COLEOPTERA, ESPECIALLY CURCULIONIDAE, OF TALLGRASS PRAIRIE

by

ROBERT L. BERTWELL

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Approved by:

H D Blocker
Major Professor

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INTRODUCTION

Although some progress has been made in dealing with the complexity of structure and interaction at the community level (Elton and Miller 1954, Elton 1966), studies of a single community and its invertebrate fauna are still largely in the natural history stage of development (McDaniel 1971).

Detailed studies and analysis of plant and animal populations and their relations to one another and to the environment should be continued over a long period of years because fluctuations in rainfall (Table 22) and the differences noted in families of Coleoptera collected on a yearly basis (Tables 14 & 15) show the variability encountered in short term studies. This 2-year study can at least provide methodology and a basis for future studies involving grassland ecosystems.

Little consideration has been given to date to the quantitative sampling of Coleoptera in the tall-grass prairie of eastern Kansas or to the periodic burning of such areas. Furthermore, investigation of the responses of invertebrate populations, other than grasshoppers, to burning and grazing of rangelands has been limited.

Therefore, the primary purpose of this study was to quantitatively measure the effects of differently managed grassland treatments on the Coleoptera, specifically Curculionidae, of a tall-grass prairie located in the "Flint Hills" of eastern Kansas.

REVIEW OF LITERATURE

The Flint Hills area was described by Fly (1946) as a 3,800,000 acre region extending from a few miles south of the Nebraska line into Oklahoma where it is known as the "Osage Hills". The name "Flint Hills" came from the flinty or cherty limestone over which many of the soils have developed.

Average annual precipitation ranges downward from about 38 inches in Osage County, Oklahoma, to nearly 32 inches at Manhattan, Kansas. From three-fourths (north) to two-thirds (south) of the precipitation occurs as rainfall during the growing season, which approximates 6 months (Kollmorgen and Simonett 1965).

Many investigators have made observations on prairie insects. Hendrickson (1930) made sweep net collections over a 4-year period in the prairie plant associations of Iowa. Whelan (1936) has reported on the Coleoptera of an original prairie area near Lincoln, Nebraska. The study area in which he worked was similar to the pastures used in this study. Insects in little bluestem, barley and bromegrass pastures were studied by Wilbur and Fritz (1940) and Wilbur and Sabrosky (1936). Osborn (1939) discussed the ecological relationships of meadow and pasture insects. Brandhorst (1943) reported on the insects associated with pasture forbs and weedy plants in western Kansas, some of which were found in the grassland treatments used during this study. Schwitzgebel and Wilbur (1942) reported on the Coleoptera found associated with baldwin ironweed in Kansas. Walkden and Wilbur (1944) studied the insects and other arthropods found in pasture grasses, waste land and forage crops.

Reed (1972) reviewed the more recent literature on grassland invertebrates including trapping methods, efficiency of the DeVac, and the major families of Coleoptera found in this study.

MATERIALS AND METHODS

Areas of Study

Two treatments, burned-grazed and unburned-grazed, were located in "Donaldson Pastures", a 1143 acre tract purchased by the Kansas Agricultural Experiment Station in 1946. It is located approximately 2 miles west of Manhattan (T9, R7E, Sec. 27, Riley Co. Kansas). The physiognomy of range sites in these pastures has been thoroughly studied and reported by Anderson and Fly (1955).

A third treatment, unburned-ungrazed, was located in the Kansas State University Nuclear Shielding Site approximately 2.5 miles west of Manhattan (T10, R7E, Sec. 8, Riley Co. Kansas). Treatments were selected in areas that would not be affected by radioactivity.

The unburned-grazed and burned-grazed areas have been treated in that manner since 1950. The unburned-ungrazed area was acquired in 1964 and has since been ungrazed. One accidental fire occurred which burned most of the area in the mid 1960's (Faw, personal communication).

The range sites in this study can be summarized as follows:

Ordinary upland range site. Lands having sufficient depth of soil with medium or loamy texture and hence with suitable soil-plant moisture relations to support the type of vegetation that is climax on the zonal soils of the regional climate (Anderson and Fly 1955).

Clay upland range site. Lands having sufficient depth of soil but with somewhat less infiltration, slower permeability and a smaller percentage of water available to plants than ordinary uplands, hence supporting at best a somewhat preclimax vegetation (Anderson and Fly 1955). Therefore, the following 6 treatment combinations were used: burned-grazed, ordinary upland (BUGR-2); burned-grazed, clay upland (BUGR-5); unburned-grazed, ordinary upland (UBGR-2); unburned-grazed, clay upland (UBGR-5); unburned-ungrazed, ordinary upland (UBUG-2); and unburned-ungrazed, clay upland (UBUG-5).

Recording of Plant Information

Plant information was recorded for each 1/2 m^2 replicate on a data sheet designed for this study. Information recorded included: species present, estimates of the total grams of green vegetation, the average height of vegetation present and estimates of the percentage of weight and canopy cover for each species present. With this information, correlations were made between the plants and insects found in each replicate.

Periodic checks of estimates for percent weight of each species present and the total grams of green vegetation were made during this study. A 1/2 m^2 sample space adjacent to a collecting area was estimated, then clipped to ground level and weighed to make sure that estimates of the total grams of green vegetation were within 50g of the actual weight and that the estimates for percent weight of each species was accurate. Adjustments were made when necessary but estimates were generally in the 50g range.

Collecting Procedure

Coleoptera were sampled between May 26 and October 7, 1971 and between May 24 and August 17, 1972 from 3 treatments in 2 soil types with 3 replications in each. There were 100 sample points spaced approximately 15 feet apart in each treatment and soil type. Samples of 1/2 m^2 were taken at 3 predesignated random points for each collection period. The 100 sample points were selected randomly without replacement.

The stabilized drop trap used in this study was designed and built by C. E. Mason. An unpublished manuscript by Mason and Blocker describes the trap in detail. It was designed to be set in an inverted position on an adjacent replication which prevented the area to be sampled from being disturbed before the trap was dropped (Fig. 1).

A portable gasoline-powered vacuum collector (DeVac) was used to remove the above ground invertebrate population (Fig. 2). Several modifications were made prior to initiating this study so the DeVac would be better adapted to this trapping method and easier to transport in the field (Reed 1972).

The above ground herbage in the three replicates of each treatment and soil type (i.e., 18 samples) were clipped to near ground level during 1971 to determine how much more efficient clipping would make the sampling technique. Clipping increased the total number of adult beetles by approximately 14.5% and the total number of immatures by approximately 13.2%. Therefore, all samples were clipped in 1972.

Separation and Weighing Technique

Modified Berlese funnels were used to separate invertebrates from soil and litter. During the 1971 collecting season, the funnels shown in Fig. 3 were used. They were made from 7.5 liter galvanized tin cans. However, samples taken during 1971 proved to be too large and new funnels were constructed from 75 liter galvanized garbage cans for the 1972 season (Fig. 4).

Samples were placed in funnels for 48-96 hours and specimens were collected in jars containing 70% isopropyl alcohol. A kerosene extraction method suggested by Dr. Carl Rettenmeyer, former Professor of Entomology at Kansas State University, was used to remove invertebrates from soil and mulch that fell through the funnels. Material was air dried in jars in order to remove most of the excess alcohol. Then, 2-4 ml of kerosene and approximately 400 ml of water were added to the nearly dry material and shaken vigorously. After setting for a short period of time, the kerosene and insects formed a layer on top of the water. Soil and litter sank to the bottom of the jar. The kerosene layer was then poured off and filtered through a fine mesh cloth (50-mesh/cm). More water was then added to the soil and litter in the bottom of the jar and the sample was shaken and poured off again. The extracted invertebrates and a small amount of material that refused to separate were then washed back into a clean jar with 70% isopropyl alcohol and hand sorted.

This technique proved to be efficient in removing the desired insects. Samples were periodically examined throughout the course of

FIG. 1. Stabilized drop trap being lifted from an inverted position in preparation for sampling drop.

FIG. 2. Vacuum collector and associated collecting apparatus.

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FIG. 1

FIG. 2

FIG. 3. Modified Berlese funnels used during 1971 showing general construction and method of suspension.

FIG. 4. Modified Berlese funnels used during 1972 showing general construction and method of suspension.

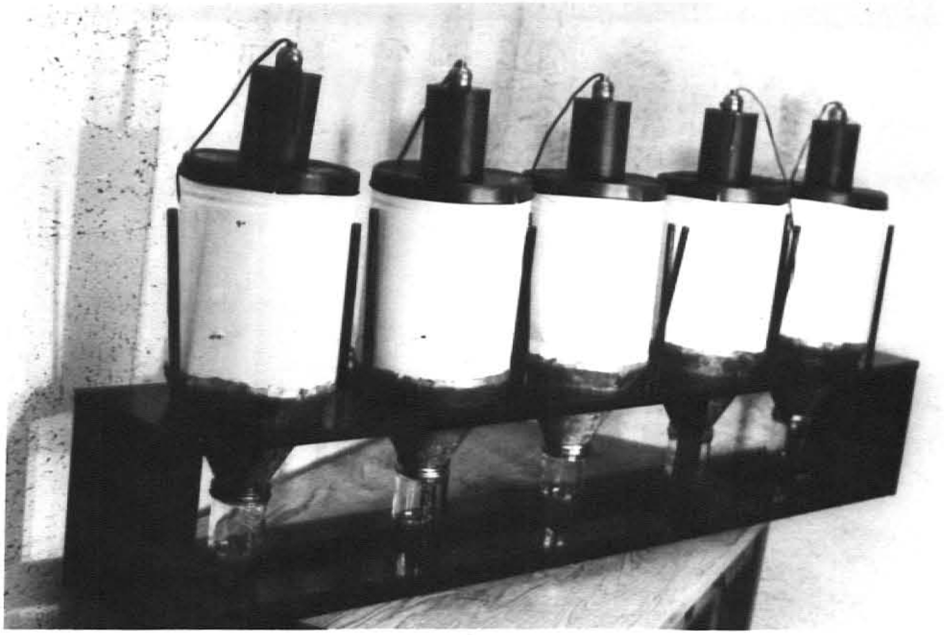

FIG. 3

FIG. 4

this study, after they had been washed. One adult curculionid was found that had failed to separate. However, other arthropods such as spiders, millipedes, mites and Collembola were found more frequently.

Adult Coleoptera were sorted to family and immatures to order. Both were counted, oven dried at 60 C for 24 hr and weighed to the nearest .0001g on a Mettler balance. Samples removed from the oven were immediately placed in an air tight plastic box which contained Drierite (anhydrous $CaSO_4$) to prevent specimens from reabsorbing moisture from the air prior to being weighed.

Methods of Analysis

An IBM 360/50 computer, using the AARDVARK system, was used to perform 2-way analysis of variance on the Coleoptera and plant data accumulated during this study. Bartlett's test of homogeneity was used to test the data for normality. Non-normal data was transformed ($\sqrt{x}$). Least significant differences (LSD) were used to determine differences in population means. A CalComp Digital Incremental Plotter was used to plot all graphs.

RESULTS AND DISCUSSION

Vegetation on the study areas was primarily warm season grasses; however, numerous forbs and woody species were also present in varying amounts (Tables 12 & 13). The burned-grazed area had fewer forbs and very low amounts of woody species compared to the unburned-grazed and unburned-ungrazed areas. Woody species were higher on the unburned-grazed than on the burned-grazed but much lower than on the unburned-ungrazed area.

Litter (dead plant material) accumulation on the soil surface was observed to be heavy in the unburned-ungrazed area, moderate in the unburned-grazed and very light in the burned-grazed area.

During 1971 and 1972, 37 families of Coleoptera were determined from grassland treatments (Tables 14 & 15). Of the family Curculionidae, 30 genera and 35 species were determined (Table 16). These numbers include 17 genera and 14 species of weevils collected from grassland treatments during 1971 (Table 18) and 18 genera and 17 species during 1972 (Table 20). The disproportion of genera to species is because some specimens were determined only to genus. Additional species were taken from areas other than grassland treatments (Tables 19 & 21). The trophic level, number of individuals/m^2 and biomass (g/m^2) for all Coleoptera families, was determined for 1971 and 1972 (Tables 14 & 15).

Major families according to numbers and biomass for 1971 and 1972 were similar. In both years, Carabidae, Chrysomelidae, Coccinellidae, Curculionidae and Staphylinidae were major contributors to numbers and biomass. Lathridiidae, Nitidulidae and Ptiliidae contributed considerable numbers but little biomass due to their small size. Elateridae, on the other hand, were not found in large numbers but made a significant contribution to biomass because of their large size.

Adult Coleoptera numbers in 1971 (Fig. 5) underwent considerable fluctuation. A steady increase began with collecting period 4 (16 June 1971) and peaked during collecting period 10 (11 August 1971) with over

90 individuals/m^2. A second peak in adult numbers occurred in collecting period 14 (23 September 1971).

