivated plots (Figure 8). This is evident at all depths although there are more individuals at the six inch level than at the four or two inch level. There was no apparent difference between the number of individuals in the watered and unwatered plots.

In the uncultivated plots, there was no clear population peak in either the watered or unwatered plots although a gradual increase over the summer to August 28 was evident (Figure 11). This corresponds also to peak abundance in the cultivated plots. The population at the two inch level in the cultivated plots did not recover to the level of the population in the uncultivated plots.

Malaconothrus.--The *Malaconothrus* exhibited peak abundance early in the summer in the cultivated plots (Figure 9). In the unwatered plot, peak abundance was reached on June 20 at the two and four inch levels, while in the watered plots peak abundance occurred on July 17 at the six inch level. However, this was before water had been applied to the plots. The populations remained stable throughout the rest of

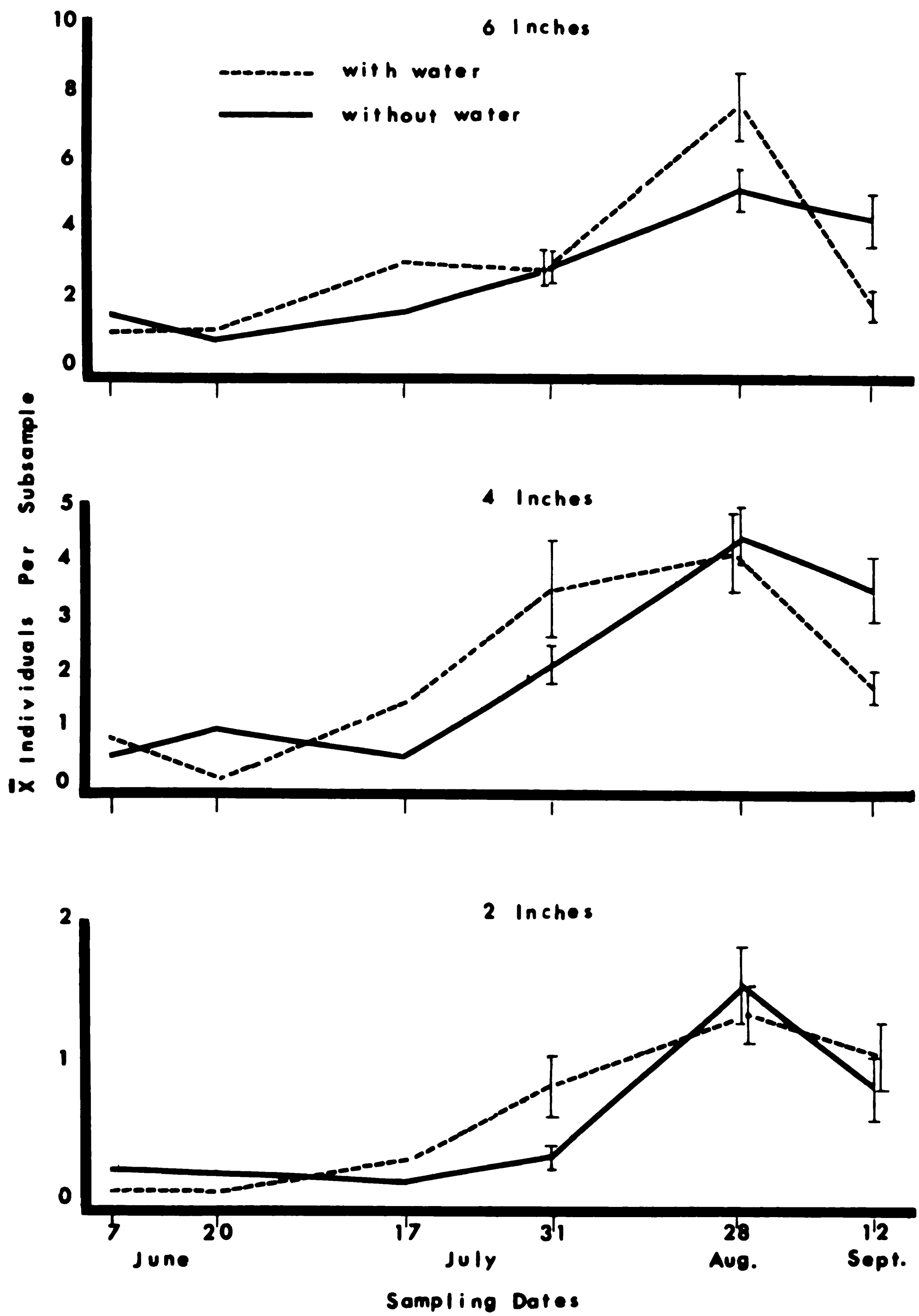

Figure 8.--The verticle and seasonal distribution of Gamasides in cultivated plots.

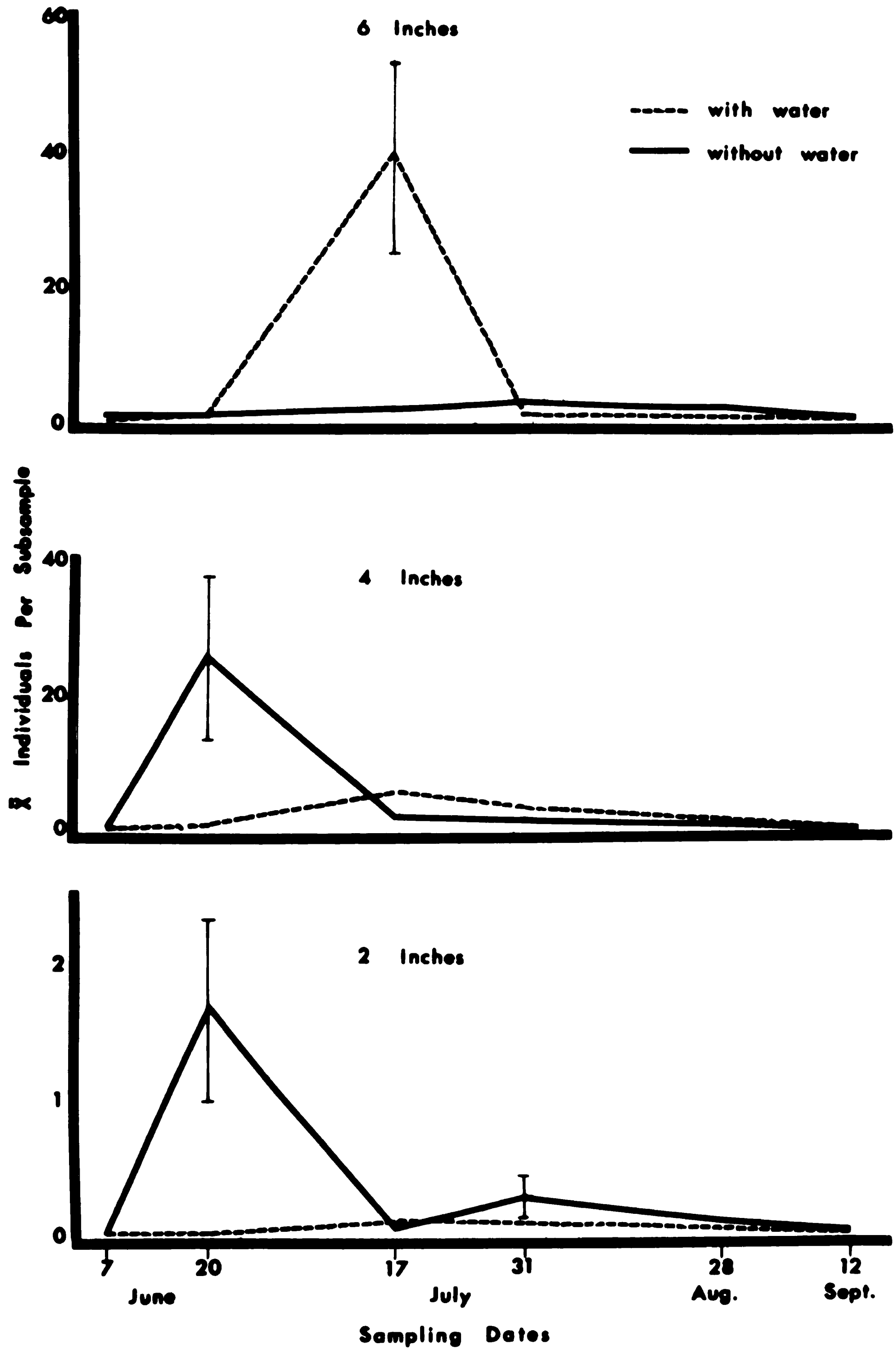

Figure 9.--The verticle and seasonal distribution of Malaconothrus in cultivated plots.

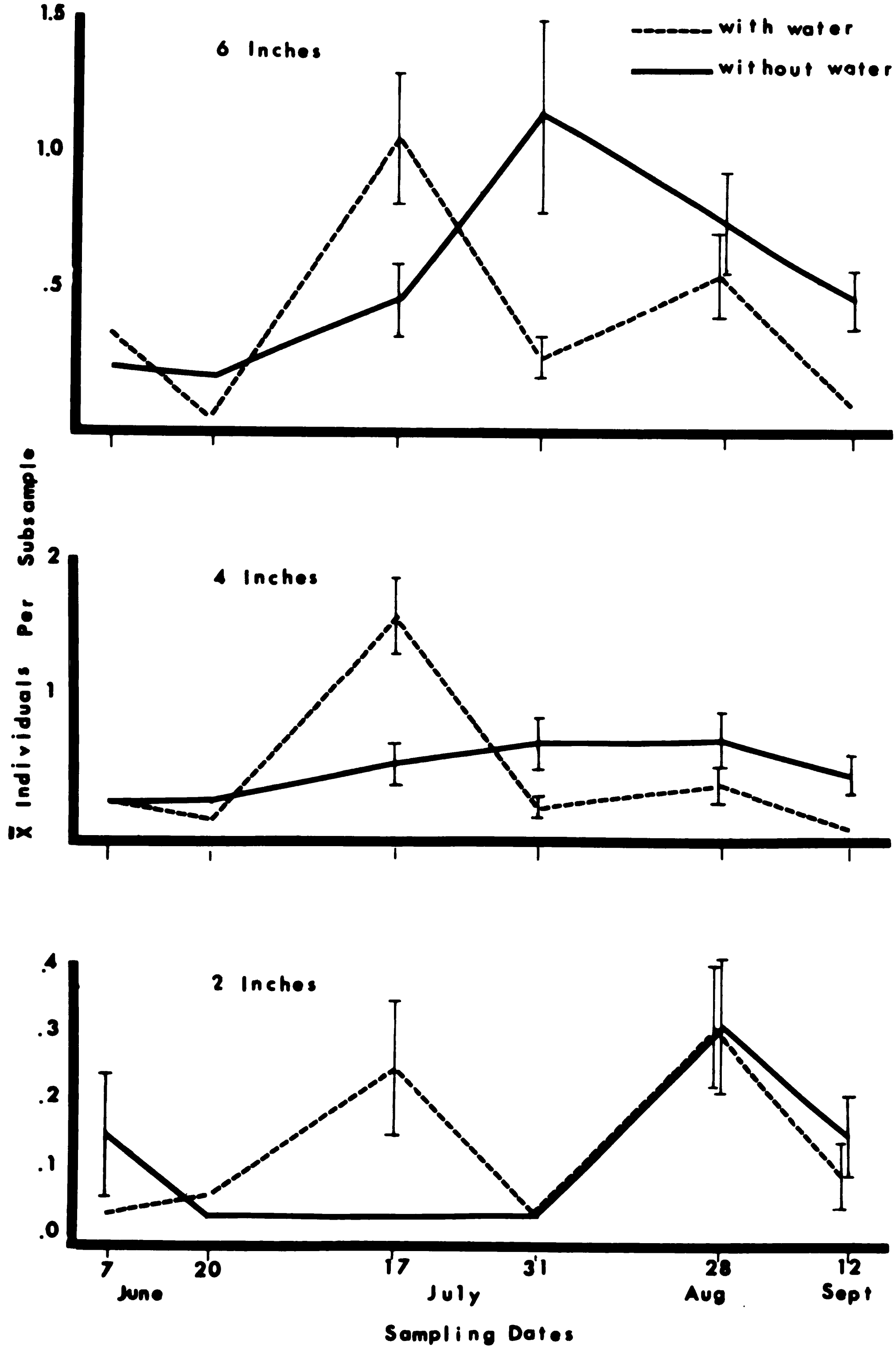

Figure 10.--The verticle and seasonal distribution of <u>Mesaphorura granulata</u> in cultivated plots.

