Technical Report No. 194

INSECT STUDIES AT THE OSAGE COMPREHENSIVE SITE, 1971 SEASON

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ABSTRACT

Invertebrate data for 1971 from the Osage Site are summarized and compared with 1970 data. Eleven collections were taken between April 24 and November 7, 1971, in grazed and ungrazed treatments. Each treatment consisted of two replications containing five quadrats each. The vegetation in each quadrat was estimated by the primary producer workers prior to each collection, and these data are available for subsequent analysis. A circular 0.5-m^2 quick trap and D-Vac suction apparatus were used for invertebrate samples; additional collecting methods were employed to check the effectiveness of this method. Comparative aboveground and incomplete belowground data for 1971 are given in Appendices I and II, respectively.

INTRODUCTION

The Osage Site has been described in Technical Report No. 44 (Risser, 1970). Meteorological data will be available in the 1971 report by the primary producer workers.

Objectives of the invertebrate studies at Osage were: (i) to obtain a reliable estimate of the number and biomass of aboveground invertebrates, (ii) to determine, insofar as possible, the trophic level of each major group, (iii) to estimate the impact of invertebrates on primary productivity and the remainder of the ecosystem, and (iv) to check the accuracy of our collecting method by employing other methods as a check. An attempt was also made to determine the amount of belowground macrofauna present, but data on these are incomplete and fragmentary (see Appendix II).

Sample dates were April 24, May 13, June 3 and 19, July 11 and 25, August 6 and 20, September 19, October 11, and November 7. All sample dates were 1 day later than the primary productivity sampling dates. Vegetation estimates for the invertebrate plots were made by the primary producer workers prior to each collection. These data are available for subsequent analysis. On each sampling date five samples were taken in each of two replicates in each of two treatment areas. One of the treatment areas was ungrazed; the other had been grazed in previous seasons, but was ungrazed during the period of sampling.

METHODS

Collecting methods correspond closely to the methods in Technical Report No. 85 (French, 1971). The modified quick traps

used were the same as in 1970 except for minor modifications in the suspension of the cage. Eyebolts were used to replace the forked trip mechanism which provided a quicker release of the cage. The tripod was also stabilized by a 15.2-cm bridge spike driven through a hole bored in the middle support pole. This prevented overturning of the trap due to swinging of the cage caused by high winds which are common at Osage.

To reduce the amount of collecting time and to minimize disturbance of the surrounding community, a cart was constructed for use during the 1971 season which housed the D-Vac unit and provided for an ice chest in which the samples were placed after removal from the D-Vac. Samples were returned to Manhattan, Kansas, for separation. The quadrats were clipped prior to using the D-Vac; the method of clipping is described in Technical Report No. 93 (Blocker and Reed, 1971), but was altered by the use of electric shears beginning with the July 25 collection. The clippers allowed a closer, more uniform clipping of bunchgrasses, thus allowing better extraction by the D-Vac. Clippings were placed in paper bags and saved for extraction.

Modifications to the D-Vac unit in 1971 included the use of plastic dryer hose, obtained at a Sears outlet, to replace the canvas tubing on the reducer cone. The plastic hose allowed free movement of moist soil and litter and prevented clogging which often occurred with the canvas tubing. An elbow joint was also fastened to the reducer cone to provide horizontal attachment of the plastic hose; this helped reduce the amount of clogging at the point the litter entered the reducer cone. Plastic hose does not work well during cold or freezing weather, so a spare canvas hose should be at hand.

In the laboratory, samples from the D-Vac were placed in Berlese funnels for 48 hours, and the invertebrates were collected in 70% isopropyl alcohol; litter was then removed from the funnels and saved for hand sorting. The grass clippings were then placed in the funnels. Biomass was obtained by drying specimens for 48 hours in 60°C prior to weighing.

Sweep-net samples were taken, and pitfall traps were installed on each sampling date. One hundred sweeps were taken from each treatment using a 15-inch diameter net. Specimens were preserved and returned to the laboratory for sorting. Pitfall traps were pint jars containing glycerine; these were placed with the top lip even with the soil surface. Six traps were placed in each treatment on a transect covering the length of the treatment. Traps were removed at approximately 2-week intervals and taken to the laboratory for processing. Both the pitfall traps and sweep-net samples were taken to check the efficiency of the quick trap.

RESULTS

To date, 15 orders and 108 families have been identified (Table 1). Specialists have determined 26 genera and 39 species of leafhoppers, 14 genera and 15 species of Curculionidae, 5 genera and 7 species of Formicidae, and 8 genera and 13 species of Acrididae. Tropic levels of many groups are incomplete due to problems of classifying some insects and the absence of information on others; many of the immature forms are classified only to order.

Major groups of insects according to numbers and biomass (Tables 2 and 3) are determined for 1971. Major groups according to numbers are Formicidae, Thysanoptera, and Entomobryidae, respectively. Other

Table 1. List of families determined from Osage Comprehensive Site from July 3, 1970, through November 7, 1971.[a/b/]

Order	Family	Trophic Level
Thysanura	Japygidae	Unknown
Collembola	Entomobryidae	Herbivore; Omnivore
	Poduridae	Herbivore; Omnivore
	Sminthuridae	Herbivore
Orthoptera	Acrididae	Herbivore
	Blattidae	Omnivore
	Mantidae	Predator
	Gryllidae	Herbivore; Omnivore
	Phasmidae	Herbivore
Homoptera	Tettigoniidae	Herbivore
	Cicadellidae	Herbivore
	Coccoidea	Herbivore
	Issidae	Herbivore
	Aphididae	Herbivore
	Cercophidae	Herbivore
	Fulgoridae	Herbivore
	Delphacidae	Herbivore
	Membracidae	Herbivore
	Psyllidae	Herbivore
	Cixidae	Herbivore
Hemiptera	Dictyopharidae	Herbivore
	Ploiariidae	Predator
	Lygaeidae	Herbivore
	Miridae	Herbivore
	Corimelaenidae	Herbivore
	Pentatomidae	Herbivore
	Tingidae	Herbivore
	Neididae	Herbivore
	Corixidae	Herbivore; Predator
	Coreidae	Herbivore; Predator
	Reduviidae	Predator
	Scutelleridae	Herbivore
	Gerridae	Predator
Coleoptera	Cicindelidae	Predator
	Nitidulidae	Herbivore
	Lathridiidae	Scavenger
	Phalaeridae	Herbivore
	Cerambycidae	Herbivore
	Curculionidae	Herbivore
	Staphylinidae	Predator
	Chrysomelidae	Herbivore
	Pselaphidae	Herbivore
	Malachiidae	Predator
	Ptilidae	Herbivore
	Cisidae	Herbivore
	Scydmaenidae	Unknown
	Scaphidiidae	Herbivore

Table 1. (Continued).

Order	Family	Trophic Level
Coleoptera (continued)	Elateridae	Herbivore
	Meloidae	Herbivore; Predator
	Carabidae	Predator
	Coccinellidae	Predator
	Throsidae	Herbivore
	Dermestidae	Scavengers
	Euenemidae	Herbivore
	Silphidae	Scavengers
	Histeridae	Predator
	Cantharidae	Herbivore
	Mordellidae	Herbivore
	Cleridae	Predator
	Scarabaeidae	Herbivore
	Erotylidae	Herbivore
Lepidoptera	Nymphalidae[c/]	Herbivore
	Danaidae[c/]	Herbivore
	Noctuidae	Herbivore
	Pyralidae	Herbivore
	Satyridae[c/]	Herbivore
Diptera	Tabanidae	Herbivore; Predator
	Tachinidae	Parasite
	Sarcophagidae	Scavenger
	Asilidae	Predator
	Chlorophidae	Omnivore; Herbivore
	Cecidomyiidae	Herbivore
	Sciaridae	Herbivore
	Mycetophilidae	Herbivore
	Sciomyzidae	Unknown
	Pyrgotidae	Parasite
	Rhagionidae	Predator
	Piophilidae	Scavenger
	Syrphidae	Herbivore
	Pipunculidae	Parasite
	Scatopsidae	Scavenger
	Acroceridae[c/]	Herbivore; Parasites
	Culicidae	Parasite
	Chironomidae	Scavengers
	Ceratopogonidae	Parasite; Predator
	Tipulidae	Herbivore
	Otitidae	Unknown
Hymenoptera	Formicidae	Omnivore
	Trichogrammatidae	Parasite
	Encyrtidae	Parasite
	Thysanidae	Parasite
	Eulopidae	Parasite
	Dryinidae	Parasite
	Tenthredinidae	Herbivore
	Halictidae	Unknown

Table 1. (Continued).

Order	Family	Trophic Level
Hymenoptera (continued)	Pteromalidae	Parasite
	Ichneumonidae	Parasite
	Tiphiidae	Parasite
	Sierolomorphidae	Unknown
	Vespidae[c/]	Herbivore
	Scelionidae	Parasite
	Mutillidae	Parasite
	Braconidae	Parasite
Psocoptera		Scavenger
Thysanoptera		Herbivore; Predator; Omnivore
Odonata	Libellulidae[c/]	Predator
	Coenagrionidae[c/]	Predator
Neuroptera	Chrysopidae	Predator
	Hemerobiidae	Predator
	Myrmeleontidae	Predator
Dermaptera		Scavenger; Herbivore
Strepsiptera		Parasite

[a/] All orders were not determined to family (e.g., Thysanoptera, some Lepidoptera, etc.).

[b/] All immatures were not determined to family.

[c/] Families observed in the field, but never captured.

Table 2. Major groups of insects by number (mean number/m^2), Osage Site, April 24 through November 7, 1971. (imm. = immature life stages)

Date	Treatment	Order	Family	Number
Apr. 24	Ungrazed	Collembola	Entomobryidae	258.4
		Collembola	Poduridae	68.6
		Thysanoptera		44.6
		Collembola	Sminthuridae	24.0
		Homoptera	Coccoidea	12.6
		Hymenoptera	Formicidae	9.8
		Coleoptera	Carabidae	8.8
		Coleoptera	Nitidulidae	8.2
	Grazed	Thysanoptera		237.0
		Collembola	Entomobryidae	154.0
		Hymenoptera	Formicidae	89.0
		Collembola	Poduridae	70.8
		Coleoptera	Nitidulidae	46.4
		Homoptera	Coccoidea	37.8
		Homoptera	Cicadellidae	13.0
		Collembola	Sminthuridae	4.4
May 13	Ungrazed	Collembola	Entomobryidae	138.0
		Collembola	Sminthuridae	98.8
		Hymenoptera	Formicidae	68.4
		Thysanoptera		53.0
		Collembola	Poduridae	27.6
		Coleoptera	Carabidae	16.2
		Homoptera	Coccoidea	14.8
		Homoptera	Cicadellidae	11.8
	Grazed	Hymenoptera	Formicidae	348.6
		Thysonoptera		322.0
		Coleoptera	Nitidulidae	48.2
		Homoptera	Coccoidea	42.0
		Collembola	Entomobryidae	33.6
		Collembola	Sminthuridae	25.4
		Coleoptera (imm.)		20.8
		Homoptera	Cicadellidae	16.2
June 3	Ungrazed	Hymenoptera	Formicidae	491.2
		Collembola	Entomobryidae	246.2
		Collembola	Sminthuridae	101.8
		Thysanoptera		80.8
		Collembola	Poduridae	38.8
		Homoptera	Cicadellidae	33.0
		Colcoptera	Carabidae	29.0
		Homoptera	Coccoidea	24.2

Table 2. (Continued).

Date	Treatment	Order	Family	Number
	Grazed	Hymenoptera	Formicidae	652.0
		Thysanoptera		553.4
		Collembola	Entomobryidae	142.6
		Coleoptera (imm.)		89.0
		Homoptera	Coccoidea	46.0
		Diptera (imm.)		43.6
		Collembola	Poduridae	42.2
		Collembola	Sminthuridae	40.6
June 19	Ungrazed	Collembola	Entomobryidae	169.2
		Hymenoptera	Formiciadae	161.8
		Collembola	Sminthuridae	153.8
		Thysanoptera		146.2
		Hemiptera	Lygaeidae	81.0
		Homoptera	Delphacidae	45.4
		Diptera (imm.)		37.0
		Coleoptera (imm.)		34.4
	Grazed	Thysanoptera		472.6
		Hymenoptera	Formicidae	379.4
		Collembola	Entomobryidae	176.6
		Homoptera	Cicadellidae	98.2
		Collembola	Sminthuridae	83.2
		Coleoptera (imm.)		76.8
		Homoptera	Coccoidea	65.6
		Homoptera	Delphacidae	26.4
July 11	Ungrazed	Hymenoptera	Formicidae	434.4
		Collembola	Entomobryidae	374.0
		Collembola	Sminthuridae	140.8
		Thysanoptera		140.2
		Diptera (imm.)		41.2
		Homoptera	Cicadellidae	36.0
		Hemiptera	Lygaeidae	35.2
		Coleoptera (imm.)		32.0
	Grazed	Thysanoptera		306.6
		Hymenoptera	Formicidae	301.2
		Collembola	Entomobryidae	271.2
		Collembola	Sminthuridae	175.4
		Diptera (imm.)		60.8
		Homoptera	Delphacidae	48.6
		Coleoptera (imm.)		35.2
		Homoptera	Cicadellidae	28.6

Table 2. (Continued).

Date	Treatment	Order	Family	Number
July 25	Ungrazed	Hymenoptera	Formicidae	345.4
		Thysanoptera		217.8
		Hemiptera	Lygaeidae	49.4
		Homoptera	Coccoidea	35.0
		Diptera (imm.)		32.0
		Homoptera	Cicadellidae	25.2
		Collembola	Entomobryidae	22.6
		Coleoptera (imm.)		22.4
		Homoptera	Delphacidae	22.4
	Grazed	Thysanoptera		247.8
		Hymenoptera	Formicidae	237.6
		Homoptera	Coccoidea	86.0
		Collembola	Sminthuridae	63.6
		Homoptera	Delphacidae	51.4
		Coleoptera (imm.)		46.2
		Collembola	Entomobryidae	42.8
		Coleoptera	Nitidulidae	22.8
Aug. 6	Ungrazed	Hymenoptera	Formicidae	168.0
		Homoptera	Coccoidea	78.2
		Thysanoptera		42.8
		Hemiptera	Lygaeidae	16.0
		Collembola	Sminthuridae	11.2
		Coleoptera (imm.)		8.6
		Diptera (imm.)		7.0
		Hymenoptera	Scelionidae	5.6
	Grazed	Hymenoptera	Formicidae	256.2
		Thysanoptera		211.0
		Coleoptera (imm.)		98.6
		Homoptera	Coccoidea	88.6
		Collembola	Sminthuridae	19.6
		Hemiptera	Lygaeidae	15.8
		Coleoptera	Nitidulidae	9.2
		Diptera (imm.)		7.0
Aug. 20	Ungrazed	Hymenoptera	Formicidae	441.8
		Thysanoptera		238.2
		Homoptera	Coccoidea	120.4
		Collembola	Entomobryidae	102.4
		Homoptera	Delphacidae	55.0
		Homoptera	Cicadellidae	47.2
		Hemiptera	Lygaeidae	47.2
		Diptera (imm.)		21.2

Table 2. (Continued).

Date	Treatment	Order	Family	Number
	Grazed	Hymenoptera	Formicidae	262.4
		Thysanoptera		143.0
		Collembola	Entomobryidae	75.2
		Homoptera	Delphacidae	49.4
		Collembola	Sminthuridae	47.4
		Homoptera	Coccoidea	40.4
		Coleoptera (imm.)		33.6
		Coleoptera	Nitidulidae	15.4
		Homoptera	Cicadellidae	15.2
Sept. 19	Ungrazed	Collembola	Sminthuridae	109.0
		Collembola	Entomobryidae	101.2
		Hymenoptera	Formicidae	57.8
		Diptera (imm.)		39.2
		Thysanoptera		34.0
		Homoptera	Coccoidea	14.6
		Homoptera	Delphacidae	10.0
		Coleoptera (imm.)		9.8
		Homoptera	Cicadellidae	9.6
	Grazed	Collembola	Entomobryidae	240.0
		Collembola	Sminthuridae	213.2
		Hymenoptera	Formicidae	80.6
		Thysanoptera		56.8
		Homoptera	Coccoidea	18.8
		Diptera (imm.)		16.6
		Homoptera	Delphacidae	14.0
		Homoptera	Cicadellidae	13.4
Oct. 11	Ungrazed	Collembola	Entomobryidae	192.2
		Thysanoptera		92.8
		Hymenoptera	Formicidae	79.0
		Homoptera	Delphacidae	45.2
		Hemiptera	Lygaeidae	38.2
		Collembola	Sminthuridae	38.2
		Coleoptera	Carabidae	11.2
		Homoptera	Coccoidea	10.8
	Grazed	Thysanoptera		223.2
		Hymenoptera	Formicidae	151.0
		Coleoptera	Nitidulidae	43.8
		Homoptera	Delphacidae	35.4
		Collembola	Entomobryidae	29.0
		Collembola	Sminthuridae	24.8
		Homoptera	Coccoidea	19.8
		Coleoptera	Staphylinidae	13.2

Table 2. (Continued).

Date	Treatment	Order	Family	Number
Nov. 7	Ungrazed	Collembola	Entomobryidae	119.8
		Collembola	Sminthuridae	46.4
		Diptera (imm.)		41.2
		Homoptera	Delphacidae	36.2
		Thysanoptera		29.0
		Homoptera	Coccoidea	20.6
		Hemiptera	Lygaeidae	10.2
		Coleoptera	Carabidae	4.8
	Grazed	Collembola	Sminthuridae	239.0
		Collembola	Entomobryidae	192.6
		Thysanoptera		108.2
		Homoptera	Delphacidae	42.4
		Homoptera	Coccoidea	36.4
		Diptera (imm.)		28.2
		Coleoptera	Nitidulidae	17.2
		Homoptera	Cicadellidae	15.0

Table 3. Major groups of insects by biomass (g/m^2), Osage Site, April 24 through November 7, 1971. (imm. = immature life stage.)

Date	Treatment	Order	Family	Weight
Apr. 24	Ungrazed	Hymenoptera	Formicidae	.004
		Hemiptera	Lygaeidae	.002
		Homoptera	Cicadellidae	.001
		Homoptera	Fulgoridae	.001
		Homoptera	Coccoidea	.001
		Hemiptera	Scutelleridae	.001
	Grazed	Coleoptera	Chrysomelidae	.008
		Hymenoptera	Formicidae	.006
		Homoptera	Cicadellidae	.005
		Coleoptera	Nitidulidae	.002
		Thysanoptera		.002
		Coleoptera	Staphylinidae	.001
		Coleoptera	Lathrididae	.001
		Homoptera	Fulgoridae	.001
May 13	Ungrazed	Hymenoptera	Formicidae	.017
		Hemiptera	Scutelleridae	.003
		Coleoptera	Chrysomelidae	.002
		Coleoptera	Curculionidae	.002
		Hemiptera	Lygaeidae	.002
		Coleoptera	Carabidae	.002
		Homoptera	Circadellidae	.001
		Coleoptera	Elateridae	.001
	Grazed	Hymenoptera	Formicidae	.023
		Homoptera	Cicadellidae	.009
		Coleoptera	Nitidulidae	.007
		Orthoptera	Blattidae	.003
		Thysanoptera		.002
		Coleoptera	Chrysomelidae	.002
		Lepidoptera (imm.)		.002
		Coleoptera	Elateridae	.001
June 3	Ungrazed	Hymenoptera	Formicidae	.100
		Coleoptera	Elateridae	.003
		Homoptera	Cicadellidae	.002
		Hemiptera	Lygaeidae	.002
		Coleoptera	Carabidae	.002
		Coleoptera	Curculionidae	.001
		Homoptera	Fulgoridae	.001
		Hemiptera	Scutelleridae	.001
	Grazed	Hymenoptera	Formicidae	.029
		Orthoptera	Gryllidae	.023
		Lepidoptera	Noctuidae	.022
		Thysanoptera		.004
		Coleoptera	Carabidae	.002

Table 3. (Continued).

