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DIETARY COMPOSITION AND RELATIONSHIPS AMONG BREEDING BIRD POPULATIONS AT US/IBP GRASSLAND BIOME SITES, 1970

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ABSTRACT

During the 1970 breeding season, specimens of eight species of grassland birds were collected from tallgrass (Osage), mixed-grass (Cottonwood), and shortgrass (Pantex) sites in the IBP Grassland Biome. The digestive tract contents of these specimens were analyzed to determine the dietary composition of each species. Dietary composition was expressed in terms of the proportional contribution of each prey taxon to the total prey biomass (g dry wt) in a collection. Since the direct analysis of digestive tract contents recorded the estimated body lengths of individual prey items, it was necessary to use a series of prey taxa-specific body length-dry weight regression equations to estimate dietary composition. An analysis of sampling intensity and prey taxa occurrence in samples indicated that a sample size of 20 specimens may be sufficient to portray the dietary composition of a species at a site.

In general, ground- and foliage-dwelling insects and seeds made up the major portion of the diet of all species at all sites. More specifically, grasshoppers, beetles (Curculionidae, Scarabaeidae, Carabidae, Tenebrionidae, and Cerambycidae), Lepidoptera larvae, various Hemipterans and Hymenopterans, and seeds (especially Gramineae) were the most important prey taxa. Horned Larks were the most highly granivorous of the species, while meadowlarks and shorebirds were essentially carnivorous. An analysis of individual variation in dietary composition suggests that while species samples differed in the total number of prey taxa recorded, individuals characteristically contained approximately one-third the number of prey taxa in their species sample.

In some cases, sample sizes were sufficient to permit consideration of sexual and diurnal variations in dietary composition. Some sexual variations were noted especially in the importance of seeds in the diet, but in general, the dietary composition of males and females of a species at a site was quite

similar. Temporal variations in diet were more apparent. Horned Larks at Pantex and Cottonwood consumed mainly animal prey in the morning and seeds in the late afternoon and evening. The consumption of Lepidoptera larvae by several species also showed marked AM-PM differences.

Granivorous species consumed generally smaller prey items than carnivorous species. The mean size of prey items was usually proportionate with increasing body weight, bill size, and tarsus length of the consumers, although relations of these morphological features to the mean size of animal prey items only were less distinct. When animal prey were taken, they were obtained from roughly similar size ranges by most bird species; smaller species apparently tended to eat proportionately more small seeds than larger species, rather than eating smaller insects.

Detailed comparisons of similarities in diet composition, prey taxa diversity, prey biomass consumed per individual, and the sizes of prey taken indicate differences among all of the species occupying any single site, as well as between collections of the same species made at different sites.

INTRODUCTION

Knowledge of the dietary habits of populations is essential to understanding the structure and function of natural ecosystems. Ecosystems are bound together by the energy and nutrient transfers of food webs and it is disruption or modification of these natural food webs which frequently precipitates ecosystem imbalance and decay. Furthermore, food is an essential resource to all populations, and may often play a limiting role in their population dynamics. Food resources thus represent niche dimensions especially prone to competitive adjustments, and to the extent that food resources are limiting, a good deal of the structure of natural communities may be related to food supplies and dietary preferences.

The actual physiological and behavioral mechanics of diet selection are complex and are influenced by a variety of features of the consumer and that which is consumed. We may judge that certain kinds and quantities of food resources are present in an area, and we may estimate how this resource spectrum is exploited by the consumers by examining the contents of their digestive tracts. But the relationship between food presence and dietary composition is far from direct; a variety of "filters" or "amplifiers" (Wiens 1971*a*) may intercede to bias diet selection in various directions. So when we analyze the dietary composition of consumers, we are examining the end results of a complex series of processes, of which we know little about most. The matter is perhaps best summarized by Ellis (1972); it is important to mention in order to provide a perspective to view the results presented here.

In this report the results of studies of avian dietary composition conducted at three IBP Grassland Biome sites (Pantex, Osage, and Cottonwood) during the 1970 breeding season are presented and analyzed.

SAMPLING AND ANALYSIS

Specimen Collection

Bird specimens were collected by shotgun in areas at least 0.5 km from the plots on which population censuses were conducted (Wiens 1971*b*), but within similar grassland habitat. At Pantex, specimens were collected in pastures directly west of the grazed treatment plot; at Osage, most specimens were collected near the airstrip or on other portions of the Adams Ranch, although a few Eastern Meadowlarks[1/] were collected along roadsides between the Adams Ranch and Foraker; at Cottonwood, specimens were collected on the replicate grazing treatments. These collection activities are summarized in Table 1.