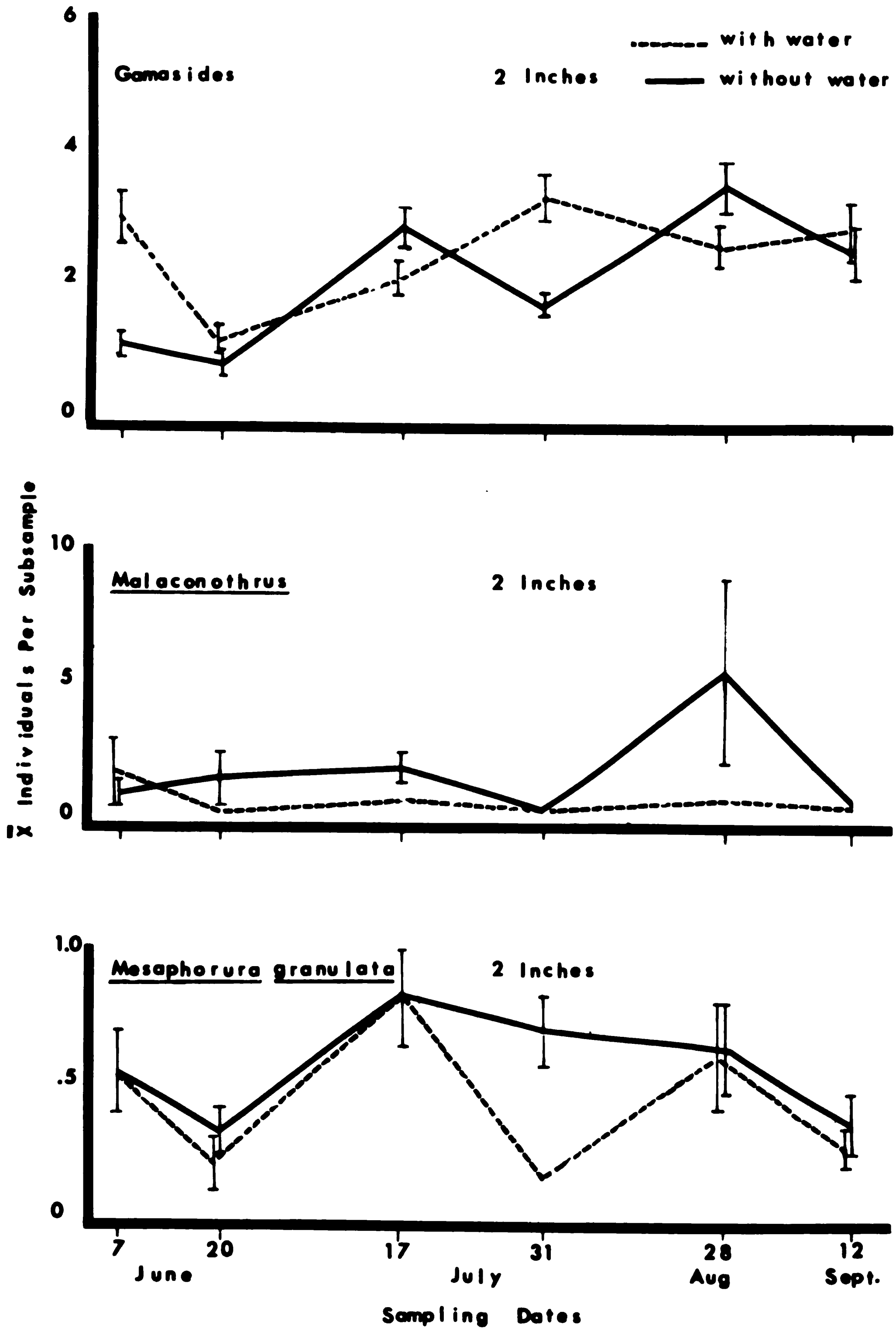

Figure 11.--The seasonal distribution of Gamasides, Malaconothrus and Mesaphorura granulata in uncultivated plots.

the summer and gradually decreased to the point where on the last sample date very few individuals were present.

The largest number of individuals in the uncultivated plots were recovered on August 28 in the unwatered plot (Figure 11). At the end of the sampling period, very few individuals were present in the uncultivated plots.

Mesaphorura granulata.--In the cultivated plots, the collembolan, Mesaphorura granulata exhibited a general increase to reach peak abundance in mid-summer with a decline toward the end of the sampling period (Figure 10). The four and six inch levels contained largest number of individuals throughout the summer. There was no apparent difference between the populations of the watered and unwatered plots.

Peak abundance, in general, occurred also in mid-summer in the uncultivated plots with a corresponding decline at the end of the sampling period (Figure 11). The number of individuals at the two inch level in the uncultivated plots remained larger than that of the cultivated plots throughout the summer.

Horizontal Pattern

The horizontal patterns of all three groups studied are presented in Tables 9-17. Because of considerable variation in the number of Collembola and Acari during the sampling period, at least five individuals of the group of Acari or species of Collembola being considered had to be present in order for that sample to be included in the analysis. Using Morisita's (1959) I value, all samples were classified as having a uniform, random, or aggregated pattern in relation to depth. The size of the aggregates as well as the relationship between the number of significantly aggregated samples (determined by Morisita's (1959) F test), the percentage of aggregated samples, and the date samples were taken have been considered. Since Gamasides is the most abundant group in this study, it was also possible to obtain information on the type of aggregation exhibited by them. Similar information was also included for the Malaconothrus where sufficient data permitted (Usher 1969).

Gamasides.--The Gamasides were somewhat randomly distributed in the upper levels of the cultivated soil (Table 9). As depth is increased, they became more aggregated. This was evident in both watered and unwatered plots. The overall percentage of aggregated samples in the cultivated-water added plot was less than that of the cultivated-no water added plot. In the uncultivated plots the majority of the samples were uniform to random. The watered plot had a slightly smaller percentage of aggregated samples.

On the first sample date there were no aggregated samples in either the cultivated - no water added plot or the cultivated - water added plot (Table 10). But on the last sample date four or 67% of the samples were aggregated in the unwatered plot indicating an increase in aggregation over the summer. There were no aggregated samples present on the last sample date in the watered plots. Aggregation appeared in the uncultivated plots on July 31 and remained throughout the sampling period with no evident differences between the watered and unwatered plots.

TABLE 9.--A summary of the spatial patterns of samples with five or more individuals per sample of the Gamasides in all plots

Depth	Total No. Samples	Uniform	Percentages Random	Aggregated
		Cultivated - No Water Added		
1	2	100		
2	2		50	50
3	4	50	50	
4	4		25	75
5	6	17	33	50
6	6	17	33	50
	24	25	33	42
		Cultivated - Water Added		
1	3	33	67	
2	4		100	
3	5	20	40	40
4	5	20	60	20
5	6	33		67
6	6		50	50
	29	17	48	35
		Uncultivated - No Water Added		
1	12	17	58	25
2	10	50	40	10
	22	32	50	18
		Uncultivated - Water Added		
1	12	17	66	17
2	10	40	50	10
	22	27	59	14

TABLE 10.--The relationship between the actual number of significantly aggregated samples, the percent of significantly aggregated samples and the date of sample for Gamasides in all plots

	Date					
	6/7	6/20	7/17	7/31	8/28	9/12
	Cultivated - No Water Added					
Actual	0	1	1	2	2	4
Percent	0	25	50	50	33	67
	Cultivated - Water Added					
Actual	0	1	2	3	2	0
Percent	0	50	40	67	50	0
	Uncultivated - No Water Added					
Actual	0	0	0	1	1	2
Percent	0	0	0	25	25	50
	Uncultivated - Water Added					
Actual	0	0	0	1	1	1
Percent	0	0	0	33	33	33

There was a significant correlation ($r = .973$, $P < .01$, $df = 4$) between the average number of individuals per aggregated sample and population density in the cultivated - no water added plot. A significant correlation ($r = .931$, $P < .01$, $df = 4$) also existed between the average number of individuals per aggregated sample and population density in the cultivated - water added plot. The relationship between the number of aggregated samples and population density was not significant in either of the uncultivated treatments. Because of an insufficient number of aggregated samples in the uncultivated plots it was not possible to obtain an indication as to the type of aggregation.

The average size of the aggregations ranged from two square inches, or less, to eight square inches with an indication that a few may be 32 square inches or larger in some plots (Table 11).

Malaconothrus.--The *Malaconothrus* were mostly aggregated in all plots (Table 12). Eighty two percent of all samples were aggregated in the cultivated - no water added plot while 88% were aggregated in the cultivated - water added plot. There were only a few individuals present in the upper layers. The majority of individuals and aggregated samples were found at lower depths. The majority of the samples were also aggregated in the uncultivated plots.

The largest number of aggregated samples (6 or 100%) in the cultivated - no water added plot occurred on June 20 (Table 13). This also corresponds to their peak abundance. In the cultivated - water added plot, four was the largest number of aggregated samples and corresponds also with peak abundance. Aggregation was present throughout

TABLE 11.--Summary of the number and size of aggregates at each depth for Gamasides in all plots

Depth	Size of Aggregates Square Inches				
	2	4	8	16*	32*
			Cultivated - No Water Added		
1					
2	1				
3					
4	1	2			
5	3	2	2		1
6	4		2		1
			Cultivated - Water Added		
1					
2					
3	1	2			
4	2				
5	3	1	1		
6	1	2	1		
			Uncultivated - No Water Added		
1	2		3		
2	1	1	1	1	
			Uncultivated - Water Added		
1	2	1	1		1
2	2	1	1	1	

*Special samples taken to determine if larger aggregates were present (see Table 1).