Date	Treatment	Order	Family	Weight
June 3	Grazed	Coleoptera	Elateridae	.002
		Coleoptera	Nitidulidae	.001
		Homoptera	Cicadellidae	.001
June 19	Ungrazed	Hymenoptera	Formicidae	.022
		Homoptera	Cicadellidae	.014
		Coleoptera	Curculionidae	.011
		Coleoptera	Scarabaeidae	.009
		Lepidoptera (imm.)		.009
		Coleoptera	Chrysomelidae	.006
		Homoptera	Delphacidae	.003
		Hemiptèra	Lygaeidae	.002
	Grazed	Hymenoptera	Formicidae	.028
		Homoptera	Cicadellidae	.010
		Coleoptera	Curculionidae	.009
		Thysanoptera		.005
		Lepidoptera	Pyralidae	.005
		Lepidoptera	Noctuidae	.003
		Homoptera	Delphacidae	.002
		Hemiptera	Scutelleridae	.001
July 11	Ungrazed	Hymenoptera	Formicidae	.142
		Coleoptera	Curculionidae	.009
		Coleoptera	Chrysomelidae	.003
		Homoptera	Delphacidae	.002
		Homoptera	Cicadellidae	.002
		Orthoptera	Gryllidae	.002
		Coleoptera	Carabidae	.002
		Diptera (imm.)		.002
	Grazed	Hymenoptera	Formicidae	.020
		Orthoptera	Gryllidae	.014
		Homoptera	Cicadellidae	.006
		Coleoptera	Curculionidae	.004
		Hemiptera	Lygaeidae	.003
		Homoptera	Delphacidae	.002
		Thysanoptera		.002
		Orthoptera	Acrididae	.002
July 25	Ungrazed	Orthoptera	Acrididae	.064
		Hymenoptera	Formicidae	.034
		Hymenoptera	Aphidae	.015
		Lepidoptera (imm.)		.013
		Coleoptera	Curculionidae	.008
		Homoptera	Circadellidae	.008
		Orthoptera	Gryllidae	.007
		Hemiptera	Reduviidae	.005

Table 3. (Continued).

Date	Treatment	Order	Family	Weight
July 25	Grazed	Hymenoptera	Formicidae	.022
		Lepidoptera (imm.)		.012
		Homoptera	Cicadellidae	.009
		Coleoptera	Curculionidae	.004
		Hemiptera	Reduviidae	.003
		Homoptera	Delphacidae	.002
		Hymenoptera	Ichneumonidae	.002
		Coleoptera	Carabidae	.001
Aug. 6	Ungrazed	Hymenoptera	Formicidae	.027
		Diptera	Tabanidae	.012
		Coleoptera	Carabidae	.010
		Coleoptera	Curculionidae	.005
		Hemiptera	Scutelleridae	.004
		Lepidoptera	Noctuidae	.004
		Hemiptera	Lygaeidae	.003
		Homoptera	Cicadellidae	.001
	Grazed	Hymenoptera	Formicidae	.030
		Coleoptera	Curculionidae	.014
		Coleoptera	Carabidae	.009
		Homoptera	Cicadellidae	.004
		Coleoptera	Chrysomelidae	.003
		Hemiptera	Reduviidae	.003
		Thysanoptera		.002
		Coleoptera (imm.)		.002
Aug. 20	Ungrazed	Hymenoptera	Formicidae	.035
		Coleoptera	Curculionidae	.007
		Hemiptera	Scutelleridae	.007
		Orthoptera	Acrididae	.006
		Homoptera	Cicadellidae	.006
		Hemiptera	Lygaeidae	.004
		Thysanoptera		.003
		Homoptera	Delphacidae	.002
	Grazed	Lepidoptera (imm.)		.037
		Hymenoptera	Formicidae	.034
		Orthoptera	Gryllidae	.020
		Orthoptera	Tettigoniidae	.013
		Homoptera	Cicadellidae	.010
		Orthoptera	Acrididae	.007
		Coleoptera	Carabidae	.006
		Hemiptera	Lygaeidae	.005

Table 3. (Continued).

Date	Treatment	Order	Family	Weight
Sept. 19	Ungrazed	Coleoptera	Curculionidae	.008
		Coleoptera	Carabidae	.007
		Hemiptera	Scutelleridae	.005
		Hymenoptera	Formicidae	.005
		Coleoptera	Staphylinidae	.002
		Homoptera	Cicadellidae	.002
		Coleoptera	Chrysomelidae	.002
		Hemiptera	Lygaeidae	.002
	Grazed	Hymenoptera	Formididae	.007
		Homoptera	Cicadellidae	.003
		Hymenoptera	Ichneumonidae	.002
		Orthoptera	Blattidae	.002
		Coleoptera	Carabidae	.001
		Coleoptera	Staphylinidae	.001
		Hemiptera	Lygaeidae	.001
Oct. 11	Ungrazed	Hemiptera	Lygaeidae	.012
		Hemiptera	Scutelleridae	.006
		Hymenoptera	Formicidae	.005
		Coleoptera (imm.)		.002
		Coleoptera	Staphylinidae	.002
		Lepidoptera (imm.)		.001
		Homoptera	Cicadellidae	.001
		Coleoptera	Carabidae	.001
	Grazed	Hymenoptera	Formicidae	.013
		Lepidoptera (imm.)		.007
		Coleoptera (imm.)		.006
		Lepidoptera	Noctuidae	.005
		Coleoptera	Carabidae	.004
		Coleoptera	Curculionidae	.004
		Hemiptera	Lygaeidae	.003
		Homoptera	Cicadellidae	.003
Nov. 7	Ungrazed	Lepidoptera	Noctuidae	.008
		Hemiptera	Scutelleridae	.003
		Hemiptera	Lygaeidae	.002
		Coleoptera	Chrysomelidae	.001
		Homoptera	Delphacidae	.001
	Grazed	Hemiptera	Pentatomidae	.009
		Homoptera	Membracidae	.005
		Hemiptera	Lygaeidae	.003
		Homoptera	Delphacidae	.002
		Homoptera	Cicadellidae	.002
		Lepidoptera (imm.)		.001

groups commonly found in high numbers are Sminthuridae, Coccoidea, Nitidulidea, Cicadellidae, Delphacidae, Lygaeidae, and Carabidae. These groups are similar to those found in high numbers in 1970 except for the higher numbers of Carabidae and Delphacidae found in 1971. Major groups by numbers for the ungrazed area in 1971 were Formicidae, Thysanoptera, Entomobryidae, and Sminthuridae, respectively. Major groups for the grazed area in 1971 were Thysanoptera, Formicidae, Entomobryidae, and Sminthuridae, respectively. It is of interest to note that Formicidae ranks as the most numerous family overall, but on April 24 in the ungrazed area there was a mean number of 9.8/m^2 as compared to 258.4 Entomobryidae/m^2; also only 2.6/m^2 of Formicidae were found on the November 7, 1971, ungrazed treatment. There is a wide fluctuation in population during a season.

Major groups of insects according to biomass are Formicidae, Cicadellidae, and Curculionidae, respectively. Secondary contributors to biomass were Gryllidae, Chrysomelidae, Acrididae, immature Lepidoptera, Carabidae, etc. Major groups by biomass for the ungrazed area 1971 were Formicidae, Acrididae, Curculionidae, Cicadellidae, and Scutelleridae, respectively. Major biomass groups for the grazed area 1971 were Formicidae, Cicadellidae, immature Lepidoptera, Gryllidae, and Curculionidae, respectively. All of these groups, with the exception of Formicidae, are almost entirely herbivorous.

Studies of Cicadellidae during 1970-71 indicated that an index of leafhopper numbers is not always a good predictor of biomass. Hence, both biomass and numbers data are necessary because of the wide variation in weight between species, sexes of the same species, and size of life stages (Blocker, Reed, and Mason, 1971).

Total numbers of insects (mean number/m^2) and biomass (g/m^2) are shown in Table 4 and Fig. 1 through 3. Fig. 1 shows that the total insect numbers in 1971 are larger than in 1970. Environmental conditions could well be responsible for this difference since there was more rainfall and cooler temperatures in 1971 than in 1970. Numbers of insects for the 2 years seem to show population trends. Low numbers are present in April and May with an increase until July, followed by a decline in August. Populations increase again in the latter part of August and September with moderate increases in October, followed by a decline in November.

A comparison of 1971 biomass data show relative low dry weight in both grazed and ungrazed treatments in April and May. The ungrazed treatment shows peak biomass during July, but the grazed decreases at that point. Weights in the ungrazed treatment decreases in August while that of the grazed treatment begins to increase; this also occurred in 1970 (Fig. 2 and 3). The latter part of August in both 1970 and 1971 shows the grazed and ungrazed with peaks of biomass. The dry weight then declines in September and stays approximately the same in October, perhaps showing moderate increases, then tapers off in November.

Trends of total invertebrate numbers for 1970 and 1971 (Fig. 4) are close to those of the total insect numbers with the exception of the latter part of August and the November collection in 1971. Invertebrate numbers in the latter part of August in 1970 declined, while in 1971 there were peak numbers; this is primarily the result of high numbers of Formicidae, Coccoidea, Thysanoptera, and Acarina.

Table 4. Total numbers (mean numbers/m²) and biomass (g/m²) of all groups of insects collected, Osage Site, April 24 through November 7, 1971.

Date	Treatment	Number	Biomass
Apr 24	Ungrazed	493.800	.017 = .01
	Grazed	684.200	.029 = .03
May 13	Ungrazed	482.000	.032 = .03
	Grazed	897.000	.055 = .06
June 3	Ungrazed	1132.200	.11 = .11
	Grazed	1700.200	.090 = .09
June 19	Ungrazed	978.800	.087 = .09
	Grazed	1471.400	.075 = .08
July 11	Ungrazed	1345.600	.173 = .17
	Grazed	1347.200	.057 = .06
July 25	Ungrazed	836.000	.172 = .17
	Grazed	878.000	.064 = .06
Aug. 6	Ungrazed	390.800	.071 = .07
	Grazed	748.000	.073 = .07
Aug 20	Ungrazed	1218.800	.082 = .08
	Grazed	767.600	.148 = .15
Sept 19	Ungrazed	454.800	.044 = .04
	Grazed	723.600	.025 = .03
Oct. 11	Ungrazed	573.400	.039 = .04
	Grazed	639.800	.064 = .06
Nov 7	Ungrazed	338.600	.022 = .02
	Grazed	730.600	.031 = .03

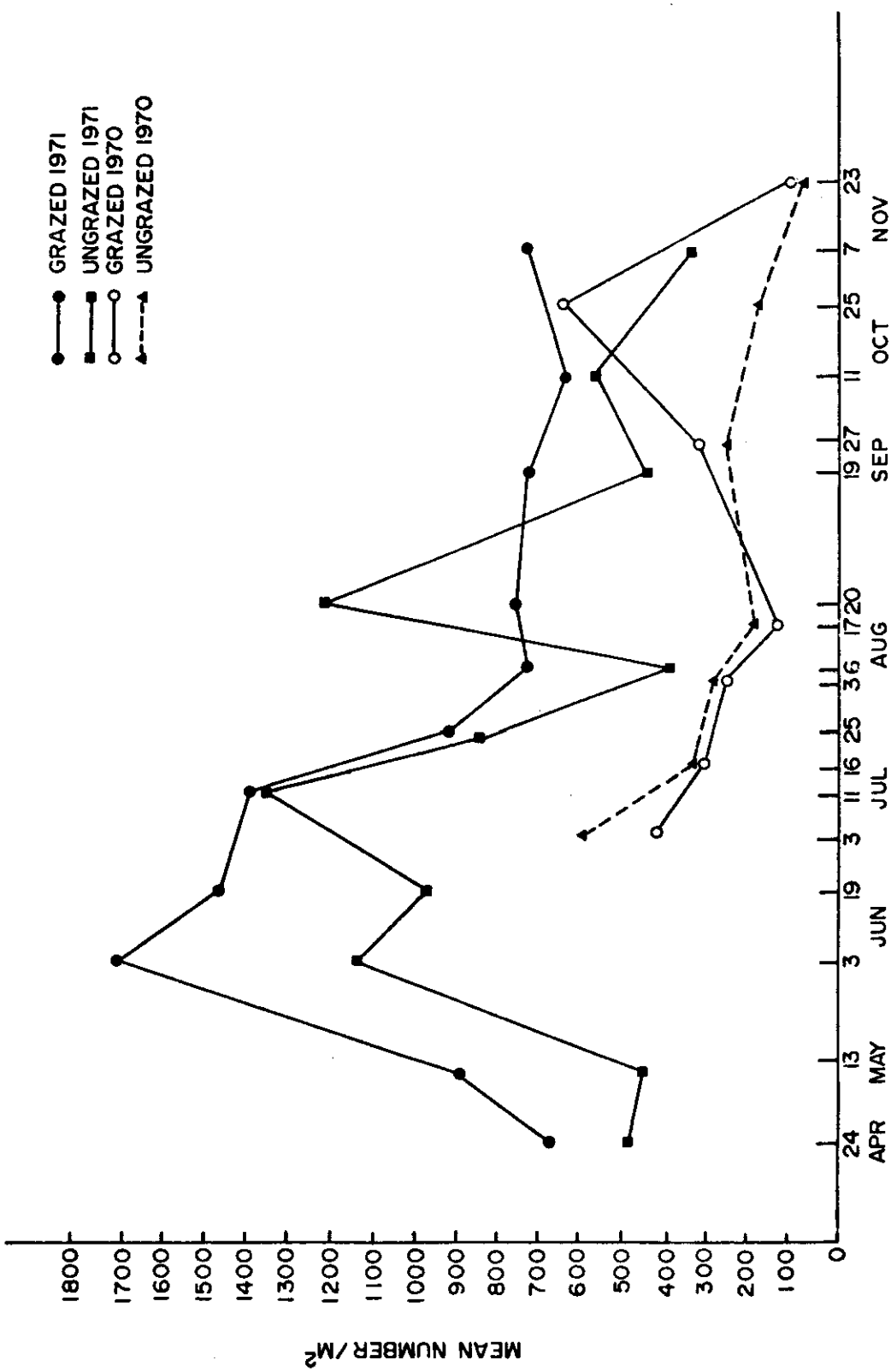

Fig. 1. 1970 and 1971 insect numbers collected from grazed and ungrazed treatments, Osage Site.

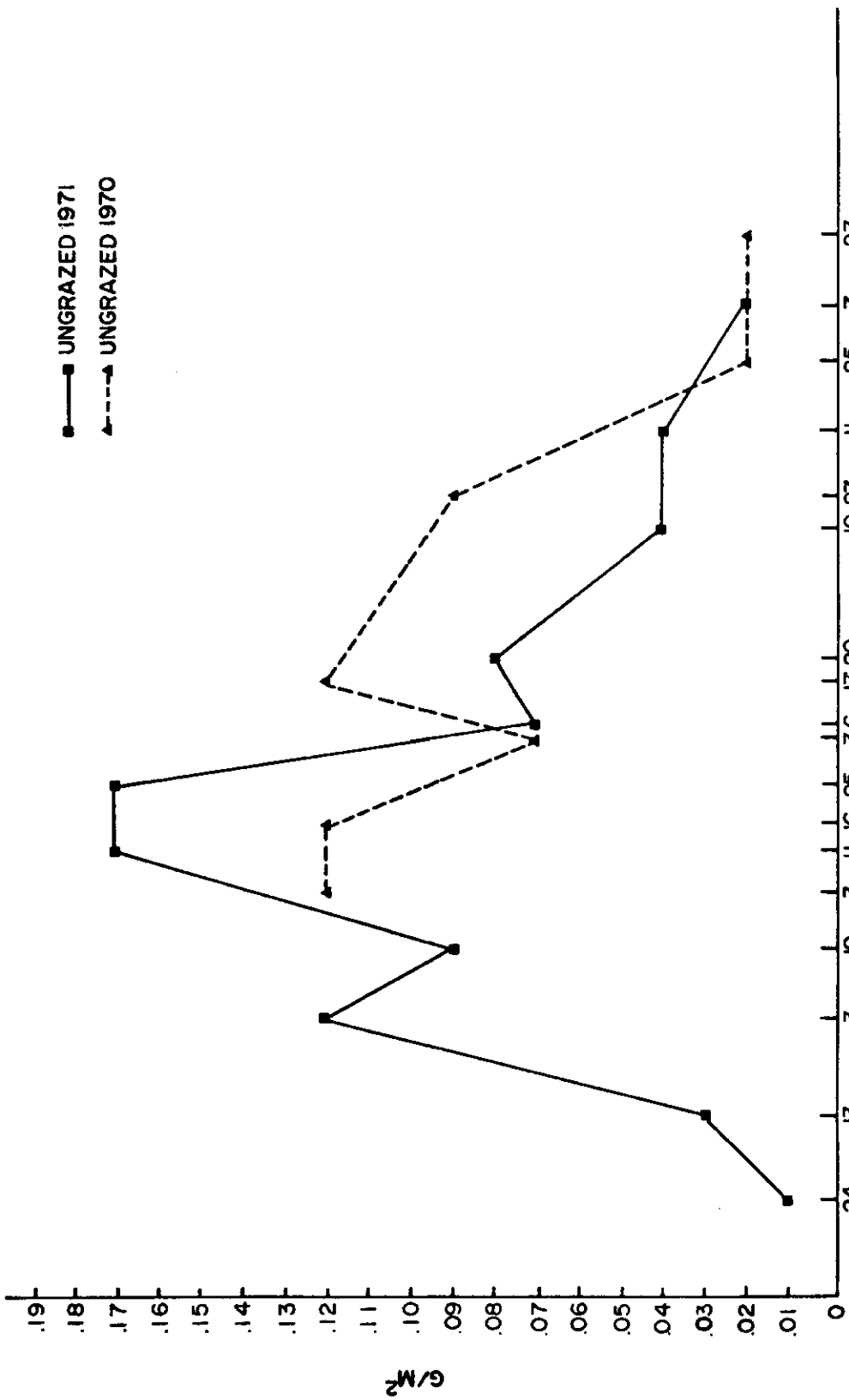

Fig. 2. 1970 and 1971 insect biomass collected from ungrazed treatment, Osage Site.