Evans and Murdoch (1968) found in the course of an annual season of insect activity that there was a gradual progression in diversity to a peak in midsummer, and a gradual decline towards autumn. The peak coincided approximately with the maximum standing crop of plant biomass.

Immature Coleoptera numbers (Fig. 5), although different from adults, are of interest because peak immature numbers preceded peak adult numbers during 1971 by less than 6 weeks in every case.

Large fluctuations in adult Coleoptera biomass occurred during 1971 (Fig. 6). Several peaks were noted during the year with the highest biomass (g/m^2) being recorded during collecting period 7 (7 July 1971).

Adult Coleoptera numbers in 1972 (Fig. 7) showed 3 peaks, during an abbreviated collecting year. The first occurred during the first collecting period (25 May 1972). An early spring with warm temperatures and above average precipitation (Table 22) may have been primarily responsible for this early peak. Other peaks in adult numbers were noted during collection period 3 (20 June 1972) and collecting period 6 (17 July 1972).

Immature Coleoptera numbers (Fig. 7) followed adult numbers closely for the first 3 collecting periods and then declined steadily for the duration of 1972. Once again peak immature numbers preceded peak adult numbers by less than 6 weeks in every case. Peak adult Coleoptera numbers may, therefore, be predictable to some extent when based on immature numbers.

Adult Coleoptera biomass for 1972 was variable. One large peak in collecting period 3 (20 June 1972) was the only major fluctuation noted. Biomass dropped rapidly after collecting period 3, leveled off for collecting periods 5 (10 July 1972) and 6 (17 August 1972), then continued to decline for the rest of the year. Vegetation in the treatment areas became very dry during the July and August collections of 1972 because of below average rainfall (Table 22). This, probably more than any other factor, contributed to the decline in biomass.

Immature Coleoptera biomass maintained an insignificant level throughout 1971 and 1972 (Figs. 6 & 8). It was, therefore, not included in the final analysis of data and will not be discussed further.

Comparisons of data collected during this study with data reported by other authors are generally not possible because quantitative sampling methods used in this study have not been widely used. The results of sweep-net collections, for example, cannot be compared to the results found here because a precise unit area is not sampled.

Nagel (1972, unpublished data), using a sweep-net collecting method in the same general sampling area during 1969, found significantly greater numbers and biomass of Coleoptera in burned-grazed treatment areas than in unburned-grazed. He did not sample an unburned-ungrazed area. Data collected during this study showed opposite results. Numbers and biomass of adult Coleoptera in the various grassland treatments sampled during 1971 and 1972 (Tables 9 & 10) are conclusive. Total numbers and biomass collected during 1971 are: unburned-ungrazed, 1155 (.6043g); unburned-grazed, 1128 (.5602g); and burned-grazed, 970 (.3882g). Total numbers and biomass collected in 1972 are: unburned-ungrazed, 961

(.3447g); unburned-grazed, 504 (.3495g); and burned-grazed, 291 (.1771g). These results differ greatly from the sweep-net studies perhaps because samples in this study included everything from the surface of the soil to the top of the vegetation. Sweeping samples no more than the top one-half of the vegetation. This helps explain why great differences in family composition are noted when the two collecting methods are compared; also, seasonal differences occur and could have contributed to the variation between these studies.

Statistical Analysis of Coleoptera and Plant Data

Numbers between treatments (Table 1) were not significant but soils and the interaction between treatments and soils were significant in 1971. Unburned-ungrazed, soil 5, produced more individuals and was significantly different from other treatment combinations.

Analysis of variance for 1971 Coleoptera biomass (Table 2) indicates that interaction between treatment combinations was significant but overlap of interaction means prevented making any clear-cut distinction between them.

Analysis of variance for the plant information was recorded during 1971 in grassland treatments (Tables 3, 4 & 5). The three variables considered were: the number of plant species, the average plant height (estimate) and plant species biomass (estimate). All plant variables showed conclusively, when compared to previously reported Coleoptera information, that beetles in grasslands are influenced by the type of vegetation present. The unburned-ungrazed treatment had significantly

FIG. 5. Adult and immature Coleoptera numbers/m^2 from all treatments for 1971. Dates corresponding to the collecting periods are:

*	1.	May 19
*	2.	May 26
*	3.	June 9
*	4.	June 16
	5.	June 23
	6.	July 1
	7.	July 7
	8.	July 21
	9.	August 3
	10.	August 11
	11.	August 18
	12.	August 27
	13.	September 9
	14.	September 23
	15.	October 7

*Collections do not include the unburned-ungrazed grassland treatment and were, therefore, not included in the analysis of data.

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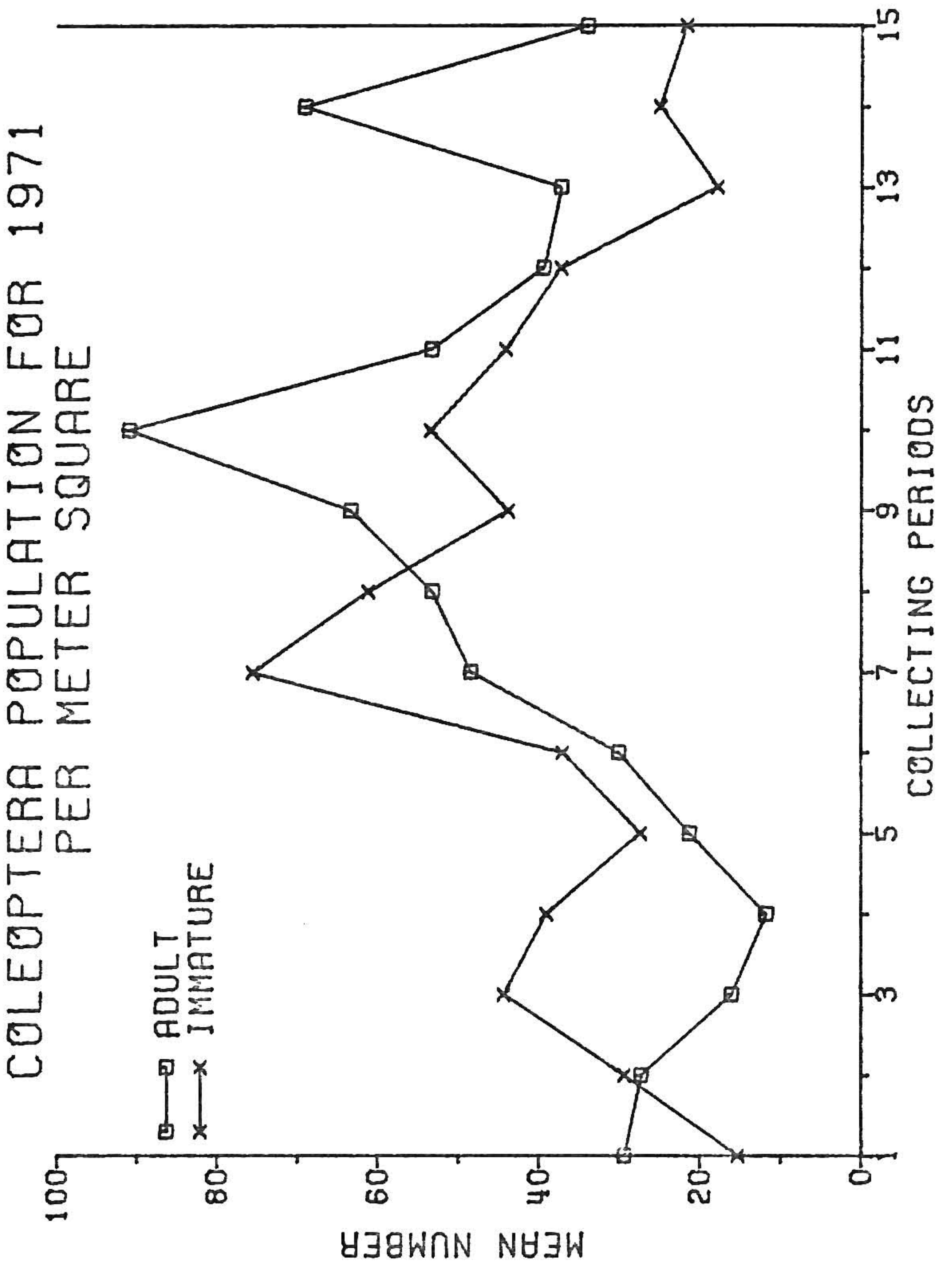

COLEOPTERA POPULATION FOR 1971
PER METER SQUARE
ADULT
IMMATURE
MEAN NUMBER
0
20
40
60
80
100
COLLECTING PERIODS
3
5
7
9
11
13
15

FIG. 5

FIG. 6. Adult and immature Coleoptera biomass (g/m^2) from all treatments for 1971.

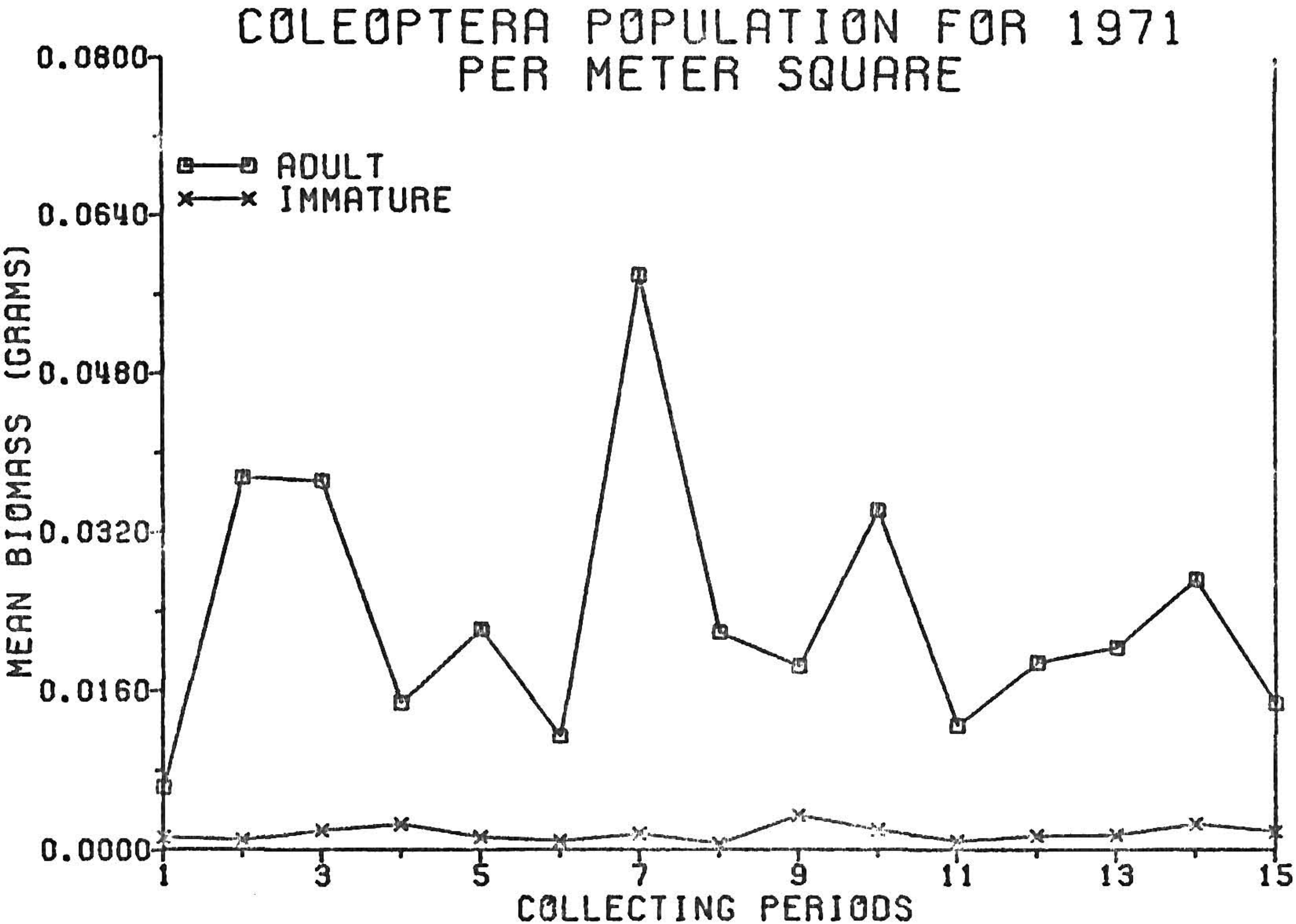

COLEOPTERA POPULATION FOR 1971
PER METER SQUARE
ADULT
IMMATURE
MEAN BIOMASS (GRAMS)
0.0800
0.0640
0.0480
0.0320
0.0160
0.0000
1
3
5
7
9
11
13
15
COLLECTING PERIODS