TABLE 12.--A summary of the spatial patterns of samples with five or more individuals per sample of the Malaconothrus in all plots

Depth	Total No. Samples	Percentages Uniform	Random	Aggregated
		Cultivated - No Water Added		
1	1			100
2	1			100
3	1			100
4	1			100
5	4	25		75
6	3		33	67
	11	9	9	82
		Cultivated - Water Added		
1				
2				
3	2		50	50
4	2			100
5	3		33	67
6	2			100
	9		22	88
		Uncultivated - No Water Added		
1	6			100
2	4		50	50
	10		20	80
		Uncultivated - Water Added		
1	2			100
2	2			100
	4			100

TABLE 13.--The relationship between the actual number of significantly aggregated samples, the percent of significantly aggregated samples and the date of sample for Malaconothrus in all plots

	Date					
	6/7	6/20	7/17	7/31	8/28	9/12
	Cultivated - No Water Added					
Actual	1	6	0	0	1	1
Percent	100	100	0	0	50	50
	Cultivated - Water Added					
Actual	0	1	4	1	1	0
Percent	0	100	100	33	100	0
	Uncultivated - No Water Added					
Actual	1	2	3	0	1	1
Percent	100	100	75	0	100	50
	Uncultivated - Water Added					
Actual	2	0	1	0	1	0
Percent	100	0	100	0	100	0

the summer in the uncultivated plots although somewhat irregularly in the uncultivated - water added plot.

A significant correlation ($r = .993$, $P < .05$, $df = 2$) existed between the average number of individuals per aggregated sample and population density in the cultivated - no water added plot. A similar correlation ($r = .989$, $P < .05$, $df = 2$) existed in the cultivated - water added plot. There was no significance in the relationship between the number of aggregated samples and population density in the cultivated plots. In the uncultivated plots the correlation between the average number of individuals per aggregated sample and population density was significant in the uncultivated - no water added ($r = .998$, $P < .01$, $df = 3$) plot and not significant in the uncultivated - water added plot.

The most common size of the aggregates ranged between two and eight inches in all plots (Table 14). The majority of the aggregates were two square inches in size.

Mesaphorura granulata.--The collembolan, *Mesaphorura granulata*, was more uniform to randomly distributed than aggregated in the cultivated - no water added plot and completely random in the cultivated - water added plot (Table 15). The majority of the individuals and aggregation occurred at the lower depths. The distribution of *Mesaphorura granulata* in the uncultivated plots was mostly random.

There were no aggregated samples in the cultivated - water added plot and a total of only three in the cultivated - no water added plot (Table 16). In the uncultivated plots aggregation was present on the

TABLE 14.--Summary of the number and size of aggregates at each depth for Malaconothrus in all plots

Depth	Size of Aggregates Square Inches 2	4	8	16*	32*
Cultivated - No Water Added					
1	1	1			
2	1				
3		1			
4		1			
5	4	2	1		1
6	3	1	2		1
Cultivated - Water Added					
1					
2					
3	2	2	1	2	
4	2		2		
5	2	1	1		
6	2		1		
Uncultivated - No Water Added					
1	4	4	4		
2	3	1	4		2
Uncultivated - Water Added					
1	3	1	4		1
2	3	1	3		1

*Special samples taken to determine if larger aggregates were present (see Table 1).

TABLE 15.--A summary of the spatial patterns of samples with five or more individuals per sample of Mesaphorura granulata in all plots

Depth	Total No. Samples	Uniform	Percentages Random	Aggregated
		Cultivated - No Water Added		
1				
2				
3	1		100	
4	1			100
5	4	50	25	25
6	3		67	33
	9	22	45	33
		Cultivated - Water Added		
1				
2	1		100	
3	1		100	
4	2		100	
5	1		100	
6				
	5		100	
		Uncultivated - No Water Added		
1	2	50		50
2	6	17	66	17
	8	25	50	25
		Uncultivated - Water Added		
1	3	33	67	
2	5		60	40
	8	13	63	24

TABLE 16.--The relationship between the actual number of significantly aggregated samples, the percent of significantly aggregated samples, and the date of sample for Mesaphorura granulata in all plots

	Date					
	6/7	6/20	7/17	7/31	8/28	9/12
			Cultivated - No Water Added			
Actual	0	0	1	1	1	0
Percent	0	0	33	50	50	0
			Cultivated - Water Added			
			None			
			Uncultivated - No Water Added			
Actual	2	0	0	0	0	0
Percent	100	0	0	0	0	0
			Uncultivated - Water Added			
Actual	1	0	0	0	1	0
Percent	100	0	0	0	50	0

first sample date but appeared only once in the uncultivated - water added plot the remainder of the summer.

The size of the aggregations ranged from less than two inches to larger than thirty-two square inches. The majority ranged in size between two and eight square inches (Table 17).

TABLE 17.--Summary of the number and size of aggregates at each depth for *Mesaphorura granulata* in all plots

Depth	Size of Aggregates Square Inches 2	4	8	16*	32*
			Cultivated - No Water Added		
1					
2					
3					
4	1				
5	1		1		
6		1			
			Cultivated - Water Added		
1					
2					
3	1		1		
4	1		1		1
5					
6					
			Uncultivated - No Water Added		
1	1	1	2		
2	1	1	2	1	
			Uncultivated - Water Added		
1		1	1		1
2	3		2		1

*Special samples taken to determine if larger aggregates were present (see Table 1).

DISCUSSION

Extraction

The exact efficiency of any extraction process is extremely difficult to demonstrate, and will usually vary for one species to another as in the present study, and from one soil type to another (MacFadyen, 1953).

The most efficient behavioral methods used to date are MacFaydens (1961) high gradient cylinder and a modification of this cylinder by Kempson, Lloyd, and Ghelardi (1963). Kempson, Lloyd, and Ghelardi (1963) used litter samples and obtained about 90% efficiency for Collembola and 96% efficiency for Acari. This agrees well with extraction efficiencies of 90% for Collembola and 89% for the Acari in this study.

Soil and Soil Moisture

Although it is probably impossible to locate a completely homogeneous soil in nature, homogeneity has been assumed for the purpose of this study since in the soil properties evaluated, there were no important differences.

The moisture content of a soil will depend in part on the depth being sampled, the type of cover, soil type, drainage as well as when the last rain fell prior to the sample date. It is expected therefore, that significant differences in soil moisture will be observed on different dates. Such was the case in this study. In both cultivated and uncultivated plots, significant differences were present between dates at the level sampled (four inches). No significant differences were observed in the cultivated or uncultivated plots between watered and unwatered plots although the values in the watered plots were generally higher.

Seasonal Abundance and Vertical Pattern

Gamasides.--The Gamasides are members of the predatory group of Acari known as Mesostigmata. Most are known to be predatory and feed primarily on Nematodes, small insect larva and other small soil arthropods and generally are quite mobile although some are known to be ecto- and endo-parasites (Kuhnelt, 1961).

In this study the Gamasides reached a definite peak density on August 28, with almost a four fold increase over that on the first sampling date at all levels in the cultivated plots. The addition of water had no apparent effect on seasonal abundance. Very few individuals were present in the upper three inches of the soil at the beginning of the sampling. This was probably caused by the soil disruption and lack of prey at these levels since very few arthropods were found in the top three inches at the beginning of the sampling period. However, as time progressed, more animals recolonized the upper levels. Although no clear population peak was evident in the uncultivated plots, there was a gradual increase in the population in both the watered and unwatered plots which culminated on August 28 corresponding to that of the cultivated plots. Therefore cultivation had little effect on the time of peak density while cultivation does cause a vertical redistribution with the largest population located at six inches in depth in the cultivated plots as compared to the uncultivated plots where the largest population was at the two inch level. The population at the two inch level in the cultivated plots did not recover to the level of the population at two inches in the uncultivated plots.

Malaconothrus.--*Malaconothrus* is a genus of Acari found in the Orbatitei. These mites are found primarily in meadow soils (Kevan, 1962). Their feeding habits are not completely known but it is assumed they are similar to that of the orbatid mites in that they feed generally on decaying organic matter and fungal spores (Kuhnelt, 1961).

The peak population density of the cultivated plots occurred early in the summer well before that of the uncultivated plots. This could be due to a favorable effect of cultivation on the microenvironmental needs of the group, such as providing more favorable conditions for growth of the mite's food source resulting in increased numbers. This has been observed in Collembola (Christiansen, 1964). In the cultivated plots, even though peak abundance occurred before the application of water began, the two plots did not peak simultaneously. This may be explained in that different species within the genus may have reached peak densities at different times. Bellinger (1954) has suggested that in Collembola the same species may peak at different times in adjacent plots. The addition of water had no apparent effect on seasonal abundance in either the cultivated or uncultivated plots. On the last sample date few individuals were present in any plot. In general, few individuals were present in the upper layers of the cultivated plots throughout the summer.

Mesaphorura granulata.--*Mesaphorura granulata* is a true soil Collembola species in that it has lost its pigment and its furcula through evolution. It may be found deep in the soil since it is quite small and streamlined. Its feeding habits are unknown except that it can be reared successfully in the laboratory on Brewer's yeast.[2]

Mesaphorura granulata reached peak abundance in July in all plots. The lower levels contained the largest number of individuals throughout the summer. The addition of water had no apparent effect on the population abundance in either the cultivated or uncultivated plots. The number of individuals at the two inch level in the uncultivated plots remained larger than that of the cultivated plots throughout the summer. Very few individuals were present in the cultivated plots on the first sample date. The initial reduction in numbers of individuals in cultivated soil has also been observed by Sheals (1956).

Horizontal Pattern

Gamasides.--In general, the spatial pattern of this group was mostly random, especially in the upper levels of the cultivated plots and in the uncultivated plots. However, in the cultivated plots there was a trend toward aggregation at the lower levels where the population was highest. Aggregation increased toward the end of the sampling

---

[2]Personal communication from Mr. Richard Snider, Department of Entomology, Michigan State University.

period in the cultivated - no water added plot and decreased in the cultivated - water added plot. The same was true in the uncultivated plots although to a lesser degree. This implies that the addition of water acted as a dispersing agent for this group. It is also possible that this response was due to an observed lower population of prey.

Since there was a significant correlation between the average number of individuals per aggregated sample and population density in the cultivated plots, it is evident the Gamasides tended to exhibit aggregation characteristics descriptive of the Type II aggregation described by Usher (1969). (Sufficient data were not available to calculate a correlation coefficient for the uncultivated plots). This indicates that as the density increases the number of individuals forming an aggregation also increases. This type of aggregation relies on the movement of the individuals and the selection of either micro-environments that are particularly suitable to them or areas with a particularly suitable food supply. In this group, it is probably the searching for food which accounts for their aggregative tendencies. This may also account for their tendency to, at times, display a random dispersion pattern.

The size of the Gamasides aggregations ranged from two square inches or less to thirty-two square inches or larger. In all plots the most common size of an aggregate was two square inches or less.

Malaconothrus.--*Malaconothrus* was the most aggregated group studied. In all plots, at least 80% of all samples were aggregated. The majority of individuals and aggregations are found at the lower levels. The addition of water had no readily apparent effect on the aggregation characteristics of this group. In the cultivated plots, there was a significant correlation between the average number of individuals per aggregated sample and population density, which characterizes the Type II aggregation of Usher (1969). This correlation was also significant in the uncultivated - no water added plot. This would indicate that the Malaconothrus actively seek a favorable microclimate, or its food supply tends to be aggregated. There is a tendency in the data which suggest that there may be a Type III aggregation present since the number of aggregated samples tend to increase with a corresponding increase in population density. But this was not testable due to insufficient data. Because of low population density in the uncultivated - water added plot throughout the summer, it was not possible to determine the aggregation characteristics.

The size of the aggregations ranged from two square inches or less to thirty-two square inches or larger. In the cultivated plots the most common size was two square inches or less. In the uncultivated plots the most common size was two square inches and eight square inches.