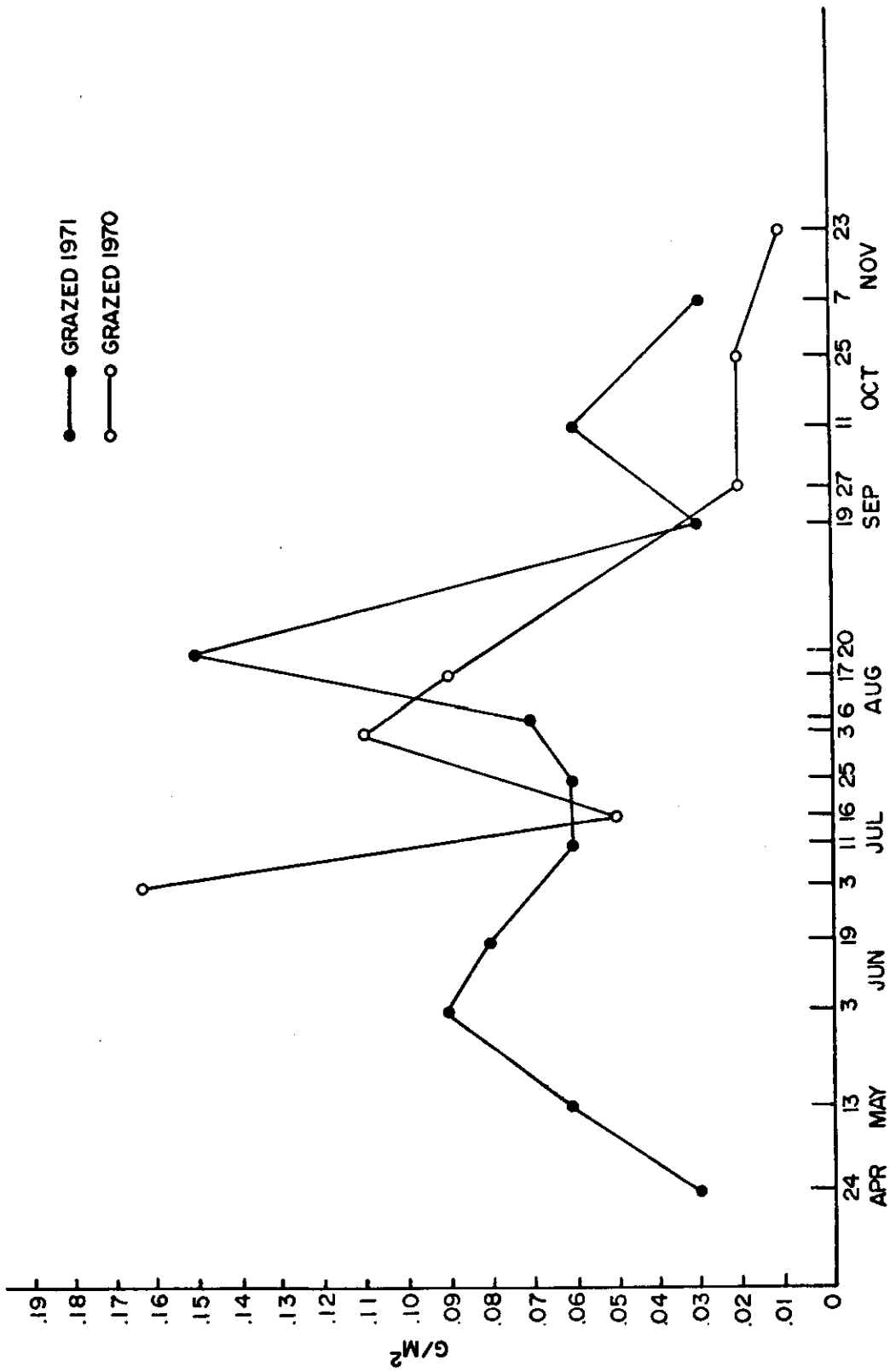

Fig. 3. 1970 and 1971 insect biomass collected from grazed treatment, Osage Site.

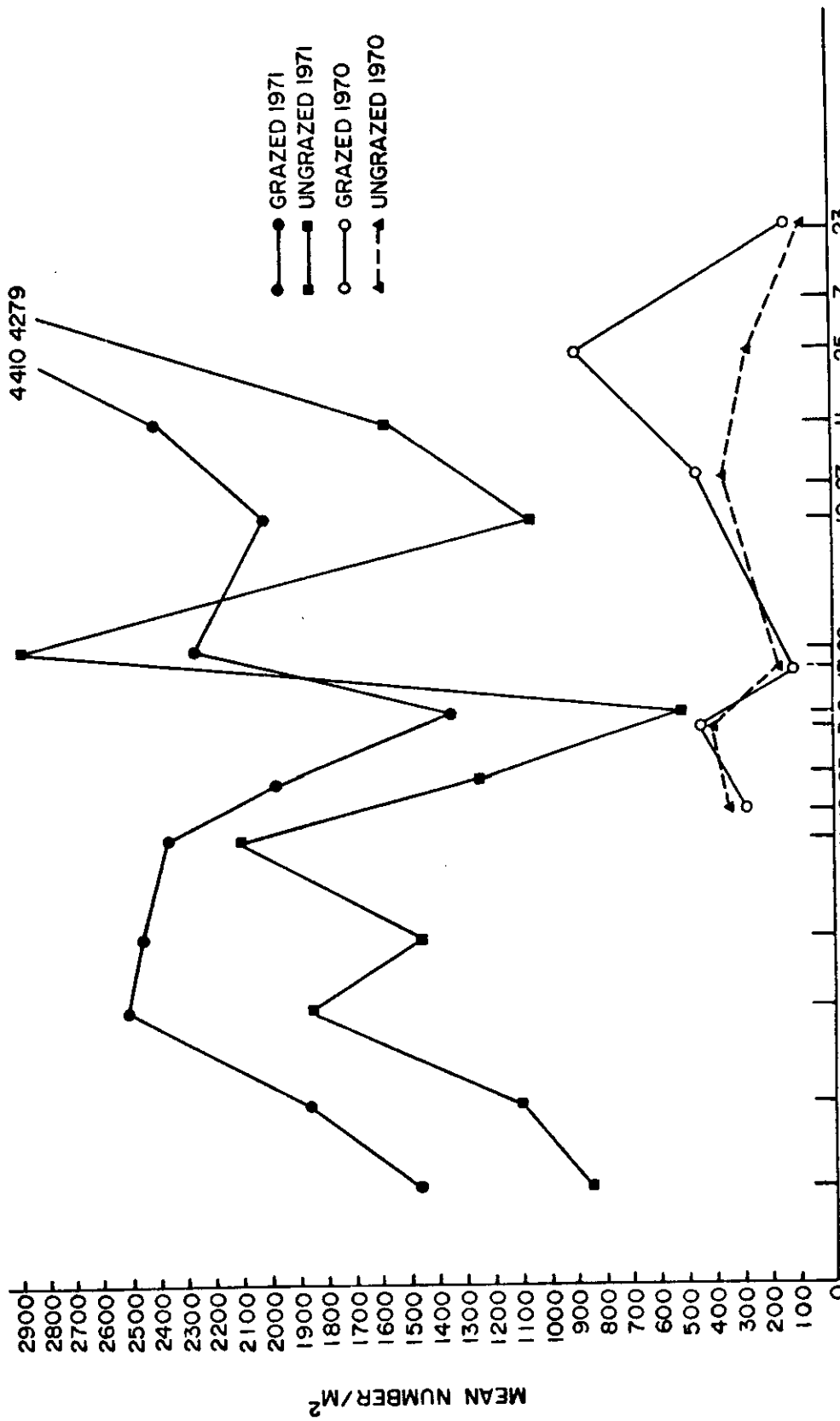

Fig. 4. 1970 and 1971 invertebrate numbers collected from grazed and ungrazed treatment, Osage Site.

The November collection showed large populations of Acarina in 1971 which accounts for the high invertebrate numbers for that month. Total invertebrate biomass and numbers for 1971 are shown in Table 5 and Fig. 5 and 6. Invertebrates collected at Osage, but not recorded as numbers or biomass are Diplopoda, Chilopoda, Isopoda, and Phalangida. These groups will probably be included in the invertebrate data for 1972.

Data on spiders (Order Araneida) are given in Table 6 and Fig. 7 through 10. Compared to other invertebrates the numbers are lower, but the biomass exceeds .01 g/m^2 on several collections. In 1971 spider numbers were high in April and May, declined in June, peaked again in July, and declined in August. Numbers rose moderately in the latter part of August, then declined in September. A large peak occurred in October, followed by a sharp decline in November. The 1970 Araneida data in the grazed area was similar to 1971 except for an increase in numbers during September as compared to a decrease in 1971. The 1970 ungrazed also showed an increase in September as compared to a decrease in 1971; the rest of the 1970 data for ungrazed followed the 1971 results. The ungrazed treatment had high numbers in April through early June, July, early August, and early October. The grazed treatment had higher numbers in early July, late August, and the early part of October. In the ungrazed treatment spider biomass was highest when the numbers were lowest in April, May, June, and early August; numbers stayed the same in late August, but biomass declined. In September, October, and November numbers and biomass corresponded. Biomass in the grazed treatment generally followed the same pattern as the mean

Table 5. Number (mean number/m^2) and biomass (g/m^2) of total invertebrates collected, Osage Site, April 24 through November 7, 1971.

Date	Treatment	Number	Dry Weight
Apr. 24	Ungrazed	848.200	.026 = .03
	Grazed	1491.600	.053 = .05
May 13	Ungrazed	1108.400	.048 = .05
	Grazed	1857.000	.075 = .08
June 3	Ungrazed	1855.200	.140 = .14
	Grazed	2529.800	.113 = .11
June 14	Ungrazed	1471.000	.103 = .10
	Grazed	2472.000	.098 = .10
July 11	Ungrazed	2120.800	.186 = .19
	Grazed	2373.600	.080 = .08
July 25	Ungrazed	1263.600	.184 = .18
	Grazed	1994.200	.077 = .08
Aug. 6	Ungrazed	521.800	.080 = .08
	Grazed	1351.200	.086 = .09
Aug. 20	Ungrazed	2963.000	.090 = .09
	Grazed	2289.000	.186 = .19
Sept. 19	Ungrazed	1065.000	.049 = .05
	Grazed	2022.600	.051 = .05
Oct. 11	Ungrazed	1597.200	.083 = .08
	Grazed	2429.400	.109 = .11
Nov. 7	Ungrazed	4279.400	.035 = .04
	Grazed	4410.200	.057 = .06

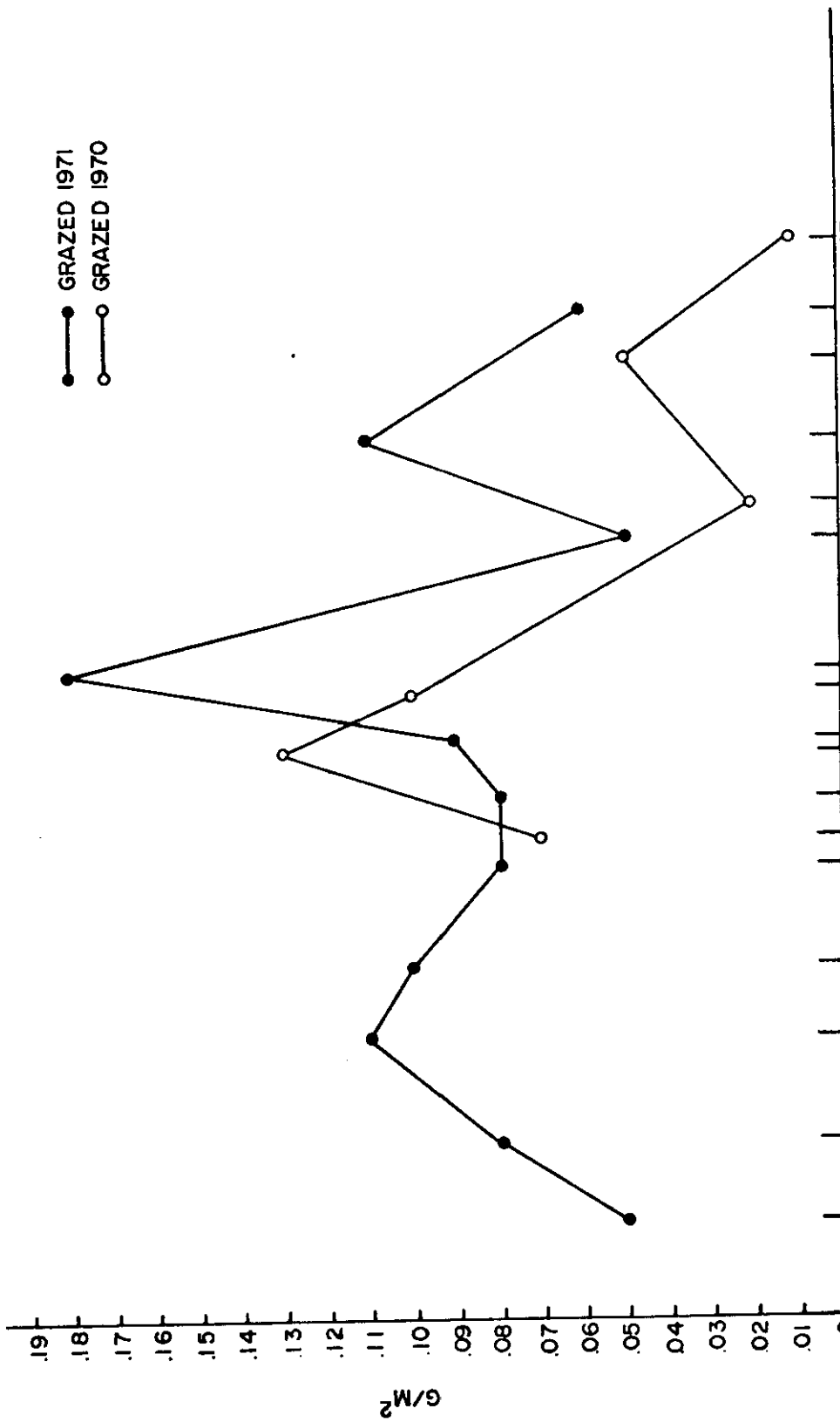

Fig. 5. 1970 and 1971 total invertebrate biomass collected from grazed treatment, Osage Site.

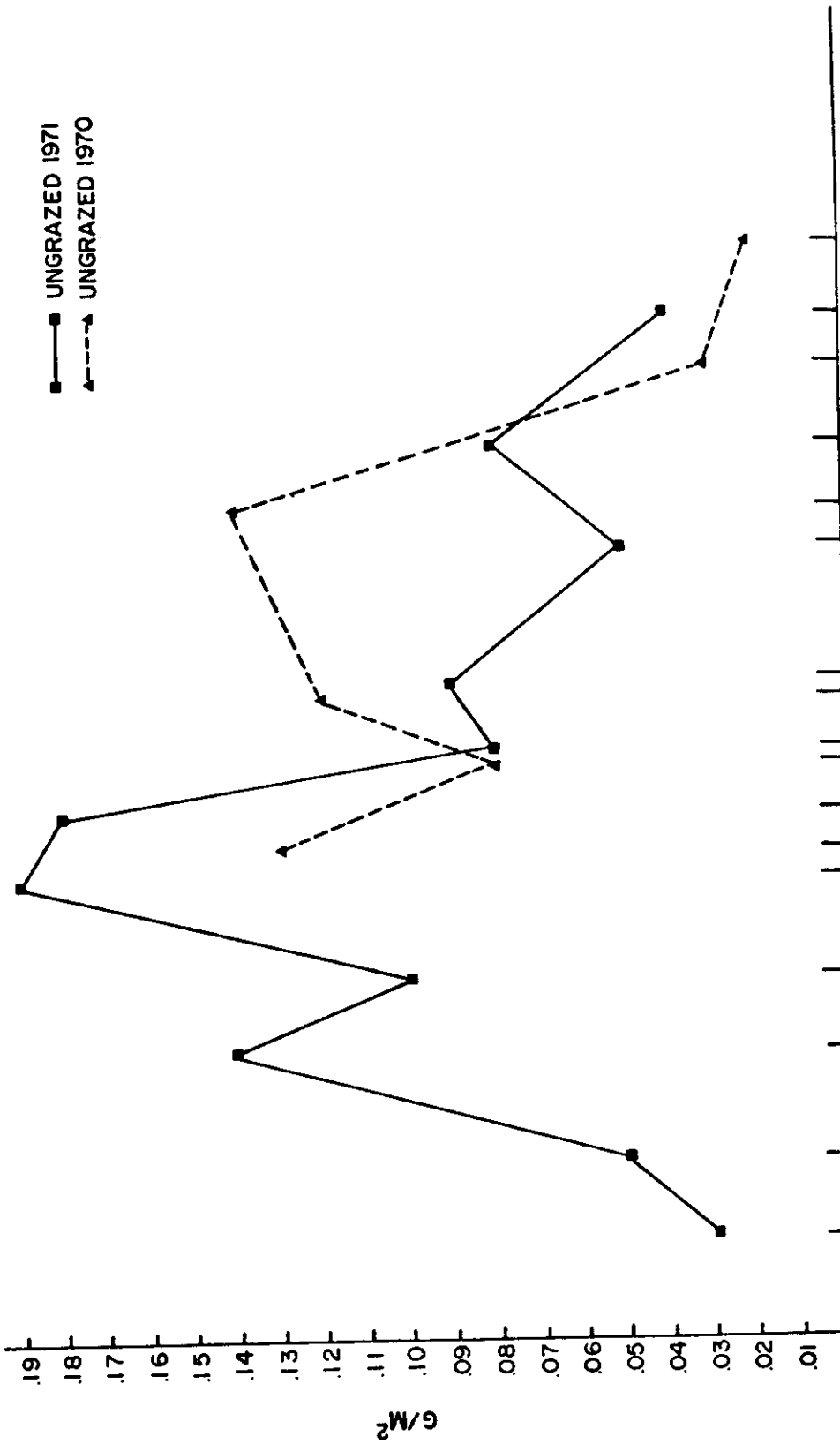

Fig. 1. 1970 and 1971 total invertebrate biomass collected from ungrazed treatment, Osage Site.

Table 6. Number (mean number/m^2) and biomass (g/m^2) of Araneida collected, Osage Site, April 24 through November 7, 1971.