FIG. 6

FIG. 7. Adult and immature Coleoptera number/m^2 from all treatments for 1972. Dates corresponding to the collecting periods are:

1. May 25
2. June 8
3. June 20
4. June 28
5. July 10
6. July 17
7. August 7
8. August 17

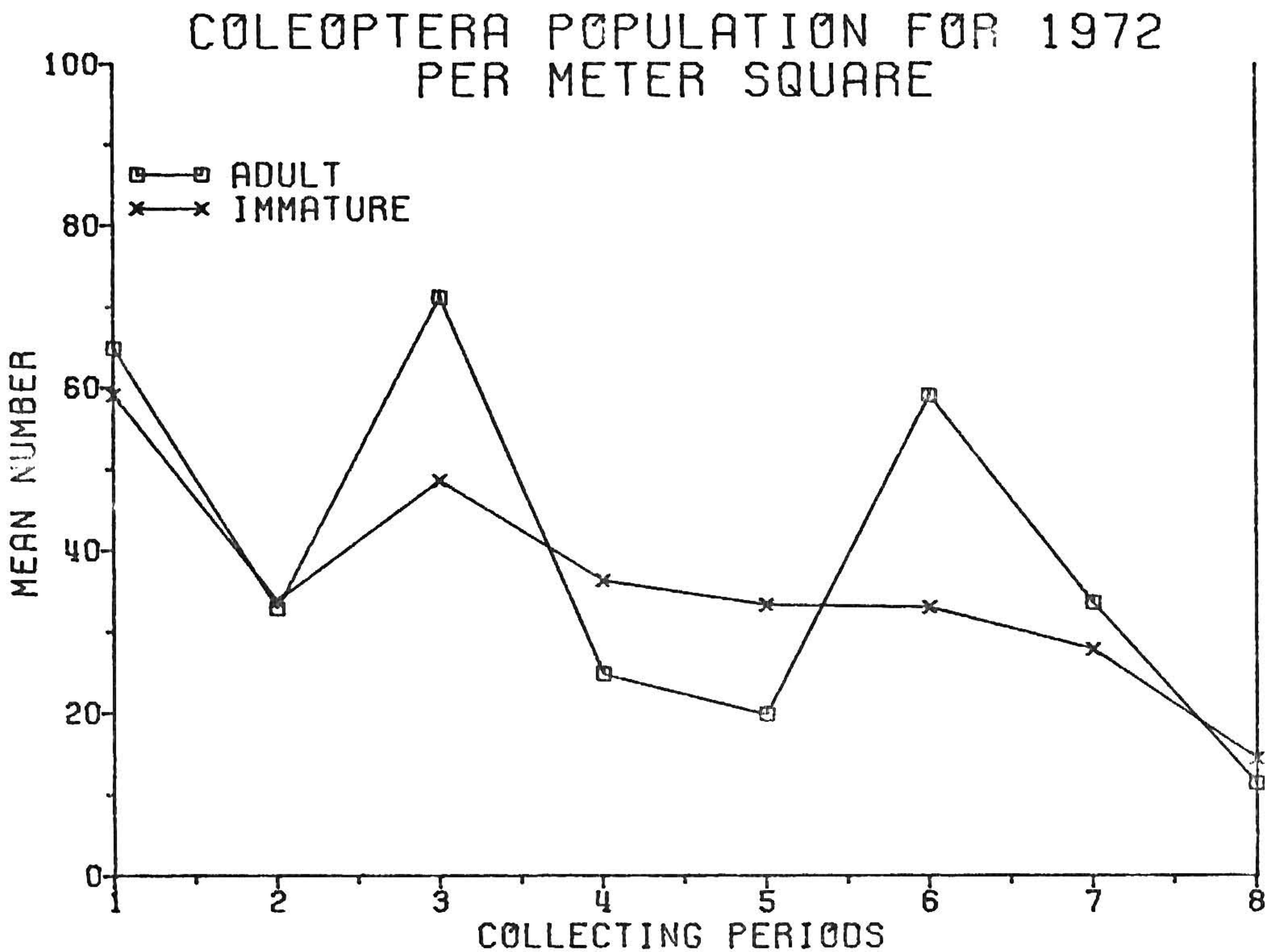

COLEOPTERA POPULATION FOR 1972
PER METER SQUARE
ADULT
IMMATURE
MEAN NUMBER
0
20
40
60
80
100
1
2
3
4
5
6
7
8
COLLECTING PERIODS

FIG. 7

FIG. 8. Adult and immature Coleoptera biomass (g/m^2) from all treatments for 1972.

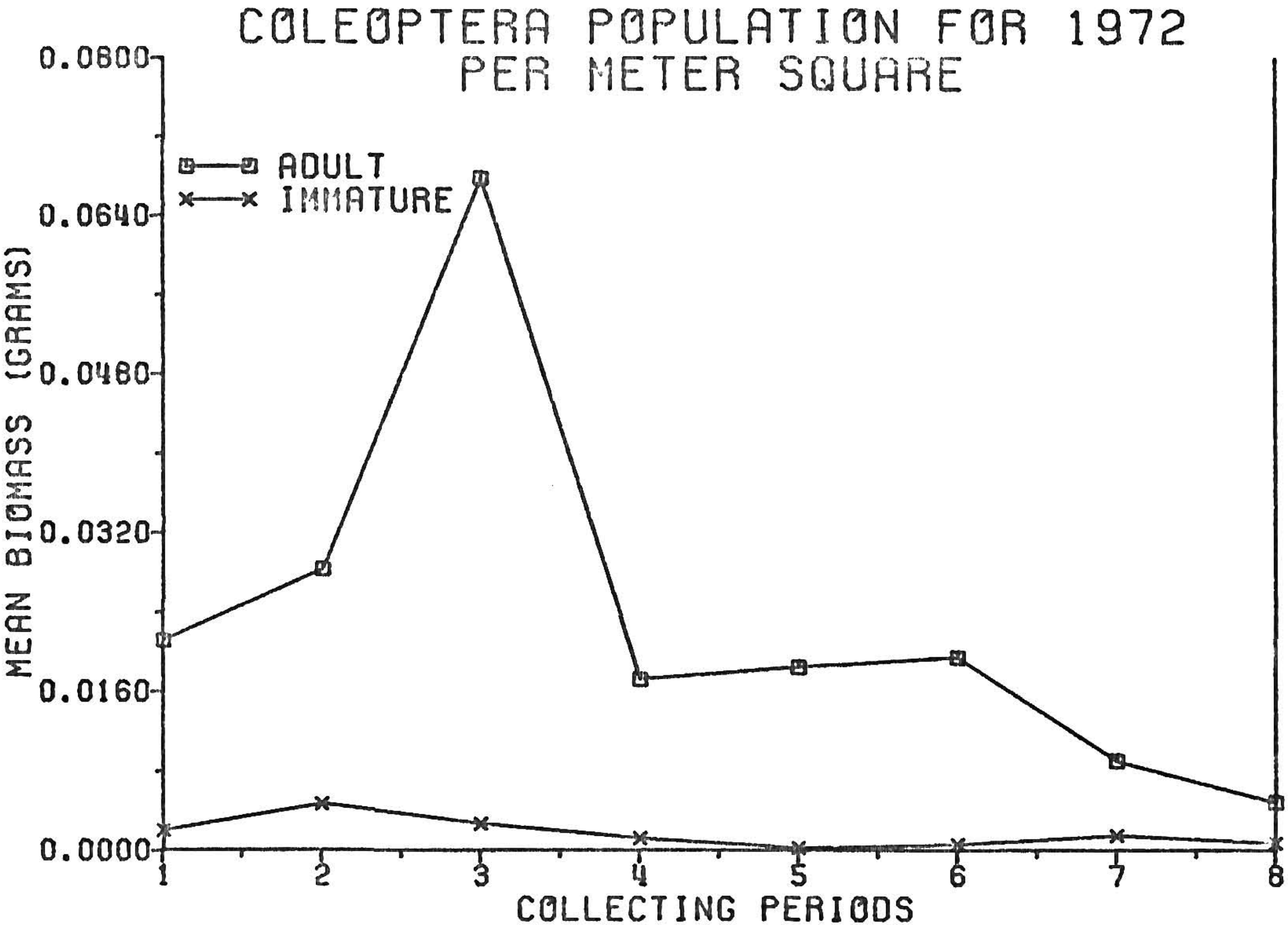
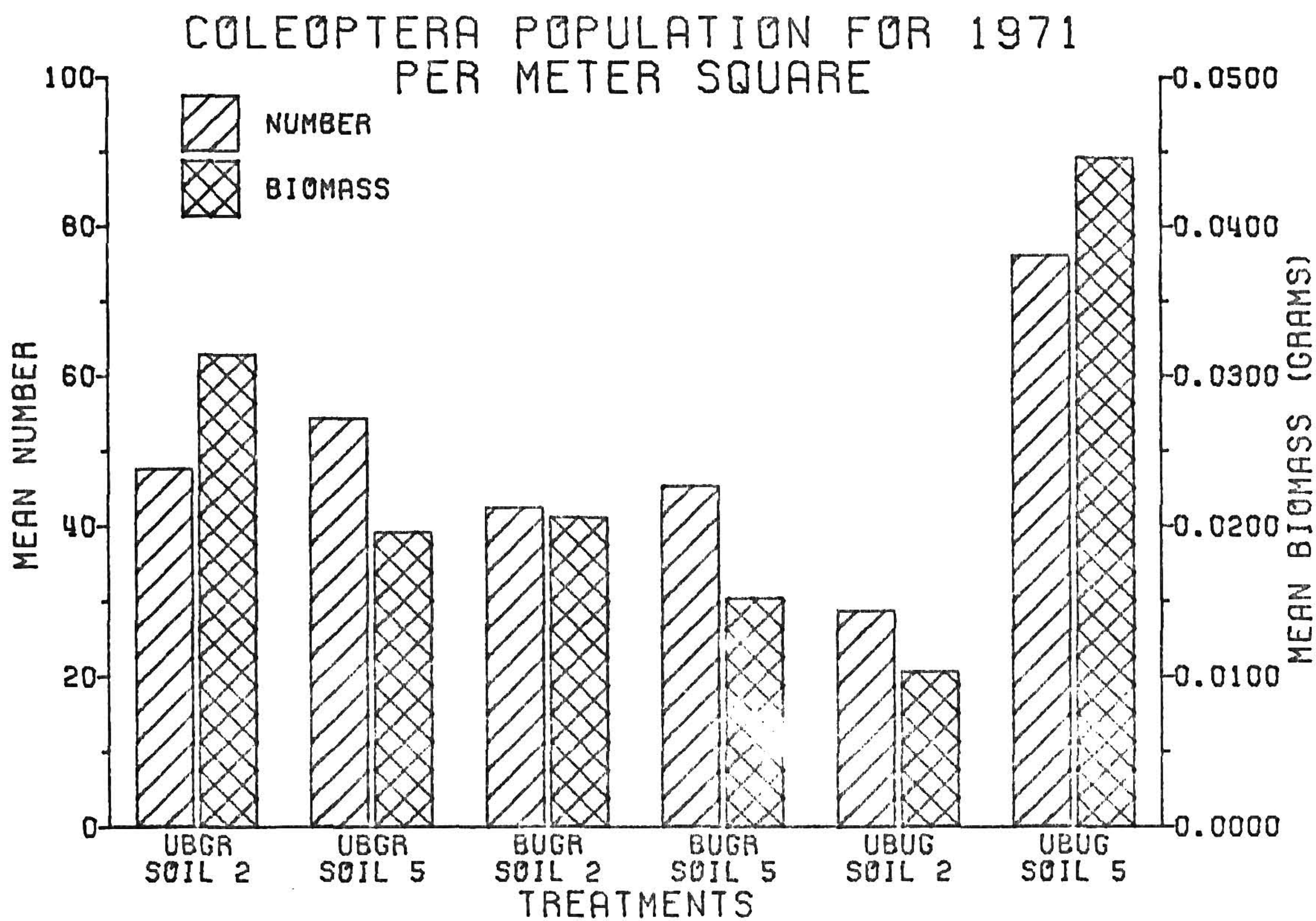

COLEOPTERA POPULATION FOR 1972
PER METER SQUARE
ADULT
IMMATURE
MEAN BIOMASS (GRAMS)
0.0800
0.0640
0.0480
0.0320
0.0160
0.0000
1
2
3
4
5
6
7
8
COLLECTING PERIODS

FIG. 8

FIG. 9. Coleoptera numbers/m^2 and biomass (g/m^2) found in grassland treatments during 1971.



COLEOPTERA POPULATION FOR 1971
PER METER SQUARE
NUMBER
BIOMASS
MEAN NUMBER
100
80
60
40
20
0
MEAN BIOMASS (GRAMS)
0.0500
0.0400
0.0300
0.0200
0.0100
0.0000
UBGR SOIL 2
UBGR SOIL 5
BUGR SOIL 2
BUGR SOIL 5
UBUG SOIL 2
UBUG SOIL 5
TREATMENTS

FIG. 9

FIG. 10. Coleoptera numbers/m^2 and biomass (g/m^2) found in grassland treatments during 1972.