Mesaphorura granulata.--Mesaphorura granulata was mostly random in its distribution in all plots. However, some aggregation was evident at the lower depths of the cultivated - no water added plot. All samples in the cultivated - water added plot were random. This has been observed by other workers (Haarlov, 1960; Christiansen, 1964) although most other species are known to be aggregated (Glasgow, 1939; Hughes, 1962; Poole, 1961). Laboratory observations made on this species have indicated a random to uniform pattern with very little aggregation in the culture jars. Their eggs are deposited singly over the bottom of the culture jar. These observations would tend to support the observed random pattern in the field although it is recognized that laboratory behavior may not be identical to field behavior.

The most common size of aggregation present was between two inches and eight inches.

CONCLUSIONS

Since this investigation was intended to be a pilot study and because of its short duration and the timing of the ecological manipulations, the trends described here will have to be examined in more detail before definite conclusions can be formed.

The extraction efficiency attained in this study with a modification of MacFayden's (1961) high gradient cylinder, was 90% for Gamasides, 100% for *Malaconothrus*, and 93% for *Mesaphorura granulata*.

The Gamasides had almost a four fold increase at all soil depths in the cultivated plots over the sampling period. Very few individuals were present in the upper three inches of the soil in the cultivated plots although recolonization of the upper layers was observed later in the summer. Cultivation had little effect on the time of peak density while cultivation did cause a vertical redistribution with the largest population occurring at six inches, which was the depth to which the plots were plowed. Water had no apparent effect on seasonal abundance. The spatial pattern of this group is mostly random. However, at the lower levels in the cultivated plots, a tendency toward aggregation was observed. A significant correlation was present between population density and the average number of individuals per aggregated sample in the cultivated plots (Type II Aggregation). This characterizes an aggregation resulting from the search for a suitable microenvironment or food supply. The most common size of an aggregation in all plots was two square inches or less.

The Malaconothrus exhibited peak abundance early in the summer in the cultivated plots well before that in the uncultivated plots. Except during peak density, where the largest populations were at four and six inches, very little difference was observed between the number of individuals in the upper and lower layers. Malaconothrus was mostly aggregated in distribution. The majority of the individuals and aggregations were found at the lower levels. A Type II aggregation characterized this group. Water had no apparent effect on seasonal abundance or aggregation characteristics. In the cultivated plots the most common size of the aggregations was two square inches or less, while in the uncultivated plots the most common sizes were two and eight square inches.

Mesaphorura granulata reached peak abundance in July in all plots. An initial reduction in numbers was observed in the cultivated plots. The distribution of this species is mostly random. The most common size of the aggregations was between two square inches or less and eight square inches.

POSSIBLE FUTURE STUDIES AND IMPROVEMENTS

Knowledge concerning the aggregation characteristics of any given species is important in the determination of its biology and ecology and proper sampling technique. The timing of the ecological manipulations could be very important. Plowing earlier in the spring and beginning application of water at the same time could bring about a completely different response by the community. Monitoring of the community by sampling should be conducted over a much longer period of time to check for delayed responses. This will also allow the following of the recolonization of a cultivated soil. The addition of more or less water could elicit a different response than was observed herein. Sampling should be to a depth of six inches in the uncultivated plots to monitor possible vertical migration of the soil animals. To aid in the analysis of this kind of data, special effort should be made to identify and separate adults from immatures. Other forms of ecological manipulations could also be useful in understanding soil communities such as the addition of nutrients or fertilizer or detailed studies on the dynamics and properties of adding artificial litter systems. Results of the above suggestions should advance the understanding of the way in which different factors determine abundance and effect the aggregation characteristics of different groups in a community.

LITERATURE CITED

LITERATURE CITED

Allee, W. C. 1931. Animal Aggregations: A Study in General Sociology. University of Chicago Press, Chicago. 431 p.

Bellinger, P. F. 1954. Studies of soil fauna with special reference to the Collembola. Conn. Agri. Exp. Stat. Bull. 538. 67 p.

Block, W. C. 1966. The distribution of soil Acarina on eroding blanket bog. Pedobiologia. 6:27-34.

Burges, A. and F. Raw. 1967. Soil Biology. Academic Press, New York. 532 p.

Christiansen, K. 1964. Bionomics of Collembola. Ann. Rev. Entomol. 9:147-178.

Edwards, C. A. and G. W. Heath. 1963. The role of soil animals in breakdown of leaf material, p. 76-85. In J. Dockson and J. Van Der Drift (ed), Soil Organisms. North-Holland Publishing Co., Amsterdam.

Edwards, C. A. 1969. Soil pollutants and soil animals. Sci. Amer. 220:88-99.

Edwards, E. A. 1929. A survey of the insect and other invertebrate fauna of permanent pasture and arable land. Ann. Appl. Biol. 16:299-323.

Ford, H. 1938. Fluctuations in natural populations of Collembola and Acarina. J. Anim. Ecol. 7:350-369.

Forsslund, K. H. 1949. Nagot om insamlingsmetodiken vid markfaunaundersökningar. Medd. Skogsforskn Inst. Stockh. 37:1-22.

Gerard, G. 1966. Etude de la repartition spatiale de quelques populations d'Orbates (Acarina:Oribatei), p. 559-568. In O. Graff and J. Satchell (ed), Progress in Soil Biology. North-Holland Publishing Co., Amsterdam.

Ghilarov, M. S. 1963. On the interrelations between soil dwelling invertebrates and soil microorganisms, p. 255-260. In J. Doekson and J. Van Der Drift (ed), Soil Organisms. North-Holland Publishing Co., Amsterdam.

Gisin, H. 1943. Ökologie und Lebensgemeinschaften der Collembolen im Schweizerischen Exkursionsgebiet Basels. Rev. Suisse Zool. 50:131-224.

________. 1955. Recherches sur la relation entre la faune endogee de Collemboles et les qualities agrologiques de sols viticoles. Rev. Suisse Zool. 62:601-648.

Glasgow, J. P. 1939. A population study of subterranean soil Collembola. J. Anim. Ecol. 8:323-353.

Haarlov, N. 1947. A new modification of the Tullgren apparatus. J. Anim. Ecol. 16:115-121.

________. 1960. Microarthropods from Danish soils, ecology and phenology. Oikos, Suppl. 3:1-165.

Hairston, N. G. and G. W. Byers. 1954. The soil Arthropods of a field in Southern Michigan: A study in community ecology. Contrib. Lab. Vert. Biol. Univ. Michigan. 64:1-37.

Hughes, R. D. 1954. The Problem of Sampling a Grassland Insect Population. Unpublished Thesis, Imperial College, University of London. 152 p.

________. 1962. The study of aggregated populations, p. 51-56. In P. W. Murphy (ed), Progress in Soil Zoology. Butterworths, London.

Karg, W. 1956. Untersuchungen über die Wirkung der Hexa Behand lung landwirtschaftlich genutzter Sandböden und Wiesenböden auf die Mesofauna, insbesonder auf Collembolen. Nachr. Deut. Pflanzenschutzdienstes, Berlin. 6:117-120.

Kempson, D., M. Lloyd, and R. Ghelardi. 1963. A new extractor for woodland litter. Pedobiologia. 3:1-21.

Kevan, D. K. McE. 1962. Soil Animals. H. F. and G. Witherby Ltd., London. 224 p.

Klopfer, P. H. 1969. Habitats and Territories. Basic Books Inc., New York. 114 p.

Knight, C. B. and J. P. Chesson, Jr. 1966. The effect of DDT on the forest floor Collembola of a loblolly pine stand. Rev. Ecol. Biol. Sol. 3:129-139.

Kubiena, W. L. 1955. Animal activity in soils as a decisive factor in establishment of humus forms, p. 73-83. In D. K. McE. Kevan (ed), Soil Zoology. Butterworths, London.

Kuhnelt, W. 1955. An introduction to the study of soil animals, p. 3-22. In D. K. McK. Kevan (ed), Soil Zoology. Butterworths, London.

________. 1961. Soil Biology. Faber and Faber, London. 397 p.

MacFadyen, A. 1952. The small Arthropods of a Molinia fen at Cothill. J. Anim. Ecol. 21:87-117.

________. 1953. Notes on methods for the extraction of small soil Arthropods. J. Anim. Ecol. 22:65-78.

________. 1961. Improved funnel-type extractors for soil Arthropods. J. Anim. Ecol. 30:171-184.

________. 1963. The contribution of the fauna to the total soil metabolism, p. 3-18. In J. Doekson and J. Van Der Drift (ed), North-Holland Publishing Co., Amsterdam.

Morisita, M. 1959. Measuring the dispersion of individuals and analysis of the distributional patterns. Mem. Fac. Sci. Kyushu University. E(Biol). 2:215-235.

Morisita, M. 1962. I-index a measure of dispersion of individuals. Res. Popul. Ecol. 4:1-7.

Murphy, P. W. 1955. Ecology of the fauna of forest soils, p. 99-124. In D. K. McE. Kevan (ed), Soil Zoology. Butterworths, London.

________. 1958. The quantitative study of soil meiofauna. I. The effect of sample treatment on extraction efficiency with a modified funnel extractor. Entomol. Experimentalis et Applicata. 1:94-108.

________ (ed). 1962. Progress in Soil Zoology. Butterworths, London. 398 p.

Nef, L. 1960. Comparaison de l'efficacite de differentes variantes de lappareil de Berlese-Tullgren. Zool. angew. Entomol. 46:178-192.

________. 1962. The roles of desiccation and temperature in the Tullgren funnel method of extraction, p. 169-173. In P. W. Murphy (ed), Progress in Soil Zoology. Butterworths, London.

Nielsen, C. O. 1949. Studies on the soil microfauna. II. The soil inhabiting nematodes. Nat. Jutland. 2:1-131.

Odum, E. P. 1959. Fundamentals of Ecology. W. B. Saunders Company, Philadelphia. 546 p.

Poole, T. B. 1961. An ecological study of the Collembola in a coniferous forest soil. Pedobiologia. 1:113-137.

Sheals, J. G. 1956. Soil population studies. I. The effect of cultivation and treatment with insecticides. Bull. Entomol. Res. 47:803-822.

Snider, R. J. 1967. An annotated list of the Collembola (springtails) of Michigan. Michigan Entomol. 1:179-234.

Southwood, T. R. E. 1966. Ecological Methods. Methuen and Company, Ltd., London. 391 p.

Strebel, O. 1957. Ein Beitrag zur Faunistik und Biologie der Aptergoten aus einem Zuckerrübenfeld in der Oberrheinischen Tiefebene. Acta Zool. Cracoviensia. 2:469-478.

Usher, M. B. 1969. Some properties of the aggregations of soil Arthropods : Collembola. J. Anim. Ecol. 38:607-622.

Weis-Fogh, T. 1948. Ecological investigations of mites and collemboles in soil. Nat. Jutland. 1:135-270.

APPENDIX A

APPENDIX A

RAW DATA COUNTS OF ARTHROPODA FROM SAMPLES

Appendix A contains the raw data counts of individuals belonging to different groups of Arthropoda. Each table represents the counts for a given sample (four square inches) on a given sampling date. All samples are presented in Tables 18 - 87.

