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INSECT STUDIES AT THE OSAGE COMPREHENSIVE SITE, 1972 SEASON

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ABSTRACT

The results of 1972 aboveground invertebrate sampling at the Osage Comprehensive Site are summarized. A list of orders and families determined from 1970 to 1972 is included.

INTRODUCTION

Eight samples of aboveground invertebrates were taken during the 1972 field season extending from April 23 to November 15. Results are presented in Tables 1-10 and are briefly discussed. Diplopoda (millipedes), Isopoda (pillbugs), and Phalangida (daddy longlegs) were recorded for the first time in 1972; they were present in 1970 and 1971 but not included in the data. Comparisons with 1970 and 1971 data are made only for orders and families collected. A comprehensive comparison will be made upon receipt of corrected data for the previous years.

METHODS

Collecting methods used at Osage in 1972 were essentially the same as in 1971 (Reed and Blocker 1972, French 1971). The 1972 methods manual (Swift and French 1972) included changes which would, in our opinion, have made it difficult to compare 1972 data to 1970 and 1971.

For the Osage data, we hand-sorted each sample after it was removed from the Berlese separator (1971 method) rather than hand-sort only one sample from each replicate (1972 method). This procedure was necessary, at Osage, to obtain a more accurate measure of grasshoppers, certain beetles, walkingsticks, etc. Most of our specimens of these groups were found in the hand-sorted material.

We also separated and weighted insects at each sample date (1971 method) instead of using average seasonal dates (1972 method). This was necessary, at Osage, because our data indicate that weight of

adult and late instar grasshoppers and other insects vary according to the degree and development of the reproductive system, nutrition, or other reasons. Visual examination of our data substantiates this concern.

It is felt that the 1971 method of recording data was more complete and representative of the existing situation. Numbers and biomass estimates were higher (overall) when the 1971 method was used. The 1972 method would distort weights and mask the differences in individual weights that occur during the life cycle of many invertebrates.

RESULTS AND DISCUSSION

Aboveground Invertebrates

During 1972, 13 orders and more than 85 families of insects were collected by the prescribed IBP collecting procedure. In addition, specimens of Isopoda (pillbugs), Diplopoda (millipedes), Phalangida (daddy longlegs), Araneida (spiders), and Acarina (mites) were collected. Isopoda, Diplopoda, and Phalangida were present in previous years but were not recorded. An additional order (Ephemeroptera) and 19 families were collected by sweeping and/or in pitfall traps. These were: One family of Ephemeroptera; Phasmidae (Orthoptera); Coreidae and Neididae (Hemiptera); Cantharidae, Cerambycidae, Cicindelidae, Cleridae, Malachiidae, and Silphidae (Coleoptera); Asilidae, Bombyliidae, Chironomidae, Culicidae, Dolichopodidae, Otitidae, Pipunculidae, and Stratiomyiidae (Diptera); and Halictidae (Hymenoptera). Specimens of Apidae (Hymenoptera) were collected in 1972 by Karen Bowers of the University of Oklahoma and families of Odonata (Coenagrionidae and Libellulidae), Lepidoptera

(Danaidae, Nymphalidae, and Satyridae), and Diptera (Acroceridae) were observed but not collected. This is a total of at least 111 families present during 1972.

In 1972, 21 families were collected that were not found in 1970 or 1971. These were: Cydnidae, Nabidae, Piesmidae, and Phymatidae (Hemiptera); Cucujidae, Lampyridae, Limnebiidae, Scolytidae, and Tenebrionidae (Coleoptera); Geometridae (Lepidoptera); Bombyliidae, Calliphoridae, Chironomidae, Dolichopodidae, Empididae, Muscidae, Phoridae, Stratiomyiidae, and Figitidae (Diptera); and Proctotrupidae and Vespidae (Hymenoptera). Of these families, only Vespidae, Calliphoridae, and Muscidae contributed appreciable biomass.

During 1970 and 1971, 20 families were collected that were not found in 1972. These were: Poduridae (Collembola); Mantidae (Orthoptera); One family of Dermaptera; Corimelaenidae, Corixidae, Gerridae, and Ploiariidae (Hemiptera); Cisidae and Ptilidae (Coleoptera); Myrmeleontidae (Neuroptera); Ceratapogonidae, Piophilidae, Pyrgotidae, Rhagionidae, and Tabanidae (Diptera); and Tipulidae, Mutillidae, Sierolomorphidae, Tenthredinidae, and Tiphiidae (Hymenoptera).

For the 3 years of the study, more than 131 families of insects representing 16 orders were collected in the tallgrass IBP Comprehensive Site utilizing three trapping methods. Of these, approximately 65% of the families were collected by the prescribed IBP quick-trap during the 1972 field season. Most of the important groups (in both numbers and biomass) were represented in this trapping method during the year. Comparisons are difficult to make because the sweeping and pit-trapping methods are difficult or impossible to quantify. Silphidae (carrion

beetles) was the major family caught only by the pit traps, while the sweep net method was apparently more efficient than the IBP method in catching specimens of Acrididae (short-horned grasshoppers), Tettigoniidae (long-horned grasshoppers), and Phasmidae (walkingsticks).

The above data are shown in Table 1. Conclusions are that no single collecting method will sample the total aboveground fauna of a tallgrass prairie. Also, the faunal groups are not present in the same proportions each year and probably an appreciable number of taxa are actually absent during some years. The IBP quick-trap, however, did collect the major taxa (by number and biomass) during each year of the study.

The most important groups (orders) of invertebrates in terms of total annual biomass in 1972 were Hymenoptera, Coleoptera, Isopoda (present but not recorded in previous years), Hemiptera, Orthoptera, Araneida, and Acarina, respectively. The most important groups (orders) in terms of numbers were Acarina, Hymenoptera, Thysanoptera, Homoptera, Collembola, Coleoptera, Araneida, Hemiptera, and Diptera, respectively.