Date	Treatment	Number	Dry Weight
Apr. 24	Ungrazed	35.800	.010
	Grazed	10.200	.005
May 13	Ungrazed	36.400	.009
	Grazed	9.800	.006
June 3	Ungrazed	17.000	.017
	Grazed	5.800	.010
June 19	Ungrazed	11.200	.012
	Grazed	14.400	.012
July 11	Ungrazed	24.600	.007
	Grazed	29.600	.013
July 25	Ungrazed	26.000	.007
	Grazed	15.200	.001
Aug. 6	Ungrazed	21.200	.008
	Grazed	14.200	.004
Aug. 20	Ungrazed	21.000	.001
	Grazed	25.800	.021
Sept. 19	Ungrazed	6.800	.001
	Grazed	11.600	.015
Oct. 11	Ungrazed	69.400	.030
	Grazed	53.600	.018
Nov. 7	Ungrazed	17.000	.010
	Grazed	11.600	.015

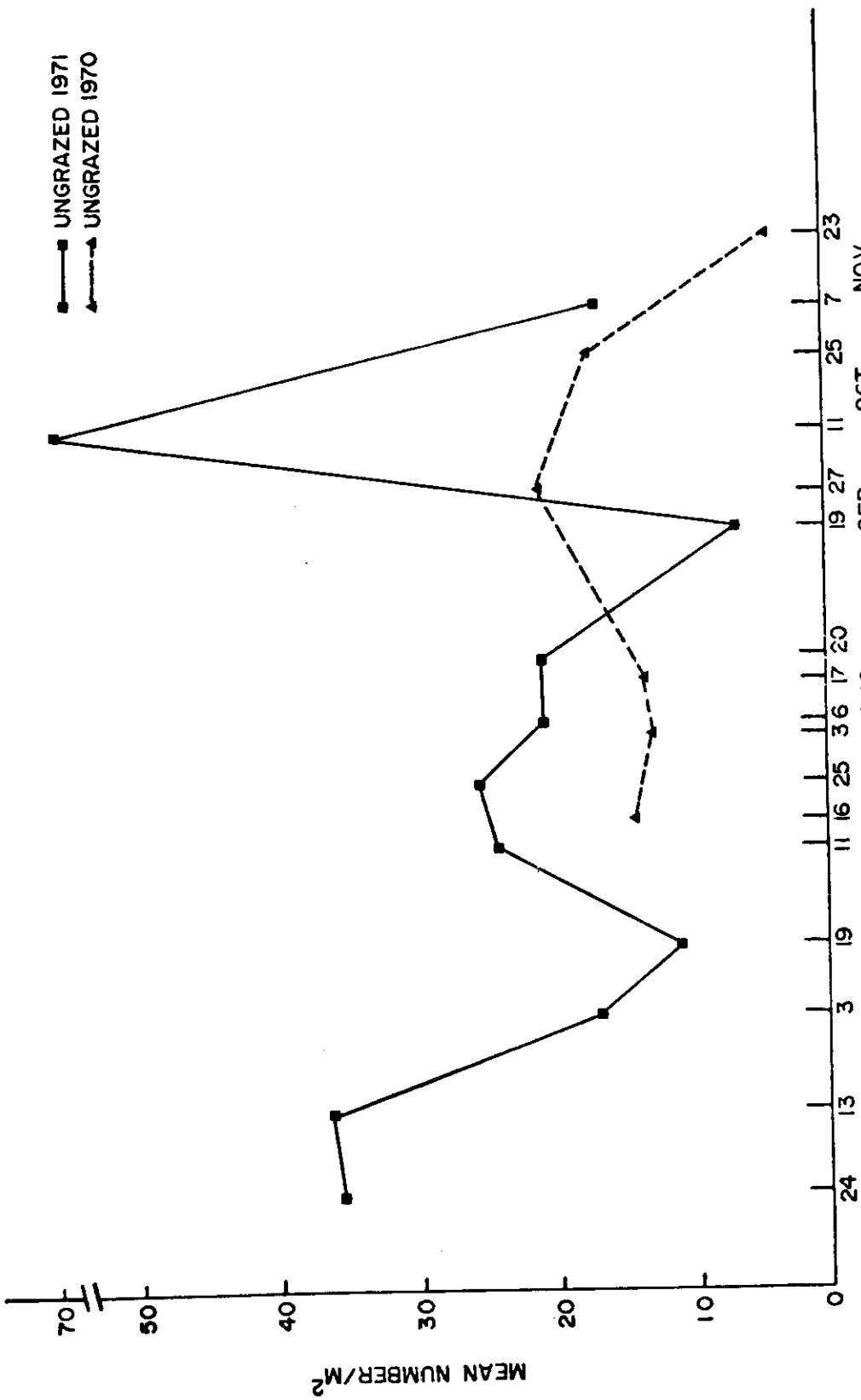

Fig. 7. 1970 and 1971 Araneida numbers collected from ungrazed treatment, Osage Site.

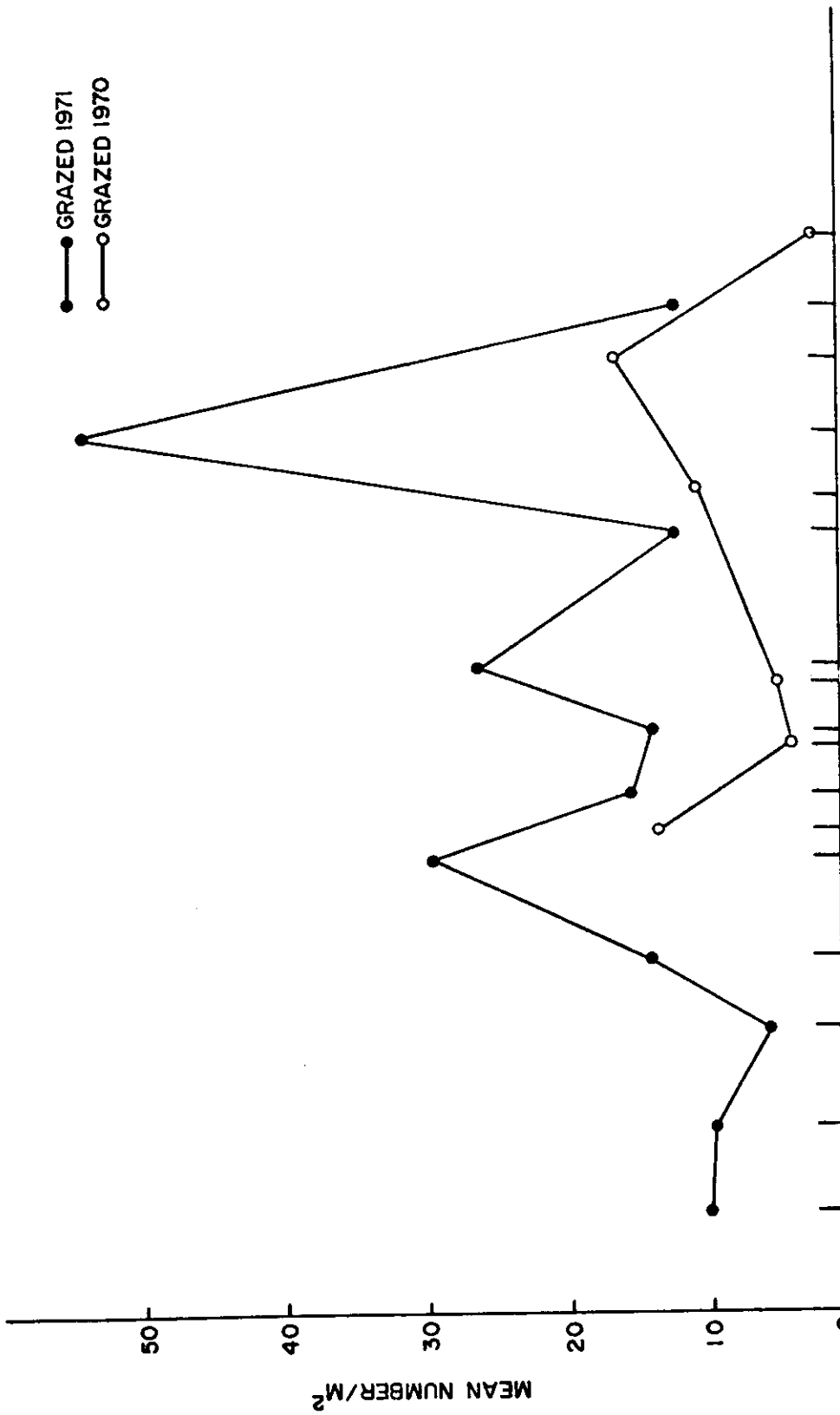

Fig. 8. 1970 and 1971 Araneida numbers collected from grazed treatment, Osage Site.

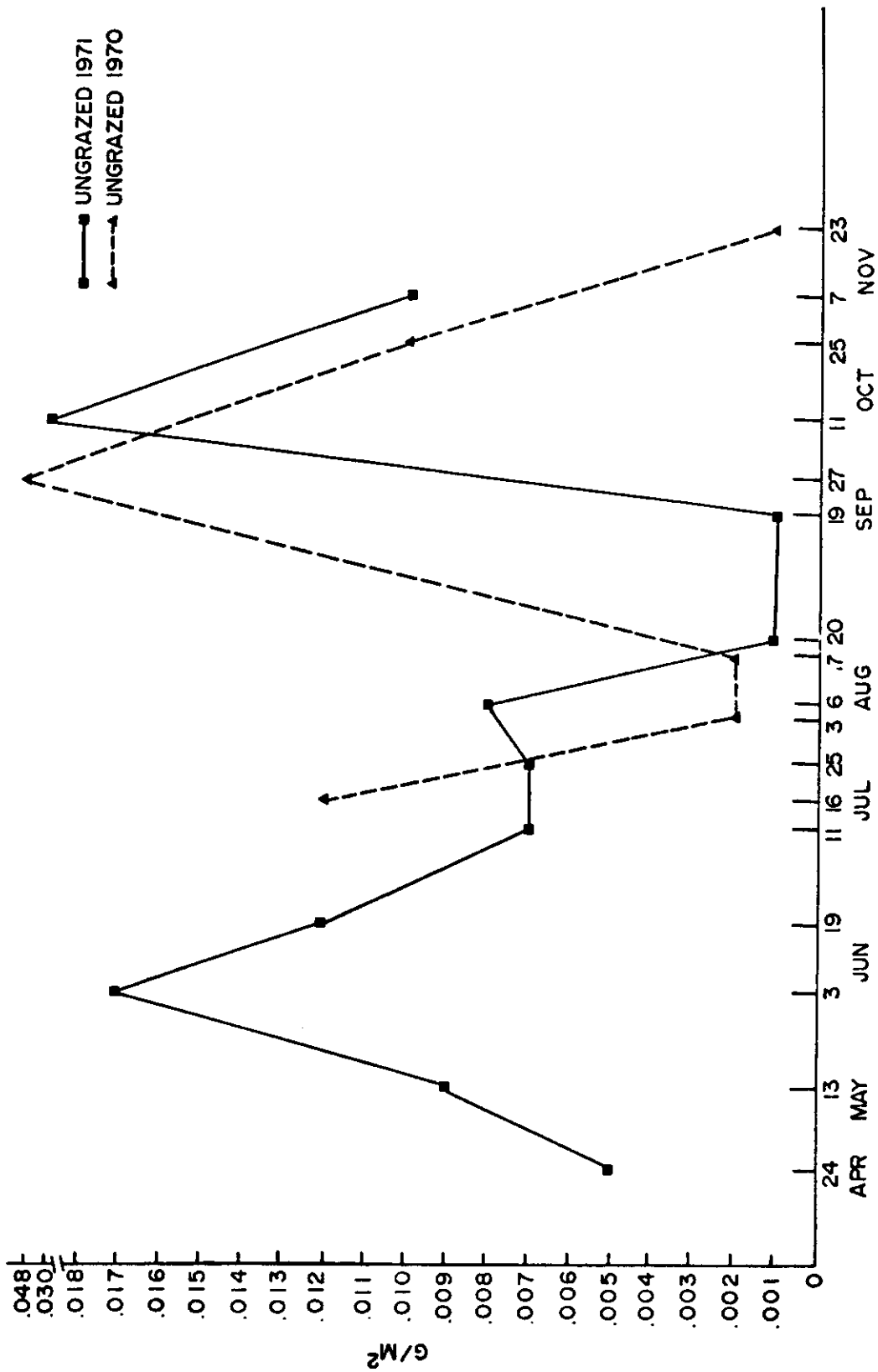

Fig. 9. 1970 and 1971 biomass of Araneida collected from ungrazed treatment, Osage Site.

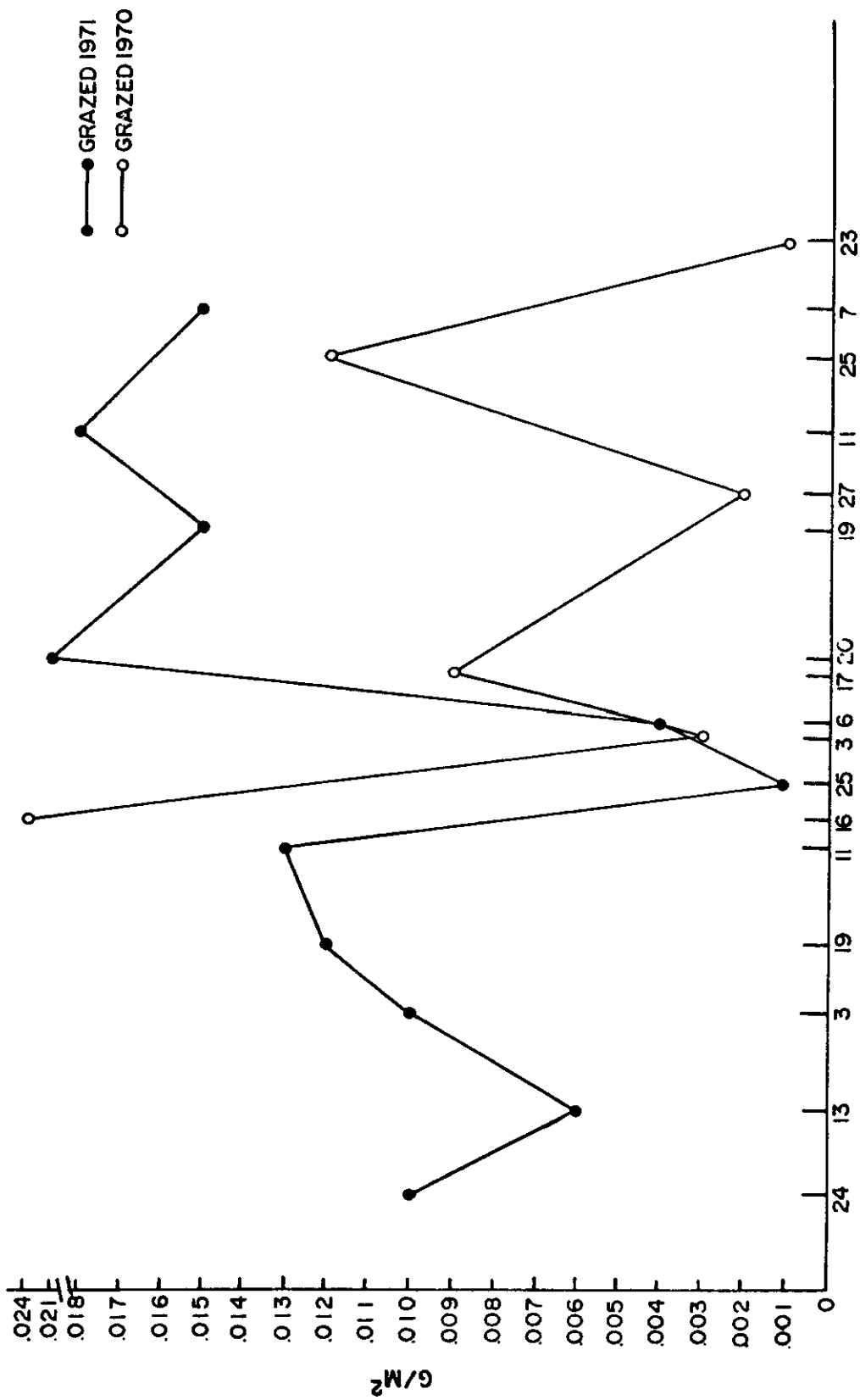

Fig. 10. 1970 and 1971 biomass of Araneida collected from grazed treatment, Osage Site.

number per square meter. Araneida numbers in both grazed and ungrazed 1971 exceeded the numbers in 1970 except in September when numbers in the ungrazed 1970 were higher than ungrazed 1971. Biomass of Araneida in the 1970 grazed treatment exceeded biomass of the 1971 grazed treatment only once in mid-July; 1970 biomass was greater than the 1971 biomass in ungrazed in mid-July, mid-August, and mid-September.

Mite (Order Acarina) data are shown in Table 7 and Fig. 11 through 13. Numbers of mites are quite high in 1971. Biomass in the grazed treatment exceeds .01 g/m^2 on several occasions and seems to follow numbers in increases and decreases except in mid-May and June where numbers increase but biomass decreases and also in November where large numbers of mites were recorded and biomass declined. The grazed treatment supports greater biomass of Acarina than the ungrazed; this is also the 1970 finding at Osage. The 1971 grazed treatment supports larger numbers of Acarina than the ungrazed except in mid-August and November. The 1970 grazed Acarina population contained larger numbers than the ungrazed except in mid-July and mid-August. The higher populations of Acarina in 1971 as compared to 1970 could well be due to above average rainfall and cooler temperatures in the growing season of 1971.

A comparison of herbivore to total invertebrate biomass in 1971 is shown in Table 8 and Fig. 14 and 15. Fig. 14 and 15 show that herbivore biomass follows total invertebrates throughout the collecting season in both grazed and ungrazed treatments. Table 8 shows estimates of percent of herbivores compared to total invertebrates. The ungrazed treatment had a variation of 45% on August 6, 1971, to 73% on August 20, 1971; and an average of 59% was obtained for the collecting season. The

Table 7. Number (mean number/m^2) and biomass (g/m^2) of Acarina collected, Osage Site, April 24 through November 7, 1971.

Date	Treatment	Number	Dry Weight
Apr. 24	Ungrazed	318.600	.004
	Grazed	797.200	.019
May 13	Ungrazed	590.000	.007
	Grazed	950.200	.014
June 3	Ungrazed	706.000	.006
	Grazed	823.800	.013
June 19	Ungrazed	481.000	.004
	Grazed	986.200	.011
July 11	Ungrazed	750.600	.006
	Grazed	996.800	.010
July 25	Ungrazed	401.600	.005
	Grazed	1101.000	.012
Aug. 6	Ungrazed	109.800	.001
	Grazed	589.000	.009
Aug. 20	Ungrazed	1723.200	.006
	Grazed	1495.600	.017
Sept. 19	Ungrazed	603.400	.003
	Grazed	1287.400	.011
Oct. 11	Ungrazed	954.400	.013
	Grazed	1736.000	.027
Nov. 7	Ungrazed	3923.800	.002
	Grazed	3668.000	.010

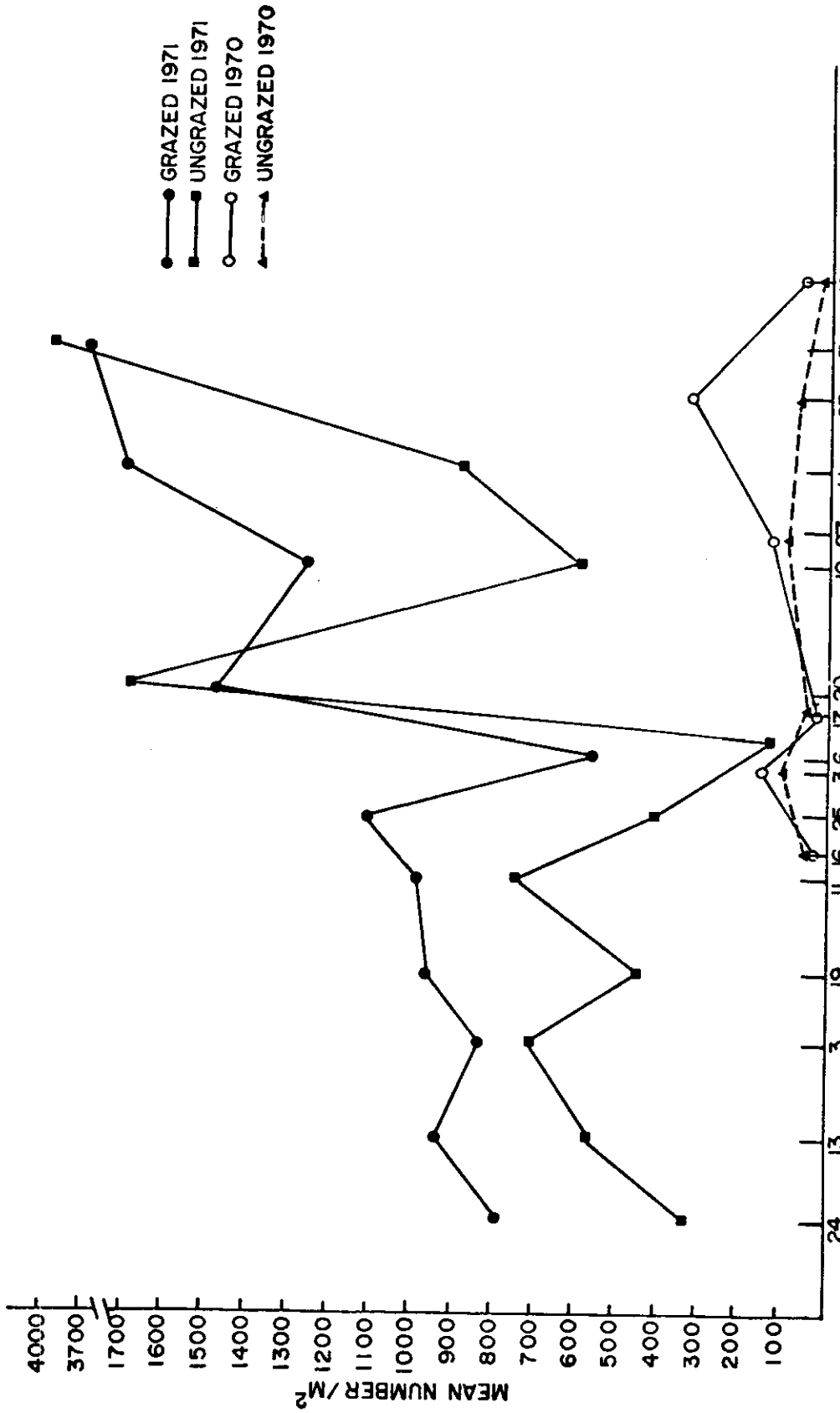

Fig. 11. 1970 and 1971 Acarina numbers collected from grazed and ungrazed treatment, Osage Site.