Immediately upon collection, the gizzard of each specimen was injected with a measured quantity of 5% Formalin. Within 6 hours the specimen was weighed, various morphological features were measured (see French 1971), and the proventriculus and gizzard were removed and placed in a labeled vial of 5% Formalin. The mouth and esophagus were examined, and any food items found were also placed in the sample vial.

Diet Analysis and Quantification

The general procedures followed in the analysis of the stomach contents of a specimen are outlined in Table 2. After opening the proventriculus and gizzard and washing the contents into a petri dish, food items were sorted into plant, animal, and grit categories. Grit was treated simply as being present or absent. Plant items (seeds) were then sorted by gross morphology and later identified and counted. The length (mm) of each seed was recorded.

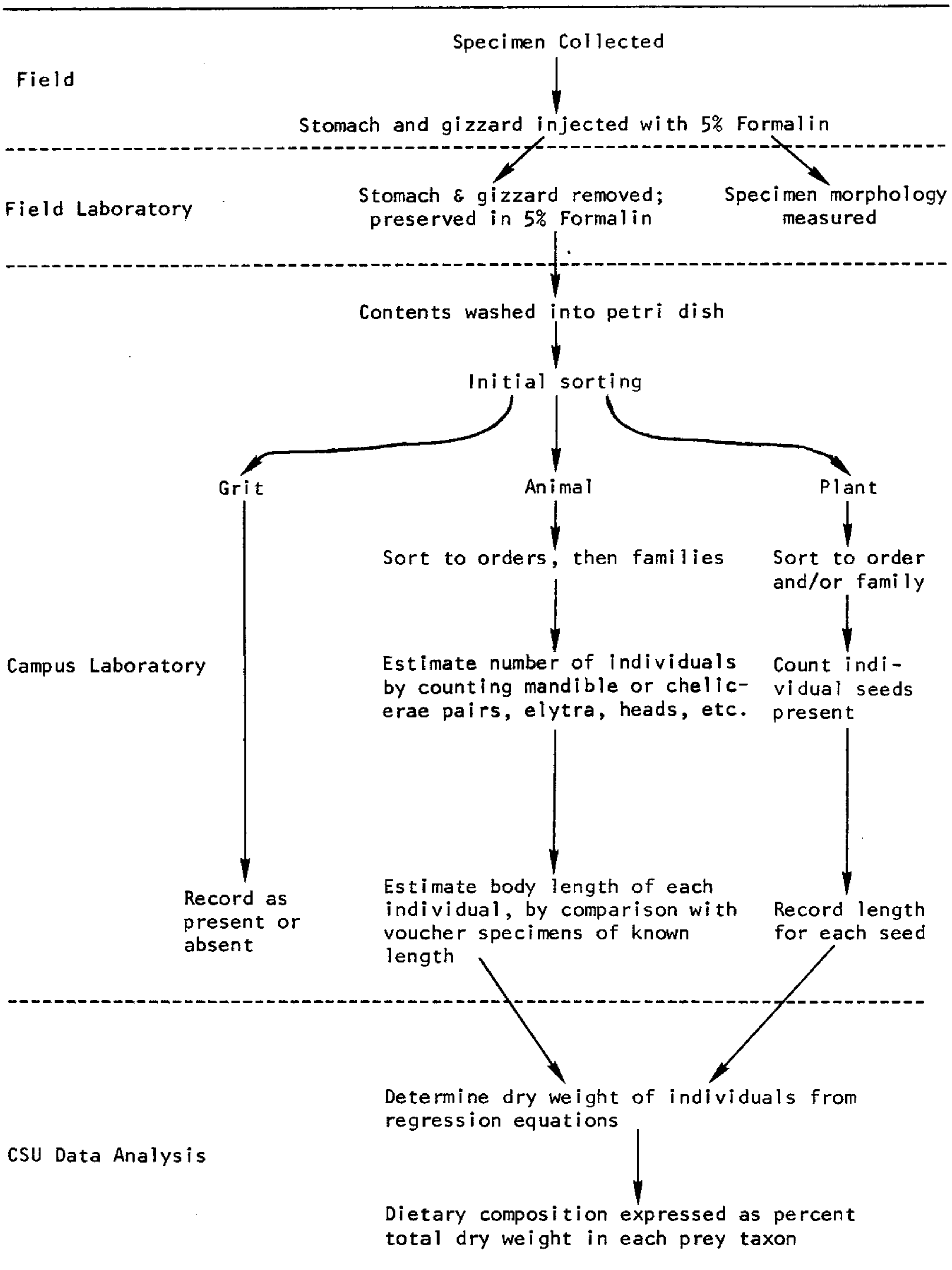
Animal prey items were generally fragmented rather excessively and required patience, consummate skill, and not infrequently imagination to identify.