TABLE 18.--Raw data

Date: 6-7-68 Plot: Cultivated - No Water Added Sample No: One

	Depth (inches)					
Organism	1	2	3	4	5	6
Gamasides	1	1		1	14	22
Malaconothrus		1			7	
Scutacaridae				1		
Tectocepheus						1
Unidentified Acari					3	3
Arrhopalites benitus		1				
Entomobrya sp.						1
Entomobryoides purpurascens	1					
Mesaphorura granulata				1	2	3
Campodea						1
Diptera					1	4
Formicidae	1				2	
Geophilomorpha						1
Heteroptera	1	1	1	1		
Symphyla			1	1	2	
Total Arthropoda	4	4	2	5	31	36

TABLE 19.--Raw data

Date: 6-7-68 Plot: Cultivated - No Water Added Sample No: Two

	Depth (inches)		
Organism	2	4	6
Gamasides	5	13	12
Malaconothrus	1		33
Tectocepheus	1	1	
Unidentified Acari	7	10	12
Arrhopalites sp.	1		
Arrhopalites benitus		1	
Isotoma notabilis			1
Mesaphorura granulata	5	6	2
Neelus minutus	1		
Protaphorura armata			1
Pseudosinella rolfsi			1
Coleoptera	1	1	1
Heteroptera	1		1
Total Arthropoda	23	32	63

TABLE 20.--Raw data

Date: 6-7-68 Plot: Cultivated - Water Added Sample No: One

Organism	Depth (inches) 1	2	3	4	5	6
Gamasides		1	8	8	11	10
Malaconothrus						1
Unidentified Acari			2	1	2	
Mesaphorura granulata		1	2	2	1	2
Coleoptera			1			1
Formicidae		1				
Psocoptera					1	
Total Arthropoda		3	13	11	15	14
				Sample No:		Two
Gamasides		1		12		8
Malaconothrus						2
Unidentified Acari				2		4
Mesaphorura granulata				3		8
Coleoptera				1		1
Diptera						1
Heteroptera						1
Total Arthropoda		1		18		25

TABLE 21.--Raw data

Date: 6-7-68 Plot: Uncultivated - No Water Added Sample No: One

	Depth (inches)	
Organism	1	2
Gamasides	12	11
Malaconothrus	21	2
Oppia	2	
Tectocepheus	2	1
Unidentified Acari	6	2
Arrhopalites benitus	1	
Entomobrya sp.	3	1
Folsomia candida	1	
Lepidocyrtus sp.	2	1
Lepidocyrtus violaceus		1
Mesaphorura granulata	8	3
Protaphorura armata	1	
Coleoptera	4	1
Diptera	1	
Formicidae	1	1
Heteroptera		1
Pauropus	3	9
Psocoptera	1	
Total Arthropoda	69	34

TABLE 22.--Raw data

Date: 6-7-68 Plot: Uncultivated - No Water Added Sample No: Two

	Depth (inches)	
Organism	1	2
Gamasides	6	4
Malaconothrus	3	
Oppia	12	2
Tectocepheus	10	2
Unidentified Acari	6	
Arrhopalites benitus	3	
Folsomia candida	1	1
Isotoma notabilis	3	
Mesaphorura granulata	1	5
Proisotoma minuta		3
Protaphorura armata	1	
Coleoptera	1	1
Formicidae	13	6
Pauropus	1	
Thysanoptera	1	21
Total Arthropoda	62	45

TABLE 23.--Raw data

Date: 6-7-68 Plot: Uncultivated - Water Added Sample No: One

	Depth (inches)	
Organism	1	2
Gamasides	32	19
Malaconothrus	41	
Oppia	1	1
Tectocepheus	4	
Unidentified Acari	7	3
Folsomia candida	2	
Lepidocyrtus sp.	2	1
Mesaphorura granulata	4	4
Pseudosinella violenta	1	2
Campodea		2
Coleoptera		2
Diptera	1	
Formicidae	4	1
Geophilomorpha	3	1
Symphyla	1	
Total Arthropoda	103	36

TABLE 24.--Raw data

Date: 6-7-68 Plot: Uncultivated - Water Added Sample No: Two

	Depth (inches)	
Organism	1	2
Gamasides	21	22
Malaconothrus		10
Oppia	3	1
Tectocepheus	23	6
Unidentified Acari	5	45
Arrhopalites benitus	1	2
Folsomia candida	1	
Lepidocyrtus sp.	6	1
Mesaphorura granulata	2	7
Proisotoma minuta	3	
Pseudosinella violenta	3	1
Pseudosinella sexoculata		1
Campodea	8	2
Coleoptera	1	1
Diptera	3	
Formicidae	4	2
Geophilomorpha	2	2
Heteroptera	14	9
Psocoptera	1	
Total Arthropoda	111	112

TABLE 25.--Raw data

Date: 6-20-68 Plot: Cultivated - Water Added Sample No: One

Organism	Depth (inches)					
	1	2	3	4	5	6
Gamasides	1		1	2	19	14
Malaconothrus					6	2
Oppia					5	1
Tectocepheus					1	
Unidentified Acari		1			4	2
Arrhopalites benitus			1			
Entomobryoides purpurascens			1	1		
Mesaphorura granulata		2	2	1		
Neanura muscorum					1	
Proisotoma minuta					2	
Protaphorura armata					1	
Coleoptera	1					
Diptera				1		1
Formicidae		1	2	1	10	1
Heteroptera		1	1	2		
Symphyla					1	1
Total Arthropoda	2	5	8	8	50	22

TABLE 26.--Raw data

Date: 6-20-68 Plot: Cultivated - Water Added Sample No: Two

	Depth (inches)		
Organism	2	4	6
Gamasides	1		2
<u>Malaconothrus</u>		1	17
Scutacaridae	23	4	2
<u>Tectocepheus</u>	3		
Unidentified Acari	1	2	2
<u>Mesaphorura</u> <u>granulata</u>			1
Formicidae	6	8	1
Geophilomorpha	1		
Heteroptera	1		
Total Arthropoda	36	15	25

TABLE 27.--Raw data

Date: 6-20-68 Plot: Cultivated - No Water Added Sample No: One

	Depth (inches)					
Organism	1	2	3	4	5	6
Gamasides		2	7	13	7	9
Malaconothrus	13	39	62	745	7	12
Oppia	1	1	3	7		
Scutacaridae		1		34		
Tectocepheus		2				
Unidentified Acari		3	9	6	2	
Folsomia candida				2		
Isotoma notabilis				1		
Lepidocyrtus violaceus			1			
Mesaphorura granulata			1	2	2	1
Proisotoma minuta	1			2		
Protaphorura armata			2			
Campodea						2
Coleoptera	1	1				
Diptera			2			
Formicidae			1	1		2
Heteroptera	1				1	
Symphyla			1			
Total Arthropoda	17	49	88	813	19	26

TABLE 28.--Raw data

Date: 6-20-68 Plot: Cultivated - No Water Added Sample No: Two

	Depth (inches)		
Organism	2	4	6
Gamasides	4	10	9
Malaconothrus	1		1
Unidentified Acari		1	1
Isotoma notabilis	1		
Mesaphorura granulata	1	4	3
Diptera			1
Formicidae		1	
Geophilomorpha	1		
Symphyla		1	
Total Arthropoda	8	17	15

TABLE 29.--Raw data

Date: 6-20-68 Plot: Uncultivated - Water Added Sample No: One

	Depth (inches)	
Organism	1	2
Gamasides	10	4
Oppia	1	
Tectocepheus	4	1
Unidentified Acari	3	7
Mesaphorura granulata	1	1
Proisotoma minuta		3
Pseudosinella violenta	1	
Unidentified Collembola	2	
Campodea		1
Coleoptera	1	
Geophilomorpha	1	
Heteroptera	11	1
Total Arthropoda	35	18

TABLE 30.--Raw data

Date: 6-20-68 Plot: Uncultivated - Water Added Sample No: Two

	Depth (inches)	
Organism	1	2
Gamasides	19	4
Malaconothrus	3	
Oppia	1	
Tectocepheus	3	
Unidentified Acari	5	3
Isotoma notabilis	1	1
Lepidocyrtus violaceus	1	
Mesaphorura granulata	2	2
Campodea	1	
Coleoptera	4	
Formicidae	1	
Heteroptera	1	
Psocoptera	1	
Symphyla	1	
Total Arthropoda	41	10

TABLE 31.--Raw data

Date: 6-20-68 Plot: Uncultivated - No Water Added Sample No: One

	Depth (inches)	
Organism	1	2
Gamasides	9	3
Oppia	2	
Tectocepheus	1	
Unidentified Acari	3	3
Folsomia candida	2	
Lepidocyrtus sp.	1	
Lepidocyrtus violaceus	1	1
Mesaphorura granulata	4	2
Proisotoma minuta	5	
Pseudosinella violenta		1
Campodea		4
Diptera	2	
Heteroptera	1	
Symphyla	1	5
Total Arthropoda	32	19

TABLE 32.--Raw data

Date: 6-20-68 Plot: Uncultivated - No Water Added Sample No: Two

	Depth (inches)	
Organism	1	2
Gamasides	5	8
Malaconothrus	35	5
Unidentified Acari	1	1
Isotoma notabilis	3	1
Mesaphorura granulata	1	3
Pseudosinella rolfsi	1	
Pseudosinella violenta	2	2
Campodea	1	4
Coleoptera	1	
Formicidae		1
Heteroptera	1	
Symphyla	1	
Total Arthropoda	52	25

TABLE 33.--Raw data

Date: 7-2-68 Plot: Cultivated - No Water Added Sample No: One

	Depth (inches)	
Organism	3	4
Gamasides		1
Unidentified Acari		1
Folsomia candida		2
Mesaphorura granulata	6	10
Formicidae	1	
Psocoptera	2	
Total Arthropoda	9	14
		Sample No: Two
Gamasides	7	8
Malaconothrus	1	1
Tectocepheus	1	
Unidentified Acari		1
Entomobryoides purpurascens		1
Isotoma notabilis	1	2
Mesaphorura granulata	1	4
Protaphorura armata		1
Coleoptera		3
Formicidae	2	
Total Arthropoda	13	21

TABLE 34.--Raw data

Date: 7-2-68 Plot: Cultivated - No Water Added Sample No: Three

	Depth (inches)	
Organism	3	4
Gamasides	1	3
Unidentified Acari		1
Arrhopalites benitus	1	
Mesaphorura granulata	2	3
Protaphorura armata		1
Pseudosinella violenta		1
Coleoptera		1
Formicidae	1	
Psocoptera	1	1
Total Arthropoda	6	11

TABLE 35.--Raw data

Date: 7-2-68 Plot: Cultivated - No Water Added Sample No: Four

	Depth (inches)	
Organisms	3	4
Gamasides	5	9
Arrhopalites benitus	1	1
Isotoma notabilis	1	1
Megalothorax albus	7	
Mesaphorura granulata		1
Sminthurinus elegans		1
Coleoptera		1
Diptera	1	
Pauropus		1
Psocoptera	6	2
Total Arthropoda	21	17

TABLE 36.--Raw data

Date: 7-2-68 Plot: Cultivated - Water Added Sample No: One

	Depth (inches)	
Organism	3	4
Gamasides	42	29
Malaconothrus	10	1
Oppia		4
Scutacaridae		1
Unidentified Acari	16	12
Isotoma notabilis	24	16
Mesaphorura granulata	45	64
Neelus minutus	2	3
Protaphorura armata		1
Pseudosinella violenta		1
Coleoptera	1	2
Diptera	1	4
Formicidae	1	1
Pauropus		3
Protura		1
Symphyla	2	1
Total Arthropoda	143	144