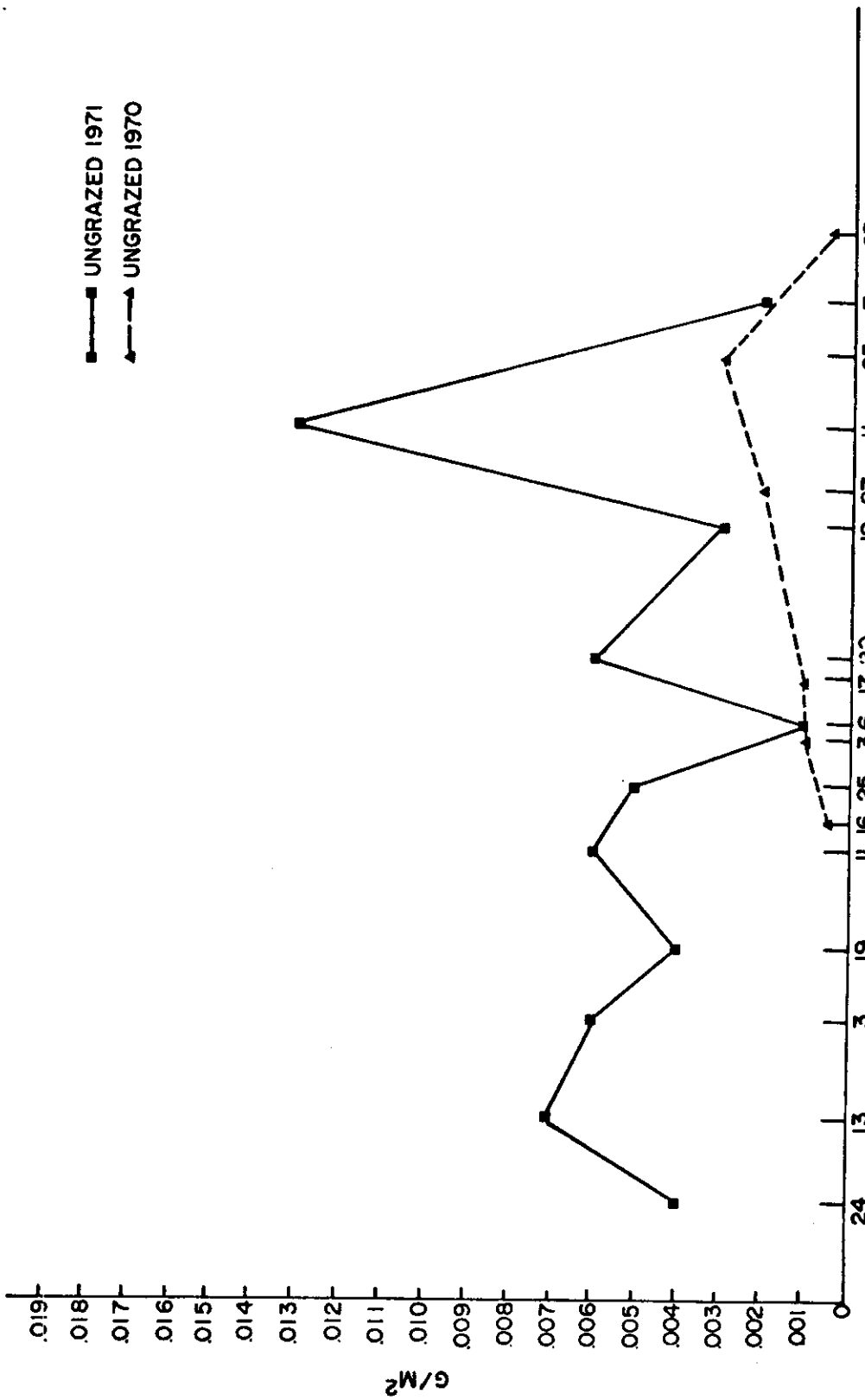

Fig. 12. 1970 and 1971 biomass of Acarina collected from ungrazed treatments, Osage Site.

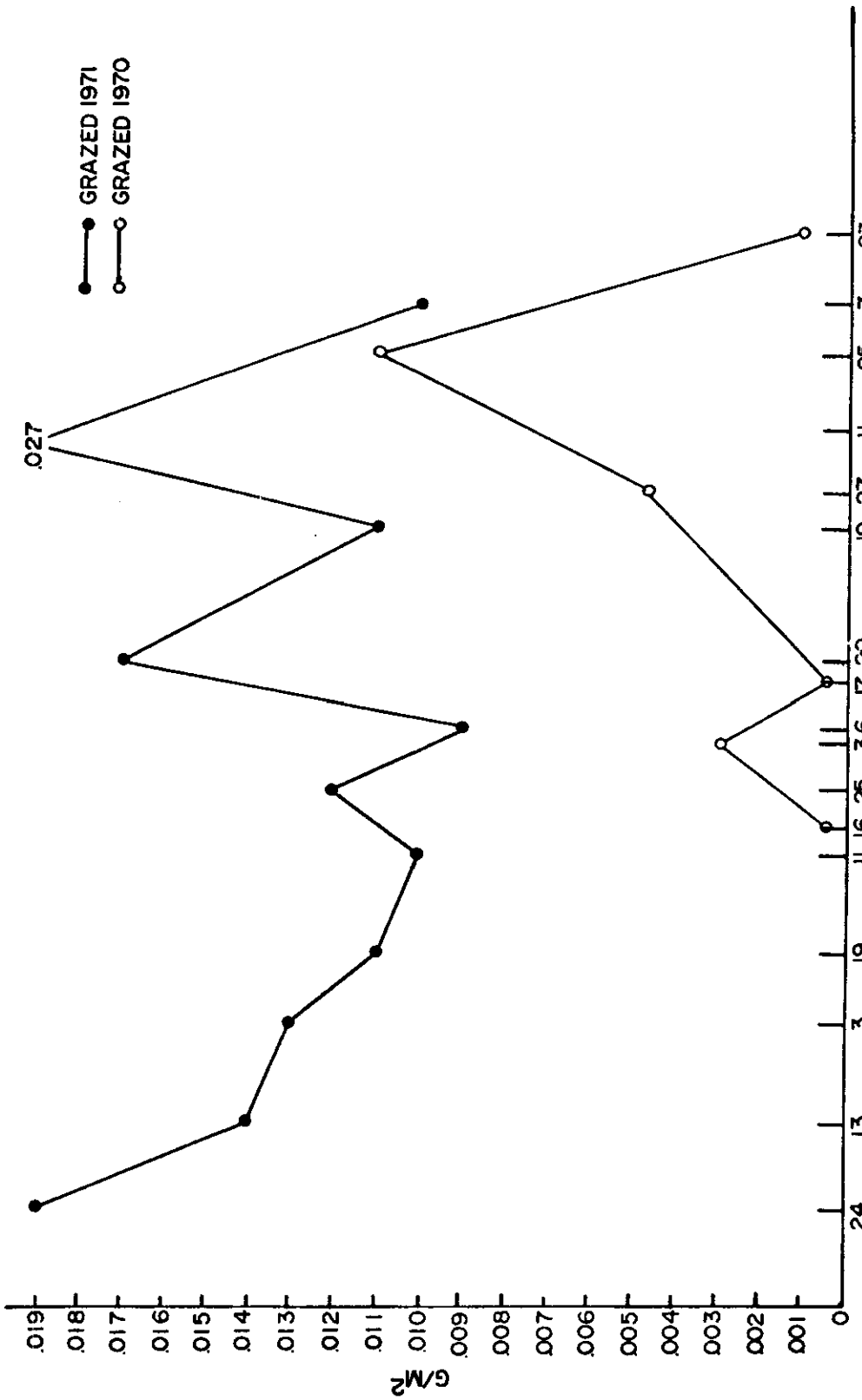

Fig. 13. 1971 and 1970 biomass of Acarina collected from grazed treatment, Osage Site.

Table 8. Estimate of percent herbivory compared to total invertebrate biomass (g/m^2).

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. 24	46	.012	.026	68	.036	.053
May 13	57	.027	.048	65	.049	.075
June 3	49	.070	.140	72	.081	.113
June 19	65	.056	.086	66	.065	.098
July 11	55	.102	.186	66	.053	.080
July 25	70	.129	.184	81	.062	.077
Aug. 6	45	.036	.080	59	.051	.086
Aug. 20	73	.066	.091	72	.131	.186
Sept. 19	67	.033	.049	48	.025	.052
Oct. 11	52	.043	.083	61	.067	.110
Nov. 7	64	.023	.036	67	.038	.057
Average	59	.046	.078	66	.055	.083

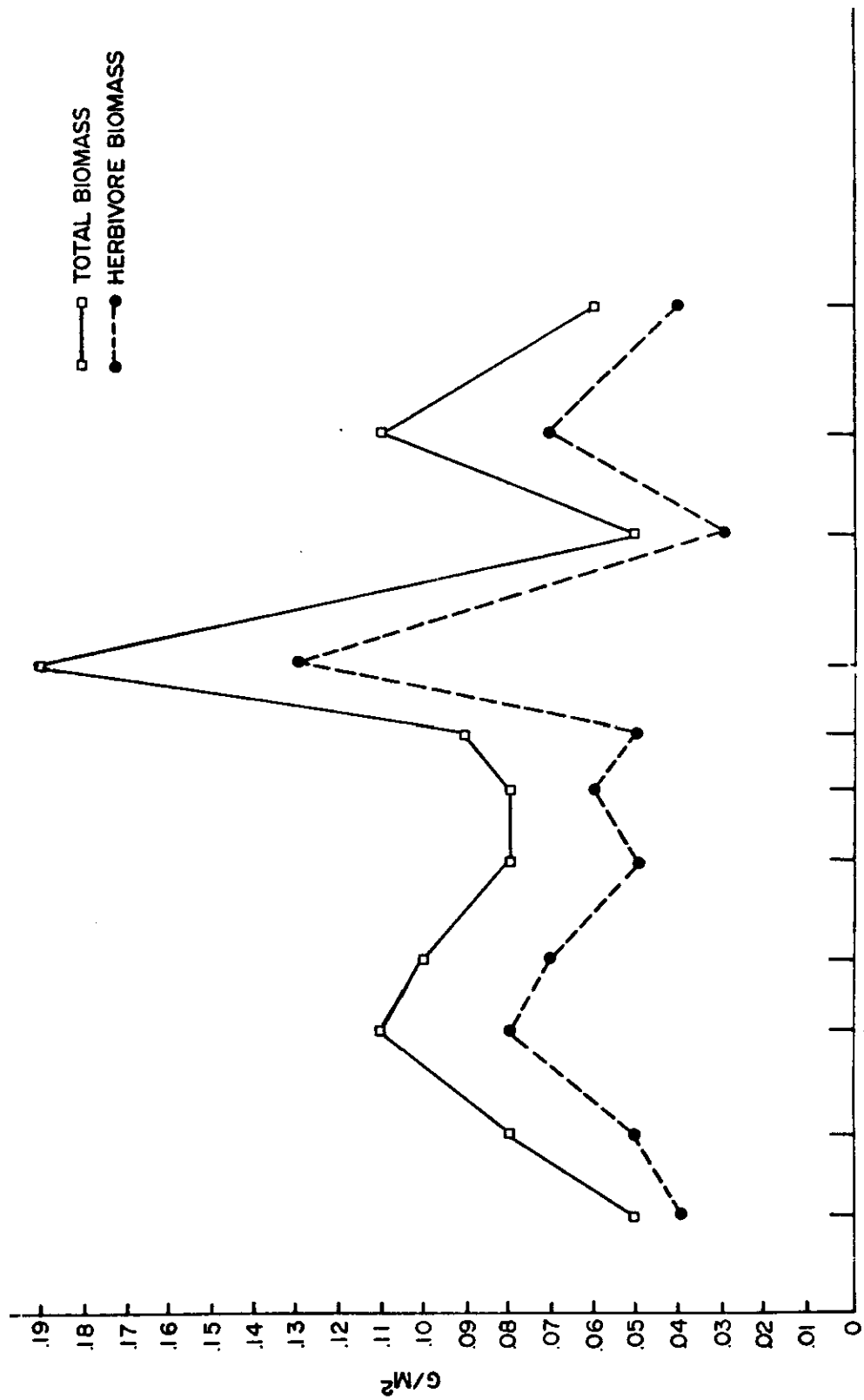

Fig. 5. 1971 total invertebrate and herbivore biomass for grazed treatment, Osage Site.

grazed treatment ranged from 48% on September 19, 1971, to 81% on J 25, 1971, and had an average of 66% herbivores for the total collecting seasor.

A list of orders and families found in sweep-net collections are shown in Table 9, quick-trap collections in Table 10, and pitfall trap collections in Table 11. A total of 11 orders and 70 families were obtained using the sweep-net capture method. The pitfall traps yielded 11 orders and 56 families; the quick trap captured 13 orders and 75 families. Table 12 shows certain orders and families that are unique to a given type of collecting method. More families of Diptera were captured by the sweep-net method than pitfalls or quick traps. Pitfall traps can also function as bait traps. Once an organism is trapped and dies, its decomposition serves as an attractor to certain groups of insects. This might be the reason for reasonably large numbers of Silphidae captured in the pitfall traps. Table 12 shows the insect families observed in the field, but never captured by any of the trapping methods.

It is of interest to note that relatively high numbers of immature Hemiptera, Homoptera, and Coleoptera were collected by the quick trap-suction method. The high numbers of immatures are in no way proportional to the small number of adults which were collected. There is the possibility that some of these insects leave the grassland community at certain stages of their life cycle and spend the adult stage in other communities, such as field crops. There is also the possibility of a high mort ity rate in immatures. This same trend was noted during 1970.

CONCLUSIONS

Efforts are being made to refine sampling equipment to provide more precise data. After 2 years insect and total invertebrate populatior

Table 9. Orders and families (or groups) captured by sweep net in grazed and ungrazed treatment, Osage Site. 1971.

Order	Family (or Group)
Collembola	Entomobryidae
Orthoptera	Acrididae
	Tettigoniidae
	Phasmidae
	Gryllidae
Homoptera	Issidae
	Cicadellidae
	Fulgoridae
	Aphididae
	Cixidae
	Membracidae
	Delphacidae
	Dictyopharidae
	Psyllidae
Hemiptera	Scutelleridae
	Lygaeidae
	Psyllidae
	Miridae
	Tingidae
	Phymatidae
	Corimelaenidae
	Reduviidae
	Coreidae
	Pentatomidae
Coleoptera	Carabidae
	Chrysomelidae
	Cerambycidae
	Cantharidae
	Coccinellidae
	Throscidae
	Staphylinidae
	Curculionidae
	Lathridiidae
	Mordellidae
	Dermestidae
	Elateridae
	Cleridae
	Scarabaeidae
	Nitidulidae
	Ptiliidae
	Cisidae
	Erotylidae
Lepidoptera	Pyralidae
	Nectuidae

Table 9. (Continued).

Order	Family (or Group)
Diptera	Tachinidae
	Pipunculidae
	Chloropidae
	Rhagionidae
	Sciomyzidae
	Chironomidae
	Otitidae
	Syrphidae
	Asilidae
	Calliphoridae
	Piophilidae
	Sarcophagidae
	Pyrgotidae
	Tipulidae
	Cecidomyiidae
	Ceratopogonidae
	Culicidae
Hymenoptera	Formicidae
	Braconidae
	Pteromalidae
	Ichneumonidae
	Halictidae
	Dryinidae
	Eulophidae
Neuroptera	Chrysopidae
	Myrmeleontidae
Psocoptera	
Thysanoptera	

Table 10. Orders and families (or groups) captured by quick trap in grazed and ungrazed treatments, Osage Site, 1971.

Order	Family (or Group)
Collembola	Entomobryidae
	Podoridae
	Sminthuridae
Orthoptera	Blattidae
	Gryllidae
	Acrididae
	Tettigoniidae
	Mantidae
Homoptera	Delphacidae
	Coccoidea
	Psyllidae
	Membracidae
	Cicadellidae
	Fulgoridae
	Aphididae
	Dictyopharidae
	Issidae
Hemiptera	Lygaeidae
	Miridae
	Scutelleridae
	Coreidae
	Pentatomidae
	Ploiariidae
	Tingidae
	Reduviidae
	Gerridae
	Phymatidae
Coleoptera	Carabidae
	Coccinellidae
	Curculionidae
	Throscidae
	Staphylinidae
	Eucnemidae
	Lathridiidae
	Nitidulidae
	Pselaphidae
	Phalacridae
	Elateridae
	Chrysomelidae
	Scydmaenidae
	Cleridae
	Cantharidae
	Meloidae
	Pitiliidae
	Scaphidiidae
	Cisidae

Table 10. (Continued).

Order	Family (or Group)
Lepidoptera	Noctuidae
	Pyralidae
Diptera	Cecidomyiidae
	Sciaridae
	Tabanidae
	Phoridae
	Chironomidae
	Chloropidae
	Scatopsidae
	Ceratopogonidae
	Syrphidae
	Otitidae
	Tipulidae
	Mycetophilidae
	Tachinidae
Hymenoptera	Formicidae
	Encyrtidae
	Pteromalidae
	Trichogrammatidae
	Thysanidae
	Eulophidae
	Dryinidae
	Scelionidae
	Braconidae
	Ichneumonidae
	Cynipidae
	Tenthredinidae
Neuroptera	Hemerobiidae
Psocoptera	
Thysanoptera	
Thysanura	Japygidae
Strepsiptera	

Table 11. Orders and families (or groups) captured by pitfall traps in grazed and ungrazed treatments, Osage Site, 1971.

