Technical Report No. 104 SOIL MACRO-ARTHROPODS OF THE PAWNEE SITE

John E. Lloyd and Russell R. Grow

Plant Science Division

University of Wyoming

Laramie, Wyoming

Investigators: John E. Lloyd - Principal Investigator

Russell R. Grow - Research Assistant

GRASSLAND BIOME

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ABSTRACT

The summer of 1970 was devoted to collection on a biweekly basis and identification of soil insects from the four differentially grazed pasture types. All organisms that were retained on a one millimeter sieve were considered macro-arthropods. Major insect groups collected and identified, in order of decreasing abundance were: Formicidae, Scarabaeidae, Staphylinidae, Rhinotermitidae, Tenebrionidae, Carabidae, Margarodidae, Curculionidae, Annelida, Asilidae, Elateridae, Lepidoptera, Lygaeidae, and Cerambycidae. Biomass and caloric values of the abundant groups will be determined.

SOIL MACRO-ARTHROPODS OF THE PAWNEE SITE

Little is known of the soil fauna of the shortgrass prairie. The presence of some adult insects in aboveground collections indicated that their immature stages should be present in the soil. Animals that inhabited the soil exclusively were completely unknown. The object of this study was therefore to collect, enumerate, and identify as far as practical, and then to determine insect biomass and caloric value.

Methods

The soil samples were collected from four differentially grazed pastures. The pasture treatments were ungrazed (exclosures in pastures 23 east and 15 west), lightly grazed (pasture 23 west), moderately grazed (pasture 15 east), and heavily grazed (pasture 23 east). Each pasture type was replicated twice. The replicates were called watersheds or plots. Each watershed was divided into 10 rows and 10 columns, totaling 100 sample areas (except study plots 2, 5, and 8), each containing a permanent study point or quadrat .25 m² for the purpose of estimating plant biomass changes.

All soil samples were taken between the permanent study points. Each sample was assigned the coordinate numbers of the nearest permanent study point to the right (facing the plot from the lower edge). Each set of coordinates was made up of a row number followed by a column number.

In the appendix are diagrams of each study plot giving the important information concerning each individual plot. The points sampled on the first sampling date of 1970 are circled.

The biweekly samples were collected in conjunction with samples of aboveground insects and above- and belowground plant biomass. Sampling points for each study plot were selected at random on each sampling date. Once a

point was sampled, it was excluded from further sampling until all points on the plot were sampled. Five soil samples were removed from the two watersheds of each pasture type resulting in a total of 40 samples for each sample date.

The initial samples, taken in mid-April, consisted of 12.5 cm diameter cores 30.5 cm deep. Subsequent cores were only 15.25 cm deep, as no macro-arthropods were found in the 15-30 cm samples. However, additional 30.5 cm cores were taken at 3 month intervals. The bimonthly collections terminated with 30.5 cm samples in late October, with additional 30.5 cm samples being planned for mid-January, 1971. These 30.5 cm cores, except those of the first sampling date, were split in the field into two 15.25 cm cores, resulting in a 15.25 cm core and a 15.25-30.25 cm core. All soil cores were placed in plastic bags and refrigerated until they were sieved.

After the third sampling date, vegetation associated with the soil core sample was identified and recorded prior to taking the sample.

Extraction

Each core was soaked in a 10.6 liter pail of water, then gradually wet sieved through a series of three sieves: 4 mm on top; 2 mm in the middle; and 1 mm on the bottom. Three sieves permitted the use of high water pressure necessary to break the larger soil particles into smaller sievable sizes. Otherwise, the water pressure would have forced smaller organisms through the smallest sieve.

The larger roots were removed from the sieves and placed in plastic bags for later examination. The accumulated debris collected on the sieves was then rinsed into a pail containing a concentrated magnesium sulfate solution. The debris was thoroughly mixed, then allowed to settle. The mixture was

poured through fine mesh organdy cloth to collect the organisms from the surface for later separation. The sediment on the bottom of the pail was discarded, and the magnesium sulfate solution was saved for re-use. The organdy with the collected material was placed in the plastic bag with the roots. Organisms observed during extraction were removed and placed in a vial of 75% ethyl alcohol. No deliberate attempt was made, however, to find specimens during the extraction.

In Laramie, all the samples were again wet sieved, providing an additional washing of the roots. The roots were then removed and carefully, but quickly examined for organisms and then discarded. All material remaining on the sieves was rinsed into a pail and everything, including the sediment, was collected in the organdy cloth.