1/ Scientific names of bird species are presented in Appendix I.

Table 1. Avian specimens collected at three IBP grassland sites, 1970.

Site	Dates Sampled (1970)	Number of Specimens: Upland Plover	Long-billed Curlew	Horned Lark	Eastern Meadowlark	Western Meadowlark	Dickcissel	Grasshopper Sparrow	Chestnut-collared Longspur
Pantex	3 June - 7 June	0	0	25	0	13	0	0	0
Osage	12 June - 15 June	3	0	0	10	0	11	4	0
Cottonwood	25 June - 28 June	0	2	24	0	11	0	7	4

Table 2. Flow chart depicting the procedures used in determining the diet composition of grassland birds.



Most identifications were made on the basis of characteristics of legs, mandibles, heads, elytra, or occasional whole individuals. Questionable identifications and spot-checks of other identifications were verified by several Oregon State University entomologists. The number of individuals of each taxon present in a sample was estimated by comparing the size of characteristic body fragments (e.g., heads, elytra, etc.) with voucher specimens of known body length.

The importance of various prey taxa in the diet of an individual was expressed in terms of their absolute and relative contributions to the total biomass (g dry wt) represented by the stomach contents. Dry weight estimates of stomach contents were obtained in the following manner. Using dry weight measurements of a variety of entire insects and seeds of known length supplied by Paul Baldwin of Colorado State University, and similar measures obtained by the authors from collections made at IBP sites and in Oregon grasslands, various regression models were fitted to the dry weight-body length measures for the taxa. The regression models providing the best fit (i.e., those with the highest R^2 value) were adopted. In all, 13 equations were used to determine dry weight-length relationships for the prey taxa involved in the studies. The data and regressions are given in Fig. 1. Using the appropriate regression equations, the dry weight of individual prey items in the diet could then be determined from the estimate of body length. These 13 equations were included in the analytic program for avian diet data (Appendix II), and dry weight estimates were thus calculated from our inputs of the taxonomic identity and length of individual food items.

Sampling Adequacy

Collection of avian specimens in the field is a time-consuming process. In addition to the logistical restrictions there are ethical as well as legal

Fig. 1. Regressions of body length (x) with dry weight biomass (y) for various prey taxa. Data points are measures from complete individuals obtained independently of avian dietary samples. Circled data points deviate from the regression model by at least two standard deviations. (Note that for equations 1 and 2 the ordinate is arithmetic, while for the remaining equations the scale is logarithmic.)