Biomass and number ranks of the various orders vary (e.g., Orthoptera ranks 5th in biomass and 12th in number, Table 2). For this reason both measures of these populations are considered necessary. Reporting of numbers alone is a meaningless method of presenting data on the total invertebrate population. Seasonal variation in weight was briefly discussed previously.

The most important families (or groups) of insects in terms of total annual biomass were Formicidae, Scutelleridae, Curculionidae, Acrididae, Vespidae, Chrysomelidae, Carabidae, Tettigoniidae, Lepidoptera larvae (order), and Tachinidae. The most important families (or groups)

Table 1. Orders and families of aboveground insects determined from the Osage Comprehensive Site for 1970-72.[a,b/]

ORDER	FAMILY	1972 S	1972 P	1972 Q[c/]	1970-71	TROPHIC LEVEL[d/] Adult	TROPHIC LEVEL[d/] Immature
Thysanura	Japygidae			x	x	5	5
Collembola	Entomobryidae		x	x	x	8	8
	Poduridae				x	8	8
	Sminthuridae		x	x	x	1	1
Ephemeroptera		x				9	1
Odonata	Coenagrionidae[e/]					5	5
	Libellulidae[e/]					5	5
Orthoptera	Acrididae	x	x	x	x	1	1
	Blattidae		x	x	x	8	8
	Gryllidae	x	x	x	x	7	7
	Mantidae				x	5	5
	Phasmidae	x			x	1	1
	Tettigoniidae	x		x	x	1	1
Dermaptera					x	8	8
Psocoptera			x	x	x	8	8
Thysanoptera		x		x	x	2	2
Hemiptera	Coreidae	x	x		x	2	2
	Corimelaenidae				x	2	2
	Corixidae				x	5	5
	Cydnidae	x		x		2	2
	Gerridae				x	5	5
	Lygaeidae	x	x	x	x	2	2

Table 1 (cont.)

ORDER	FAMILY	1972 S	1972 P	1972 Q c/	1970-71	TROPHIC LEVEL d/ Adult	TROPHIC LEVEL d/ Immature
Hemiptera (cont.)	Miridae	x	x	x	x	2	2
	Nabidae			x		5	5
	Neididae	x			x	2	2
	Pentatomidae			x	x	2	2
	Piesmidae	x		x		2	2
	Phymatidae	x		x		5	5
	Ploiariidae				x	5	5
	Reduviidae		x	x	x	5	5
	Scutelleridae	x	x	x	x	2	2
	Tingidae	x		x	x	2	2
Homoptera	Aphididae	x	x	x	x	2	2
	Cercopidae	x		x	x	2	2
	Cicadellidae	x	x	x	x	2	2
	Cixidae			x	x	2	2
	Coccoidea			x	x	2	2
	Delphacidae	x	x	x	x	2	2
	Dictyopharidae	x		x	x	2	2
	Fulgoridae	x	x	x	x	2	2
	Issidae	x	x	x	x	2	2
	Membracidae	x		x	x	2	2
	Psyllidae	x		x	x	2	2

Table 1 (cont.)

ORDER	FAMILY	1972 S	1972 P	1972 Q[c]	1970-71	TROPHIC LEVEL[d] Adult	TROPHIC LEVEL[d] Immature
Coleoptera	Cantharidae	x			x	3	5
	Carabidae	x	x	x	x	5	5
	Cerambycidae	x	x		x	3	1
	Chrysomelidae	x	x	x	x	1	1
	Cicindelidae		x		x	5	5
	Cisidae				x	8	8
	Cleridae	x			x	5	5
	Coccinellidae	x		x	x	5	5
	Cucujidae			x		5	5
	Curculionidae	x	x	x	x	1	1
	Dermestidae				x	8	8
	Elateridae	x	x	x	x	1	1
	Erotylidae			x	x	8	8
	Eucnemidae			x	x	8	8
	Histeridae		x	x	x	5	5
	Lampyridae			x		3	5
	Lathridiidae	x	x	x	x	8	8
	Limnebiidae			x		8	8
	Malachiidae	x			x	5	5
	Meloidae	x	x	x	x	1	5
	Mordellidae	x		x	x	3	1
	Nitidulidae			x	x	3	8
	Phalacridiidae	x		x	x	1	1

Table 1 (cont.)

ORDER	FAMILY	1972 S	1972 P	1972 Q[c]	1970-71	TROPHIC LEVEL[d] Adult	TROPHIC LEVEL[d] Immature
Coleoptera (cont.)	Pselaphidae		x	x	x	5	5
	Ptilidae				x	8	8
	Scaphidiidae			x	x	8	8
	Scarabaeidae		x	x	x	1,8	1,8
	Scolytidae			x		1	1
	Scydmaenidae		x	x	x	8	8
	Silphidae		x		x	8	8
	Staphylinidae	x	x	x	x	5	5
	Tenebrionidae			x		8	1
	Throscidae	x	x	x	x	3	3
Strepsiptera				x	x	6	6
Neuroptera	Chrysopidae		x	x	x	5	5
	Hemerobiidae		x		x	5	5
	Myrmeleontidae				x	5	5
Lepidoptera	Danaidae[e]					3	1
	Geometridae			x		3	1
	Noctuidae	x	x	x	x	3	1
	Nymphalidae[e]					3	1
	Pyralidae	x	x	x	x	3	1
	Satyridae[e]					3	1
Diptera	Acroceridae[e]					0	6
	Asilidae	x			x	5	5
	Bombyliidae	x				3	5
	Calliphoridae	x	x	x		3	8

Table 1 (cont.)