TABLE 37.--Raw data

Date: 7-2-68 Plot: Cultivated - Water Added Sample No: Two

Organism	Depth (inches) 3	4
Gamasides	27	20
Malaconothrus	3	60
Oppia		4
Scutacaridae	1	
Tectocepheus		1
Unidentified Acari	2	7
Isotoma notabilis	3	9
Megalothorax albus		1
Mesaphorura granulata	13	17
Protaphorura armata	9	5
Coleoptera	2	3
Diptera	1	7
Formicidae		6
Psocoptera	2	1
Symphyla	2	
Total Arthropoda	65	141

TABLE 38.--Raw data

Date: 7-2-68 Plot: Cultivated - Water Added Sample No: Three

	Depth (inches)	
Organism	3	4
Gamasides	20	33
Malaconothrus	1	2
Unidentified Acari	9	7
Isotoma notabilis	22	23
Lepidocyrtus sp.	1	
Lepidocyrtus violaceus	1	
Mesaphorura granulata	22	26
Protaphorura armata	1	14
Campodea	1	
Coleoptera	4	
Diptera	1	2
Formicidae	1	1
Psocoptera	7	3
Thysanoptera		1
Total Arthropoda	91	112

TABLE 39.--Raw data

Date: 7-2-68 Plot: Cultivated - Water Added Sample No: Four

	Depth (inches)	
Organism	3	4
Gamasides	14	25
Malaconothrus		6
Oppia	4	6
Scutacaridae		3
Unidentified Acari	8	14
Isotoma notabilis	15	14
Lepidocyrtus sp.	2	2
Lepidocyrtus paradoxus	1	
Lepidocyrtus violaceus	1	2
Mesaphorura granulata	10	6
Metakatianna macgillivrayi		1
Protaphorura armata	3	2
Pseudosinella violenta		1
Campodea	1	
Coleoptera	4	
Diptera	5	12
Formicidae	1	
Heteroptera	1	
Pscoptera	6	12
Symphyla	1	
Total Arthropoda	77	106

TABLE 40.--Raw data

Date: 7-17-68 Plot: Cultivated - No Water Sample No: One

	Depth (inches					
Organism	1	2	3	4	5	6
Gamasides		2	3	4	20	12
Malaconothrus		1	1		1	
Unidentified Acari			1	1	2	1
Bourletiella juanitae		2	1			
Isotoma notabilis					1	
Mesaphorura granulata			9	6	7	6
Protaphorura armata			1			
Unidentified Collembola	1					
Coleoptera		1				
Diptera					1	2
Formicidae					5	
Heteroptera	2				1	
Protura				1		
Psocoptera	1		1			2
Thysanoptera		1				
Total Arthropoda	3	8	17	12	38	23

TABLE 41.--Raw data

Date: 7-17-68 Plot: Cultivated - No Water Added Sample No: Two

	Depth (inches)		
Organism	2	4	6
Gamasides	2	7	14
Malaconothrus	1	57	59
Oppia	3	11	3
Scutacaridae		3	
Unidentified Acari	7	15	9
Bourletiella juanitae	1		
Isotoma notabilis		4	7
Megalothroax albus		2	
Mesaphorura granulata	1	1	2
Coleoptera		2	2
Diptera	1	2	1
Formicidae		3	
Heteroptera			1
Psocoptera	1		4
Total Arthropoda	17	107	102

TABLE 42.--Raw data

Date: 7-17-68 Plot: Cultivated - Water Added Sample No: One

Organism	Depth (inches)					
	1	2	3	4	5	6
Gamasides	1	6	19	22	54	33
<u>Malaconothrus</u>		2	17	91	748	218
<u>Oppia</u>			1			
Scutacaridae				3	128	31
<u>Tectocepheus</u>				3	128	31
Unidentified Acari	1	1	1	3	5	12
<u>Isotoma notabilis</u>				2		2
<u>Lepidocyrtus lignorum</u>		1				
<u>Mesaphorura granulata</u>	1	7	23	15	16	4
<u>Protaphorura armata</u>			2		1	
<u>Pseudosinella violenta</u>				2		
<u>Tomocerus flavescens</u>			1			
Coleoptera		1			1	
Diptera					2	1
Formicidae		1				3
Heteroptera				1		
Psocoptera		2	2	12	2	1
Symphyla					1	
Thysanoptera		1	1			
Total Arthropoda	4	22	66	151	960	305

TABLE 43.--Raw data

Date: 7-17-68 Plot: Cultivated - Water Added Sample No: Two

	Depth (inches)		
Organism	2	4	6
Gamasides	1	6	12
Malaconothrus	1	57	290
Oppia			1
Scutacaridae		2	8
Tectocepheus	1		
Unidentified Acari	2	1	1
Entomobrya multifasciata			1
Isotoma notabilis		2	2
Mesaphorura granulata		13	14
Protaphorura armata		2	
Tomocerus flavescens			1
Coleoptera			1
Diptera	1		4
Formicidae		6	3
Pauropus	1		1
Psocoptera		1	
Total Arthropoda	7	90	339

TABLE 44.--Raw data

Date: 7-17-68 Plot: Uncultivated - No Water Added Sample No: One

	Depth (inches)	
Organism	1	2
Gamasides	29	20
Malaconothrus	20	15
Oppia	8	
Scutacaridae	3	2
Tectocepheus	3	
Unidentified Acari	16	8
Bourletiella juanitae	1	
Entomobrya sp.		2
Isotoma notabilis	15	10
Mesaphorura granulata	3	5
Protaphorura armata		1
Sminthurinus elegans	1	
Coleoptera	2	1
Diptera	4	
Heteroptera	8	3
Pauropus	1	
Psocoptera	7	
Total Arthropoda	121	67

TABLE 45.--Raw data

Date: 7-17-68 Plot: Uncultivated - No Water Added Sample No: Two

Organism	Depth (inches) 1	2
Gamasides	26	15
Malaconothrus	16	5
Oppia	10	
Scutacaridae	2	3
Tectocepheus	6	1
Unidentified Acari	17	3
Entomobryoides purpurascens	1	
Isotoma notabilis	50	7
Mesaphorura granulata	7	11
Neanura muscorum	2	
Orchesella ainsliei	1	
Protaphorura armata	9	
Unidentified Collembola		1
Coleoptera	2	
Diptera	2	1
Formicidae	1	1
Geophilomorpha	1	
Heteroptera	14	17
Pauropus	1	4
Symphyla		2
Thysanoptera	1	
Total Arthropoda	169	71

TABLE 46.--Raw data

Date: 7-17-68 Plot: Uncultivated - Water Added Sample No: One

Organism	Depth (inches) 1	2
Gamasides	22	29
Oppia	2	
Tectocepheus	5	2
Unidentified Acari	13	4
Isotoma notabilis	2	3
Lepidocyrtus violaceus		1
Mesaphorura granulata	7	7
Protaphorura armata		1
Pseudosinella violenta	1	1
Unidentified Collembola	1	
Campodea	2	
Coleoptera		1
Diptera	1	
Formicidae	8	2
Heteroptera	1	
Pauropus		1
Psocoptera	7	1
Symphyla	1	5
Total Arthropoda	73	58

TABLE 47.--Raw data

Date: 7-17-68 Plot: Uncultivated - Water Added Sample No: Two

Organism	Depth (inches) 1	2
Gamasides	5	10
Malaconothrus	6	6
Oppia	2	
Scutacaridae	2	2
Tectocepheus	2	5
Unidentified Acari	8	3
Entomobrya sp.	1	
Entomobrya multifasciata	1	1
Isotoma notabilis	4	4
Lepidocyrtus violaceus	2	
Mesaphorura granulata	5	7
Orchesella ainsliei	1	
Pseudosinella violenta	4	1
Tomocerus sp.	10	
Tomocerus flavescens	1	
Campodea	1	3
Coleoptera	1	
Formicidae	3	
Heteroptera	4	1
Psocoptera	5	2
Symphyla		2
Total Arthropoda	68	47

TABLE 48.--Raw data

Date: 7-31-68 Plot: Cultivated - Water Added Sample No: One

Organism	Depth (inches)					
	1	2	3	4	5	6
Gamasides	8	9	29	76	43	40
Malaconothrus			12	74	8	2
Oppia	4	3	7	47	6	3
Scutacaridae	1		7	7	8	11
Tectocepheus		1				
Unidentified Acari	2		1	7	4	6
Isotoma notabilis		1	4	12	1	4
Lepidocyrtus violaceus		1		1		
Mesaphorura granulata		1		6	3	3
Protaphorura armata				3		
Pseudosinella violenta	2	1	1	7		1
Unidentified Collembola					3	1
Campodea			1			1
Coleoptera	2			1	1	1
Diptera					1	2
Formicidae	1	1	1	7		
Heteroptera	1					
Pauropus	1	1				
Psocoptera	5	7	5	3	6	6
Total Arthropoda	27	26	68	252	84	81

TABLE 49.--Raw data

Date: 7-31-68 Plot: Cultivated - Water Added Sample No: Two

	Depth (inches)		
Organism	2	4	6
Gamasides	9	5	6
Malaconothrus	3		
Oppia	6	1	3
Scutacaridae		1	1
Tectocepheus			1
Unidentified Acari	4	3	
Arrhopalities benitus		1	
Mesaphorura granulata			2
Protaphorura armata			1
Formicidae	3	2	
Psocoptera	4	3	9
Total Arthropoda	29	16	23

TABLE 50.--Raw data

Date: 7-31-68 Plot: Cultivated - No Water Added Sample No: One

	Depth (inches)					
Organism	1	2	3	4	5	6
Gamasides	1	4	21	15	21	25
Malaconothrus		1	1			
Scutacaridae		1				
Unidentified Acari				4		
Arrhopalites benitus		1				
Arrhopalites pygmaeus						1
Entomobrya sp.	3	1				
Isotoma notabilis	1	1			2	
Mesaphorura granulata			3	2	8	18
Neanura muscorum	1					
Protaphorura armata		1				
Pseudosinella violenta				1	1	1
Unidentified Collembola	1					
Coleoptera	1		1			
Formicidae			1	1		
Psocoptera	1	12	4	3	5	
Thysanoptera	1				1	
Total Arthropoda	10	22	31	26	38	45

TABLE 51.--Raw data

Date: 7-31-68 Plot: Cultivated - No Water Added Sample No: Two

Organism	Depth (inches) 2	4	6
Gamasides	4	32	44
Malaconothrus	8	50	106
Oppia		1	1
Scutacaridae	1	23	36
Unidentified Acari	5	6	7
Arrhopalites benitus		1	
Isotoma notabilis	1	3	1
Lepidocyrtus sp.		1	
Mesaphorura granulata	1	16	11
Coleoptera	1	1	
Diptera	1		
Formicidae		1	
Geophilomorpha			1
Psocoptera	1	1	
Total Arthropoda	23	136	207

TABLE 52.--Raw data

Date: 7-31-68 Plot: Uncultivated - Water Added Sample No: One

	Depth (inches)	
Organism	1	2
Gamasides	26	16
Tectocepheus		1
Unidentified Acari	7	5
Entomobrya sp.		1
Isotoma notabilis	12	7
Isotoma viridis	2	
Lepidocyrtus paradoxus	1	
Protaphorura armata	1	3
Pseudosinella violenta	2	2
Unidentified Collembola		1
Campodea	3	5
Coleoptera	4	
Formicidae	1	2
Heteroptera	13	7
Pauropus		1
Psocoptera	3	11
Symphyla	1	2
Total Arthropoda	76	64