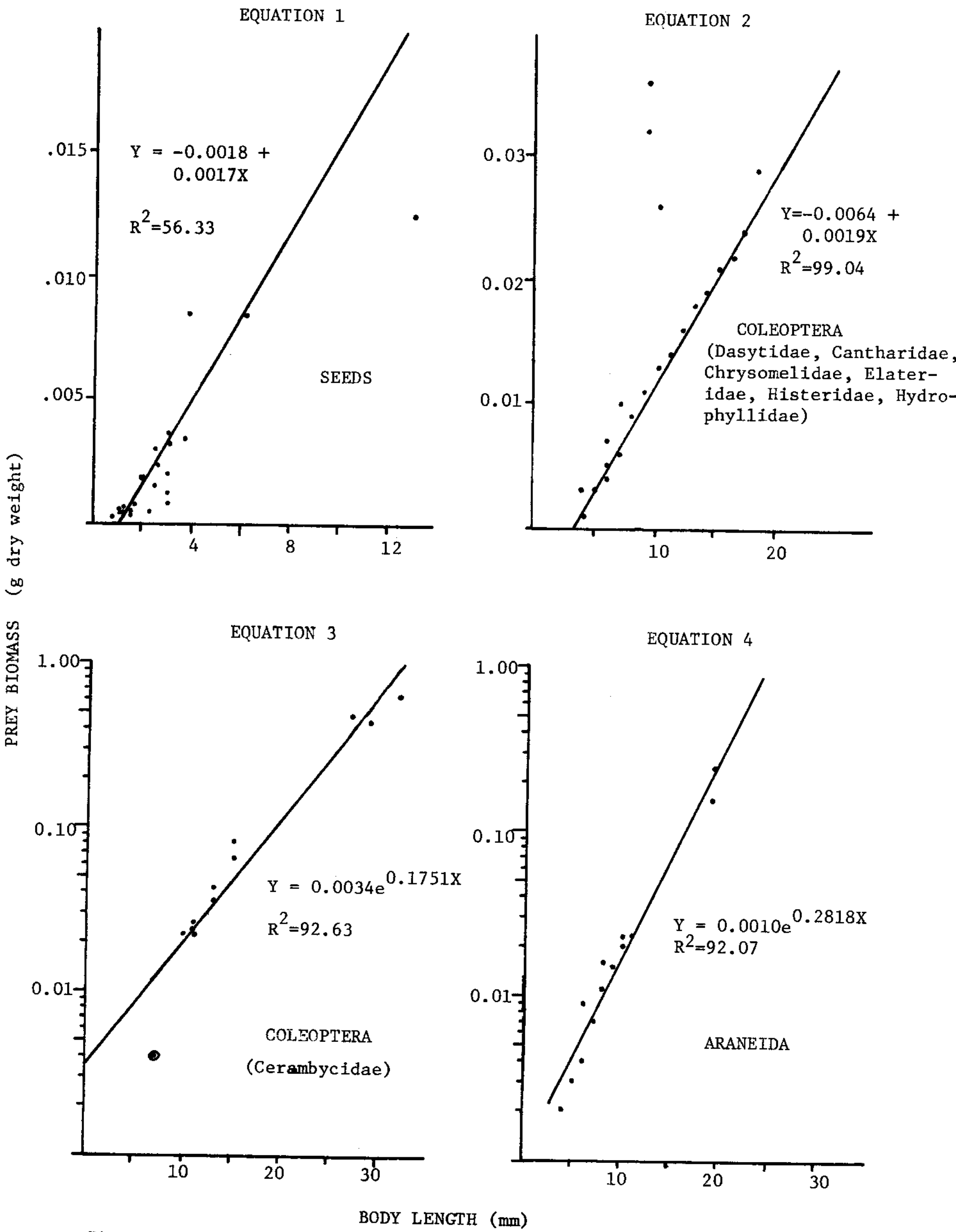

EQUATION 1
Y = -0.0018 + 0.0017X
R2=56.33
SEEDS
.015
.010
.005
4
8
12
EQUATION 2
Y=-0.0064 + 0.0019X
R2=99.04
COLEOPTERA
(Dasytidae, Cantharidae, Chrysomelidae, Elater-idae, Histeridae, Hydro-phyllidae)
0.03
0.02
0.01
10
20
EQUATION 3
Y = 0.0034e0.1751X
R2=92.63
COLEOPTERA
(Cerambycidae)
1.00
0.10
0.01
10
20
30
EQUATION 4
Y = 0.0010e0.2818X
R2=92.07
ARANEIDA
1.00
0.10
0.01
10
20
30
PREY BIOMASS (g dry weight)
BODY LENGTH (mm)

Figure 1.