ORDER	FAMILY	1972 S	1972 P	1972 Q[c]	1970-71	TROPHIC LEVEL[d] Adult	TROPHIC LEVEL[d] Immature
Diptera (cont.)	Cecidomyiidae		x	x	x	3	1
	Ceratopogonidae				x	6	8
	Chironomidae	x				3	1
	Chlorophidae	x	x	x	x	3	1
	Culicidae	x	x		x	6	8
	Dolichopodidae	x				5	5
	Empididae			x		5	5
	Muscidae	x	x	x		3	8
	Mycetophilidae	x	x	x	x	3	8
	Otitidae	x	x		x	0	8
	Phoridae	x	x	x		3	8
	Piophilidae				x	0	8
	Pipunculidae	x			x	3	6
	Pyrgotidae				x	3	6
	Rhagionidae				x	5	5
	Sarcophagidae	x	x	x	x	3	6
	Scatopsidae			x	x	3	8
	Sciaridae		x	x	x	8	8
	Sciomyzidae	x		x	x	6	6
	Stratiomyiidae		x			3	8
	Syrphidae	x		x	x	3	5
	Tabanidae				x	6	5
	Tachinidae	x	x	x	x	3	6
	Tipulidae				x	3	1

Table 1 (cont.)

ORDER	FAMILY	1972 S	1972 P	1972 Q[c]	1970-71	TROPHIC LEVEL[d] Adult	TROPHIC LEVEL[d] Immature
Hymenoptera	Apidae[f]					3	3
	Braconidae	x	x	x	x	3	6
	Dryinidae	x	x	x	x	6	6
	Encyrtidae			x	x	3	6
	Eulopidae	x	x	x	x	6	6
	Figitidae	x	x	x		3	6
	Formicidae	x	x	x	x	7	7
	Halictidae[f]					3	3
	Ichneumonidae	x	x	x	x	3	6
	Mutillidae				x	3	6
	Proctotrupidae			x		3	6
	Pteromalidae	x	x	x	x	3	6
	Scelionidae			x	x	3	6
	Sierolomorphidae				x	0	0
	Tenthredinidae				x	1	1
	Tiphiidae				x	3	6
	Thysanidae			x	x	3	6
	Trichogrammatidae			x	x	3	6
	Vespidae			x		5	5

[a] All orders were not determined to family.

[b] All immatures were not determined to family.

[c] S = sweeping, P = pitfall trap, Q = quick-trap.

[d] Trophic level: 0 = unknown, 1 = plant tissue, 2 - plant sap, 3 = plant pollen and nectar, 4 = plant seed, 5 = predators, 6 = parasites, 7 = omnivores, 8 = saprophages, 9 = nonfeeding stage.

[e] Observed, never captured.

[f] Collected by Karen Bowers, University of Oklahoma, on October 1972: 10 specimens, 4 spp. Apidae; 1 specimen Halictidae.

Table 2. Total numbers and biomass of aboveground invertebrate orders collected by the quick-trap method at the Osage Comprehensive Site, 1972.

ORDER	BIOMASS (g)	NUMBER	NUMBER RANK
Hymenoptera	2.2354	18,561	2
Coleoptera	1.4812	4,226	6
Isopoda	1.3051	531	10
Hemiptera	.7965	1,223	8
Orthoptera	.6344	37	12
Araneida	.6059	1,284	7
Acarina	.5468	55,813	1
Diptera	.2798	1,119	9
Homoptera	.2689	6,905	4
Lepidoptera	.2608	50	11
Diplopoda (Class)	.1571	7	13
Thysanoptera	.1044	17,066	3
Collembola	.0484	5,499	5
Phalangida	.0108	2	14
Neuroptera	.0041	1	15
Total insect biomass = 6.1139		Total insect number = 54,684	
Total noninsect biomass = 2.6275		Total noninsect number = 57,637	
Total biomass = 8.7396		Total number = 112,324	

in terms of total annual numbers were Formicidae, Thysanoptera, Collembola (order), Coccoidea, Coleoptera larvae (order), and Lygaeidae.

There is an even wider disparity among numbers and biomass of families than among orders, also indicating the necessity for collecting both kinds of data (Table 3).

Peak insect numbers in the grazed treatment occurred on 17 May, with lesser peaks on 6 July and 29 September, respectively. Biomass was highest on 29 September, 17 May, and 6 July, respectively. This indicates a higher weight/individual insect late in the season. Peak numbers in the ungrazed treatment occurred on 6 July, 9 August, and 29 September while peak biomass occurred on 6 July, 29 September, and 9 August, respectively. The highest weights/individual occurred at midseason in this treatment.

The above data (Table 4) show that the average number of insects/m^2 was lower in the ungrazed treatment, but weight/insect was higher. Conclusions, therefore, cannot be based on numbers or biomass data alone.

Peak insect plus arachnid biomass (total invertebrate biomass of 1970 and 1971) occurred on the same dates as for insects alone, for both treatments, but arachnid numbers (primarily mites) resulted in differences in the dates of peak numbers. Highest numbers for the grazed treatments occurred on 17 May, 29 September, and 6 July, respectively, and for the ungrazed treatment on 6 July, 29 September, and 9 August, respectively. This is characteristic for a group such as mites with high numbers and a low individual biomass (Table 5).

When the numbers and biomass of Diplopoda (millipedes), Isopoda (pillbugs), and Phalangida (daddy longlegs) were added to the total

Table 3. Total numbers and biomass of aboveground invertebrate orders and families collected by the quick-trap method at the Osage Comprehensive Site, 1972.

ORDER	FAMILY	BIOMASS (g)	NUMBER	NUMBER RANK
Hymenoptera	Formicidae	1.9179	18,067	2
Isopoda		1.3051	531	14
Araneida		.6059	1,284	6
Hemiptera	Scutelleridae	.5824	287	19
Acarina		.5468	55,813	1
Coleoptera	Curculionidae	.5140	214	21
Orthoptera	Acrididae	.3856	11	
Hymenoptera	Vespidae	.2835	9	
Coleoptera	Chrysomelidae	.2610	328	18
Coleoptera	Carabidae	.2528	855	10
Orthoptera	Tettigoniidae (immatures)	.2099	8	
Lepidoptera	(immatures)	.1672	45	
Diptera	Tachinidae	.1666	23	
Diplopoda (Class)		.1571	7	
Hemiptera	Lygaeidae	.1536	911	8
Homoptera	Cicadellidae	.1204	705	12
Coleoptera	(immatures)	.1180	967	7
Thysanoptera		.1044	17,066	3
Lepidoptera	Noctuidae	.0807	1	
Coleoptera	Scarabaeidae	.0697	2	
Coleoptera	Elateridae	.0668	34	

Table 3 (cont.)