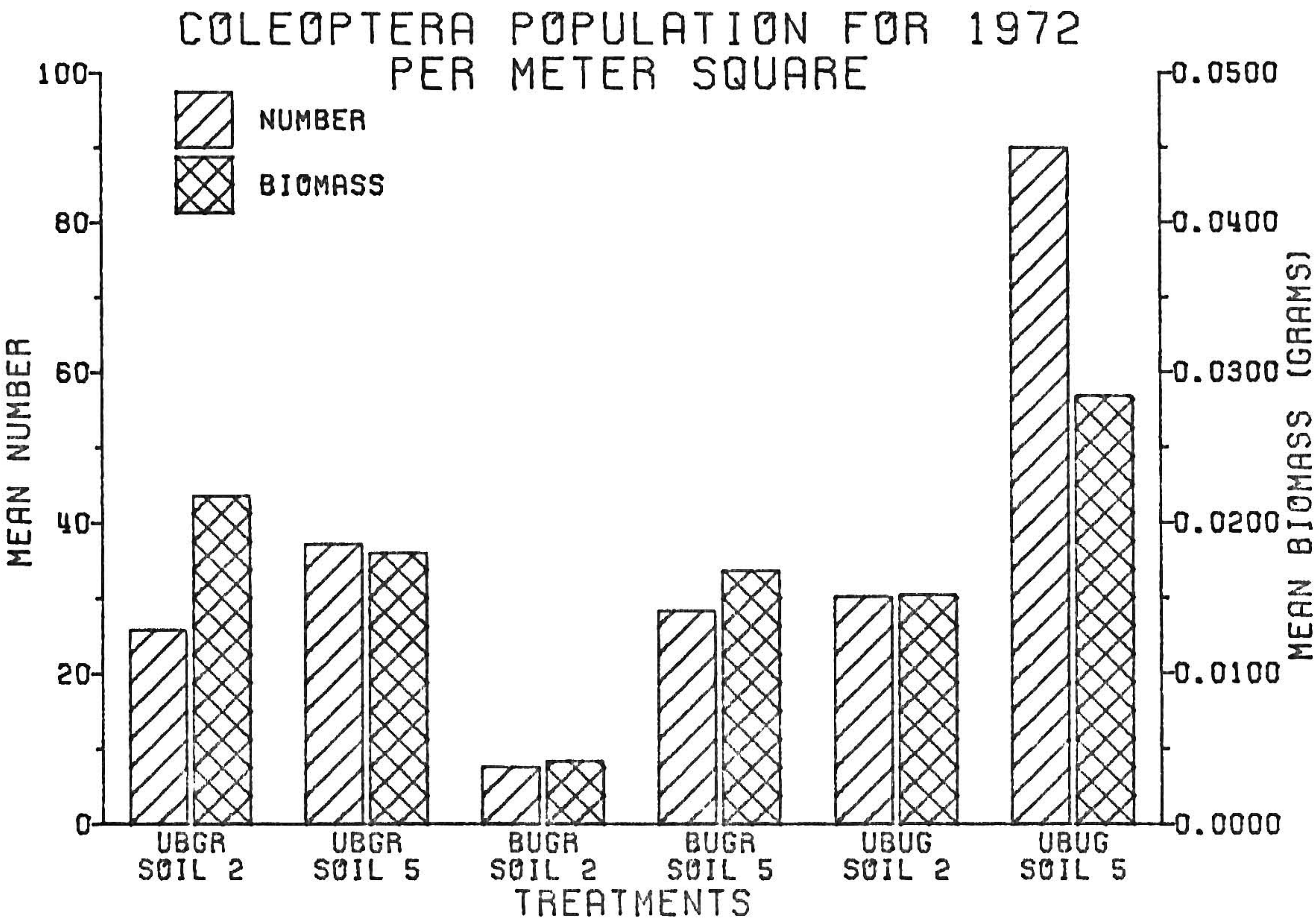

COLEOPTERA POPULATION FOR 1972
PER METER SQUARE
NUMBER
BIOMASS
MEAN NUMBER
MEAN BIOMASS (GRAMS)
100
80
60
40
20
0
0.0500
0.0400
0.0300
0.0200
0.0100
0.0000
UBGR SOIL 2
UBGR SOIL 5
BUGR SOIL 2
BUGR SOIL 5
UBUG SOIL 2
UBUG SOIL 5
TREATMENTS

FIG. 10

fewer plant species than the other treatments (Table 3) and unburned-ungrazed in both soil types had significantly greater plant heights and biomass than the other treatment combinations (Tables 4 & 5).

The analysis of variance for Coleoptera numbers in 1972 is recorded in Table 6. Differences in treatments, soils and interaction proved to be highly significant. Unburned-ungrazed, soil 5, had significantly higher numbers of Coleoptera than did the other treatment combinations. In addition, treatments were all significantly different, with unburned-ungrazed having the largest number of individuals.

Analysis of variance for 1972 Coleoptera biomass is reported in Table 7. As opposed to the inconclusive results in 1971, 1972 biomass showed significant differences between treatments and soils. Unburned-ungrazed and unburned-grazed were significantly different from burned-grazed and both soils were significantly different.

The plant analysis for 1972 is reported in Tables 8, 9 and 10. Treatments and interaction were significantly different for the number of plant species present (Table 8). Unburned-ungrazed, as in 1971, had significantly fewer plant species than did the other treatments. In addition, Tables 9 and 10 show conclusively that unburned-ungrazed had a greater plant species height and more plant species biomass than did the other treatments.

Significant differences between treatment means for Coleoptera numbers and biomass occurred in 1972. Mean number and biomass were greater in the unburned-ungrazed treatment. Furthermore, a general trend in 1971 concerning Coleoptera numbers and biomass and how they

Table 1. Analysis of variance and LSD's for 1971 Coleoptera numbers using transformed data.[1]

Source	Analysis of Variance D. F.	M. S.	F-test[2]
Treatments	2	2.0065	0.4569
Soils	1	27.7173	6.3126 *
T x S	2	23.2287	5.2903 **
Error	192	4.3907	
Total	197		

Soil[3]	Means	Treatments x Soil[3]	Means[4]
5	4.8343	UBUG-5	5.7191
2	4.0860	BUGR-5	4.4352 *
		UBGR-5	4.3485 *
		UBGR-2	4.3412 *
		BUGR-2	4.3144 *
		UBUG-2	3.6023 *
$LSD_{.05}$ = .5837		$LSD_{.05}$ = 1.0111	

[1]Square root transformation ($\sqrt{x}$).

[2]One asterisk (*) indicates significance at the 0.05 probability level, two asterisks indicate significance at the 0.01 probability level and three asterisks indicate a significance level of 0.005.

[3]Soil 2 = ordinary (loamy) upland.
Soil 5 = clay upland.
UBGR = unburned-grazed.
BUGR = burned-grazed.
UBUG = unburned-ungrazed.

[4]Non-significant means connected by a column of asterisks.

Note: 2 to 4 applies to Tables 1-10; 1 applies only to those tables using transformed data.

Table 2. Analysis of variance and LSD's for 1971 Coleoptera biomass using transformed data.[1]

Analysis of Variance			
Source	D. F.	M. S.	F-test[2]
Treatments	2	0.0031	0.7641
Soils	1	0.0036	0.8824
T x S	2	0.0206	5.0758 **
Error	192	0.0040	
Total	197		

Treatments x Soil[3]	Means[4]
UBUG-5	0.1130 *
UBGR-2	0.1021 **
UBGR-5	0.0845 ***
BUGR-2	0.0826 ***
BUGR-5	0.0769 **
UBUG-2	0.0642 *

$LSD_{.05} = 0.0308$

Table 3. Analysis of variance and LSD's for 1971 plant species numbers using transformed data.

Analysis of Variance			
Source	D. F.	M. S.	F-test
Treatments	2	19.6482	126.8496 ***
Soils	1	1.7426	11.2502 ***
T x S	2	0.8107	5.2338 **
Error	192	0.1549	
Total	197		

Treatments	Means	Soil	Means	Treatments x Soil	Means
BUGR	3.2352 *	5	3.0133	UBGR-5	3.4448 *
UBGR	3.2337 *	2	2.8256	BUGR-5	3.3148 **
				BUGR-2	3.1556 **
				UBGR-2	3.0227 *
				UBUG-2	2.2987 *
				UBUG-5	2.2802 *
$LSD_{.05} = 0.1343$		$LSD_{.05} = 0.1096$		$LSD_{.05} = 0.1899$	

Table 4. Analysis of variance and LSD's for 1971 average plant height using raw data.

Source	D. F.	M. S.	F-test
		Analysis of Variance	
Treatments	2	8856.1797	158.9543 ***
Soils	1	629.3389	11.2956 ***
T x S	2	265.2317	4.7605 **
Error	192	55.7152	
Total	197		

Treatments	Means	Soil	Means	Treatments x Soil	Means
UBUG	41.8939	2	30.6162	UBUG-5	42.4242 *
UBGR	24.8030	5	27.0505	UBUG-2	41.3636 *
BUGR	19.8030			UBGR-2	27.8182
				BUGR-2	22.6666 *
				UBGR-5	21.7879 *
				BUGR-5	16.9394
$LSD_{.05}$ = 2.5467		$LSD_{.05}$ = 2.0794		$LSD_{.05}$ = 3.6016	

Table 5. Analysis of variance and LSD's for 1971 plant species biomass using raw data.

Source	D.F.	M. S.	F-test
		Analysis of Variance	
Treatments	2	503042.9375	44.9482 ***
Soils	1	91224.3125	8.1511 ***
T x S	2	33724.5000	3.0134 *
Error	192	11191.5976	
Total	197		

Treatments	Means	Soil	Means	Treatments x Soil	Means
UBUG	381.8181	2	306.5654	UBUG-5	386.3635 *
UBGR	261.3635	5	263.6362	UBUG-2	377.2727 *
BUGR	212.1211			UBGR-2	293.9392 *
				BUGR-2	248.4848 **
				UBGR-5	228.7879 *
				BUGR-5	175.7576
$LSD_{.05}$ = 36.0948		$LSD_{.05}$ = 29.4713		$LSD_{.05}$ = 51.0457	

Table 6. Analysis of variance and LSD's for 1972 Coleoptera numbers using transformed data.

Source	D. F.	M. S.	F-test
Treatments	2	98.9053	24.9551 ***
Soils	1	72.5586	18.3075 ***
T x S	2	23.7485	5.9921 ***
Error	138	3.9633	
Total	143		

Treatments	Means	Soil	Means	Treatments x Soil	Means
UBUG	5.0292	5	4.2110	UBUG-5	6.4350
UBGR	3.2933	2	2.7913	UBUG-2	3.6234 *
BUGR	2.1810			UBGR-2	3.2941 *
				UBGR-5	3.2926 *
				BUGR-5	2.9055 *
				BUGR-2	1.4564
$LSD_{.05}$ = 0.8046		$LSD_{.05}$ = 0.6570		$LSD_{.05}$ = 1.1379	

Table 7. Analysis of variance and LSD's for 1972 Coleoptera biomass using transformed data.

Source	D. F.	M. S.	F-test
Treatments	2	0.0246	8.4422 ***
Soils	1	0.0177	6.0921 *
T x S	2	0.0053	1.8245
Error	138		
Total	143		

Treatments	Means	Soil	Means
UBUG	0.0909 *	5	0.0844
UBGR	0.0813 *	2	0.0622
BUGR	0.0478		
$LSD_{.05}$ = 0.0218		$LSD_{.05}$ = 0.0178	

Table 8. Analysis of variance and LSD's for 1972 plant species numbers using transformed data.

Source	D. F.	M. S.	F-test
Treatments	2	9.8960	76.7006 ***
Soils	1	0.0619	0.4799
T x S	2	2.1790	16.8891 ***
Error	138	0.1290	
Total	143		

Treatments	Means	Treatments x Soil	Means
BUGR	3.3280 *	UBGR-5	3.5041 *
UBGR	3.2853 *	BUGR-5	3.3760 **
UBUG	2.5211	BUGR-2	3.2800 *
		UBGR-2	3.0664
		UBUG-2	2.7257
		UBUG-5	2.3164
$LSD_{.05}$ = 0.1452		$LSD_{.05}$ = 0.2053	

Table 9. Analysis of variance and LSD's for 1972 average plant height using raw data.

Source	D. F.	M. S.	F-test
Treatments	2	5031.4336	119.1588 ***
Soils	1	75.1109	1.7788
T x S	2	96.5066	2.2856
Error	138	42.2246	
Total	143		

Treatments	Means
UBUG	38.2292
BUGR	21.9166 *
UBGR	19.3542 *
$LSD_{.05}$ = 2.6263	

Table 10. Analysis of variance and LSD's for 1972 plant species biomass using raw data.