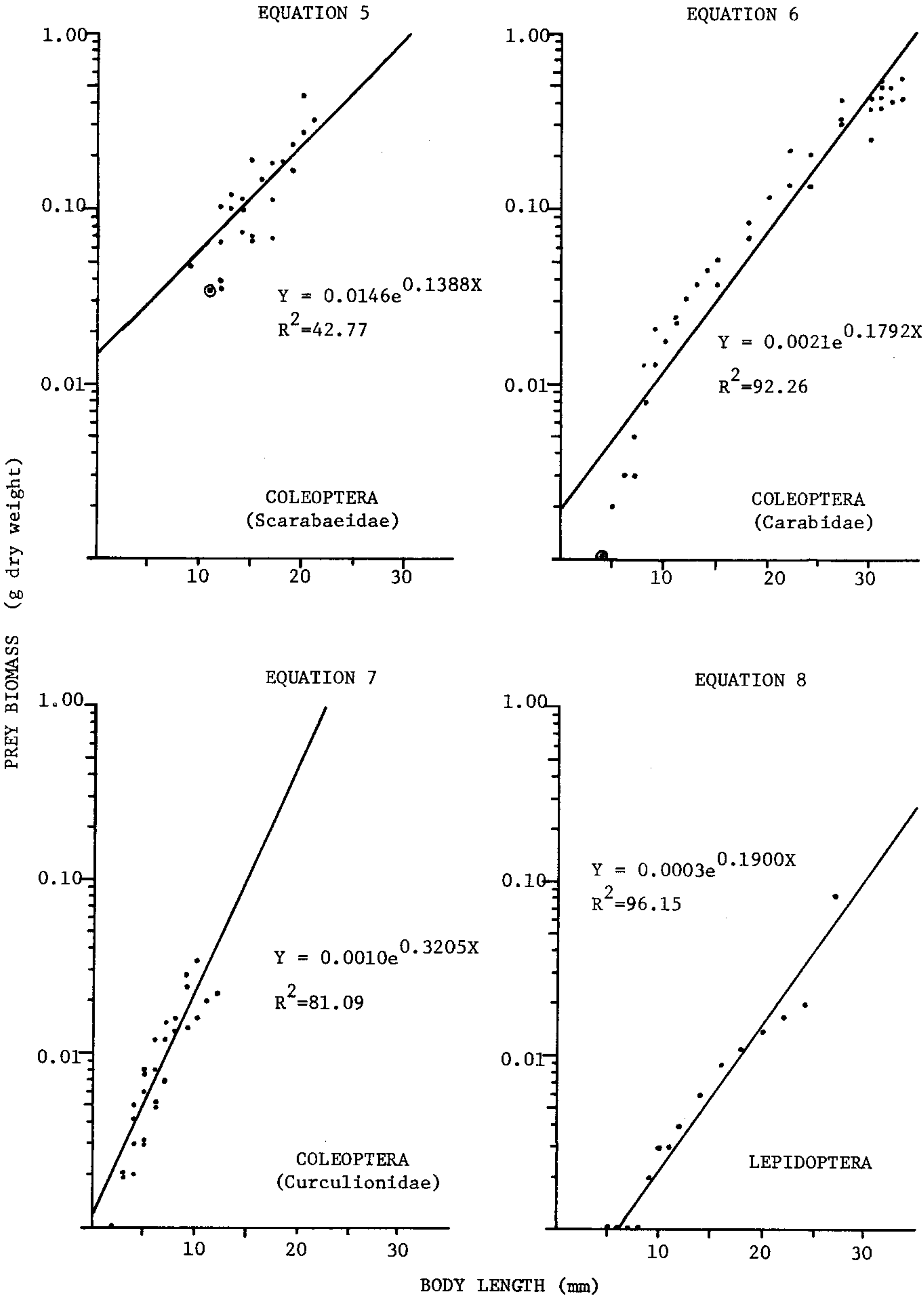
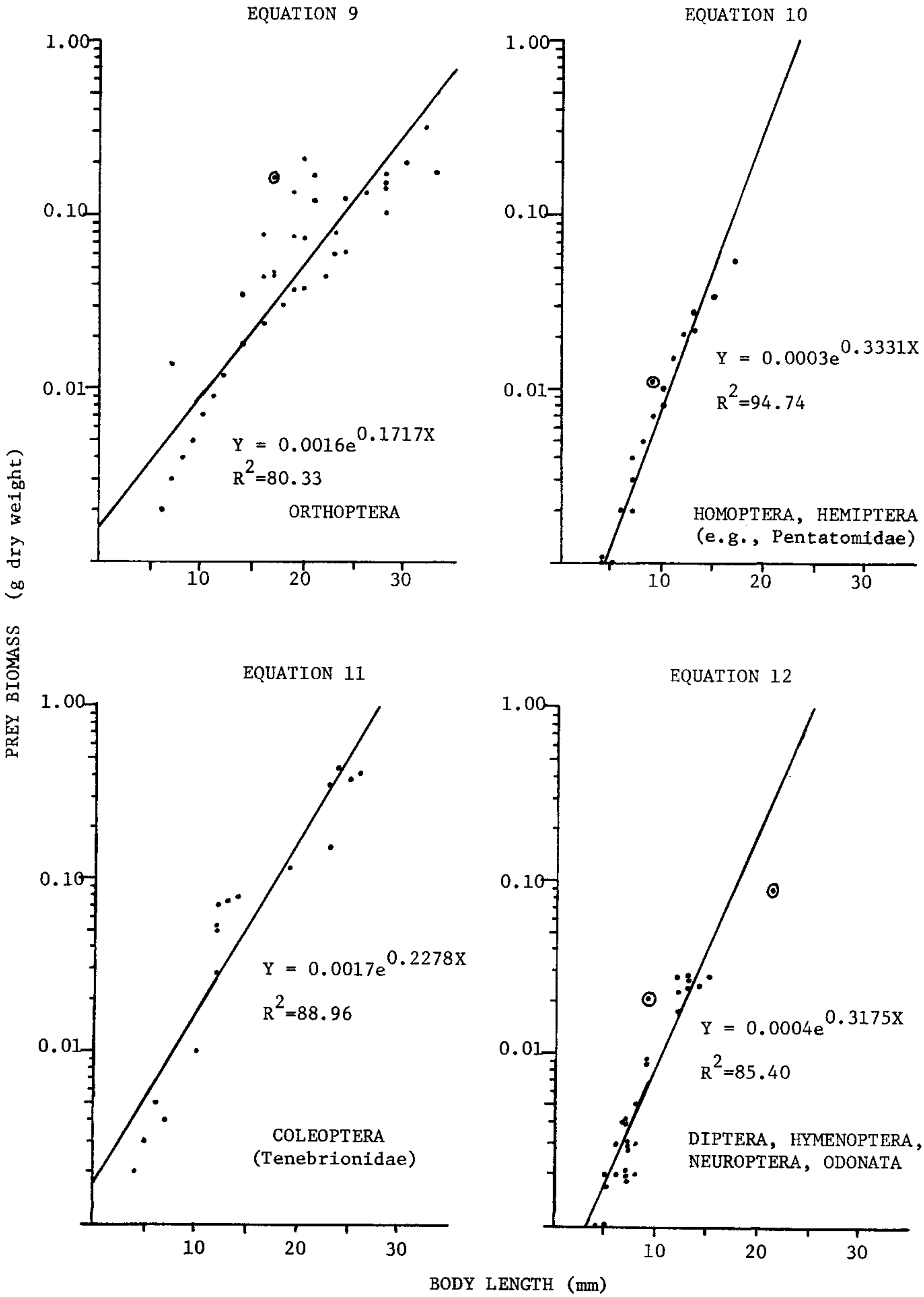