Order	Family (or Group)
Collembola	Entomobryidae
	Poduridae
	Sminthuridae
Orthoptera	Gryllidae
	Blattidae
	Tettigoniidae
Homoptera	Fulgoridae
	Issidae
	Delphacidae
	Cicadellidae
	Cixidae
Hemiptera	Lygaeidae
	Coreidae
	Neididae
	Reduviidae
	Pentatomidae
Coleoptera	Silphidae
	Carabidae
	Curculionidae
	Scarabaeidae
	Chrysomclidae
	Lathridiidae
	Elateridae
	Coccinellidae
	Cicindelidae
	Staphylinidae
	Nitidulidae
	Phalacridae
	Histeridae
	Pselaphidae
	Scydmaenidae
	Scaphididae
Lepidoptera	Noctuidae
Diptera	Cecidomyiidae
	Chloropidae
	Sciaridae
	Phagionidae
	Tachinidae
	Culicidae
	Muscidae
	Chironomidae
	Otitidae
	Dolichopodidae
	Phoridae
	Sarcophagidae
	Syrphidae

Table 11. (Continued).

Order	Family (or Group)
Hymenoptera	Formicidae
	Ichneumonidae
	Braconidae
	Encyrtidae
	Pteromalidae
	Mutillidae
	Eulophidae
	Dryinidae
	Thysanidae
Neuroptera	Chrysopidae
Thysanoptera	
Dermaptera	

Table 12. Orders and families (or groups) unique to the following trapping methods, Osage Site, 1971.[a/]

Pitfall	Sweep net	Quick trap
Silphidae	Halictidae	Tenthredinidae
Mutillidae	Sciomyzidae	Gerridae
Neididae	Myrmeleontidae	Meloidae
Histeridae	Dermestidae	Mantidae
Dermaptera	Pyrgotidae	Strepsiptera
Cicindelidae	Rhagionidae	Ploiariidae
	Erotylidae	Hemerobiidae
	Ephemeroptera	Scatopsidae
	Piophilidae	Tabanidae
	Asilidae	Scelionidae
	Pipunculidae	Euenemidae
	Phasmidae	Trichogrammatidae
		Japygidae

[a/] Families observed in the field, but never captured:

Acroceridae
Coenagrionidae
Danaidae
Libellulidae
Nymphalidae
Satyridae
Vespidae

figures show some evidence of consistency, but at least two or three more seasons of collecting is needed before any statement concerning trends can be substantianted.

Research on energy flow through invertebrates is needed to provide more refined figures to be placed in the Osage compartmental model that is being developed by the primary producer workers. It has also been indicated that one of the major impacts of insects on grassland is the delay in attainment of maximum biomass by the primary producers; evidence to substantiate this statement is needed. Insect competition with livestock at the Osage Site is probably very small, primarily due to good range condition. This is probably not true for surrounding areas where good management practices are not so evident.

It appears that certain life stages of Hemiptera, Homoptera, and perhaps Coleoptera leave the grassland communities or have a high immature mortality rate. The small numbers of adults collected as compared to immatures is evidence that numbers are out of proportion.

A full season's data (April through November) were obtained and processed in 1971. Adult insects were identified as to family and immatures at least to order. Numbers per square meter and biomass (g/m^2) were obtained and submitted with other data. This will serve as a good basis for comparison to subsequent data. As we have indicated previously, there is no apparent direct correlation between numbers and biomass. Numbers in 1971 were much higher than in 1970, but biomass differences were not great. Biomass is probably a better indicator of invertebrate impact than numbers data.

Plans are to continue the collection of data during 1971 after incorporation of necessary modifications. An extensive review of

available literature on energy transfer through insects is being considered for 1972.

ACKNOWLEDGEMENTS

It is impossible to adequately acknowledge everyone who has assisted us in this project; we are sure that we will exclude many and for this we apologize. Special thanks are due Dr. Charles O'Brien of Texas Tech University for identification of Curculionidae, Dr. Robert Lavigne of the University of Wyoming for Formicidae identifications, and Dr. Herbert Knutson of Kansas State University for Acrididae identifications. Others who assisted were Bob Bertwell and Charles Mason. Belowground data were furnished by Robert M. Stepanich of Kansas State University.

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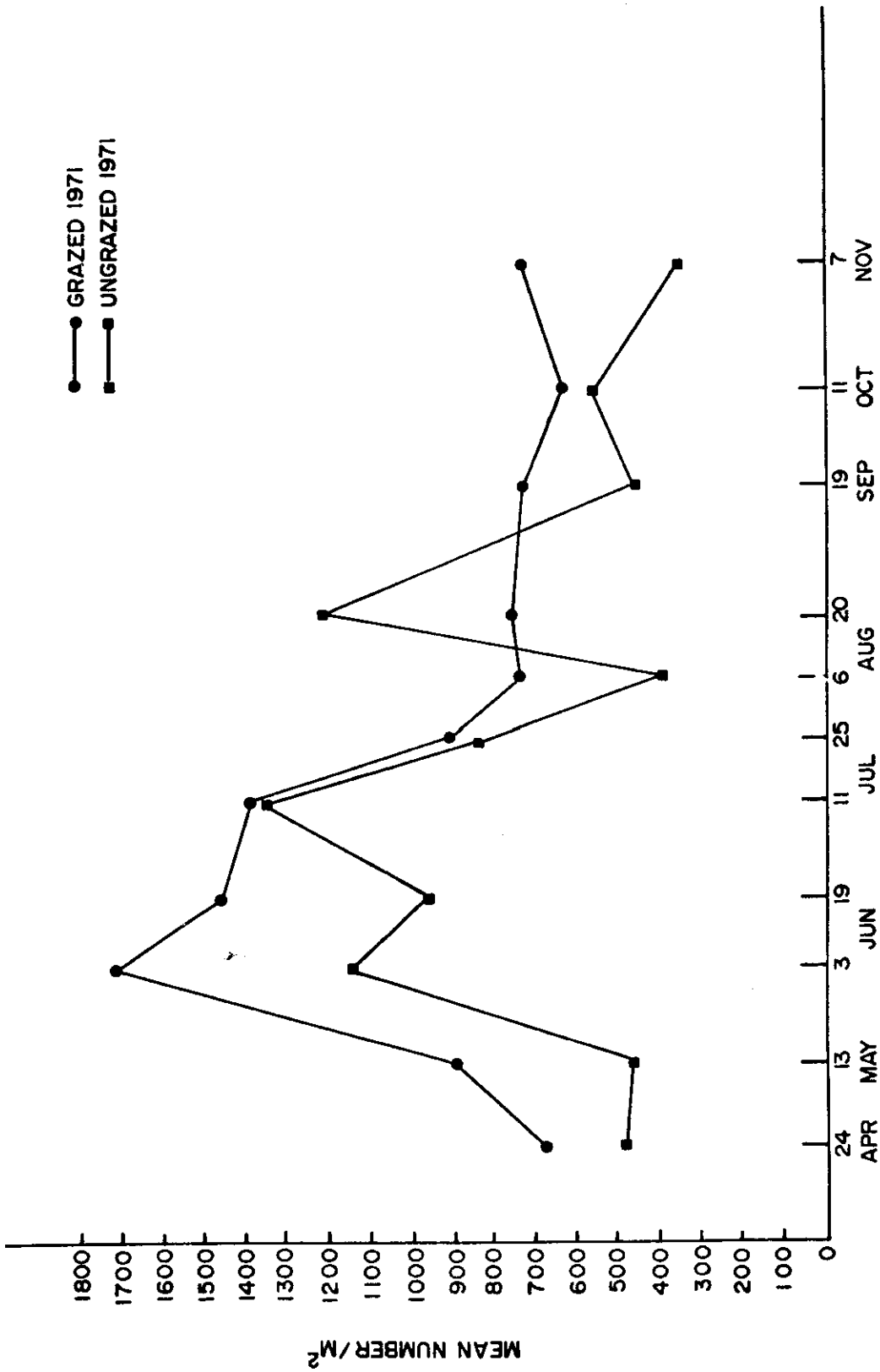
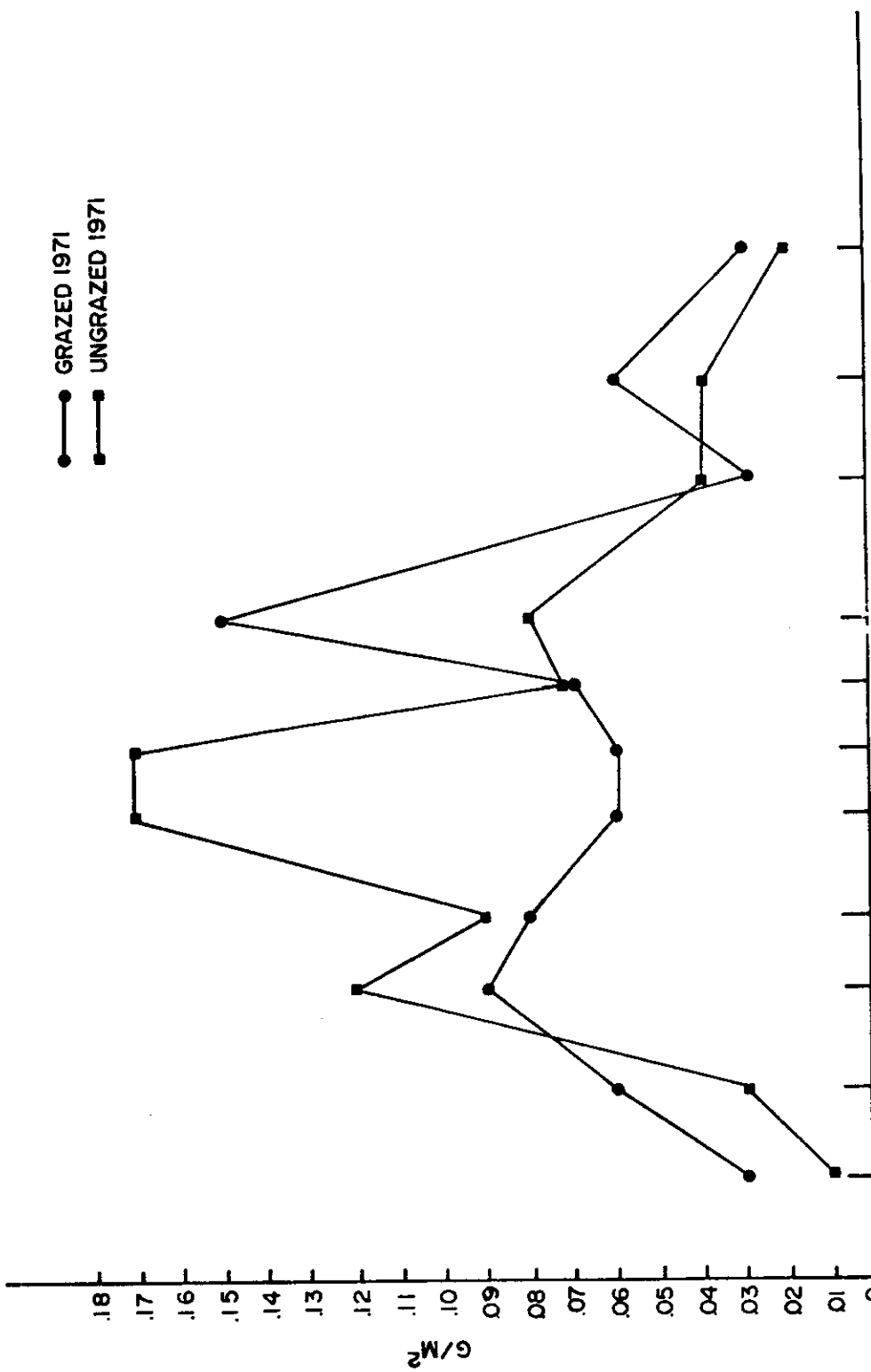
APPENDIX I

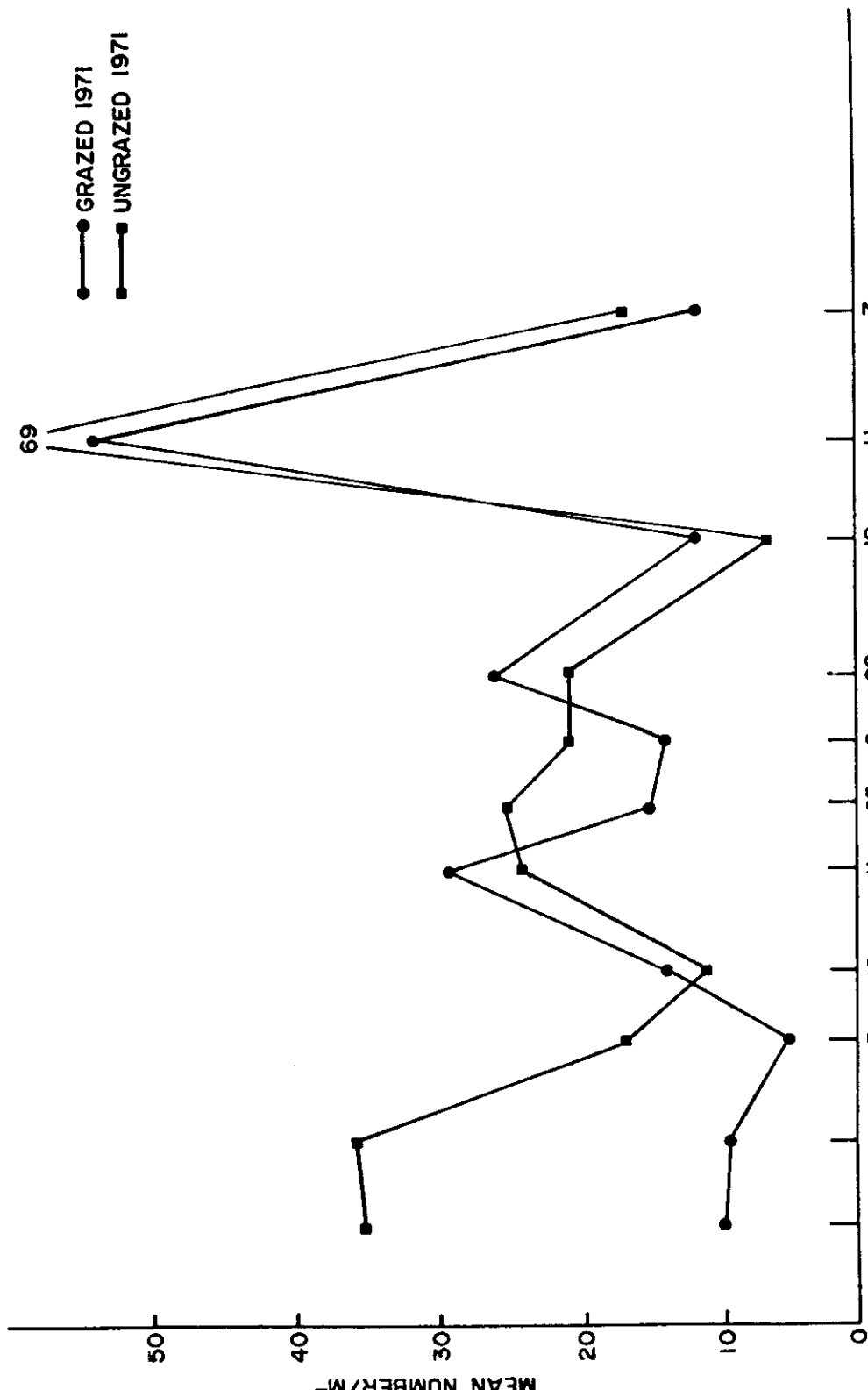
GRAZED AND UNGRAZED DATA COMPARISONS FOR 1971



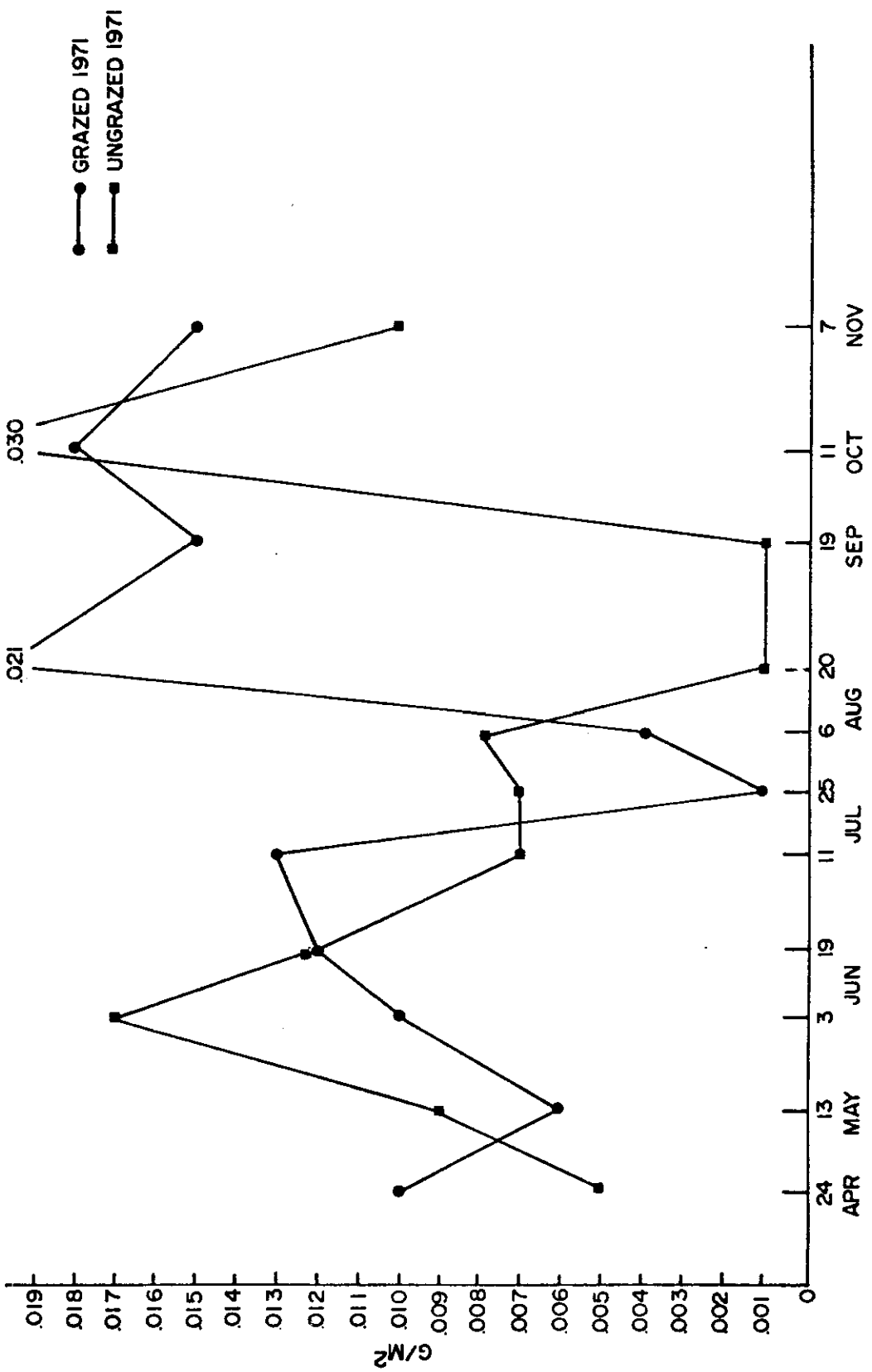
Appendix Fig. 1. Numbers of insects collected from grazed and ungrazed treatment, Osage Site, 1971.