ORDER	FAMILY	BIOMASS (g)	NUMBER	NUMBER RANK
Coleoptera	Staphylinidae	.0548	367	16
Homoptera	Delphacidae	.0536	699	13
Collembola		.0484	5,499	4
Hemiptera	Pentatomidae	.0463	1	
Orthoptera	Blattidae	.0389	18	
Homoptera	Cercopidae	.0379	43	
Coleoptera	Cerambycidae	.0342	1	
Diptera	Calliphoridae	.0308	9	
Homoptera	Membracidae	.0262	6	
Diptera	Muscidae	.0255	8	
Coleoptera	Coccinellidae	.0239	12	
Coleoptera	Nitidulidae	.0237	810	11
Hymenoptera	Tiphiidae	.0200	13	
Diptera	Chloropidae	.0185	173	23
Homoptera	Coccoidae	.0170	5,018	5
Diptera	(immatures)	.0162	862	9
Coleoptera	Scaphidiidae	.0147	89	25
Coleoptera	Lathrididae	.0124	222	20
Coleoptera	Phalacrididae	.0115	79	
Diptera	Sarcophagidae	.0110	5	
Phalangida		.0108	2	
Lepidoptera	Pyralidae	.0105	3	
Homoptera	Issidae	.0094	13	
Diptera	Syrphidae	.0090	2	

Table 3 (cont.)

ORDER	FAMILY	BIOMASS (g)	NUMBER	NUMBER RANK
Hymenoptera	(immatures)	.0078	340	17
Homoptera	Fulgoridae	.0059	22	
Coleoptera	Meloidae	.0055	17	
Hemiptera	Coreidae	.0048	1	
Homoptera	Aphididae	.0047	397	15
Coleoptera	Scymaenidae	.0044	174	22
Coleoptera	Lampyridae	.0042	1	
Neuroptera	Chrysopidae	.0041	1	
Hemiptera	Phymatidae	.0039	1	
Coleoptera	Pselaphidae	.0035	59	
Homoptera	Dictyopharidae	.0031	1	
Lepidoptera	Geometridae	.0024	1	
Hymenoptera	Scelionidae	.0024	97	24
Hymenoptera	Braconidae	.0023	11	
Hemiptera	Nabidae	.0023	2	
Diptera	Phoridae	.0021	36	
Coleoptera	Lathridiidae	.0017	25	
Coleoptera	Throscidae	.0012	1	
Coleoptera	Erotylidae	.0011	2	
Hemiptera	Reduviidae (immatures)	.0010	1	
Coleoptera	Cucujidae	.0009	5	
Hemiptera	Tingidae	.0009	15	
Hymenoptera	Ichneumonidae	.0008	1	

Table 3 (cont.)

ORDER	FAMILY	BIOMASS (g)	NUMBER	NUMBER RANK
Hemiptera	Miridae	.0007	1	
Hemiptera	Cydnidae	.0006	1	
Coleoptera	Scolytidae	.0005	1	
Hymenoptera	Eulopidae	.0005	20	
Coleoptera	Histeridae	.0004	1	
Coleoptera	Tenebrionidae	.0003	1	
Hymenoptera	Dryinidae	.0002	3	
Homoptera	Psyllidae	.0001	1	
Diptera	Otitidae	.0001	1	

Table 4. Numbers (mean/m^2) and biomass (g/m^2) of insects collected at the Osage Comprehensive Site, 1972.

Date	Treatment	Number	Biomass
Apr. 23	Ungrazed	363.25	.05678
	Grazed	581.75	.05154
May 17	Ungrazed	711.00	.09840
	Grazed	1904.25	.19139
June 7	Ungrazed	450.00	.07522
	Grazed	1148.50	.04969
July 6	Ungrazed	1391.00	.20257
	Grazed	1634.50	.11064
Aug. 9	Ungrazed	1147.50	.11486
	Grazed	1104.50	.07955
Sept. 3	Ungrazed	411.50	.05626
	Grazed	483.25	.04200
Sept. 29	Ungrazed	1100.25	.14867
	Grazed	1349.25	.23009
Nov. 15	Ungrazed	677.00	.04352
	Grazed	403.75	.03353
Average	Ungrazed	781.438	.09954
	Grazed	1076.219	.09855

Table 5. Number (mean/m^2) and biomass (g/m^2) of total invertebrates collected, Osage Comprehensive Site, 1972.

Date	Treatment	Number [a]	Biomass [a]
Apr. 23	Ungrazed	870.25 (882.00)	.079 (.160)
	Grazed	1337.50 (1338.50)	.061 (.064)
May 17	Ungrazed	1911.75 (1929.25)	.129 (.189)
	Grazed	3799.50 (3803.25)	.218 (.245)
June 7	Ungrazed	1275.77 (1277.25)	.082 (.094)
	Grazed	1592.00 --	.054 --
July 6	Ungrazed	2036.00 (2050.75)	.222 (.253)
	Grazed	2924.75 (2929.50)	.122 (.128)
Aug. 9	Ungrazed	2141.75 (2147.00)	.137 (.168)
	Grazed	2275.75 (2276.75)	.094 (.100)
Sept. 3	Ungrazed	841.25 (859.25)	.067 (.091)
	Grazed	1150.00 (1158.25)	.049 (.056)
Sept. 29	Ungrazed	2221.25 (2243.50)	.174 (.200)
	Grazed	3013.25 (3027.75)	.270 (.292)
Nov. 15	Ungrazed	1221.75 (1232.50)	.063 (.085)
	Grazed	752.50 (755.25)	.052 (.057)
Average	Ungrazed	1564.97 (1577.69)	.119 (.155)
	Grazed	2105.66 (2110.16)	.115 (.125)

[a] Numbers in parentheses include Diplopods, Isopods, and Phalangida; these groups were not included in the 1971 data.

invertebrate figures (done only in 1972), there was no change in the numbers rank. Biomass, however, did change. In the ungrazed treatment, high Isopod biomass on 23 April and 17 May caused an increase in the biomass rank for these dates and a decrease on 7 June and 9 August. In the grazed treatment, the high Isopod biomass on 29 September and the high Isopod and Diplopod biomass on 17 May kept these dates ranked first and second. The absence of these groups on 7 June caused this date to drop in rank and allowed 3 September and 15 November to advance one rank (Table 5).