Fig. 1. (continued).



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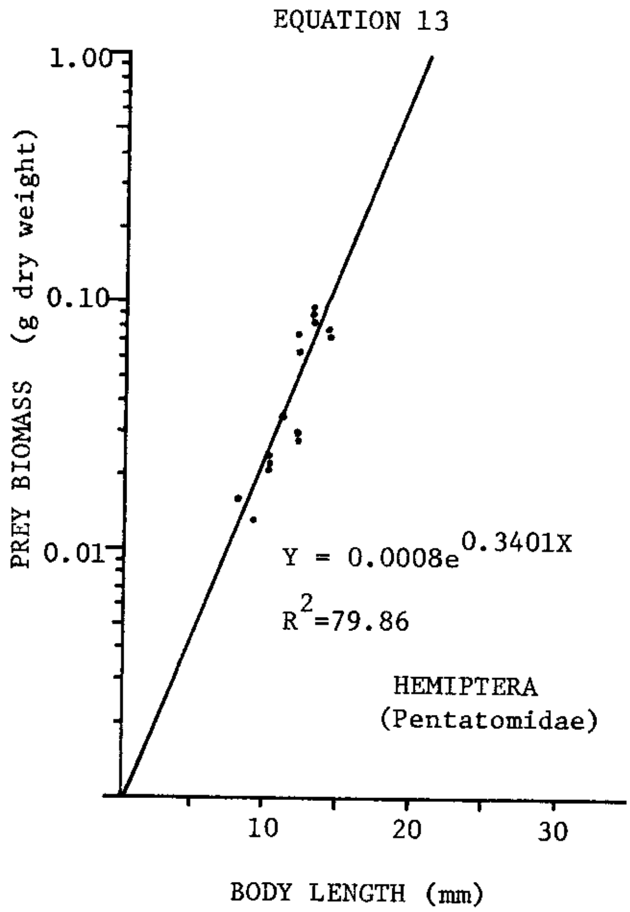


Fig. 1. (continued).

constraints against shooting large numbers of breeding individuals in any restricted locality. Thus in most cases sample sizes were not large, ranging from 2 to 25 specimens of any species per site. Sample sites of less than 10 specimens were obviously inadequate. In order to obtain some feel for the adequacy of larger sample sizes in depicting dietary composition, the authors examined the rate at which prey taxa not previously recorded were added to the list of prey taxa of a bird species at a site with increasing sample size. In theory, the rate of appearance of new prey taxa should rise rapidly at small sample sizes, and then lessen when the sample size approaches adequacy. The results of this analysis (Fig. 2) are somewhat difficult to interpret. The samples of Eastern Meadowlarks and Dickcissels at Osage, though relatively small, portrayed in adequate fashion the occurrence of major prey taxa in the diets. On the other hand, samples of Western Meadowlarks at Pantex and Cottonwood were not as large as they probably should have been, while the rate of addition of prey taxa to Horned Lark diets was very low beyond a sample size of 20. On the basis of these curves, the authors sought to obtain sample sizes of 20 specimens of each species at each site during the 1971 field season.