	Analysis of Variance		
Source	D. F.	M. S.	F-test
Treatments	2	611317.5000	74.4778 ***
Soils	1	13611.0625	1.6582
T x S	2	1319.4536	0.1608
Error	138	8208.0469	
Total	143		

Treatments	Means
UBUG	324.9998
BUGR	139.5832 *
UBGR	120.8333 *

$LSD_{.05} = 36.6167$

are influenced by the type of vegetation present, was much more evident in 1972. Low plant species diversity, high average plant height and greater plant species biomass increased both Coleoptera numbers and biomass. The conclusion from this study is, therefore, that burning and grazing inhibit, to a large degree, total Coleoptera numbers and biomass.

Curculionidae, a Discussion of Individual Species

A complete species list, plant associations and the occurrence of Curculionidae in grasslands during 1971 and 1972 are shown in Tables 16-21.

Anthonomus sp. One specimen of this genus was found in the unburned-grazed treatment during 1972.

Apion spp. Blatchley and Leng (1916) have reported that the larvae of this genus feed, for the most part, on seeds of legumes.

Tatschel (1970) studied the occurrence of the legumes *Psoralea tenuiflora* Pursh and *P. floribunda* (Nutt.) Rydb. in Kansas and found that in some areas *Apion oblitum* made up as much as 45% of the total number of insects found on these plants. The adults of *A. oblitum* emerged in the spring and fed on foliage until flower buds were produced. Adults then bored a hole in the bud and oviposited. After hatching, the larvae apparently fed on the gynoecium and androecium of the bud (i.e., ovarian tissue). Most larval activity took place in June and early July with new adults emerging in mid-July. In spite of the short period of development, there probably was only one generation per season; the new adult weevils continued to feed on foliage until the plants began to wither, at which time hibernation began.

The *Apion* spp. collected in grasslands during this study showed a preference for the burned-grazed treatment. Of 58 specimens, 51 were collected there in 1971 (Table 18) and 74 of 78 in 1972 (Table 20). In addition, *Apion* spp. were found to be associated with *P. floribunda* (manyflower scurfpea) and *Helianthus annuus* L. (common sunflower). Although *P. floribunda* occurred in less than 10% of the replicates during 1971 and 1972, it did occur more frequently in the burned-grazed treatment and was the only species of *Psoralea* recorded during this study.

Auleutes tenuipes LeConte. This weevil was not found in association with any particular plant. One specimen was captured during 1971 by sweeping adjacent to the unburned-grazed treatment.

Blatchley and Leng (1916) reported that *A. tenuipes* ranged from New England and Canada to Missouri, Georgia and Texas. Pierce (1907) stated that at Dallas, Texas, it bred in the buds of Hartweg's primrose, *Galpinsia hartwegi* Beuth., and pupated in the ground. The time from egg to adult required about 24 days.

Aulobaris nasutus (LeConte). Specimens of this weevil were collected by hand from the blooms of *Vernonia baldwini baldwini* Torr. (baldwin ironweed). Blatchley and Leng (1916) noted that *A. nasutus* had been recorded from Agricultural College, Mississippi, in November and had been reported also from Iowa and Kansas.

Baris sp. Four weevils of this genus were found in grasslands during 1971. Three were taken in the unburned-ungrazed treatment and 1 was collected by hand from *P. floribunda*. Five specimens were collected in 1972; 1 from unburned-grazed and 4 from unburned-ungrazed. Blatchley and Leng (1916) reported that this species of *Baris* were usually taken by sweeping low moist meadows. The larvae bred in the roots or stems near the roots of various plants and pupated in their burrows.

Centrinaspis sp. Two specimens were collected in the burned-grazed treatment during 1971 and 2 were taken in 1972; 1 from burned-grazed and 1 from unburned-grazed.

Ceutorhynchus atriculus Dietz. Blatchley and Leng (1916) reported this species as being known only from Pennsylvania and District of Columbia. Three specimens of *C. atriculus* were found during 1972, 1 in burned-grazed and 2 in unburned-grazed.

Ceutorhynchus erysimi F. Blatchley and Leng (1916) reported that this weevil ranged from Canada and New England west to Idaho and California and south to Maryland. *C. erysimi* is a well known European species which attacks cabbage, horseradish and also wild cruciferous plants. One specimen of this species was collected adjacent to the unburned-ungrazed treatment. Sixteen specimens, however, of *Ceutorhynchus* sp. were found in grassland treatments during 1971, 15 of which were collected in the burned-grazed treatment. Four specimens, 2 from burned-grazed and 2 from unburned-grazed, were collected during 1972.

Chalcoderma inaequalicollis Horn. One specimen was taken from the unburned-ungrazed treatment in 1971. Blatchley and Leng (1916) reported this species from Georgia, Florida and Arkansas.

Chelonchus longipes Dietz. This weevil was found only in close association with *Artemesia ludoviciana* (Louisiana sagewort) in grasslands during 1971 and 1972. Adults were observed oriented in a head down position between the leaf stalk and stem of the plant. Rarely were they observed moving freely around the plant.

A. ludoviciana was the third most frequently recorded plant species in grassland treatments during 1971 (Table 12) and second in 1972 (Table 13). C. longipes was second only to Apion spp. in Curculionidae numbers in both years. Unburned-grazed and unburned-ungrazed contained much higher C. longipes numbers and a more frequent occurrence of A. ludoviciana than did the burned-grazed.

Cylindrocopturus adspersus (LeConte). One specimen of C. adspersus was found in the unburned-grazed grassland treatment during 1972.

Cylindrocopturus frontalis (Casey). Only 2 specimens of this genus were collected during 1971. One specimen of C. frontalis was collected in burned-grazed and 1 Cylindrocopturus sp. was swept from pasture adjacent to the treatment areas. Four specimens of C. frontalis were taken during 1972; 1 from burned-grazed, 2 from unburned-grazed and 1 from unburned-ungrazed.

Endalus cribricollis LeConte. One specimen was swept from an area adjacent to unburned-ungrazed during 1971 and 1 specimen was collected in the burned-grazed grassland treatment in 1972.

Epicaerus imbricatus Say. Blatchley and Leng (1916) reported that E. imbricatus ranged from New York, New Jersey and Michigan west and south to Colorado and Texas. Chittenden (1899) recorded this species attacking the foliage of young apple trees, potatoes, onions, cabbages and many other vegetables. Clover and various grasses also were reported as plant hosts.

E. imbricatus collected during this study were found in association with Baptisia minor (blue wildindigo), Schrankia nuttallii (catclaw sensitivebriar) and Artemesia ludoviciana (Louisiana sagewort). Three

E. imbricatus specimens were collected from treatments during 1971; 2 from unburned-grazed and 1 from burned-grazed. Two other specimens were taken by hand adjacent to unburned-ungrazed and 2 were collected in general sweeping. Three specimens were taken in 1972; 2 from unburned-grazed and 1 from unburned-ungrazed.

Hypera postica (Gyllenhal). Just 1 specimen of H. postica was collected during 1971 and it was taken from unburned-ungrazed. Two specimens were taken during 1972; 1 from unburned-grazed and 1 from unburned-ungrazed.

Hypera punctata (F.). Blatchley and Leng (1916) reported that this species was introduced into the United States in about 1850 and is now established from Newfoundland to North Carolina west to Iowa and Texas; also a few places on the Pacific Coast. Hypera punctata is known as the "clover-leaf beetle" since both the larvae and adults feed upon the tender stems and young leaves of all kinds of clover and alfalfa.

One specimen was collected in the unburned-ungrazed treatment during 1972.

Hyperodes echinata Dietz. This weevil species reportedly ranges from Massachusetts and Michigan to Colorado, south to Mississippi, Texas and Arizona (Blatchley and Leng 1916). Pierce (1916) stated that H. echinata bred in the roots of Senecio (groundsel) and Plantago (plantain).

Five specimens of this weevil species were collected in the burned-grazed treatment during 1971. No Senecio or Plantago plant species were found in this treatment.

Hyperodes obscurellus (Dietz). One specimen of H. obscurellus was collected during 1971 from the burned-grazed treatment.

Hyperodes rotundicollis Dietz. Blatchley and Leng (1916) reported that this species ranged from New York to Nebraska and Colorado, south to Texas. Two specimens of H. rotundicollis were taken during 1972; 1 from the burned-grazed treatment and 1 from unburned-grazed.

Maemactes cribratus (LeConte). One specimen was collected during 1971 in burned-grazed.

Mesagroicus minor Buchanan. One specimen of this weevil was collected during 1972 in the burned-grazed grassland treatment.

Odontocorynus sp. Twenty weevils of this genus were collected during 1971 and 1972; 10 from burned-grazed, 3 adjacent to burned-grazed, 5 adjacent to unburned-grazed, and 2 from other pasture locations. All specimens collected adjacent to treatment areas or in other pasture locations were found in association with Asclepias latifolia (broadleaf milkweed) and A. decumbens (spider milkweed).

Onchobaris millepora Casey. One specimen of this weevil was collected during 1972 in the burned-grazed grassland treatment.

Pantomorus pallidus Horn. Blatchley and Leng (1916) reported specimens of P. tesselatus var. pallidus from the leaves of Vernonia fasciculata (ironweed) in Indiana. This weevil species ranged from southwestern Indiana and southern Illinois west and southwest to Nebraska and New Mexico. It reportedly attacks the foliage of sweet potato.

Schwitzgebel and Wilbur (1942) observed adults of P. pallidus feeding on the terminal growth of ironweed in June. No other life stages of this weevil were found associated with the plant.

During this study, P. pallidus was found on Artemesia ludoviciana (Louisiana sagewort), Vernonia baldwini baldwini (baldwin ironweed) and

Psoralea tenuiflora var. floribunda (manyflower scurfpea). It was found most commonly in the unburned-grazed grassland treatment.

Promecotarsus fumatus Casey. This weevil species was found in both burned-grazed and unburned-grazed grassland treatments in 1971 and in unburned-grazed and unburned-ungrazed during 1972. One specimen was collected from another pasture area in 1971 on Artemesia ludoviciana (Louisiana sagewort).

Pseudobaris farcta (LeConte). P. farcta was not collected in grassland treatments during this study but was found in large numbers in other areas of the pasture on Salvia azurea var. grandiflora (pitcher sage).

Rhodabaenus tredecimpunctatus (Illiger). This weevil species according to Blatchley and Leng (1916), occurred throughout the United States. It reportedly bred in the stems of ironweed (Vernonia) and cockle-bur (Xanthium commune) but also in many other Compositae such as joe-pye weed, leaf-cup, sunflower, thistle, greater ragweed, and rosinweed. It hibernated in the adult stage with the newly bred imagoes appearing in August and September. Schwitzgebel and Wilbur (1942) reported adults of this insect being taken from ironweed in the spring. No other stages were found associated with the plant but the feeding punctures made by the adults were observed. Kelly (1931) reported the insect on cocklebur (Xanthium spp.).

One specimen was found during 1971 on baldwin ironweed (Vernonia baldwini baldwini) adjacent to unburned-grazed. Two were collected in 1972 adjacent to unburned-grazed and unburned-ungrazed.

Rhynchites deneus Boheman. Eight specimens of R. deneus were collected from sunflower (Helianthus annuus) during 1971. None were found in grassland treatments.

Rhyssematus lineaticollis Say. Ten weevils of this species were collected during 1971 and 1972. All specimens were collected adjacent to the burned-grazed and unburned-ungrazed treatment areas and were found feeding on Asclepias latifolia (broadleaf milkweed).

Blatchley and Leng (1916) reported that R. lineaticollis ranged from Massachusetts to Michigan and Kansas, south to Florida and Texas. It bred in the pods of several species of milkweed (Asclepias).

Sitona cylindricollis Say. One specimen of this weevil was collected during 1972 in the unburned-grazed grassland treatment.

Smicronyx fulvus LeConte and S. sordidus (LeConte). Both weevil species were found in large numbers on the blooms of sunflower (Helianthus annuus) in 1971. One specimen of S. fulvus was collected during 1972 in the unburned-grazed grassland treatment.

Smicronyx squalidas Casey. One specimen of S. squalidas was collected in the burned-grazed treatment during 1971. Blatchley and Leng (1916) reported that this species was known from Pennsylvania, District of Columbia, Ohio, Illinois and Indiana.

Smicronyx tesselatus Dietz. Blatchley and Leng (1916) reported that S. tesselatus was found frequently throughout Indiana and was taken by sweeping the leaves of mullein. Twenty-one specimens of this weevil were collected during 1972. Thirteen were taken from burned-grazed, 5 from unburned-grazed and 3 from the unburned-ungrazed treatment.

Smicronyx sp. One specimen was collected in the unburned-grazed treatment during 1972.