Isopoda (Table 6) were present except in the grazed treatment on 7 June. Highest biomass was found early in the season in the ungrazed treatment and later in the season in the grazed treatment. Higher average numbers and higher individual biomass of Isopods occurred in the ungrazed. Diplopod and Phalangid numbers and biomass were generally insignificant.

Peak spider numbers (Table 7) in the ungrazed treatment were highest on 29 September and 9 August. There was a smaller peak on 17 May and reasonably high comparative numbers remained on 15 November although there had been freezing temperatures by this time. Biomass was highest on 17 May and 23 April, respectively, with a lesser peak on 29 September. Apparently the species present in early spring were much heavier per spider. Peak numbers in the grazed treatment occurred on 29 September and 9 August and peak biomass occurred on 29 September. There were fewer specimens and less biomass/individual in the grazed area.

Table 6. Number (mean/m^2) and biomass (g/m^2) of Diplopoda, Phalangida, and Isopoda collected at Osage Comprehensive Site during 1972.

Date	Treatment	Diplopoda		Phalangida		Isopoda	
		Number	Biomass	Number	Biomass	Number	Biomass
Apr. 23	Ungrazed	.25	.00561			11.50	.07505
	Grazed	.25	.00020	.25	.00220	0.50	.00067
May 17	Ungrazed					17.50	.06042
	Grazed	.25	.01205	.25	.00050	3.25	.01367
June 7	Ungrazed					1.50	.01222
	Grazed						
July 6	Ungrazed	.25	.00002			14.50	.03145
	Grazed					4.75	.00572
Aug. 9	Ungrazed					5.25	.03130
	Grazed					1.00	.00560
Sept. 3	Ungrazed	.25	.00002			17.75	.02375
	Grazed	.25	.00002			8.00	.00669
Sept. 29	Ungrazed	.25	.00140			22.00	.02517
	Grazed					14.50	.02202
Nov. 15	Ungrazed					10.75	.02233
	Grazed					2.75	.00462
Average	Ungrazed	.125	.00088			12.594	.03521
	Grazed	.094	.00153	.063	.00034	4.344	.00490

Table 7. Number (mean/m^2) and biomass (g/m^2) of Araneida collected at the Osage Comprehensive Site during 1972.

Date	Treatment	Number	Biomass
Apr. 23	Ungrazed	18.00	.02080
	Grazed	12.00	.00070
May 17	Ungrazed	24.50	.02247
	Grazed	10.00	.00097
June 7	Ungrazed	17.25	.00394
	Grazed	9.50	.00272
July 6	Ungrazed	16.25	.01377
	Grazed	7.00	.00187
Aug. 9	Ungrazed	42.50	.01477
	Grazed	21.00	.00262
Sept. 3	Ungrazed	4.50	.00627
	Grazed	2.75	.00370
Sept. 29	Ungrazed	43.00	.01667
	Grazed	53.50	.02365
Nov. 15	Ungrazed	23.00	.00897
	Grazed	12.75	.00367
Average	Ungrazed	23.63	.01364
	Grazed	16.06	.00499

There is no apparent relationship between spider and insect weights and biomass. The high biomass at the beginning of the season in the ungrazed treatment is unexplained.

Peak mite numbers (Table 8) in the ungrazed treatment occurred on 17 May, 29 September, and 9 August, respectively. Peak biomass, for some unexplained reason, occurred on 15 November with 17 May, 29 September, and 9 August following, in that order. Peak numbers in the grazed treatment occurred on 17 May, 29 September, and 6 July, respectively, with peak biomass occurring on 17 May, 29 September, and 15 November, respectively. Larger numbers and biomass/individual were present in the grazed treatment.

An estimate of the percentage of herbivory compared to the total invertebrate biomass was made (Table 9). Although the percentage was lower in the ungrazed treatment, the average herbivory biomass and total biomass was very close.

Sampling Problems

An analysis of our total sampling program for above- and belowground invertebrates has revealed several weaknesses. Several of these are shown in Table 1 and have been discussed previously. In addition, we found that we missed a considerable number of invertebrate specimens which inhabit the plant crown areas. Aboveground samples (reported here) included the litter but not the crowns. In belowground samples, the crown was removed by the botanists prior to the collection of soil samples.

Table 8. Number (mean/m^2) and biomass (g/m^2) of Acarina collected at the Osage Comprehensive Site during 1972.

Date	Treatment	Number	Biomass
Apr. 23	Ungrazed	489.00	.00207
	Grazed	743.75	.00902
May 17	Ungrazed	1176.25	.00820
	Grazed	1885.25	.01760
June 7	Ungrazed	808.50	.00290
	Grazed	434.00	.00197
July 6	Ungrazed	628.75	.00506
	Grazed	1283.25	.01000
Aug. 9	Ungrazed	951.75	.00733
	Grazed	1150.25	.01240
Sept. 3	Ungrazed	425.25	.00488
	Grazed	664.00	.00367
Sept. 29	Ungrazed	1078.00	.00800
	Grazed	1610.50	.01574
Nov. 15	Ungrazed	521.75	.01003
	Grazed	336.00	.01480
Average	Ungrazed	759.90	.00606
	Grazed	1013.38	.01065

Table 9. Estimate of herbivory (%) compared to total insect and arachnid (total invertebrate) biomass (g/m^2), Osage Comprehensive Site, 1972.