Final extraction was done in the laboratory by floating small portions of the collected material on water in a white porcelain tray. The material was observed carefully to find specimens both floating and submerged. An attempt was made to determine whether specimens were living by touching a few drops of alcohol to them. If no movement resulted, they were listed as in an unknown condition because they may have been killed by the extraction process. Insects were listed as dead if they were brittle or incomplete. All specimens were stored in 75% ethyl alcohol and identified as far as possible, which to this point has been primarily to family.

Dry weights were obtained on specimens for the first two sampling dates, but due to the destruction of the dried insects, estimated weights were taken on all subsequent samples until more complete identifications can be obtained.

The following data were recorded for each specimen where possible:

Data Type 33 Soil Macro-arthropods Site 11 Pawnee	Level 1 15.25 cm 2 15.25 cm - 30.5 cm 3 0 - 30.5 cm 4 Unknown
<u>Date</u> Day Month	Condition 1 Alive 2 Dead 3 Unknown
Year	Class
Time (hour) 00 Unknown	<u>Order</u>
Treatment	Family
1 Ungrazed 2 Lightly grazed	Genus
3 Moderately grazed 4 Heavily grazed	Species
5 Grazed 1969; Ungrazed 1970	Subspecies
Replicate 1 2	Life Stage 00 Undetermined 10 Adult 11 Adult male
Plot No.	12 Adult female 20 Pupa
2	30 Egg 31 Egg case
3 4 5 6 7 8	32 Egg case with eggs
5	33 Egg case with nymphs
6	40 Nymph or Larvae 41 Nymph or Larvae, early
8	41 Nymph or Larvae, early 42 Nymph or Larvae, middle
·	43 Nymph or Larvae, late
Quadrat	50 Instar
	51 Instar, 1st
Trophic	52 Instar, 2nd
0 Unknown	53 Instar, 3rd 54 Instar, 4th
1 Plant feeding (tissue)2 Plant feeding (sap)	54 Instar, 4th 55 Instar, 5th
3 Root feeding	56 Instar, 6th
4 Predator	57 Instar, 7th
5 Scavenger	
6 Non-feeding stage	Total No.
<pre>7 Root feeding (tissue) 8 Root feeding (sap)</pre>	Dry Weight (mg)

Host

00 Unknown

- 01 Agropyron smithii Rydb.
- 02 Artemisia frigida Willd.
- 03 Aristida longiseta Steud.
- 04 Bouteloua gracilis (H.B.K.) Lag.
- 05 Buchloe dactyloides (Nutt.) Engelm.

06 Carex filifolia Nutt.

07 Carex heliophila MacKenz.

08 Chrysothamnus nauseosus (Pall.) Britt.

09 Eriogonum effusum Nutt.

10 Muhlenbergia torreyi (Kunth) Hitchc.

11 Opuntia polyacantha Haw.

12 Psoralea tenuiflora Pursh.

13 Sphaeralcea coccinea (Pursh.) Rydb.

14 Stipa comata Trin. and Rupr.

Estimate

E = estimate on weight

No. Weighed

Head Capsule Width (mm)

Table 1 represents the groups of soil organisms that have been identified thus far from the Pawnee Site. The major insect families represented in our collections are in the orders Coleoptera, Diptera, and Lepidoptera. The samples included obvious litter inhabitants as well as soil inhabitants.

Table 2 presents abundance and estimated biomass of the more common organisms. Cerambycidae, although few in number, were also included because of their large contribution to biomass. Ranking by biomass changes the order. The Formicidae were the most numerous because one sample included a large colony accounting for 911 individuals. The Scarabaeidae were also extremely abundant and responsible for one third of the biomass. The Annelida occurred in fewer numbers than the Scarabaeidae, but were responsible for over 15% of the biomass as they were individually much larger than the Scarabaeidae.

The numbers of certain organisms found in the four different pasture types are shown in Table 3. The Formicidae data confound the table, so we excluded this group in our final totals and came up with an interesting picture in regard to the heavy use pasture. This pasture has far fewer numbers of individuals than do the other three types. This is especially apparent in the Scarabaeidae, which is the group contributing the most to total biomass.