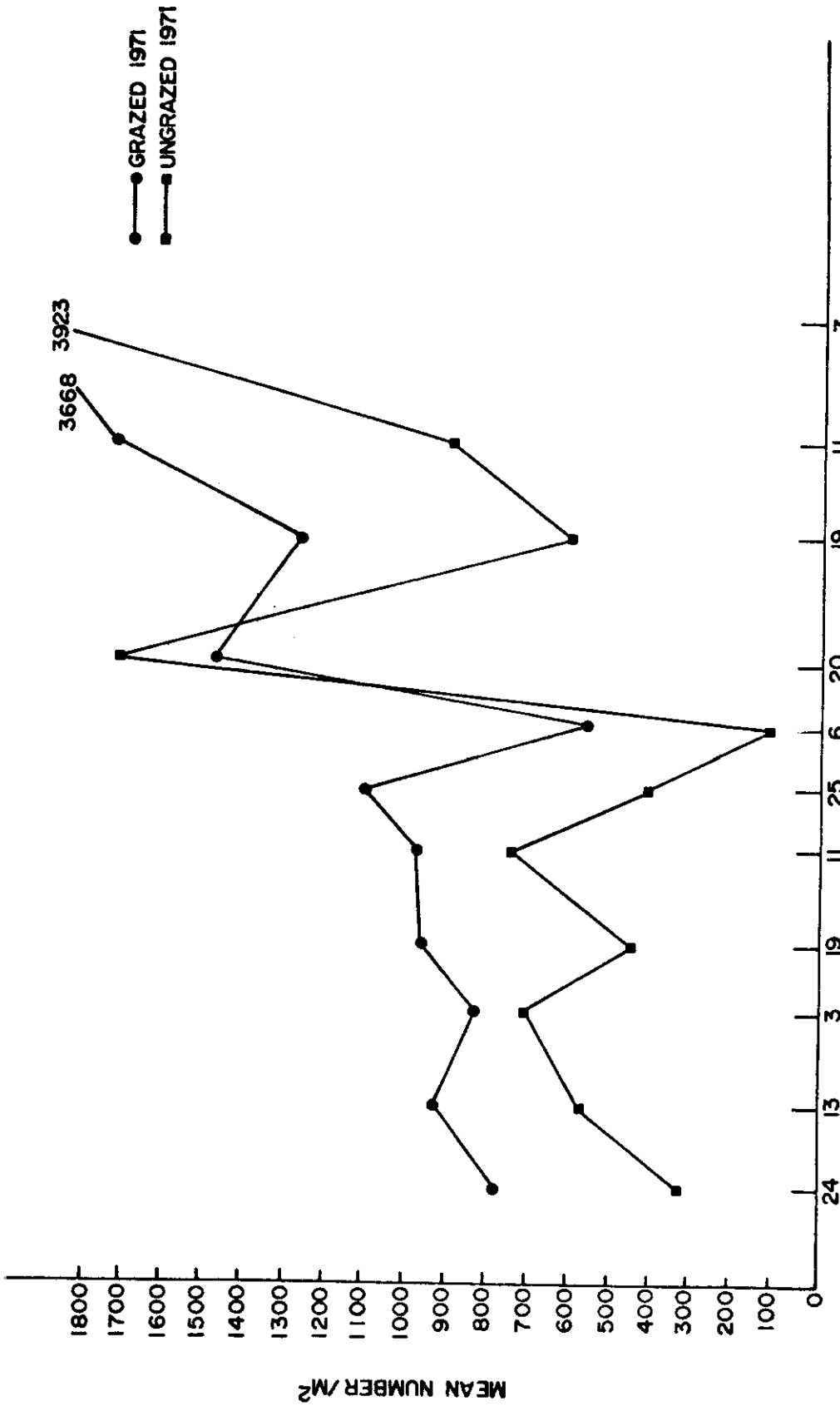
Appendix Fig. 2. Biomass of insects collected from grazed and ungrazed treatment, Osage Site, 1971.



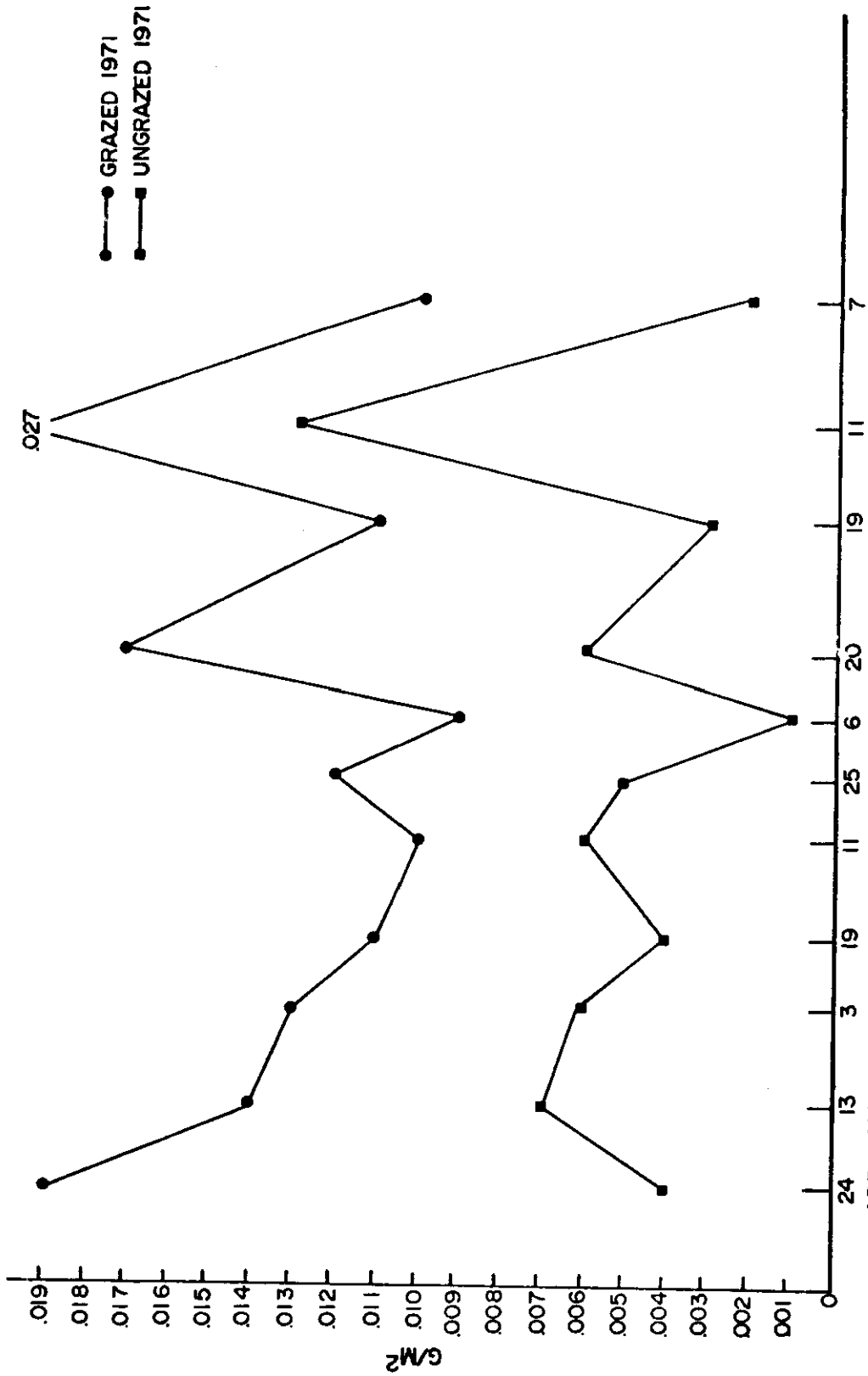
Appendix Fig. 3. Araneida numbers collected from grazed and ungrazed treatments, Osage Site, 1971.



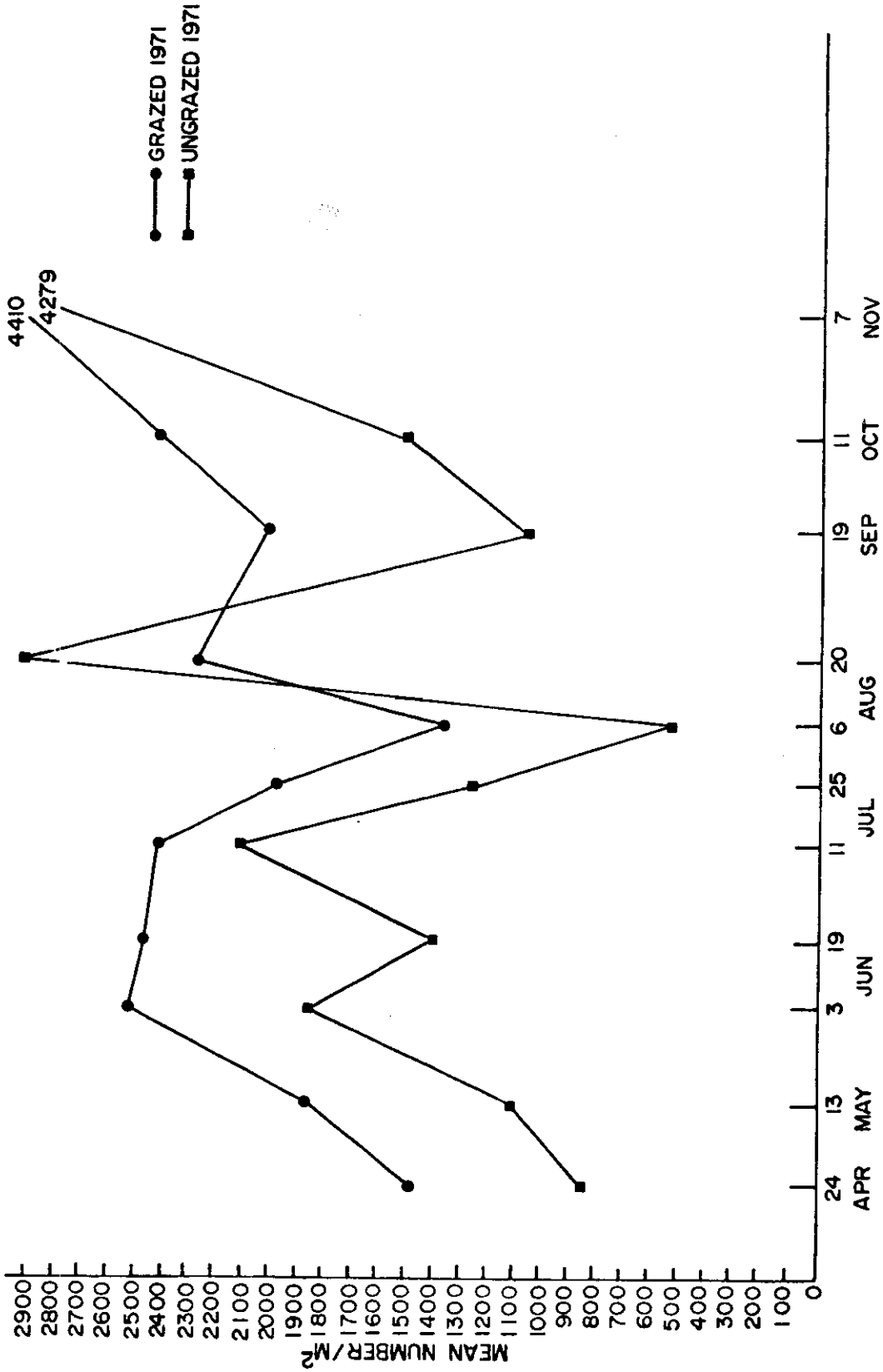
Appendix Fig. 4. Biomass of Araneida collected, Osage Site, 1971.



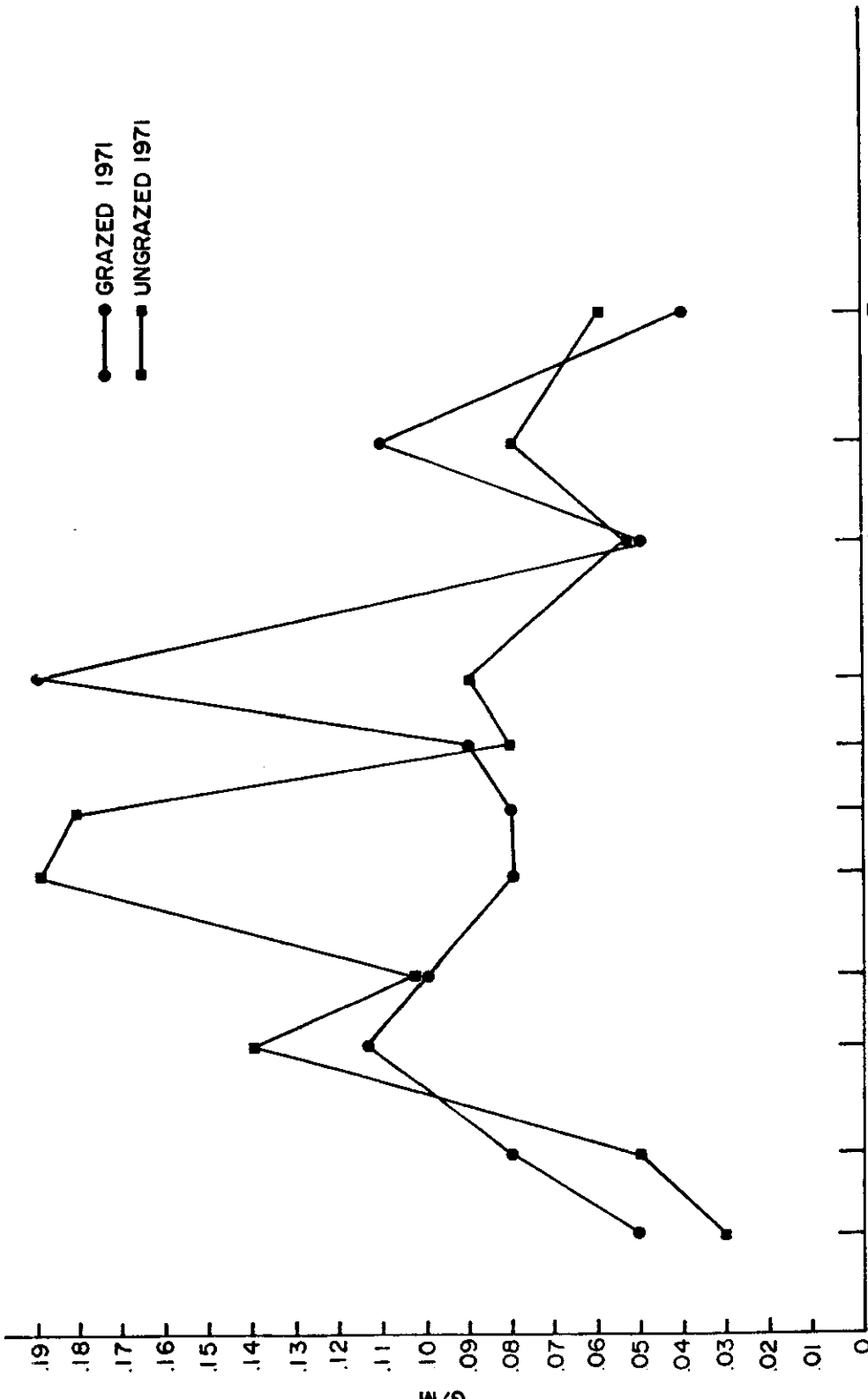
Appendix Fig. 5. Acarina numbers collected from grazed and ungrazed treatments, Osage Site, 1971.



Appendix Fig. 6. Biomass of Acarina collected from grazed and ungrazed treatments, Osage Site, 1971.



Appendix Fig. 7. Total invertebrate numbers collected from grazed and ungrazed treatments, Osage Site, 1971.



Appendix Fig. 3. Total invertebrate biomass collected from grazed and ungrazed treatments, Osage Site, 1971.

APPENDIX II

BELOWGROUND INVERTEBRATE DATA FOR 1971

Data from soil collections made during 1971 are included; however, these have not been carefully analyzed so they must be considered incomplete at the present time. Taxa collected are shown in Appendix Table 1.

Soil samples consisted of six cores, 2 inches in diameter and 50 cm deep, which were taken in each treatment. Cores were placed in modified Berlese funnels for several days for extraction of specimens into 70% isopropyl alcohol. Cores were subsequently placed in a kerosene-water mixture in an attempt to float any remaining specimens. Frequent checks of the core remnants under a binocular microscope indicated that extraction efficiency was high. The average number of specimens per core was determined, and this number was multiplied by 493.63 to arrive at the average number per square meter. Biomass was calculated by weighing the total number of specimens per treatment. The average weight per core was then determined, and the above conversion factor was used to determine biomass per square meter.

No specimens were collected below 20 cm in June; a considerable number occurred here during October suggesting movement deeper into the soil in the fall. Comparisons are shown in Appendix Table 2.

During October a total of approximately 134,682 specimens/m^2 were collected from the ungrazed plots; biomass was approximately 1.43 g/m^2. Approximately 57,776 specimens/m^2 were collected in the grazed plots in October; biomass was approximately 1.2 g/m^2. Careful data analysis might alter these figures to some extent.

Appendix Table 1. Taxa collected from soil cores taken in grazed and ungrazed treatments in June and October 1971, Osage Site.

Chilopoda
Acarina
Collembola
Entomobryidae
Poduridae
Sminthuridae
Coleoptera
Nitidulidae
Pselaphidae
Diptera
Chironomidae
Chloropidae
Homoptera
Coccidae
Hemiptera
Miridae
Hymenoptera
Formicidae
Mymaridae
Eupelmidae?
Orussidae?
Orthoptera
Blattidae
Thysanoptera
Thysanura
Japygidae
Protura
Pseudoscorpionidae
Symphyla

Appendi Table 2. Invertebrate numbers per square meter collected at various soil depths, Osage Site, 1971.

Date of Treatment[a] (depth in cm)	Acarina	Collembola	Thysanura	Protura	Insecta	Other[b]
Ungrazed: 6-18-1971						
0 to 5	12,425	1,397	331			
5 to 10	8,772	163	331			
10 to 20	2,799	84	331			
20 to 50						
Total (0 to 50)	23,946	1,644	987			
Grazed: 6-18-1971						
0 to 5	10,613	3,125	163			247
5 to 10	1,975	578	578			247
10 to 20	2,715	494	331			331
20 to 50						
Total (0 to 50)	15,303	4,196	1,071			824
Ungrazed: 10-10-1971						
0 to 5	50,513	1,071		247	414	84
5 to 10	13,659	247			420	163
10 to 20	27,890	2,552	657	331	1,896	578
20 to 50	22,791	6,664	1,234	331	2,054	410
Total (0 to 50)	114,853	11,023	1,891	903	4,778	1,234
Grazed: 10-10-1971						
0 to 5	8,308	578		247	2,221	
5 to 10	6,170	247	163		987	
10 to 20	6,170	578	657	84	583	331
20 to 50	16,783	7,158	3,949	410	1,401	740
Total (0 to 50)	37,432	8,555	4,773	740	5,193	1,071

[a] Counts of Acarina, Collembola, and Thysanura are all that is available for 6/18/1971 (except for other).