TABLE 53.--Raw data

Date: 7-31-68 Plot: Uncultivated - Water Added Sample No: Two

	Depth (inches)	
Organism	1	2
Gamasides	23	40
Malaconothrus	4	
Oppia	1	
Scutacaridae	4	1
Tectocepheus	2	
Unidentified Acari	6	6
Entomobrya sp.	3	
Isotoma notabilis	18	14
Mesaphorura granulata	4	
Neanura muscorum		1
Pseudosinella violenta	3	2
Sinella curviseta		1
Campodea	2	
Coleoptera	4	2
Diptera	1	
Formicidae	1	
Geophilomorpha		1
Heteroptera	2	1
Protura		1
Psocoptera	4	3
Thysanoptera	1	
Total Arthropoda	83	71

TABLE 54.--Raw data

Date: 7-31-68 Plot: Uncultivated - No Water Added Sample No: One

Organism	Depth (inches) 1	2
Gamasides	16	12
Unidentified Acari	5	2
Isotoma notabilis	15	9
Mesaphorura granulata	5	9
Pseudosinella violenta		1
Campodea	2	10
Diplopoda	3	
Formicidae	6	10
Geophilomorpha	1	
Heteroptera	10	4
Psocoptera	6	2
Total Arthropoda	69	59

TABLE 55.--Raw data

Date: 7-31-68 Plot: Uncultivated - No Water Added Sample No: Two

	Depth (inches)	
Organism	1	2
Gamasides	18	6
Malaconothrus		1
Oppia	1	
Scutacaridae	5	5
Unidentified Acari	3	3
Isotoma notabilis	9	4
Mesaphorura granulata	2	6
Campodea	7	8
Coleoptera		1
Diptera	1	
Formicidae		1
Heteroptera	13	1
Pauropus	1	
Psocoptera	2	8
Symphyla	4	3
Total Arthropoda	66	47

TABLE 56.--Raw data

Date: 8-14-68 Plot: Cultivated - No Water Added Sample No: One

Organism	Depth (inches) 5	6
Gamasides	35	45
Malaconothrus	1	2
Scutacaridae	2	5
Unidentified Acari		6
Isotoma notabilis	1	
Lepidocyrtus violaceus		1
Mesaphorura granulata	2	3
Protaphorura armata	6	11
Diptera	1	
Geophilomorpha		1
Psocoptera	13	2
Symphyla		2
Total Arthropoda	61	78

TABLE 57.--Raw data

Date: 8-14-68 Plot: Cultivated - No Water Added Sample No: Two

	Depth (inches)	
Organism	5	6
Gamasides	36	42
Malaconothrus	4	3
Scutacaridae	39	27
Unidentified Acari	7	1
Isotoma notabilis		2
Mesaphorura granulata	2	6
Campodea		1
Coleoptera		1
Diptera	2	1
Psocoptera	16	8
Total Arthropoda	106	92

TABLE 58.--Raw data

Date: 8-14-68 Plot: Cultivated - No Water Added Sample No: Three

	Depth (inches)	
Organism	5	6
Gamasides	26	34
Malaconothrus	1	
Scutacaridae	7	4
Unidentified Acari	1	3
Arrhopalites benitus	1	
Mesaphorura granulata	3	8
Protaphorura armata	1	9
Campodea	2	2
Heteroptera	1	
Psocoptera	15	7
Total Arthropoda	58	67

TABLE 59.--Raw data

Date: 8-14-68 Plot: Cultivated - No Water Added Sample No: Four

	Depth (inches)	
Organism	5	6
Gamasides	81	62
Malaconothrus	31	10
Scutacaridae	95	47
Unidentified Acari	4	1
Arrhopalites benitus		1
Isotoma notabilis	2	1
Lepidocyrtus violaceus	1	1
Mesaphorura granulata	2	2
Protaphorura armata	6	3
Campodea	1	
Coleoptera	1	1
Diptera		1
Formicidae	1	
Psocoptera	4	11
Total Arthropoda	229	141

TABLE 60.--Raw data

Date: 8-14-68 Plot: Uncultivated - No Water Added Sample No: One

	Depth (inches)	
Organism	1	2
Gamasides	32	15
Malaconothrus	9	1
Oppia	7	1
Scutacaridae		1
Tectocepheus	3	
Unidentified Acari	10	3
Isotoma notabilis	5	2
Lepidocyrtus violaceus	3	
Orchesella ainsliei	1	
Protaphorura armata	6	7
Campodea	1	
Coleoptera	1	1
Psocoptera	12	26
Thysanoptera	1	
Total Arthropoda	91	57

TABLE 61.--Raw data

Date: 8-14-68 Plot: Uncultivated - No Water Added Sample No: Two

	Depth (inches)	
Organism	1	2
Gamasides	17	17
Malaconothrus		3
Oppia	3	
Unidentified Acari	4	
Isotoma notabilis	2	5
Mesaphorura granulata	1	2
Orchesella ainsliei	2	
Protaphorura armata	12	5
Campodea	1	
Coleoptera	4	4
Psocoptera	12	5
Total Arthropoda	58	41

TABLE 62.--Raw data

Date: 8-14-68 Plot: Uncultivated - No Water Added Sample No: Three

	Depth (inches)	
Organism	1	2
Gamasides	12	22
Scutacaridae	1	1
Unidentified Acari	4	6
Isotoma notabilis	18	8
Mesaphorura granulata	7	5
Orchesella ainsliei	1	
Protaphorura armata	9	5
Tomocerus flavescens	1	
Coleoptera	1	1
Diplopoda	1	
Formicidae	1	
Psocoptera	1	5
Thysanoptera		1
Total Arthropoda	57	54

TABLE 63.--Raw data

Date: 8-14-68 Plot: Uncultivated - No Water Added Sample No: Four

	Depth (inches)	
Organism	1	2
Gamasides	19	19
Malaconothrus	47	10
Oppia	6	
Scutacaridae	14	
Tectocepheus	1	
Unidentified Acari	9	1
Entomobrya sp.		1
Isotoma notabilis	14	6
Lepidocyrtus violaceus	1	
Mesaphorura granulata	3	8
Orchesella ainsliei	1	
Protaphorura armata	6	8
Coleoptera	1	1
Heteroptera	1	
Psocoptera	3	6
Symphyla	2	
Total Arthropoda	128	60

TABLE 64.--Raw data

Date: 8-28-68 Plot: Cultivated - No Water Added Sample No: One

	Depth (inches)					
Organism	1	2	3	4	5	6
Gamasides	22	15	45	53	38	76
Malaconothrus			1		8	43
Scutacaridae		2	1		10	44
Tectocepheus		1				
Unidentified Acari	12	12	7	7	2	
Isotoma notabilis	2				1	2
Lepidocyrtus violaceus	6	2				
Mesaphorura granulata	1	1	1	2	12	5
Protaphorura armata	2	5	2	1	1	3
Pseudosinella violenta	2	1				
Campodea				2		
Coleoptera				1		
Diptera		1				
Formicidae					3	
Heteroptera	1	1				
Pauropus				1		
Psocoptera	3	1		3	9	61
Thysanoptera		1				
Total Arthropoda	51	43	58	70	84	234

TABLE 65.--Raw data

Date: 8-28-68 Plot: Cultivated - No Water Added Sample No: Two

	Depth (inches)		
Organism	2	4	6
Gamasides	12	42	47
Malaconothrus	3	6	23
Oppia	3		
Scutacaridae	2	2	2
Unidentified Acari	4	4	5
Arrhopalites benitus		3	1
Isotoma notabilis			4
Mesaphorura granulata	8	19	7
Protaphorura armata	2	9	1
Pseudosinella violenta			1
Campodea			1
Formicidae	2		
Pauropus		1	1
Psocoptera	17	25	28
Total Arthropoda	53	111	121

TABLE 66.--Raw data

Date: 8-28-68 Plot: Cultivated - Water Added Sample No: One

	Depth (inches)					
Organism	1	2	3	4	5	6
Gamasides	8	27	64	47	75	121
Malaconothrus			1			6
Scutacaridae			5	7	3	18
Unidentified Acari	6	4	4	6	9	12
Arrhopalites benitus						1
Isotoma notabilis	1	1				2
Lepidocyrtus violaceus					1	
Mesaphorura granulata	3	2	4	4	4	3
Orchesella ainsliei			1			
Protaphorura armata		6	2	3	8	12
Pseudosinella violenta	4	2		1	1	
Unidentified Acari	1					
Pauropus	3					
Protura			1			
Psocoptera		3	46	41	24	12
Symphyla	1					
Total Arthropoda	27	45	128	109	125	187

TABLE 67.--Raw data

Date: 8-28-68 Plot: Cultivated - Water Added Sample No: Two

	Depth (inches)		
Organism	2	4	6
Gamasides	7	23	42
Malaconothrus	1	2	3
Scutacaridae	1		2
Unidentified Acari	2	2	4
Arrhopalites benitus			1
Mesaphorura granulata	5	3	11
Protaphorura armata	2	1	5
Pseudosinella violenta	1		
Coleoptera	1		
Heteroptera	1		
Psocoptera	34	8	12
Total Arthropoda	55	39	80

TABLE 68.--Raw data

Date: 8-28-68 Plot: Uncultivated - No Water Added Sample No: One

Organism	Depth (inches) 1	2
Gamasides	18	13
Malaconothrus	1	2
Oppia	3	
Scutacaridae	1	2
Tectocepheus		1
Unidentified Acari	7	5
Isotoma notabilis	9	2
Mesaphorura granulata	3	1
Protaphorura armata	5	4
Campodea	2	3
Coleoptera	2	2
Diptera	1	1
Formicidae	10	
Geophilomorpha	1	
Heteroptera	4	1
Pauropus	1	
Psocoptera	6	1
Total Arthropoda	74	38

TABLE 69.--Raw data

Date: 8-28-68 Plot: Uncultivated - No Water Added Sample No: Two

	Depth (inches)	
Organism	1	2
Gamasides	43	35
Malaconothrus	164	4
Oppia	5	4
Scutacaridae	142	4
Unidentified Acari	15	4
Isotoma notabilis	7	
Megalothorax albus	1	
Mesaphorura granulata	4	12
Tomocerus flavescens	1	
Coleoptera	4	1
Diptera	2	
Formicidae	1	
Geophilomorpha	1	
Heteroptera	3	3
Pauropus	8	19
Psocoptera	17	47
Thysanoptera	1	
Total Arthropoda	419	133

TABLE 70.--Raw data

Date: 8-28-68 Plot: Uncultivated - Water Added Sample No: One

	Depth (inches)	
Organism	1	2
Gamasides	15	20
Oppia	2	1
Scutacaridae		1
Tectocepheus		2
Unidentified Acari	3	2
Isotoma notabilis	1	1
Mesaphorura granulata	1	
Pseudosinella violenta	1	1
Campodea	2	1
Coleoptera		2
Diptera	1	
Geophilomorpha	2	
Heteroptera	17	1
Psocoptera	41	22
Symphyla	1	1
Thysanoptera	1	4
Total Arthropoda	88	59