DIETARY COMPOSITION

General Analysis

Analysis results of the stomach contents of the specimens collected at each site are presented in Tables 3 to 13 and summarized in Table 14. It is apparent that ground- and foliage-dwelling insects and seeds comprised the major portion of the diet of all species at all sites and that the range of prey taxa was relatively broad. Many taxa, however, contributed very minor amounts to the total prey biomass consumed. In order to discern the major

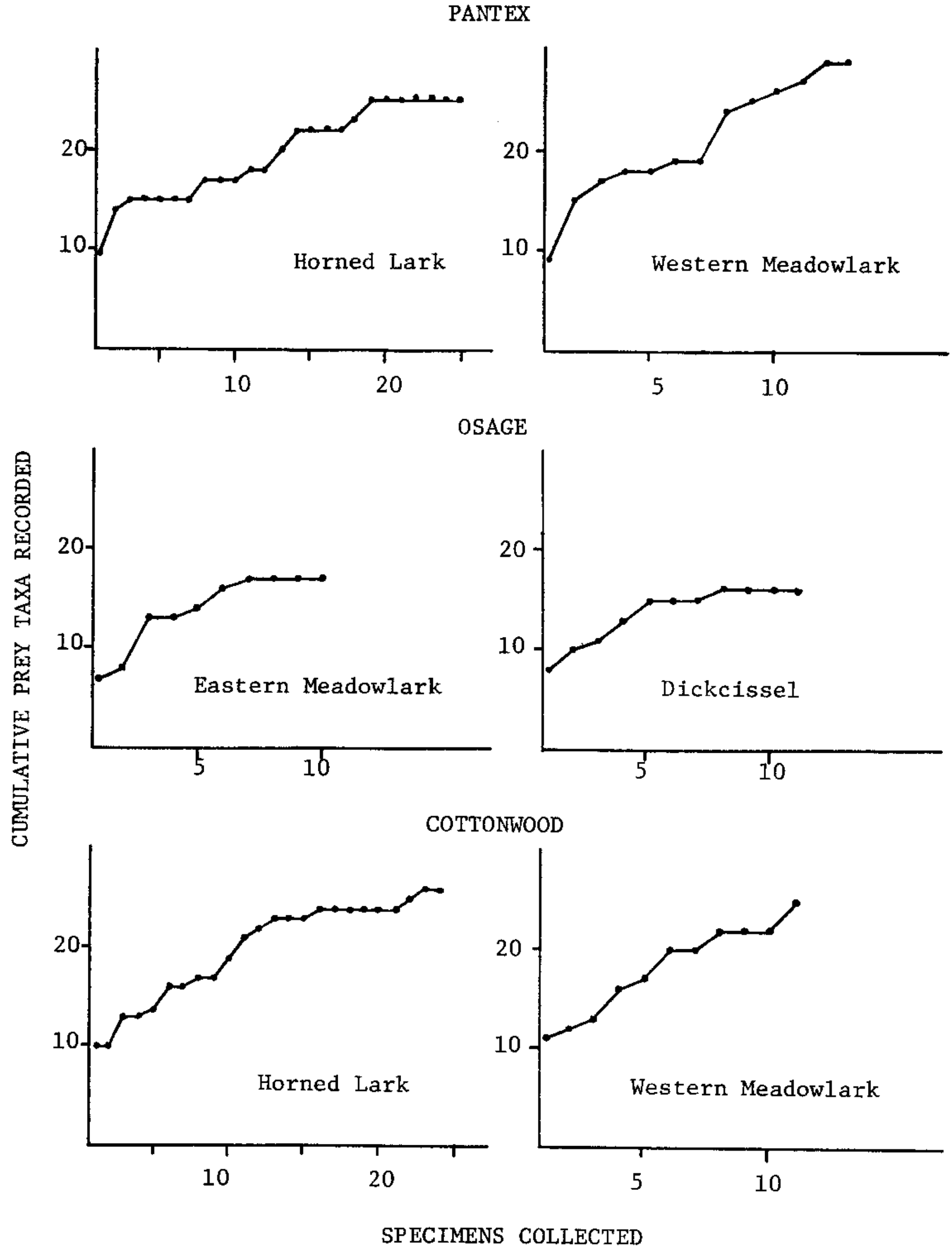


Fig. 2. Rate of appearance of previously unrecorded prey taxa in the diet of several species with increasing sample size.