[b] This category consists of Chilopoda (June & October) and Symphyla and Pseudoscorpionida (October).

APPENDIX III

FIELD DATA

Invertebrate data collected at the Osage Site in 1971 is Grassland Biome Data Set A2U3009. Data were collected on form NREL-30. A copy of the form and an example of the data are attached.

IBP

GRASSLAND BIOME

U.S. INTERNATIONAL BIOLOGICAL PROGRAM

FIELD DATA SHEET - INVERTEBRATE

D/ TYPE	SITE	INITIALS	DATE Day	DATE Mo	DATE Yr	TREATMENT	REPLICATE	PLOT SIZE	QUADRAT	TROPHIC	HOST	ORDER	FAMILY	GENUS	SPECIES	SUBSPECIES	LIFE STAGE	TOTAL NO.	DRY WT.	NO. WEIGH
									20-21	33	25-29	31-32	35-37	39-40	42-43	45	47-48	50-55	57-62	64-66

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
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

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

TREATMENT

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

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 +++

```
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3009RR	250771120.5004	1	[illegible]	10	1	.0069 2
3009RR	250771120.5004	2	[illegible]	40	41	
3009RR	250771120.5004	5	[illegible]	40	1	.0229 1
3009RR	250771120.5004	0	[illegible]	40	15	
3009RR	250771120.5004	5	[illegible]	10	38	
3009RR	250771120.5004	0	[illegible]	10	130	
3009RR	250771120.5005	7	[illegible]	10	162	
3009RR	250771120.5005	6	[illegible]	10	1	
3009RR	250771120.5005	6	[illegible]	10	7	
3009RR	250771120.5005	1	[illegible]	10	9	
3009RR	250771120.5005	0	[illegible]	10	13	
3009RR	250771120.5005	2	[illegible]	10	1	
3009RR	250771120.5005	1	[illegible]	10	1	
3009RR	250771120.5005	[illegible]	[illegible]	10	1	
3009RR	250771120.5005	1	[illegible]	10	1	
3009RR	250771120.5005	1	[illegible]	40	9	
3009RR	250771120.5005	2	[illegible]	10	24	
3009RR	250771120.5005	2	[illegible]	10	2	
3009RR	250771120.5005	2	[illegible]	40	13	
3009RR	250771120.5005	2	[illegible]	40	2	
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3009RR	250771120.5005	3	[illegible]	10	275	
3009RR	250771120.5005	2	[illegible]	10	2	.0004 2
3009RR	250771120.5005	2	[illegible]	40	47	
3009RR	250771120.5005	2	[illegible]	40	1	
3009RR	250771120.5005	0	[illegible]	40	7	
3009RR	250771120.5005	5	[illegible]	10	3	
3009RR	250771120.5005	0	[illegible]	10	150	
3009RR	250771510.5001	7	[illegible]	10	23	.0548 584
3009RR	250771510.5001	6	[illegible]	10	1	
3009RR	250771510.5001	6	[illegible]	10	1	
3009RR	250771510.5001	6	[illegible]	10	1	
3009RR	250771510.5001	0	[illegible]	10	10	
3009RR	250771510.5001	1	[illegible]	10	21	
3009RR	250771510.5001		[illegible]	10		.0009 230
3009RR	250771510.5001	5	COLESTAP	10	3	.0001 5

3009RR	250771510.5001	5	COLECAPA	10	1	.0009 2
3009RR	250771510.5001	1	COLE	40	15	.0005 79
3009RR	250771510.5001	2	HOMOCOCC	10	29	.0010 144
3009RR	250771510.5001	2	HOMOCICI	10	1	.0064 6
3009RR	250771510.5001	2	HOMOCICI	40	4	.0080 31
3009RR	250771510.5001	2	HOMOFILG	40	1	.0007 4
3009RR	250771510.5001	2	HOMOFILP	40	3	.0065 136
3009RR	250771510.5001	3	THY2	10	73	.0026 476
3009RR	250771510.5001	0	TEST	40		
3009RR	250771510.5001	1	DIPTSCIA	10	1	
3009RR	250771510.5001	5	ARAN	10	2	.0032 43
3009RR	250771510.5001	0	ACAR	10	607	.02903293
3009RR	250771510.5001	8	[illegible]	10	1	
3009RR	250771510.5001	1	COLECHRY	10	1	.0007 2
3009RR	250771510.5002	7	HYMEFCOA	10	148	
3009RR	250771510.5002	6	HYMETHYS	10	2	.0001 13
3009RR	250771510.5002	6	HYMFRTED	10	2	
3009RR	250771510.5002	1	COLISMIN	10	18	
3009RR	250771510.5002	0	COLIENTO	10	21	
3009RR	250771510.5002		COLI	10		
3009RR	250771510.5002	5	COLESTID	10	1	
3009RR	250771510.5002	2	COLENTTI	10	5	.0003 27
3009RR	250771510.5002	1	COLECURC	10	2	.0145 4
3009RR	250771510.5002	3	COLETHED	10	1	
3009RR	250771510.5002	1	COLE	40	13	
3009RR	250771510.5002	2	HOMOISST	40	1	.0008 2
3009RR	250771510.5002	2	HOMOCOCC	10	10	
3009RR	250771510.5002	2	HOMOCICI	40	5	
3009RR	250771510.5002	2	HOMOFILG	40	1	
3009RR	250771510.5002	2	HOMOFILP	40	16	
3009RR	250771510.5002	3	THY2	10	114	
3009RR	250771510.5002	2	HEMILYSA	40	1	.0017 9
3009RR	250771510.5002	0	TST	40	5	
3009RR	250771510.5002	5	ARAN	10	2	
3009RR	250771510.5002	0	ACAR	10	917	
3009RR	250771510.5003	7	HYMEFCOA	10	150	
3009RR	250771510.5003	6	HYMEFNCY	10	4	
3009RR	250771510.5003	6	HYMETHYS	10	4	
3009RR	250771510.5003	6	HYMFRTC	10	1	
3009RR	250771510.5003	6	HYMFRTED	10	1	
3009RR	250771510.5003	6	HYMFHRAC	10	1	.0002 3
3009RR	250771510.5003	1	COLISMIN	10	28	
3009RR	250771510.5003	0	COLIENTO	10	7	
3009RR	250771510.5003		COLI	10		
3009RR	250771510.5003	5	COLECAPA	10	1	
3009RR	250771510.5003	2	COLENTTI	10	8	
3009RR	250771510.5003	1	COLECURC	10	1	
3009RR	250771510.5003	1	COLE	40	24	
3009RR	250771510.5003	2	HOMOCOCC	10	26	
3009RR	250771510.5003	2	HOMOCICI	40	6	
3009RR	250771510.5003	2	HOMOFILP	40	13	
3009RR	250771510.5003	3	THY2	10	136	
3009RR	250771510.5003	1	[illegible]	40	1	
3009RR	250771510.5003	8	[illegible]	10	1	.0020 1

3009RR	250771510.5003	1	[illegible]	40	1	.0031 2
3009RR	250771510.5003	2	[illegible]	40	2	
3009RR	250771510.5003	0	[illegible]	40	6	
3009RR	250771510.5003	5	[illegible]	10	1	
3009RR	250771510.5003	0	ACAR	10	598	
3009RR	250771510.5003	8	THYLIARY	10	1	
3009RR	250771510.5004	7	HYMEFORM	10	189	
3009RR	250771510.5004	6	HYMEFUL0	10	1	
3009RR	250771510.5004	6	HYMETHYS	10	3	
3009RR	250771510.5004	6	HYMERTED	10	1	
3009RR	250771510.5004	6	HYMERRAC	10	1	
3009RR	250771510.5004	0	HYME	10	6	.0002 17
3009RR	250771510.5004	1	COLLSMTN	10	39	
3009RR	250771510.5004	1	COLLPODU	10	2	
3009RR	250771510.5004	0	COLLENTO	10	35	
3009RR	250771510.5004		COLL	10		
3009RR	250771510.5004	2	COLENTTT	10	13	
3009RR	250771510.5004	1	COLECHRY	10	1	
3009RR	250771510.5004	1	COLE	40	22	
3009RR	250771510.5004	2	HOMOCOCC	10	10	
3009RR	250771510.5004	2	HOMOCTC1	10	3	
3009RR	250771510.5004	2	HOMOCTC1	40	9	
3009RR	250771510.5004	2	HOMOFUL0	40	2	
3009RR	250771510.5004	2	HOMOARHT	40	1	
3009RR	250771510.5004	2	HOMODELP	40	75	
3009RR	250771510.5004	3	THY2	10	94	
3009RR	250771510.5004	2	HOMOTSST	40	1	
3009RR	250771510.5004	2	HEATLY0A	40	2	
3009RR	250771510.5004	0	FIRT	40	5	
3009RR	250771510.5004	5	ARAN	10	13	
3009RR	250771510.5004	0	ACAR	10	440	
3009RR	250771510.5005	7	HYMEFORM	10	72	
3009RR	250771510.5005	6	HYMETHYS	10	4	
3009RR	250771510.5005	6	HYMEFNCY	10	2	
3009RR	250771510.5005	6	HYMEDRYT	10	1	
3009RR	250771510.5005	6	HYMERRAC	10	1	
3009RR	250771510.5005	6	HYMEFUL0	10	2	
3009RR	250771510.5005	6	HYMETCHN	10	1	.0117 1
3009RR	250771510.5005	5	ARAN	10	10	
3009RR	250771510.5005	0	ACAR	10	631	
3009RR	250771510.5005	8	PSOC	40	1	
3009RR	250771510.5005	1	COLLSMTN	10	21	
3009RR	250771510.5005	1	COLLPODU	10	2	
3009RR	250771510.5005	0	COLLENTO	10	23	
3009RR	250771510.5005	2	COLENTTT	10	1	
3009RR	250771510.5005	1	COLECHRY	10	1	
3009RR	250771510.5005	1	COLECURC	10	1	
3009RR	250771510.5005	3	COLETHER	10	1	
3009RR	250771510.5005	1	COLE	40	4	
3009RR	250771510.5005	2	HOMOCOCC	10	69	
3009RR	250771510.5005	2	HOMOCTC1	10	2	
3009RR	250771510.5005	2	HOMOCTC1	40	7	
3009RR	250771510.5005	2	HOMOFUL0	40	1	
3009RR	250771510.5005	2	HOMODELP	40	25	

3009RR	250771510.5005	3	THY2	10	61	
3009RR	250771510.5005	2	HOMOTSST	10	1	
3009RR	250771510.5005	1	LEPT	40	1	
3009RR	250771510.5005	2	HEMILYGA	40	4	
3009RR	250771510.5005	2	HEMIPENT	40	1	.0003 1
3009RR	250771510.5005	0	DIPT	40	4	
3009RR	250771520.5001	7	HYMEFORM	10	93	.0535 606
3009RR	250771520.5001	6	HYMEDPYT	10	1	
3009RR	250771520.5001	6	HYMEPTER	10	2	
3009RR	250771520.5001	6	HYMEBRAC	10		
3009RR	250771520.5001	1	COLLSMIN	10	66	
3009RR	250771520.5001	0	COLLENTO	10	28	
3009RR	250771520.5001		COLL	10		.0031 312
3009RR	250771520.5001	5	COLECARA	10	1	.0021 6
3009RR	250771520.5001	2	COLENTTI	10	25	.0027 87
3009RR	250771520.5001	1	COLE	40	81	.0021 153
3009RR	250771520.5001	2	HOMOCOCC	10	167	.0005 286
3009RR	250771520.5001	2	HOMOCIC1	10	1	.0251 7
3009RR	250771520.5001	2	HOMOCIC1	40	4	.0071 30
3009RR	250771520.5001	2	HOMOFULG	40	1	
3009RR	250771520.5001	2	HOMODELP	40	19	.0042 121
3009RR	250771520.5001	3	THY2	10	148	.0011 250
3009RR	250771520.5001	2	HEMILYGA	10	1	.0067 33
3009RR	250771520.5001	0	DIPT	40	5	
3009RR	250771520.5001	8	DIPTPHOR	10	1	
3009RR	250771520.5001	6	DIPTCEC1	10	1	
3009RR	250771520.5001	5	ARAN	10	3	.0043 42
3009RR	250771520.5001	0	ACAR	10	451	.03112312
3009RR	250771520.5001	8	PSOC	10	3	
3009RR	250771520.5001	0	HYME	10	5	.0004 11
3009RR	250771520.5002	7	HYMEFORM	10	141	
3009RR	250771520.5002	0	HYME	10	4	
3009RR	250771520.5002	6	HYMEDPYT	10	1	
3009RR	250771520.5002	6	HYMETHYS	10	4	.0007 18
3009RR	250771520.5002	6	HYMEENCY	10	3	
3009RR	250771520.5002	6	HYMETRIC	10	1	
3009RR	250771520.5002	1	COLLSMIN	10	31	
3009RR	250771520.5002	1	COLLPODU	10	5	
3009RR	250771520.5002	0	COLLENTO	10	34	
3009RR	250771520.5002		COLL	10		
3009RR	250771520.5002	5	COLESTAP	10	1	.0030 11
3009RR	250771520.5002	2	COLENTTI	10	4	
3009RR	250771520.5002	1	COLECHRY	10	1	.0016 1
3009RR	250771520.5002	1	COLECURC	10	5	.0064 12
3009RR	250771520.5002	3	COLETHER	10	1	.0023 17
3009RR	250771520.5002	1	COLE	10	13	
3009RR	250771520.5002	2	HOMOCOCC	10	8	
3009RR	250771520.5002	2	HOMOCIC1	10	3	
3009RR	250771520.5002	2	HOMOCIC1	40	9	
3009RR	250771520.5002	2	HOMODELP	40	26	
3009RR	250771520.5002	3	THY2	10	110	
3009RR	250771520.5002	2	HEMIMTPI	10	1	.0009 1
3009RR	250771520.5002	2	HEMILYGA	10	1	.0021 1
3009RR	250771520.5002	2	HEMILYGA	40	5	

3009RR	250771520.5002	5	ARAN	10	9
3009RR	250771520.5002	0	ACAR	10	386
3009RR	250771520.5002	8	PSOC	40	1
3009RR	250771520.5002	2	HEMIPENT	40	1 .0037 2
3009RR	250771520.5003	7	HYMEFORM	10	43
3009RR	250771520.5003	6	HYMEDRYI	10	1
3009RR	250771520.5003	0	HYME	10	1
3009RR	250771520.5003	6	HYMETRIC	10	2
3009RR	250771520.5003	6	HYMETHYS	10	4
3009RR	250771520.5003	6	HYMEENCY	10	6
3009RR	250771520.5003	6	HYMEPTER	10	2
3009RR	250771520.5003	1	COLLSMIN	10	43
3009RR	250771520.5003	0	COLLENTO	10	21
3009RR	250771520.5003		COLL	10	
3009RR	250771520.5003	5	COLECARA	10	1
3009RR	250771520.5003	3	COLEPHAL	10	1
3009RR	250771520.5003	2	COLENITI	10	47
3009RR	250771520.5003	1	COLECOCC	10	2 .0049 3
3009RR	250771520.5003	3	COLETHER	10	1
3009RR	250771520.5003	1	COLECURC	10	2
3009RR	250771520.5003	8	COLELATH	10	6 .0016 12
3009RR	250771520.5003	1	COLE	10	25
3009RR	250771520.5003	0	COLESCYD	10	1
3009RR	250771520.5003	2	HOMOCOCC	10	46
3009RR	250771520.5003	2	HOMOCICI	10	1
3009RR	250771520.5003	2	HOMOCICI	40	3
3009RR	250771520.5003	2	HOMODELP	40	34
3009RR	250771520.5003	3	THY2	10	155
3009RR	250771520.5003	1	ORTHGRYL	40	1
3009RR	250771520.5003	1	LEPI	40	1 .0589 1
3009RR	250771520.5003	5	HEMIREDU	10	1 .0126 1
3009RR	250771520.5003	2	HEMILYGA	40	14
3009RR	250771520.5003	2	HEMIPENT	40	1
3009RR	250771520.5003	0	DIPT	40	10
3009RR	250771520.5003	5	ARAN	10	17
3009RR	250771520.5003	0	ACAR	10	372
3009RR	250771520.5003	8	PSOC	40	2
3009RR	250771520.5003	5	NEUROPTE	10	1 .0014 1
3009RR	250771520.5004	7	HYMEFORM	10	86
3009RR	250771520.5004	6	HYMEDRYI	10	1
3009RR	250771520.5004	6	HYMETHYS	10	5
3009RR	250771520.5004	6	HYMEPTER	10	2
3009RR	250771520.5004	1	COLLSMIN	10	20
3009RR	250771520.5004	1	COLLROOT	10	1
3009RR	250771520.5004	0	COLLENTO	10	22
3009RR	250771520.5004		COLL	10	
3009RR	250771520.5004	5	COLECARA	10	4
3009RR	250771520.5004	5	COLESTAP	10	3
3009RR	250771520.5004	2	COLENITI	10	7
3009RR	250771520.5004	1	COLECOCC	10	1
3009RR	250771520.5004	1	COLECURC	10	2
3009RR	250771520.5004	8	COLELATH	10	5
3009RR	250771520.5004	3	COLETHER	10	4
3009RR	250771520.5004	1	COLE	40	15

3009RR	250771520.5004	2	HOMOCOCC	10	29
3009RR	250771520.5004	2	HOMOCIC1	10	2
3009RR	250771520.5004	2	HOMOCIC1	40	10
3009RR	250771520.5004	0	COLESCYD	10	3
3009RR	250771520.5004	3	THY2	10	166
3009RR	250771520.5004	2	HOMODELP	40	18
3009RR	250771520.5004	2	HEMILYGA	40	10
3009RR	250771520.5004	0	OIDT	40	9
3009RR	250771520.5004	5	ARAN	10	7
3009RR	250771520.5004	0	ACAP	10	491
3009RR	250771520.5004	8	PSOC	40	1
3009RR	250771520.5005	7	HYMEFORM	10	243
3009RR	250771520.5005	6	HYMEENCY	10	3
3009RR	250771520.5005	6	HYMETHYS	10	5
3009RR	250771520.5005	6	HYMERTED	10	4
3009RR	250771520.5005	6	HYMETRIC	10	2
3009RR	250771520.5005	1	COLLSMIN	10	31
3009RR	250771520.5005	0	COLLENTO	10	10
3009RR	250771520.5005		COLL	10	
3009RR	250771520.5005	5	COLESTAP	10	7
3009RR	250771520.5005	3	COLEPHAL	10	1
3009RR	250771520.5005	2	COLENTIT	10	4
3009RR	250771520.5005	1	COLECURC	10	3
3009RR	250771520.5005	8	COLELATH	10	1
3009RR	250771520.5005	3	COLETHER	10	11
3009RR	250771520.5005	1	COLE	40	19
3009RR	250771520.5005	2	HOMOCOCC	10	36
3009RR	250771520.5005	2	HOMOCIC1	40	4
3009RR	250771520.5005	2	HOMODELP	40	19
3009RR	250771520.5005	3	THY2	10	184
3009RR	250771520.5005	2	HEMILYGA	40	3
3009RR	250771520.5005	0	OIDT	40	8
3009RR	250771520.5005	5	ARAN	10	6
3009RR	250771520.5005	0	ACAP	10	612
3009RR	250771520.5005	8	PSOC	10	2