Sphenophorus cultellatus Horn. One specimen of S. cultellatus was collected in the burned-grazed treatment during 1971. Blatchley and Leng (1916) reported that species of Sphenophorus passed the winter in the imago stage in dead leaves and rubbish, and laid eggs early the following summer. Larvae hatched in June, fed on the roots of grasses and grass-like plants, including corn, and pupated in July. Adult emergence began in late July and continued into August or later. The normal food plants were wild grasses, especially those with bulbous roots.

Sphenophorus parvulus Gyllenhal. Blatchley and Leng (1916) reported that this species ranged from New England to Michigan and Nebraska, south to Florida and Texas. It bred in the roots of blue-grass (Poa pratensis) and timothy (Phleum pratense). Forbes (1902) stated that S. parvulus hibernated as an imago, the eggs were deposited in May, the larvae appeared in June and pupation occurred in late July, and adults emerged in August and September.

Two specimens of this species were collected during 1971; 1 in unburned-grazed and 1 in burned-grazed. Two specimens, 1 from burned-grazed and the other from unburned-grazed were also taken during 1972.

Stethobaris commixta Blatchley. This weevil has been reported from Michigan, Ohio, Indiana and the District of Columbia. It has been found in association with coral-root (Corallorhiza) according to Blatchley and Leng (1916).

One specimen was swept adjacent to unburned-grazed during 1971.

Trichobaris texana LeConte. Six specimens were collected in grasslands from Solanum rostratum (buffalobur nightshade) during 1971. None were taken in pasture treatments.

Trichobaris trinotata Say. Blatchley and Leng (1916) reported that this species ranged from New York, Canada, Michigan and Colorado, south to Florida. Chittenden (1902) reported on its life history and recorded it as boring into the stems of a number of members of the potato family (Solanaceae) some of which, as the jimson-weed, horse-nettle and ground cherry, were noxious weeds; also in those of cockle-bur, Xanthium canadense.

One specimen was collected in grasslands from Solanum rostratum (buffalobur nightshade) during 1971.

Tychius sordidus LeConte. Blatchley and Leng (1916) reported that this species ranged from Illinois and Iowa to Louisiana and Texas. Pierce (1907) stated that in Louisiana and Texas it bred in the seed pods of wild or false indigo (Baptisia bracteata and B. leucantha). The larvae entirely consumed the contents of the pod, then ate their way out and pupated in the ground.

Basically the same information on T. sordidus was recorded in this study. Adults were found in large numbers on B. leucophaea (plains wildindigo) and B. minor (blue wildindigo) on May 25, 1972. Approximately one week later, all adults had disappeared but very small larvae were found inhabiting the seed pods of both previously mentioned indigo species. Only 1 adult weevil of this species was collected from grasslands during 1971 and it was taken from the unburned-grazed treatment. An early spring and a short adult life span of less than 2 weeks may have prevented adult weevils from being taken in greater numbers during the first collecting period on May 19, 1971.

Coleoptera as Herbivores

During 1971, 63.4% of all Coleoptera collected were herbivores and they constituted 33% of the total Coleoptera biomass. In 1972, 47% of the adults collected were herbivores and they constituted 33.8% of the total Coleoptera biomass. Three families, Chrysomelidae, Curculionidae and Elateridae were the major contributors to herbivore biomass in both years. In 1971, they totaled 85.7% of the herbivore biomass and 85.3% in 1972. Individually, Chrysomelidae made up 16.5% of the numbers and 62.7% of the biomass for herbivores in 1971. Curculionidae contributed 4.1% of the numbers and 18.8% of the biomass during the same year. In 1972, Chrysomelidae constituted 12% of the numbers and 34.6% of the biomass as opposed to 16.5% and 39.4% for Curculionidae.

To make conclusions concerning the role of herbivorous Coleoptera in grasslands, it is necessary to first look at the plants supporting the population. Of the Curculionidae found in grasslands during this study, only 3 species are known to be directly associated with grasses. All others are known to be forb feeders.

Basically the same thing can be said for Chrysomelidae. Although a few species are known to attack grasses, most are forb feeders. Green (1961) reports that the main plants acting as hosts for this family in the invaded prairies are goldenrod (Solidago), sage (Artemesia), ragweed (Ambrosia) and Aster.

It is reasonable to conclude, therefore, that the majority of herbivorous Coleoptera in grasslands may be beneficial rather than harmful from a range management point of view. By attacking forbs that are for the most part unpalatable to cattle, they may be limiting undesirable plant species.

SUMMARY AND CONCLUSIONS

Coleoptera data were collected from 2 treatments, burned-grazed and unburned-grazed, in "Donaldson Pastures" located 2 miles west of Manhattan, Kansas. A third treatment, unburned-ungrazed, was located in the Kansas State University Nuclear Shielding site approximately 2.5 miles west of Manhattan.

Vegetation on the study areas was primarily warm season grasses; however, numerous forbs and woody species were also present in varying amounts. Litter accumulation on the soil surface was observed to be heavy in the unburned-ungrazed area, moderate in the unburned-grazed and very light in the burned-grazed area.

Samples were obtained using a stabilized drop trap, designed and built especially for this study, and a DeVac (vacuum) collector. Modified Berlese funnels were used to separate Coleoptera from sample litter. All adult Coleoptera were separated to family, dried at 60 C for 24 hours and weighed; immatures were classified only to order. Thirty-seven families of beetles including 30 genera and 35 species of Curculionidae were determined from grasslands during 1971 and 1972.

Major families of Coleoptera collected were similar in both years. Carabidae, Chrysomelidae, Coccinellidae, Curculionidae and Staphylinidae were major contributors to numbers and biomass in 1971 and 1972.

Large fluctuations in adult Coleoptera numbers and biomass were noted in both years. During 1971, peak numbers were recorded on 11 August 1971 and peak biomass on 7 July 1971. In 1972, both numbers and biomass peaked on 20 June 1972. Statistical analyses of Coleoptera and plant data indicated that beetles in grasslands were influenced by the type of vegetation present. Low plant species diversity, high average plant height and greater plant species biomass increased both Coleoptera numbers and biomass. Therefore, burning and grazing inhibited, to a large degree, total Coleoptera numbers and biomass.

Three families, Chrysomelidae, Curculionidae and Elateridae contributed more than 85% of herbivore biomass in 1971 and 1972.

Only 3 species of Curculionidae found in this study are known to be directly associated with grasses. All others are known to be forb feeders. The same thing is known to be primarily true for Chrysomelidae. Therefore, the majority of herbivorous Coleoptera in grasslands may be beneficial in that they may be limiting undesirable plant species.

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A P P E N D I X

Table 11. Scientific and common names[1] of plants found in grassland treatments during 1971 and 1972.

Scientific name	Common name
Perrenial Grasses	
Andropogon gerardi Vitman	big bluestem
Andropogon scoparius Michx.	little bluestem
Bouteloua curtipendula (Michx.) Torr.	sideoats grama
Bouteloua gracilis (H.B.K.) Lag x Steud.	blue grama
Bouteloua hirsuta Lag.	hairy grama
Buchloe dactyloides (Nutt.) Engelm.	buffalograss
**Elymus canadensis L.	Canada wildrye
Koeleria cristata (L.) Pers.	prairie junegrass
Leptoloma cognatum (Schult.) Chase	fall witchgrass
Mulenbergia cuspidata (Torr.) Rybd.	plains muhly
Panicum scribnerianum Nash	scribner panicum
Panicum virgatum L.	switchgrass
**Panicum wilcoxianum Vasey	wilcox panicum
Poa pratensis L.	Kentucky bluegrass
Schedonnardus paniculatus (Nutt.) Trel.	tumblegrass
Sorghastrum nutans (L.) Nash	indiangrass
Sporobolus asper (Michx.) Kunth	tall dropseed
Sporobolus cryptandrus (Torr.) A. Gray	sand dropseed
Sporobolus heterolepis (A. Gray) A. Gray	prairie dropseed
Annual Grasses	
Bromus sp. L.	brome
**Eragrostis intermedia Hitchc.	plains lovegrass
*Eragrostis spectabilis (Pursh) Steud.	purple lovegrass
**Hordeum pusillum Nutt.	little barley
Grass-like Plants	
Carex sp. L.	sedge
Perennial Forbs	
Achillea millefolium subsp. lanulosa (Nutt.) Piper	western yarrow
Ambrosia psilostachya DC.	western ragweed
Antennaria neglecta Greene	field pussytoes
Artemesia ludoviciana Nutt.	Louisiana sagewort
**Asclepias pumila (Gray)	plains milkweed
**Asclepias viridiflora Raf.	green milkweed

Table 11 (cont'd).

Scientific name	Common name
Asclepiodora decumbens (Nutt.) Gray	spider antelopehorn
Aster ericoides L.	heath aster
**Aster oblongifolius Nutt.	aromatic aster
Aster sericeus Vent.	silky aster
Aster sp. L.	astor
Astragalus missouriensis Nutt.	Missouri milkvetch
Baptisia leucophaea Nutt.	plains wildindigo
Baptisia minor Lehm.	blue wildindigo
Callirhoe involucrata (T. & G.) Gray	purple poppymallow
* Desmodium illinoense Gray	Illinois tickclover
Echinacea angustifolia DC.	blacksamson echinacea
* Lespedeza capitata Michx.	roundhead lespedeza
**Lespedeza procumbens Michx.	trailing lespedeza
Liatris punctata Hook.	dotted gayfeather
**Lithospermum incisum Lehm.	narrowleaf gromwell
Oenothera speciosa Nutt.	white eveningprimrose
Onosmodium occidentale Mackenz.	western marbleseed
Oxalis violacea L.	violet woodsorrel oxalis
* Petalostemum candidum (Willd.) Michx.	white prairieclover
Petalostemum purpureum (Vent.) Rybd.	purple prairieclover
Physalis sp. L.	groundcherry
**Plantago sp. L.	plantain
Psoralea tenuiflora Pursh var. floribunda (Nutt.) Rybd.	manyflower scurfpea
Ruellia humilis Nutt.	fringeleaf ruellia
Salvia azurea Lam.	pitcher sage
* Schrankia nuttallii (DC.) Standl.	catclaw sensitivebriar
* Senecio plattensis Nutt.	prairie groundsel
* Solidago altissima L.	tall goldenrod
Solidago missouriensis Nutt.	Missouri goldenrod
**Solidago rigida L.	stiff goldenrod
**Stenosiphon linifolius (Nutt.) Britt.	stenosiphon
Verbena stricta Vent.	woolly verbena
Vernonia baldwini Torr. var. baldwini	baldwin ironweed
Biennial Forbs	
Cirsium undulatum (Nutt.) Spreng.	wavyleaf thistle
Grindelia squarrosa (Pursh) Dunal	curlycup gumweed
**Hymenopappus scabiosaeus L'Her.	whitebract hymenopappus
**Tragopogon dubius Scop.	western salsify

Table 11 (concluded).

Scientific name	Common name
Annual Forbs	
* Conyza canadensis (L.) Cron.	horseweed
Croton capitatus Michx.	woolly croton
**Croton monanthogynus Michx.	oneseed croton
Erigeron strigosus Muhl.	daisy fleabane
Euphorbia marginata Pursh	snow-on-the-mountain
**Hedeoma hispida Pursh	rough falsepennyroyal
* Lactuca scariola L.	prickly lettuce
Lepidium densiflorum Schrad.	peppergrass
Linum sulcatum Riddell	grooved flax
**Linum sp. L.	flax
Plantago purshii R. & S.	woolly plantain
Silene antirrhina L.	sleepy silene
Solanum carolinense L.	horsenettle
* Specularia perfoliata (L.) A. DC.	clasping venuslookingglass
* Spermolepis inermis (Nutt.) Math. & Const.	spermolepis
Woody Plants	
Amorpha canescens Pursh	leadplant
**Ceanothus ovatus Desf.	inland ceanothus
Opuntia humifusa Raf.	common pricklypear
**Prunus americana	American plum
* Rhus radicans L.	poisonivy
Symphoricarpos orbiculatus Moench	buckbrush
**Ulmus americana L.	American elm

*Species occurred only in 1971.

**Species occurred only in 1972.

[1] Scientific and common names are according to Anderson, K. L. and C. E. Owensby (1969), Common names of a selected list of plants. Kans. Agr. Expt. Sta. Tech. Bul. 117.

Table 12. Species list and percent occurrence of plants that occurred in more than 10% of the replicates in grassland treatments during 1971.