Date	Ungrazed			Grazed		
	Herbivory (%)	Herbivory biomass (g/m^2)	Total biomass (g/m^2)	Herbivory (%)	Herbivory biomass (g/m^2)	Total biomass (g/m^2)
Apr. 23	41[a]	.032	.079	80	.049	.061
May 17	60	.078	.129	58	.127	.218
June 7	57	.047	.082	76	.041	.054
July 6	61	.135	.222	65	.079	.122
Aug. 9	60	.082	.137	72	.068	.094
Sept. 3	67	.045	.067	31[b]	.015	.049
Sept. 29	51	.088	.174	56	.150	.270
Nov. 15	56	.035	.063	67	.035	.052
Average	57	.068	.119	62	.071	.115

[a] A high proportion of predators (spiders) and parasites (Tachinidae).

[b] A high proportion of predators (Carabidae).

To gain some knowledge of the fauna missed as a result of our procedure, we took crown samples from our above-ground plots on 9 August and 15 November and extracted the invertebrates. In both the grazed and ungrazed treatments, we found significant numbers of Acarina, Coccoidea, Psyllidae, and Thysanoptera; moderate numbers of Formicidae and Entomobryidae; and small numbers of Araneida, Isopoda, Diplopoda, and numerous small families of insects. It was concluded that crown samples would have increased the numbers of invertebrates found,but would have had little effect on total biomass. Groups of invertebrates found are shown in Table 10; all were collected by other methods. Previous sampling problems have been discussed in Blocker and Reed (1971), Blocker et al. (1971), Reed and Blocker (1972), Reed (1972), and Stepanich (1974).

Table 10. Invertebrates collected from plant crown samples, Osage Comprehensive Site, 1972.

Order	Family	Ungrazed	Grazed
Thysanura	Japygidae	x	x
Collembola	Entomobryidae[a/]	x	x
	Sminthuridae	x	x
Orthoptera	Blattidae (immatures)	x	x
Thysanoptera[a/]		x	x
Hemiptera	Lygaeidae (immatures)	x	x
	Scutelleridae		
Homoptera	Cicadellidae (immatures)	x	x
	Coccoidae[a/]	x	x
	Delphacidae (immatures)		x
	Psyllidae[a/]	x	x
Coleoptera (immatures)		x	x
Coleoptera	Carabidae	x	
	Chrysomelidae		x
	Nitidulidae		x
	Phalacridae		x
	Pselaphidae	x	
	Scydmaenidae	x	
	Staphylinidae	x	x
Lepidoptera (immatures)		x	x
Diptera (immatures)		x	x
Diptera	Cecidomyiidae	x	x
	Sciaridae	x	x
Hymenoptera (immatures)		x	x
Hymenoptera	Encyrtidae		x
	Formicidae[a/]	x	x
Acarina[a/]		x	x
Araneida		x	x
Isopoda		x	x
Diplopoda (Class)		x	x

[a/] Found in significant or moderate numbers.

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APPENDIX I

FIELD DATA

Aboveground invertebrate data collected at the Osage Site were recorded on form NREL-30. These data are stored as Grassland Biome data set A2U30E9 with a format slightly expanded from the original data form. Dry weight is in columns 56 to 63; number weighed is in columns 64 to 68; a sample-date identifier is in columns 76 to 80. A sample data form and an example of the data are attached.

IBP

GRASSLAND BIOME

U.S. INTERNATIONAL BIOLOGICAL PROGRAM

FIELD DATA SHEET - INVERTEBRATE

DATA TYPE	SITE	INITIALS	DATE			TREATMENT	REPLICATE	PLOT SIZE	QUADRAT	TROPHIC	HOST	ORDER	FAMILY	GENUS	SPECIES	SUBSPECIES	LIFE STAGE	TOTAL NO.	DRY WT.	NO. WEIGH
			Day	Mo	Yr															

DATA TYPE

01 Aboveground Biomass
02 Litter
03 Belowground Biomass
10 Vertebrate - Live Trapping
11 Vertebrate - Snap Trapping
12 Vertebrate - Collection
20 Avian Flush Census
21 Avian Road Count
22 Avian Road Count Summary
23 Avian Collection - Internal
24 Avian Collection - External
25 Avian Collection - Plumage
30 Invertebrate
40 Microbiology - Decomposition
41 Microbiology - Nitrogen
42 Microbiology - Biomass
43 Microbiology - Root Decomposition
44 Microbiology - Respiration

SITE

01 Ale
02 Bison
03 Bridger
04 Cottonwood
05 Dickinson
06 Hays
07 Hopland
08 Jornada
09 Osage
10 Pantex
11 Pawnee

TREATMENT

1 Ungrazed
2 Lightly grazed
3 Moderately grazed
4 Heavily grazed
5 Grazed 1969, ungrazed 1970
6
7
8
9

TROPHIC

0 Unknown
1 Plant feeding (tissue)
2 Plant feeding (sap)
3 Plant feeding (pollen and nectar)
4 Plant feeding (seed)
5 Predator
6 Parasitoid
7 Parasite
8 Scavenger
9 Non-feeding stage

LIFE STAGE

00 Undetermined
10 Adult
20 Pupae
30 Egg
40 Nymph or Larva
41 Nymph or Larva, early
42 Nymph or Larva, middle
43 Nymph or Larva, late
50 Instar
51 Instar, 1st
52 Instar, 2nd
53 Instar, 3rd