Table 1. Groups represented in soil Macro-Arthropod survey of the Pawnee Site. April 17-October 30, 1970

Insects		Non Insects
Anthicidae	Arctiidae	Araneida
Carabidae	Noctuidae	Acarina
Cerambycidae	Geometridae	ANNELIDA
Chrysomelidae		Oligochaeta
Cicindelidae		NEMATODA
Curculionidae		
Elateridae		
Endomychidae		
Meloidae		
Mycetophagidae		
Phalaeridae		
Scarabaeidae		
Scaphidiidae		
Staphylinidae		
Tenebrionidae		
Heteroceridae		
Hydrophilidae		
Formicidae		
Rhinotermitidae		
Lygaeidae		
Pentatomidae		
Corixidae		
Margarodidae		
Aphididae		

Table 2. Abundance and biomass of organisms collected from soil samples taken at Pawnee Site. April 17 - October 30, 1970.

Group	Rank	No.	Percent of Numbers	Biomass (mg)	Rank	Percent of Mass
Formicidae	1	1605	55.5	642.0	3	12.9
Scarabaeidae	2	577	20.0	1615.6	1	32.4
Staphylinidae	3	89	3.1	53.4	13	1.1
Rhinotermitidae	4	87	3.0	96.6	11	1.9
Tenebrionidae	5	66	2.3	182.4	8	3.7
Carabidae	6	65	2.2	422.5	4	8.5
Margarodidae	7	56	1.9	58.7	12	1.2
Curculionidae	8	56	1.9	142.8	9	2.9
Annelida	9	52	1.8	780	2	15.6
Asilidae	10	40	1.4	198.6	7	4.0
Elateridae	11	38	1.3	117.8	10	2.4
Lepidoptera	12	33	1.1	264.0	6	5.3
Lygaeidae	13	26	0.9	8.3	14	0.2
Cerambycidae	14	5	0.2	402.9	5	8.1

Table 3. Distribution of soil organisms among the four pasture types. April 17 - October 30, 1970.

		Grazing I	ntensity	
Group	Ungrazed	Light	Moderate	Heavy
Formicidae	340	911	126	228
Scarabaeidae	232	124	174	47
Staphylinidae	24	17	29	19
Rhinotermitidae	3	11	73	0
Tenebrionidae	16	19	20	11
Carabidae	10	29	12	14
Margarodidae	26	4	12	14
Curculionidae	20	18	10	8
Annelida	8	40	3	1
Asi lidae	8	9	15	8
Elateridae	19	1	10	8
Lepidoptera	1	17	14	1,
Lygaeidae	2	11	12	1
Cerambycidae	1	1	1	2
Others	_12	44		_17
Total	722	1256	535	379
Total <u>a</u> /	382	345	409	151

 $[\]underline{a}/$ Excluding Formicidae

Table 4 presents seasonal abundance of organisms. The most interesting data are those of the Annelida which showed an almost complete absence of organisms after May. The larval Scarabaeidae displayed two peaks in their abundance, the first peak occurred during May and the second in August. The adult Scarabaeidae showed a more general distribution indicating a peak in abundance in mid September. Lepidoptera were most abundant during August and early September. Most groups were encountered in such small numbers, however, that it is difficult to discern any actual peaks in their occurrence.

A comparison of the frequency of occurrence of soil organisms at four different grazing intensities is shown in Table 5. This shows the difference between sample sites. Each replicate is a plot located adjacent to a watershed. Differences in insect abundance did occur among the plots. For example, heavy grazing treatment replicate 1, which was watershed 1, consistently had fewer insects than any other plot. Considerable variation also occurred between watersheds as to the number of samples containing organisms.

This year's study provided information on the abundance and estimated biomass of soil organisms collected on the four differentially grazed pasture types. Our sampling indicated that the Scarabaeidae were the most abundant and accounted for nearly a third of the biomass. Annelida were far fewer in number, but did contribute considerably to total biomass. The Annelida, however, were collected only in early spring and only two individuals were encountered after May. We also found that differences in insect abundance did occur among the plots, and also between the replicates themselves.

The attached tables present the information obtained on soil macroarthropods this far.

Table 4. Seasonal abundance of the more obvious soil organisms at the Pawnee Site.