Species name	Treatments						Total
	UBGR 2	UBGR 5	BUGR 2	BUGR 5	UBUG 2	UBUG 5	year
Andropogon gerardi	97.0	97.0	97.0	93.9	87.9	100	95.4
Ambrosia psilostachya	93.9	93.9	100	100	51.5	63.6	83.8
Artemesia ludoviciana	93.7	93.7	57.6	69.7	93.7	90.0	83.3
Aster ericoides	75.8	72.7	48.5	81.8	42.4	27.3	58.1
Poa pratensis	90.9	87.9	0	30.3	21.2	84.8	52.5
Sorghastrum nutans	72.7	60.6	72.7	66.7	21.2	15.2	51.5
Carex sp.	27.3	45.4	63.6	66.7	12.1	18.2	38.8
Panicum scribnerianum	57.6	36.4	54.5	54.5	9.1	15.2	37.9
Bouteloua curtipendula	45.4	39.4	54.5	27.3	12.1	21.2	33.3
Leptoloma cognatum	60.6	57.6	24.2	54.5	0	0	32.8
Andropogon scoparius	60.6	51.5	30.3	30.3	15.2	0	31.3
Achillea millefolium lanulosa	39.4	60.6	15.2	42.4	18.2	12.1	31.3
Sporobolus asper	15.2	33.3	24.2	45.4	30.3	18.2	27.8
Linum sulcatum	9.1	33.3	42.4	51.5	3.0	0	23.2
Amorpha canescens	6.1	15.2	45.4	39.4	9.1	3.0	19.7
Solidago missouriensis	12.1	15.2	15.2	66.7	3.0	0	18.7
Sporobolus cryptandrus	21.2	24.2	27.3	36.4	0	0	18.2
Vernonia baldwini baldwini	3.0	30.3	30.3	6.1	27.3	6.1	17.2
Ruellia humilis	18.2	21.2	18.2	27.3	12.1	0	16.2
Symphoricarpos orbiculatus	0	24.2	0	0	21.2	36.4	13.6

Table 13. Species list and percent occurrence of plants that occurred in more than 10% of the replicates in grassland treatments during 1972.

Species name	Treatments						Total
	UBGR 2	UBGR 5	BUGR 2	BUGR 5	UBUG 2	UBUG 5	year
Andropogon gerardi	100	83.3	100	100	100	91.7	95.8
Artemesia ludoviciana	100	100	50.0	83.3	100	100	88.9
Ambrosia psilostachya	87.5	100	95.8	75.0	70.8	37.5	77.8
Carex sp.	70.8	87.5	57.6	95.8	54.2	45.8	72.2
Aster ericoides	87.5	87.5	66.7	87.5	41.7	29.2	66.7
Poa pratensis	91.7	87.5	0	12.5	16.7	83.3	48.6
Panicum scribnerianum	50.0	50.0	66.7	66.7	20.8	25.0	46.5
Achillea millefolium lanulosa	45.8	70.8	37.5	75.0	25.0	4.2	43.0
Andropogon scoparius	58.3	41.7	66.7	20.8	41.7	0	38.2
Sorghastrum nutans	50.0	50.0	70.8	41.7	16.7	0	38.2
Solidago missouriensis	41.7	41.7	33.3	75.0	12.5	0	34.0
Ruellia humilis	6.3	33.3	29.2	50.0	29.2	0	25.0
Amorpha canescens	12.5	12.5	70.8	33.3	4.2	12.5	24.3
Sporobolus asper	16.7	33.3	12.5	41.7	33.3	4.2	23.6
Bouteloua curtipendula	20.8	4.2	45.8	12.5	25.0	16.7	20.8
Panicum virgatum	8.3	16.7	33.3	54.2	4.2	0	19.4
Vernonia baldwini baldwini	4.2	37.5	33.3	4.2	25.0	8.3	18.7
Symphoricarpos orbiculatus	0	12.5	0	0	45.8	41.7	16.7
Leptoloma cognatum	50.0	16.7	4.2	16.7	0	0	14.6
Bromus sp.	33.3	20.8	0	16.7	4.2	4.2	13.2
Sporobolus cryptandrus	12.5	20.8	16.7	20.8	0	0	11.8
Bouteloua gracilis	0	4.2	4.2	58.3	0	0	11.1
Erigeron strigosus	12.5	12.5	8.3	29.2	4.2	0	11.1

Table 14. Family list, trophic level, numbers/m^2 and biomass (g/m^2) of Coleoptera in grassland treatments from June 23, 1971 through October 7, 1971.

Family	Trophic level	Treatments: UBGR 2 num.	UBGR 2 bio.	UBGR 5 num.	UBGR 5 bio.	BUGR 2 num.	BUGR 2 bio.	BUGR 5 num.	BUGR 5 bio.	UBUG 2 num.	UBUG 2 bio.	UBUG 5 num.	UBUG 5 bio.
Anthicidae	Herbivore	8	.0013	1	.0004	3	.0009	21	.0032	9	.0018	4	.0009
Bruchidae	Herbivore	-	-	-	-	1	T	1	T	-	-	-	-
*Cantharidae	Herbivore	-	-	-	-	-	-	1	.0024	-	-	-	-
Carabidae	Predator	28	.1652	37	.1031	73	.1513	77	.0535	37	.0210	15	.2316
Chrysomelidae	Herbivore	66	.0570	81	.0635	31	.0296	53	.0545	52	.0394	57	.0771
*Cicindellidae	Predator	1	.0131	-	-	-	-	-	-	-	-	-	-
Cleridae	Predator	-	-	-	-	1	.0004	1	.0003	2	.0017	1	.0002
Coccinellidae	Predator	23	.0216	23	.0044	10	.0061	23	.0057	15	.0263	51	.1176
*Cryptophagidae	Herbivore	-	-	-	-	-	-	1	.0003	-	-	1	T
Curculionidae	Herbivore	7	.0327	9	.0131	35	.0132	13	.0123	13	.0067	8	.0181
Dascillidae	Carnivore	-	-	-	-	-	-	-	-	-	-	1	.0006
Dermestidae	Scavenger	6	.0029	2	.0009	1	.0004	-	-	1	.0006	-	-
Elateridae	Herbivore	-	-	5	.0057	3	.0031	8	.0125	-	-	-	-
Hydrophilidae	Scavenger	41	.0067	2	.0001	-	-	1	T	-	-	-	-
Lathridiidae	Herbivore	18	.0013	22	.0018	37	.0030	19	.0012	10	.0009	53	.0037
Leiodidae	Herbivore	1	T	-	-	-	-	-	-	42	.0031	79	.0060
Melandryidae	Unknown	2	.0010	-	-	2	.0010	-	-	5	.0018	4	.0011
Mordellidae	Herbivore	2	.0008	2	.0004	1	.0003	1	.0003	1	.0003	1	.0004
*Mycetophagidae	Herbivore	-	-	-	-	-	-	1	.0003	-	-	-	-
Nitidulidae	Herbivore	15	T	23	.0002	200	.0039	224	.0039	1	T	-	-
*Orthoperidae	Carnivore	1	T	-	-	-	-	-	-	-	-	-	-
*Ostomidae	Herbivore	-	-	-	-	-	-	-	-	1	T	-	-

Table 14 (concluded).

Family	Trophic level	UBGR 2 num.	UBGR 2 bio.	UBGR 5 num.	UBGR 5 bio.	BUGR 2 num.	BUGR 2 bio.	BUGR 5 num.	BUGR 5 bio.	UBUG 2 num.	UBUG 2 bio.	UBUG 5 num.	UBUG 5 bio.
Phalacridae	Herbivore	11	.0011	35	.0040	13	.0016	18	.0026	1	T	5	.0005
Pselaphidae	Herbivore	29	.0029	13	.0011	3	.0003	1	T	21	.0016	24	.0015
Ptiliidae	Herbivore	59	.0003	211	.0015	2	T	1	T	-	-	-	-
Scaphidiidae	Herbivore	37	.0059	3	.0005	-	-	1	.0002	3	.0003	4	.0004
Scarabaeidae	Reducer	11	.0101	1	.0006	-	-	4	.0101	-	-	-	-
Scydmaenidae	Unknown	7	T	1	T	4	T	-	-	5	T	69	.0033
Silvanidae	Herbivore	4	.0005	-	-	-	-	-	-	2	.0002	1	.0002
Staphylinidae	Predator	147	.0211	124	.0097	43	.0031	31	.0045	88	.0072	465	.0271
Tenebrionidae	Scavenger	1	.0002	2	.0007	5	.0019	-	-	2	.0009	-	-
*Throscidae	Herbivore	-	-	6	.0027	1	.0003	-	-	1	.0002	-	-

T = < .0001g.

*Family occurred only in 1971.

Table 15. Family list, trophic level, numbers/m^2 and biomass (g/m^2) of Coleoptera in grassland treatments from May 25, 1972 through August 17, 1972.

Family	Trophic level	Treatments											
		UBGR 2		UBGR 5		BUGR 2		BUGR 5		UBUG 2		UBUG 5	
		num.	bio.	num.	bio.	num.	bio.	num.	bio.	num.	bio.	num.	bio.
**Anobiidae	Herbivore	-	-	-	-	-	-	-	-	1	.0007	1	.0001
Anthicidae	Herbivore	2	.0005	1	.0001	1	T	3	.0002	18	.0052	11	.0027
**Bostrichidae	Herbivore	-	-	-	-	-	-	-	-	1	T	-	-
Bruchidae	Herbivore	-	-	1	.0003	1	T	1	.0001	1	.0001	1	T
Carabidae	Predator	15	.0600	19	.0601	1	.0056	8	.0161	47	.0408	20	.0782
**Cerambycidae	Herbivore	-	-	-	-	-	-	-	-	1	.0113	2	.0034
Chrysomelidae	Herbivore	20	.0128	14	.0371	11	.0071	25	.0337	14	.0229	23	.0204
Cleridae	Predator	1	.0015	1	.0007	-	-	-	-	1	.0015	3	.0024
Coccinellidae	Predator	9	.0063	4	.0034	2	.0028	5	.0097	10	.0064	40	.0297
Curculionidae	Herbivore	33	.0646	25	.0179	10	.0055	56	.0264	16	.0093	8	.0286
Dascillidae	Carnivore	-	-	-	-	-	-	-	-	-	-	1	.0007
Dermestidae	Scavenger	10	.0043	-	-	-	-	1	.0003	-	-	1	.0009
Elateridae	Herbivore	2	.0125	5	.0109	2	.0103	5	.0067	2	.0029	1	.0006
**Histeridae	Predator	-	-	-	-	-	-	3	.0212	-	-	-	-
Hydrophilidae	Scavenger	3	.0003	5	.0005	-	-	28	.0131	-	-	-	-
Lathridiidae	Herbivore	17	.0011	7	.0005	8	.0006	12	.0009	7	.0005	54	.0033
Leiodidae	Herbivore	-	-	-	-	-	-	-	-	21	.0016	28	.0019
**Malachiidae	Carnivore	-	-	-	-	-	-	-	-	1	.0012	1	.0013
Melandryidae	Unknown	1	T	-	-	-	-	-	-	9	.0017	35	.0049
Mordellidae	Herbivore	3	.0009	3	.0014	1	.0002	1	.0004	5	.0010	5	.0017
Nitidulidae	Herbivore	1	T	7	.0002	19	.0003	61	.0011	-	-	-	-

Table 15 (concluded).

Family	Trophic level	UBGR 2 num.	UBGR 2 bio.	UBGR 5 num.	UBGR 5 bio.	BUGR 2 num.	BUGR 2 bio.	BUGR 5 num.	BUGR 5 bio.	UBUG 2 num.	UBUG 2 bio.	UBUG 5 num.	UBUG 5 bio.
Phalacridae	Herbivore	7	.0007	7	.0009	5	.0012	6	.0013	-	-	2	.0003
Pselaphidae	Herbivore	16	.0011	18	.0016	-	-	-	-	23	.0016	78	.0027
Ptiliidae	Herbivore	15	.0001	95	.0005	-	-	23	T	1	T	1	T
Scaphidiidae	Herbivore	3	.0004	5	.0005	-	-	-	-	2	.0005	7	.0011
Scarabaeidae	Reducer	3	.0009	2	.0037	-	-	48	.2725	-	-	-	-
Scydmaenidae	Unknown	10	.0003	2	T	-	-	-	-	13	.0003	33	.0024
Silvanidae	Herbivore	1	.0001	-	-	-	-	5	.0007	-	-	-	-
Staphylinidae	Predator	34	.0073	77	.0037	3	.0003	86	.0111	46	.0083	365	.0397
Tenebrionidae	Scavenger	-	-	-	-	-	-	-	.0006	-	-	-	-

T = < .0001g.

**Family occurred only in 1972.

Table 16. Species list of Curculionidae found in tall-grass prairie during 1971 and 1972.