*** EXAMPLE OF DATA ***

```
         1         2         3         4         5         6         7         8
12345678901234567890123456789012345678901234567890123456789012345678901234567890

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30 9RR 23 47211.50001 6      HYMEDRYI        10      1.   .00010   1.      M71 1
30 9RR 23 47211.50001 8      COLLENTO        10     48.   .00340 270.      M71 1
30 9RR 23 47211.50001 1      COLLSMIN        10     17.   .00340 270.      M71 1
30 9RR 23 47211.50001 8      COLLENTO        40      4.   .00340 270.      M71 1
30 9RR 23 47211.50001 0      COLL            40      1.   .00340 270.      M71 1
30 9RR 23 47211.50001 6      HYMESCEL        10      1.   .00240  97.      M71 1
30 9RR 23 47211.50001 5      COLECARA        10     17.   .03570 101.      M71 1
30 9RR 23 47211.50001 5      COLESTAP        10      7.   .00220  19.      M71 1
30 9RR 23 47211.50001 0      COLESCYD        10      5.   .00010  10.      M71 1
30 9RR 23 47211.50001 1      COLECHRY        10      1.   .00270   1.      M71 1
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30 9RR 24 47211.50002 2      HEMILYGA        40      9.   .00020  29.      M71 1
30 9RR 24 47211.50002 0      DIPT            40     12.   .00030  52.      M71 1
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30	9RR	23	47211.50003	2	HEMISCUT	10	3. .03570	6.	M71	1
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30	9RR	23	47212.50001	5	COLELAMP	10	1. .00420	1.	M71	1
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30	9RR	23	47212.50001	2	HOMOFOLG	40	1. .00020	7.	M71	1
30	9RR	23	47212.50001	2	HOMODELP	40	2. .00240	10.	M71	1
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30	9RR	23	47212.50001	8	DIPTPHOR	10	1. .00010	3.	M71	1
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30	9RR	23	47212.50002	1	COLLSMIN	10	12.	.00210	333.	M71	1
30	9RR	23	47212.50002	0	COLL	40	32.	.00210	333.	M71	1
30	9RR	23	47212.50002	5	COLECARA	10	11.	.00170	40.	M71	1
30	9RR	23	47212.50002	0	COLESCYD	10	1.	.00010	10.	M71	1
30	9RR	23	47212.50002	1	COLECHRY	10	2.	.00540	5.	M71	1
30	9RR	23	47212.50002	2	HOMOCICI	40	1.	.00120	6.	M71	1
30	9RR	23	47212.50002	2	HOMOFOLG	40	3.	.00020	7.	M71	1
30	9RR	23	47212.50002	2	HOMODELP	40	4.	.00240	10.	M71	1
30	9RR	23	47212.50002	2	HOMOLOCC	10	15.	.00010	32.	M71	1
30	9RR	23	47212.50002	1	LEPI	40	1.	.16720	45.	M71	1
30	9RR	23	47212.50002	2	HEMILYGA	40	17.	.00040	44.	M71	1
30	9RR	23	47212.50002	2	HEMISCUT	10	1.	.03570	6.	M71	1
30	9RR	23	47212.50002	0	DIPT	40	18.	.00200	73.	M71	1
30	9RR	23	47212.50002	3	DIPTCECI	10	1.	-0.00000	-0.	M71	1
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30	9RR	23	47212.50002	6	DIPTTACH	10	1.	.01970	1.	M71	1
30	9RR	23	47212.50002	5	DIPTSCIO	10	2.	-0.00000	-0.	M71	1
30	9RR	23	47212.50002	6	HYMEPROC	10	1.	-0.00000	-0.	M71	1
30	9RR	23	47212.50002	6	HYMECERA	10	1.	-0.00000	-0.	M71	1
30	9RR	23	47212.50003	7	HYMEFORM	10	3.	.01230	11.	M71	1
30	9RR	23	47212.50003	6	HYMEENCY	10	1.	-0.00000	-0.	M71	1
30	9RR	23	47212.50003	1	COLE	40	2.	.01110	3.	M71	1
30	9RR	23	47212.50003	5	COLECARA	10	9.	.00170	40.	M71	1
30	9RR	23	47212.50003	5	COLESTAP	10	1.	.00160	9.	M71	1
30	9RR	23	47212.50003	0	COLESCYD	10	2.	.00010	10.	M71	1
30	9RR	23	47212.50003	2	HOMOCICI	40	2.	.00120	6.	M71	1
30	9RR	23	47212.50003	2	HOMOFOLG	40	2.	.00020	7.	M71	1
30	9RR	23	47212.50003	2	HOMODELP	40	2.	.00240	10.	M71	1
30	9RR	23	47212.50003	8	COLLENTO	10	21.	.00210	333.	M71	1
30	9RR	23	47212.50003	1	COLLSMIN	10	21.	.00210	333.	M71	1
30	9RR	23	47212.50003	0	COLL	40	9.	.00210	333.	M71	1
30	9RR	23	47212.50003	2	HOMOLOCC	10	6.	.00010	32.	M71	1
30	9RR	23	47212.50003	2	HEMILYGA	40	21.	.00040	44.	M71	1
30	9RR	23	47212.50003	2	HEMISCUT	10	2.	.03570	6.	M71	1
30	9RR	23	47212.50003	0	DIPT	40	17.	.00200	73.	M71	1
30	9RR	23	47212.50003	3	DIPTCECI	10	1.	-0.00000	-0.	M71	1
30	9RR	23	47212.50003	3	THY2	10	8.	.00320	243.	M71	1
30	9RR	23	47212.50003	3	THY2	40	5.	-0.00000	-0.	M71	1