Group	April 17	May 1	Мау 15	May 29	June 13	June 25	July 11	July 22	Aug.	Aug.	Sept.	Sept.	0ct.	Oct.
Formicidae	13	58	52	∞	155	7	62	1117	45	77	7	15	16	12
Scarabaeidae (adult)	15	œ	14	18	5	2	12	26	16	12	16	65	30	19
(larvae)	2	36	40	43	17	22	11	15	77	97	17	14	10	00
Staphylinidae	6	10	12	7	5	Н	3	5	11	3	9	∞	3	9
Annelida	6	18	24	0	2	0	0	0	0	0	0	0	0	0
Carabidae	7	7	2	0	7	3	7	2	6	80	7	7	н	7
Tenebrionidae (adult)	7	\vdash	2	-	3	0	-	2	2	4	E)	8	3	
(larvae)	8	2	2	н	Н	1	2	Н	٦	9	Н	7	4	7
Curculionidae (adult)	Н	-	2	7	0	3	2	0	Н	H	ю	7	Н	2
(larvae)	0	Н	4	0	0	Н	2	2	- 5	7	0	2	0	7
Elateridae (larvae)	3	0	ન .	72	4	н.	4	က	H	2	0	7	H	9
Margarodidae	0	0	0	12	2	. 2	0	2	н	0	15	9	12	7
Lepidoptera (larvae)	0	Н	0	0	0	7		2	6	7	∞	0	Н	
Asilidae	H	3	Н	3	7	7	Н	2	7	2	8	5	3	3
Cerambycidae (larvae)	0	0	0	0	2	0	0	Н.	0	Н	0	0	0	ਜ
Lygaeidae	0	3	7	9	H	7	0	Н	0	0	1	н	2	0
													-	

Table 5. Comparison of the frequency of occurrence of soil organisms at four different grazing intensities. 1970.

Sample Date	Grazing Intensity	No. S Conta Arthr		Avg. Organ per Sa	isms
		Rep. 1	Rep. 2	Rep. 1	Rep. 2
April 17	Zero	5	1	4.2	0.4
	Light	5	3	2.4	2.8
	Moderate	5	4	4.4	1.6
	Heavy	5 3	3	0.8	2.0
May 1	0	4	4	5.2	12.2
	L	3	3	4.0	2.8
	M	5	4	2.6	2.4
	Н	1	2	0.6	0.4
May 15	0	4	4	2.0	7.0
	L	5	4	4.0	7.4
	M	5	5	6.4	4.2
	Н	2	4	0.4	6.2
May 29	0	5	4	6.2	4.4
	L	4	4	1.6	3.8
	M	4	4	1.4	1.6
	H	2	3	0.4	2.0
June 13	0	3	4	0.8	1.0
	L	4	4	2.0	2.0
	M	2	5	0.4	4.2
	Н	1	5	0.2	31.8
June 25	0	2	3	0.4	3.4
	L	2	3	0.6	0.6
	M	3	4	2.2	2.2
	Н	2	2	0.4	0.6
July 11	0	2	5	2.6	3.4
	L	4	2	5.0	4.8
	M	4 2	2 2	1.8	0.8
	Н	2	4	0.4	1.4
July 22	0	3	5	45.2	3.8
10757	L		4	15.4	152.8
	M	5 5 3	.5	4.6	5.2
	Н	3	4	0.6	3.4
Aug. 4	0	1	°3	2.0	6.0
	L	4	4	7.8	3.2
	M	5 4	4	4.2	6.0
	H	4	5	1.4	2.0

Table 5. (Continued)

Sample Date	Grazing Intensity	No. Sai Contai Arthro	ning	Avg. Organ per Sa	Lsms
		Rep. 1	Rep. 2	Rep. 1	Rep. 2
A 10		3		0.6	7.0
Aug. 18	0	2 3	5 3	1.8	
	L	3	4		2.4
	M H	5 3	3	11.8	4.8 2.0
	***	•	3		
Sept. 1	0	5	5	3.8	4.2
	L	3	4	2.0	3.0
	М	3	3	1.2	1.6
	H	3	2	1.4	1.4
Sept. 14	0	5	4	5.4	4.2
	L	4	3	2.6	1.4
	М	4	4	6.0	6.2
	Н	3	3	1.6	1.6
Oct. 1	0	3	5	1.8	1.2
	L	4	5	2.0	2.2
	M	3	2	2.0	4.6
*	Н	4	2	1.8	0.8
Oct. 29	0	4	4	1.0	2.6
	L	5	3	5.2	1.6
	М	2	2	0.6	2.0
	Н	3	4	1.6	1.4

APPENDIX I

FIELD DATA

Soil Macro-arthropod Data

Soil macro-arthropod data collected in 1970 at the Pawnee Site is Grassland Biome data set A2U302B. Data were collected on form NREL-33. A sample data form and a sample of the data follow.



GRASSLAND BIOME

U.S. INTERNATIONAL BIOLOGICAL PROGRAM

FIELD DATA SHEET - SOIL MACROARTHROPODS

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Carlos Colores and the Colores

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