**Anthonomus sp.
Apion spp.
*Auleutes tenuipes LeConte
*Aulobaris nasutus (LeConte)
Baris sp.
Centrinaspis sp.
**Ceutorhynchus atriculus Dietz
*Ceutorhynchus erysimi F.
Ceutorhynchus sp.
*Chalcoderma inaequalicollis Horn
Chelonychus longipes Dietz
**Cylindrocopturus adspersus (LeConte)
Cylindrocopturus frontalis (Casey)
*Cylindrocopturus sp.
Endalus cribricollis LeConte
Epicaerus imbricatus Say
Hypera postica (Gyllenhal)
**Hypera punctata (F.)
*Hyperodes echinata Dietz
*Hyperodes obscurellus (Dietz)
**Hyperodes rotundicollis Dietz
*Maemactes cribratus (LeConte)
**Mesagroicus minor Buchanan
Odontocorynus spp.
**Onchobaris millepora Casey
Pantomorus pallidus Horn
Promecotarsus fumatus Casey
*Pseudobaris farcta (LeConte)
Rhodabaenus tredecimpunctatus (Illiger)
*Rhynchites deneus Boheman
Rhyssematus lineaticollis Say
**Sitona cylindricollis F.
Smicronyx fulvus LeConte
*Smicronyx sordidus (LeConte)
*Smicronyx squalidas Casey
**Smicronyx tesselatus Dietz
**Smicronyx sp.
*Sphenophorus cultellatus Horn
Sphenophorus parvulus Gyllenhal
*Stethobaris commixta Blatchley
*Trichobaris texana LeConte
*Trichobaris trinotata Say
Tychius sordidus LeConte

*Species found only in 1971.
**Species found only in 1972.

Table 17. Species of Curculionidae found in association with plants during 1971 and 1972.

On Louisiana sagewort (Artemesia ludoviciana)

- Chelonychus longipes Dietz
- Pantomorus pallidus Horn
- Promecotarsus fumatus Casey

On milkweed flower (Asclepias latifolia and A. decumbens)

- Odontocorynus sp.

Feeding on milkweed (Asclepias latifolia)

- Rhyssematus lineaticollis Say

On plains wildindigo (Baptisia leucophaea)

- Tychius sordidus LeConte

On blue wildindigo (Baptisia minor)

- Epicaerus imbricatus Say
- Tychius sordidus LeConte

On blooms of sunflower (Helianthus annuus)

- Apion spp.
- Rhynchites deneus Boheman
- Smicronyx fulvus LeConte
- Smicronyx sordidus (LeConte)

On manyflower scurfpea (Psoralea tenuiflora var. floribunda)

- Apion spp.
- Baris sp.
- Epicaerus imbricatus Say
- Odontocorynus sp.
- Pantomorus pallidus Horn

On pitcher sage (Salvia azurea)

- Pseudobaris farcta (LeConte)

On catclaw sensitivebriar (Schrankia nuttallii)

- Epicaerus imbricatus Say

On buffalobur nightshade (Solanum rostratum)

- Trichobaris texana LeConte
- Trichobaris trinotata Say

On blooms of baldwin ironweed (Vernonia baldwini baldwini)

- Aulobaris nasutus (LeConte)
- Pantomorus pallidus Horn
- Pseudobaris farcta (LeConte)

Feeding on baldwin ironweed (Vernonia baldwini baldwini)

- Pantomorus pallidus Horn
- Rhodabaenus tredecimpunctatus (Illiger)

Table 18. Species and numbers of Curculionidae in tall-grass prairie treatments from May 19, 1971 to October 7, 1971.

	BUGR		UBGR		UBUG		
	2	5	2	5	2	5	Total
Apion spp.	31	20	3	3	0	1	58
Baris sp.	0	0	0	0	2	1	3
Centrinaspis sp.	1	1	0	0	0	0	2
Ceutorhynchus sp.	12	3	1	0	0	0	16
Chalcoderma inaequalicollis Horn	0	0	0	0	0	1	1
Chelonychus longipes Dietz	3	0	5	9	15	7	39
Cylindrocopturus frontalis (Casey)	0	1	0	0	0	0	1
Epicaerus imbricatus Say	1	0	1	1	0	0	3
Hypera postica (Gyll.)	0	0	0	0	1	0	1
Hyperodes echinata Dietz	3	2	0	0	0	0	5
Hyperodes obscurellus (Dietz)	1	0	0	0	0	0	1
Maemactes cribratus (LeConte)	0	1	0	0	0	0	1
Odontocorynus spp.	1	0	0	0	0	0	1
Pantomorus pallidus Horn	0	0	3	2	0	3	8
Promecotarsus fumatus Casey	3	0	1	1	0	0	5
Smicronyx squalidas Casey	0	1	0	0	0	0	1
Sphenophorus cultellatus Horn	0	1	0	0	0	0	1
Sphenophorus parvula Gyll.	0	1	0	1	0	0	2
Tychius sordidus LeConte	0	0	0	1	0	0	1
Totals	56	31	14	18	18	13	150

Table 19. Species and numbers of Curculionidae collected adjacent to treatment areas by sweeping and collecting by hand from May 19, 1971 to October 7, 1971.

	Adjacent to			
	BUGR	UBGR	UBUG	Other
*Apion spp.	1	6	0	74
Auleutes tenuipes LeConte	0	1	0	0
Aulobaris nasutus (LeConte)	0	0	0	16
*Baris sp.	0	0	0	1
*Centrinaspis sp.	0	0	0	1
Ceutorhynchus erysimi F.	0	1	0	0
*Chelonychus longipes Dietz	0	0	0	9
Cylindrocopturus sp.	0	0	0	1
Endalus cribricollis LeConte	0	1	0	0
*Epicaerus imbricatus Say	0	0	2	2
*Odontocorynus sp.	2	5	0	2
*Pantomorus pallidus Horn	1	33	18	8
*Promecotarsus fumatus Casey	0	0	0	1
Pseudobaris farcta (LeConte)	0	0	3	25
Rhodabaenus tredecimpunctatus (Illiger)	0	1	0	0
Rhynchites deneus Boheman	0	0	0	8
Rhyssematus lineaticollis Say	4	0	1	0
Smicronyx fulvus LeConte	0	0	2	13
Smicronyx sordidus (LeConte)	0	0	13	65
Stethobaris commixta Blatchley	0	1	0	0
Trichobaris texana LeConte	0	0	0	6
Trichobaris trinotata Say	0	0	0	1

*Species previously recorded from grassland treatments.

Table 20. Species and numbers of Curculionidae in tall-grass prairie treatments from May 25, 1972 to August 17, 1972.

	BUGR		UBGR		UBUG		
	2	5	2	5	2	5	Total
<u>Anthonomus</u> sp.	0	0	0	1	0	0	1
<u>Apion</u> spp.	6	68	2	0	1	1	78
<u>Baris</u> sp.	0	0	1	0	3	1	5
<u>Centrinaspis</u> sp.	1	0	0	1	0	0	2
<u>Ceutorhynchus</u> <u>atriculus</u> Dietz	0	1	1	1	0	0	3
<u>Ceutorhynchus</u> sp.	0	2	1	1	0	0	4
<u>Chelonychus</u> <u>longipes</u> Dietz	0	0	19	37	20	5	81
<u>Cylindrocopturus</u> <u>adspersus</u> (LeConte)	0	0	1	0	0	0	1
<u>Cylindrocopturus</u> <u>frontalis</u> (Casey)	0	1	0	2	1	0	4
<u>Endalus</u> <u>cribricollis</u> LeConte	0	1	0	0	0	0	1
<u>Epicaerus</u> <u>imbricatus</u> Say	0	0	2	0	1	0	3
<u>Hypera</u> <u>postica</u> (Gyll.)	0	0	0	1	1	0	2
<u>Hypera</u> <u>punctata</u> (Fab.)	0	0	0	0	0	1	1
<u>Hyperodes</u> <u>rotundicollis</u> Dietz	0	1	1	0	0	0	2
<u>Mesagroicus</u> <u>minor</u> Buchanan	0	1	0	0	0	0	1
<u>Onchobaris</u> <u>millepora</u> Casey	0	1	0	0	0	0	1
<u>Pantomorus</u> <u>pallidus</u> Horn	0	0	0	0	0	1	1
<u>Promecotarsus</u> <u>fumatus</u> Casey	0	0	1	0	1	0	2
<u>Sitona</u> <u>cylindricollis</u> Fab.	0	0	0	1	0	0	1
<u>Smicronyx</u> <u>fulvus</u> LeConte	0	0	1	0	0	0	1
<u>Smicronyx</u> <u>tesselatus</u> Dietz	7	6	0	5	1	2	21
<u>Smicronyx</u> sp.	0	0	1	0	0	0	1
<u>Sphenophorus</u> <u>parvulus</u> Gyll.	0	0	0	1	0	0	1
Totals	14	82	21	51	29	11	218

Table 21. Species and numbers of Curculionidae collected adjacent to treatment areas by sweeping and collecting by hand from May 25, 1972 to August 17, 1972.

	Adjacent to			
	BUGR	UBGR	UBUG	Other
*Apion spp.	0	0	0	2
*Chelonychus longipes Deitz	7	0	0	0
Odontocorynus sp.	10	0	0	0
Rhodabaenus tredecimpunctatus Illiger	0	1	1	0
Rhyssematus lineaticollis Say	3	0	2	0
Tychius sordidus LeConte	0	0	6	5

*Species previously recorded from grassland treatments.

Table 22. Monthly precipitation at the Department of Physics weather station located on the campus of Kansas State University.

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
1961	0.03	0.83	2.87	3.01	7.79	4.09	3.37	1.54	7.72	4.17	2.06	0.76	29.83
1962	0.81	1.35	2.06	1.11	6.60	4.51	2.22	5.65	4.18	2.96	1.33	0.29	33.07
1963	0.48	0.06	1.84	1.70	2.47	2.90	1.24	1.80	2.16	2.16	1.41	0.29	18.51
1964	0.38	0.44	2.01	4.22	2.92	6.58	3.68	3.71	2.68	0.31	3.53	1.27	31.73
1965	2.33	2.09	2.50	1.64	2.39	12.01	3.27	3.12	8.39	1.36	0.29	2.23	41.62
1966	0.71	0.67	0.06	2.08	1.87	1.74	2.36	3.58	0.60	0.78	0.06	0.91	15.42
1967	0.38	0.21	1.59	5.02	2.95	9.86	3.10	1.42	7.97	3.08	0.77	1.24	37.59
1968	0.81	0.36	0.00	3.13	3.32	3.16	5.71	6.24	1.98	5.28	1.45	1.74	33.18
1969	0.46	0.47	2.27	4.90	3.77	4.28	8.11	0.69	2.09	4.33	0.11	1.20	32.68
1970	0.20	0.02	1.00	5.37	6.77	8.49	0.70	2.81	8.69	2.79	0.78	0.27	35.85
1971	0.75	2.18	0.82	2.07	5.56	4.37	8.10	T	1.18	6.14	4.01	0.16	35.34
1972	0.41	0.30	1.63	2.29	3.02	3.00	3.26	2.54	-	-	-	-	-
Mean[1]	0.67	0.79	1.55	2.93	4.24	5.64	3.80	2.78	3.79	3.03	1.44	0.94	

[1] Long term mean is the 1961-1971 average.

COLEOPTERA, ESPECIALLY CURCULIONIDAE, OF TALLGRASS PRAIRIE

by

ROBERT L. BERTWELL

B. S., Kansas State University, 1970

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Between 1971 and 1972, Coleoptera data were collected from 3 grassland treatments: burned-grazed and unburned-grazed, in "Donaldson Pastures", located 2 miles west of Manhattan, Kansas, and unburned-ungrazed, located in the Kansas State University Nuclear Shielding site approximately 2.5 miles west of Manhattan. Each treatment was located in 2 different soil types, ordinary upland and clay upland, giving a total of 6 treatment combinations.

Samples were obtained using a stabilized drop trap and a DeVac (vacuum) collector. Modified Berlese funnels were used to separate Coleoptera from sample litter. Thirty-seven families of beetles including 30 genera and 35 species of Curculionidae were determined from grasslands during 1971 and 1972. Major families of Coleoptera were similar in both years. Carabidae, Chrysomelidae, Coccinellidae, Curculionidae and Staphylinidae were major contributors to numbers and biomass.

Large fluctuations in adult Coleoptera numbers and biomass were noted in both years. During 1971, peak numbers occurred on August 11, and peak biomass on July 7. In 1972, peak numbers and biomass occurred on June 20.

Statistical analyses of Coleoptera and plant data showed that beetles in grasslands were influenced by the type of vegetation present, lack of plant species diversity, high average plant height and greater plant species biomass increased both Coleoptera numbers and biomass. Therefore, burning and grazing inhibited, to a large degree, total Coleoptera numbers and biomass.

Three families, Chrysomelidae, Curculionidae and Elateridae contributed more than 85% of herbivore biomass in 1971 and 1972.

Only 3 species of Curculionidae found in this study are known to be directly associated with grasses. All others are known to be forb feeders. Basically the same thing is known to be true for Chrysomelidae. Therefore, the majority of herbivorous Coleoptera in grasslands may be beneficial in that they may be limiting undesirable plant species.