30	9RR	23	47212.50003	5	ARAN	10	3.	.02010	42.	M71	1
30	9RR	23	47212.50003	0	ACAR	10	186.	.00560	814.	M71	1
30	9RR	23	47212.50003	8	ISOP	10	1.	.17280	16.	M71	1
30	9RR	23	47212.50003	8	DIPL	10	1.	.15710	7.	M71	1
30	9RR	23	47212.50004	7	HYMEFORM	10	4.	.01230	11.	M71	1
30	9RR	23	47212.50004	6	HYMETRIC	10	1.	-0.00000	-0.	M71	1
30	9RR	23	47212.50004	6	HYMEENCY	10	3.	-0.00000	-0.	M71	1
30	9RR	23	47212.50004	6	HYMESCEL	10	1.	.00240	97.	M71	1
30	9RR	23	47212.50004	6	HYMEEULO	10	1.	.00050	20.	M71	1
30	9RR	23	47212.50004	8	COLLENTO	10	25.	.00210	333.	M71	1

30	9RR	23	47212.50004	1	COLLSMIN	10	11.	.00210	333.	M71	1
30	9RR	23	47212.50004	0	COLL	40	4.	.00210	333.	M71	1
30	9RR	23	47212.50004	5	COLECARA	10	6.	.00170	40.	M71	1
30	9RR	23	47212.50004	5	COLESTAP	10	3.	.00160	9.	M71	1
30	9RR	23	47212.50004	0	COLESCYD	10	2.	.00010	10.	M71	1
30	9RR	23	47212.50004	1	COLECHRY	10	2.	.00540	5.	M71	1
30	9RR	23	47212.50004	2	HOMOFOLG	40	1.	.00020	7.	M71	1
30	9RR	23	47212.50004	2	HOMODELP	40	2.	.00240	10.	M71	1
30	9RR	23	47212.50004	2	HOMOCOCC	10	6.	.00010	32.	M71	1
30	9RR	23	47212.50004	2	HEMILYGA	40	3.	.00040	44.	M71	1
30	9RR	23	47212.50004	2	HEMISCUT	10	1.	.03570	6.	M71	1
30	9RR	23	47212.50004	0	DIPT	40	21.	.00200	73.	M71	1
30	9RR	23	47212.50004	3	THY2	10	6.	.00320	243.	M71	1
30	9RR	23	47212.50004	3	THY2	40	3.	-0.00000	-0.	M71	1
30	9RR	23	47212.50004	5	ARAN	10	7.	.02010	42.	M71	1
30	9RR	23	47212.50004	0	ACAR	10	171.	.00560	814.	M71	1
30	9RR	23	47212.50004	8	ISOP	10	12.	.17280	16.	M71	1
30	9RR	23	47212.50004	8	DIPTCALL	10	1.	-0.00000	-0.	M71	1
30	9RR	23	47251.50001	7	HYMEFORM	10	36.	.00930	154.	M71	1
30	9RR	23	47251.50001	6	HYMEPTER	10	2.	-0.00000	-0.	M71	1
30	9RR	23	47251.50001	6	HYMETRIC	10	1.	-0.00000	-0.	M71	1
30	9RR	23	47251.50001	6	HYMELNCY	10	1.	-0.00000	-0.	M71	1
30	9RR	23	47251.50001	6	HYMESCEL	10	1.	.00240	97.	M71	1
30	9RR	23	47251.50001	1	COLLSMIN	10	25.	.00170	325.	M71	1
30	9RR	23	47251.50001	8	COLLENTO	10	48.	.00170	325.	M71	1
30	9RR	23	47251.50001	0	COLL	40	5.	.00170	325.	M71	1
30	9RR	23	47251.50001	1	COLE	40	3.	.00010	14.	M71	1
30	9RR	23	47251.50001	5	COLECARA	10	2.	.00250	11.	M71	1
30	9RR	23	47251.50001	1	COLEELAT	10	2.	.00180	2.	M71	1
30	9RR	23	47251.50001	5	COLESTAP	10	5.	.00170	11.	M71	1
30	9RR	23	47251.50001	3	COLEPHAL	10	1.	.00040	5.	M71	1
30	9RR	23	47251.50001	3	COLENITI	10	31.	.00110	53.	M71	1
30	9RR	23	47251.50001	0	COLESCYD	10	4.	.00010	11.	M71	1
30	9RR	23	47251.50001	1	COLECURC	10	2.	.00740	4.	M71	1
30	9RR	23	47251.50001	2	HOMOCICI	10	1.	.00090	1.	M71	1
30	9RR	23	47251.50001	2	HOMOCICI	40	7.	.00390	25.	M71	1
30	9RR	23	47251.50001	2	HOMOFOLG	40	1.	.00020	7.	M71	1
30	9RR	23	47251.50001	2	HOMODELP	40	1.	.00290	12.	M71	1
30	9RR	23	47251.50001	2	HOMOCOCC	10	9.	.00010	32.	M71	1
30	9RR	23	47251.50001	1	LEPI	40	1.	.07500	5.	M71	1
30	9RR	23	47251.50001	2	HEMILYGA	40	2.	.00050	5.	M71	1
30	9RR	23	47251.50001	0	DIPT	40	7.	.00200	73.	M71	1
30	9RR	23	47251.50001	8	DIPTPHOR	10	4.	.00020	6.	M71	1
30	9RR	23	47251.50001	8	DIPTCHLO	10	2.	.00020	7.	M71	1
30	9RR	23	47251.50001	3	THY2	10	166.	.00170	536.	M71	1
30	9RR	23	47251.50001	3	THY2	40	5.	-0.00000	-0.	M71	1
30	9RR	23	47251.50001	5	ARAN	10	2.	.00250	10.	M71	1
30	9RR	23	47251.50001	0	ACAR	10	436.	.01680	1428.	M71	1
30	9RR	23	47251.50001	8	DIPL	10	1.	.00080	1.	M71	1
30	9RR	23	47251.50002	7	HYMEFORM	10	59.	.00930	154.	M71	1
30	9RR	23	47251.50002	6	HYMETRIC	10	1.	-0.00000	-0.	M71	1
30	9RR	23	47251.50002	6	HYMEEULO	10	1.	.00050	20.	M71	1
30	9RR	23	47251.50002	6	HYMESCEL	10	1.	.00240	97.	M71	1
30	9RR	23	47251.50002	1	COLLSMIN	10	26.	.00170	325.	M71	1
30	9RR	23	47251.50002	8	COLLENTO	10	112.	.00170	325.	M71	1
30	9RR	23	47251.50002	0	COLL	40	19.	.00170	325.	M71	1
30	9RR	23	47251.50002	1	COLE	40	9.	.00010	14.	M71	1
30	9RR	23	47251.50002	5	COLESTAP	10	3.	.00170	11.	M71	1
30	9RR	23	47251.50002	3	COLEPHAL	10	2.	.00040	5.	M71	1
30	9RR	23	47251.50002	3	COLENITI	10	6.	.00110	53.	M71	1