TABLE 71.--Raw data

Date: 8-28-68 Plot: Uncultivated - Water Added Sample No: Two

	Depth (inches)	
Organism	1	2
Gamasides	16	30
Malaconothrus		15
Scutacaridae	8	4
Tectocepheus		1
Unidentified Acari	8	2
Isotoma notabilis	3	1
Mesaphorura granulata	6	12
Protaphorura armata		1
Pseudosinella violenta	1	
Unidentified Collembola		2
Campodea	5	
Diplopoda		1
Formicidae		2
Geophilomorpha		1
Heteroptera		1
Psocoptera	7	10
Symphyla	2	3
Total Arthropoda	56	86

TABLE 72.--Raw data

Date: 9-12-68 Plot: Cultivated - Water Added Sample No: One

	Depth (inches)					
Organism	1	2	3	4	5	6
Gamasides	8	14	11	15	12	27
Malaconothrus						2
Oppia		4				
Scutacaridae		2				1
Tectocepheus		1				
Unidentified Acari	1	4	1	2	2	2
Isotoma notabilis	3	3				
Lepidocyrtus violaceus	5	4		1		
Mesaphorura granulata	1	1			1	
Orchesella ainsliei	1		1			
Protaphorura armata		2		1		1
Pseudosinella violenta	4	3	3			1
Coleoptera	1				2	
Geophilomorpha					2	1
Heteroptera		1				
Psocoptera	2	1	2		4	7
Symphyla					1	
Total Arthropoda	26	40	18	19	24	42

TABLE 73.--Raw data

Date: 9-12-68 Plot: Cultivated - Water Added Sample No: Two

	Depth (inches)		
Organism	2	4	6
Gamasides	11	28	18
Oppia	2	3	1
Scutacaridae		1	
Unidentified Acari	3	3	3
Isotoma notabilis	6	3	1
Lepidocyrtus sp.		1	
Lepidocyrtus violaceus	3		
Mesaphorura granulata	1		1
Orchesella ainsliei	1	2	
Protaphorura armata		1	1
Pseudosinella violenta	7	5	1
Coleoptera	1		1
Formicidae	1	9	5
Geophilomorpha	1		
Heteroptera			1
Procoptera	2	23	1
Total Arthropoda	39	79	34

TABLE 74.--Raw data

Date: 9-12-68 Plot: Cultivated - No Water Added Sample No: One

	Depth (inches)					
Organism	1	2	3	4	5	6
Gamasides	7	16	22	58	48	49
Malaconothrus		1			9	8
Oppia	1		1	17		
Scutacaridae			2	14	10	3
Unidentified Acari	7	4	3	7	1	4
Isotoma notabilis	2					
Lepidocyrtus violaceus	1	1		1		
Mesaphorura granulata	2	2	3	3	6	7
Protaphorura armata	1	2	3	11	2	8
Pseudosinella violenta	3	2		3		
Campodea						1
Diptera	1	2			1	
Formicidae				1		
Heteroptera						1
Psocoptera	2	1	3	1		
Symphyla					1	
Total Arthropoda	27	31	37	116	78	81

TABLE 75.--Raw data

Date: 9-12-68 Plot: Cultivated - No Water Added Sample No: Two

	Depth (inches)		
Organism	2	4	6
Gamasides	2	31	38
Malaconothrus	1		9
Oppia	6	15	7
Scutacaridae		1	4
Unidentified Acari	1	5	10
Arrhopalites benitus			1
Isotoma notabilis	1	1	1
Mesaphorura granulata	1	8	2
Protaphorura armata	3	1	2
Pseudosinella violenta		3	4
Campodea			3
Formicidae		1	
Heteroptera			1
Pauropus	1		1
Total Arthropoda	16	66	83

TABLE 76.--Raw data

Date: 9-12-68 Plot: Uncultivated - Water Added Sample No: One

	Depth (inches)	
Organism	1	2
Gamasides	19	16
Malaconothrus		2
Oppia	10	3
Scutacaridae	1	
Tectocepheus	2	1
Unidentified Acari	2	4
Isotoma notabilis	1	3
Lepidocyrtus violaceus	8	14
Mesaphorura granulata		2
Orchesella ainsliei	1	
Protaphorura armata	3	3
Pseudosinella violenta	2	1
Coleoptera		1
Geophilomorpha	1	
Heteroptera		2
Psocoptera	2	1
Thysanoptera	1	
Total Arthropoda	53	53

TABLE 77.--Raw data

Date: 9-12-68 Plot: Uncultivated - Water Added Sample No: Two

	Depth (inches)	
Organism	1	2
Gamasides	16	37
Malaconothrus	4	2
Oppia	17	3
Scutacaridae	1	
Unidentified Acari	14	4
Isotoma notabilis	5	
Lepidocyrtus violaceus	6	2
Mesaphorura granulata	1	5
Protaphorura armata	7	6
Pseudosinella violenta	3	
Willowsia platani	1	
Coleoptera	1	
Diptera	1	1
Formicidae	1	
Geophilomorpha	1	2
Pauropus	1	
Psocoptera	7	1
Thysanoptera		1
Total Arthropoda	87	64

TABLE 78.--Raw data

Date: 9-12-68 Plot: Uncultivated - No Water Added Sample No: One

	Depth (inches)	
Organism	1	2
Gamasides	8	14
Malaconothrus	1	
Oppia	9	4
Scutacaridae	2	
Tectocepheus	7	1
Unidentified Acari	10	3
Entomobrya sp.	1	
Isotoma notabilis	15	3
Lepidocyrtus violaceus	6	4
Mesaphorura granulata		1
Orchesella ainsliei		2
Protaphorura armata	1	
Pseudosinella violenta	6	4
Campodea	7	4
Coleoptera	2	2
Diptera	3	1
Formicidae		3
Geophilomorpha	1	
Heteroptera	2	
Psocoptera	1	
Total Arthropoda	82	47

TABLE 79.--Raw data

Date: 9-12-68 Plot: Uncultivated - No Water Added Sample No: Two

	Depth (inches)	
Organism	1	2
Gamasides	30	27
Malaconothrus	7	5
Oppia	8	4
Scutacaridae	2	
Tectocepheus		1
Unidentified Acari	1	3
Isotoma notabilis	4	3
Lepidocyrtus violaceus	2	1
Mesaphorura granulata	4	6
Orchesella ainsliei		3
Protaphorura armata	1	
Pseudosinella violenta	6	4
Campodea	7	8
Coleoptera	2	
Diptera	2	2
Formicidae	1	4
Geophilomorpha		1
Heteroptera	2	
Pauropus		1
Psocoptera	13	1
Total Arthropoda	92	74

TABLE 80.--Raw data

Date: 10-16-68 Plot: Uncultivated - No Water Added Sample No: One

	Depth (inches)					
Organism	1	2	3	4	5	6
Gamasides	34	14	7	7	0	0
Malaconothrus	1	1	2		0	
Oppia	3	1				
Scutacaridae	6					
Tectocepheus	2					
Unidentified Acari	14	6				1
Isotoma notabilis	1	1				
Mesaphorura granulata	2	6	6	4	5	
Protaphorura armata	1	10				
Coleoptera		1				
Diplopoda	1					
Diptera			1			
Formicidae	1					
Geophilomorpha						1
Heteroptera	8	5				
Pauropus			1	0	5	9
Psocoptera					1	
Symphyla				1		
Total Arthropoda	74	45	17	12	11	11

TABLE 81.--Raw data

Date: 10-16-68 Plot: Uncultivated - No Water Added Sample No: Two

	Depth (inches)	
Organism	1	2
Gamasides	23	22
Malaconothrus	47	13
Scutacaridae	41	4
Tectocepheus	4	2
Unidentified Acari	14	4
Mesaphorura granulata	5	2
Protaphorura armata	7	2
Campodea		1
Coleoptera	3	
Diptera	1	
Formicidae	2	
Heteroptera	8	4
Psocoptera	1	
Thysanoptera	1	
Total Arthropoda	157	54

TABLE 82.--Raw data

Date: 10-16-68 Plot: Uncultivated - No Water Added Sample No: Three

	Depth (inches)	
Organism	1	2
Gamasides	37	41
Malaconothrus	10	8
Oppia	1	2
Scutacaridae	7	14
Tectocepheus	1	1
Unidentified Acari	13	3
Isotoma notabilis	2	
Mesaphorura granulata	5	12
Protaphorura armata	1	3
Coleoptera	1	
Formicidae		1
Heteroptera	30	20
Total Arthropoda	108	105

TABLE 83.--Raw data

Date: 10-16-68 Plot: Uncultivated - No Water Added Sample No: Four

	Depth (inches)	
Organism	1	2
Gamasides	21	18
Scutacaridae	2	
Unidentified Acari	7	2
Isotoma notabilis	2	
Mesaphorura granulata	2	8
Protaphorura armata	2	
Campodea		1
Coleoptera		2
Formicidae		1
Heteroptera	16	31
Psocoptera	1	
Total Arthropoda	53	63

TABLE 84.--Raw data

Date: 10-16-68 Plot: Uncultivated - Water Added Sample No: One

	Depth (inches)					
Organism	1	2	3	4	5	6
Gamasides	6	24	8	0	0	0
Malaconothrus	23	2	2			1
Oppia	13	3	1			
Scutacaridae	5	7	4			
Tectocepheus		1				
Unidentified Acari	29	12		1	0	2
Isotoma notabilis	6	1				
Lepidocyrtus sp.	1					
Mesaphorura granulata	6	2	4	8	1	
Protaphorura armata	4	2	1	1	1	
Sminthurinus elegans		1				
Campodea	1	1		1		
Coleoptera		2		1		
Formicidae	2	2			2	
Geophilomorpha		1				
Heteroptera	1	1				
Pauropus				1		1
Psocoptera					1	
Symphyla		2	2	5	4	12
Thysanoptera						1
Total Arthropoda	97	64	22	18	9	17

TABLE 85.--Raw data

Date: 10-16-68 Plot: Uncultivated - Water Added Sample No: Two

	Depth (inches)	
Organism	1	2
Gamasides	2	6
Malaconothrus	18	21
Oppia	17	2
Scutacaridae	11	13
Tectocepheus	1	
Unidentified Acari	25	2
Mesaphorura granulata	5	3
Protaphorura armata	4	1
Sminthurinus elegans		1
Coleoptera	1	
Formicidae	1	
Heteroptera	1	
Psocoptera	1	
Symphyla		1
Total Arthropoda	87	54

TABLE 86.--Raw data

Date: 10-16-68 Plot: Uncultivated - Water Added Sample No: Three

	Depth (inches)	
Organism	1	2
Gamasides	5	7
Malaconothrus	16	
Oppia	6	
Scutacaridae	7	2
Tectocepheus	2	
Unidentified Acari	13	5
Isotoma notabilis	1	
Lepidocyrtus violaceus		1
Mesaphorura granulata	4	8
Protaphorura armata	5	4
Coleoptera	1	2
Formicidae		1
Geophilomorpha		1
Heteroptera	2	
Total Arthropoda	62	31

TABLE 87.--Raw data

Date: 10-16-68 Plot: Uncultivated - Water Added Sample No: Four

	Depth (inches)	
Organism	1	2
Gamasides		3
Malaconothrus	145	45
Oppia	2	
Scutacaridae	38	10
Unidentified Acari	6	5
Isotoma notabilis	2	
Lepidocyrtus violaceus	1	
Megalothorax albus	3	
Mesaphorura granulata	6	2
Protaphorura armata	1	1
Diptera	1	
Psocoptera		1
Symphyla	1	
Total Arthropoda	206	67