Table 3. Dietary composition (g dry wt) of Horned Larks at Pantex, 1970. Values in parentheses are percentages of the total prey dry weight.

Orders and Families		Total	Sex		Time of Collection	
			Male	Female	AM	PM
N		25	16	9	6	19
INSECTA						
Hymenoptera						
Formicidae		0.021(0.6)	0.016(0.7)	0.005(0.3)	0.004(0.4)	0.017(0.6)
Unidentified		0.012(0.3)	0.002(0.1)	0.010(0.6)	0.009(1.0)	0.002(0.1)
Σ		0.032(0.9)	0.017(0.8)	0.015(0.9)	0.013(1.4)	0.019(0.7)
Coleoptera						
Curculionidae		0.052(1.4)	0.031(1.5)	0.021(1.3)	0.033(3.4)	0.020(0.7)
Cerambycidae		0.019(0.5)	0.019(0.9)	--	0.019(1.9)	--
Chrysomelidae		0.020(0.5)	0.016(0.8)	0.004(0.2)	0.001(0.1)	0.019(0.7)
Scarabaeidae		0.581(15.6)	0.349(16.6)	0.232(14.4)	0.348(36.0)	0.233(8.5)
Unidentified		0.004(0.1)	0.001(t)	0.003(0.2)	--	0.004(0.1)
Σ		0.676(18.2)	0.416(19.8)	0.260(16.1)	0.401(41.5)	0.276(10.0)
Orthoptera						
Acrididae		0.532(14.3)	0.255(12.1)	0.277(17.2)	0.122(12.6)	0.410(14.9)
Gryllidae		0.022(0.6)	0.022(1.0)	--	--	0.021(0.8)
Σ		0.553(14.9)	0.276(13.1)	0.277(17.2)	0.122(12.6)	0.431(15.7)
Hemiptera						
Lygaeidae		0.002(0.1)	--	0.002(0.1)	--	0.002(0.1)
Miridae		0.001(t)	0.001(0.1)	--	--	0.001(0.1)
Pentatomidae		0.167(4.5)	0.129(6.1)	0.038(2.4)	0.041(4.2)	0.126(4.6)
Unidentified		0.003(0.1)	0.003(0.2)	--	--	0.003(0.1)
Σ		0.174(4.7)	0.133(6.4)	0.041(2.5)	0.041(4.2)	0.133(4.8)
Homoptera						
Aphididae		0.001(t)	0.001(t)	--	--	0.001(t)
Cicadellidae		0.052(1.4)	0.032(1.5)	0.020(1.2)	0.052(5.4)	--
Cicadidae		0.003(0.1)	0.003(0.1)	--	0.003(0.2)	--
Σ		0.055(1.5)	0.035(1.7)	0.020(1.2)	0.054(5.6)	0.001(t)
Lepidoptera		0.040(1.1)	0.023(1.1)	0.016(1.0)	0.017(1.7)	0.023(0.8)
Diptera		0.009(0.3)	--	0.009(0.6)	0.003(0.3)	0.006(0.2)
ARACHNIDA						
Araneida		0.164(4.4)	0.119(5.7)	0.045(2.8)	0.041(4.2)	0.124(4.5)
ANGIOSPERMAE						
Gramineae		0.395(10.6)	0.252(12.0)	0.143(8.8)	0.001(0.1)	0.394(14.3)
Chenopodiaceae		0.481(13.0)	0.214(10.2)	0.266(16.5)	0.198(20.5)	0.283(10.3)
Compositae		0.198(5.3)	0.088(4.2)	0.110(6.8)	0.029(3.0)	0.168(6.1)
Cruciferae		0.532(14.3)	0.237(11.3)	0.295(18.3)	0.003(0.3)	0.529(19.3)
Portulacaceae		0.008(0.2)	0.008(0.4)	--	--	0.008(0.3)
Unidentified		0.396(10.7)	0.280(13.3)	0.116(7.2)	0.044(4.5)	0.352(12.8)
Σ		2.001(54.1)	1.080(51.4)	0.929(57.6)	0.274(28.4)	1.735(63.2)
% Samples with grit		100.0	100.0	100.0	100.0	100.0
Dry weight per specimen:	$\bar{X}$	0.148	0.131	0.179	0.161	0.145
	SD	0.106	0.076	0.145	0.113	0.106
Total dry weight animal items		1.704(46)	1.021(49)	0.683(42)	0.692(72)	1.012(37)
Total dry weight plant items		2.001(54)	1.080(51)	0.929(58)	0.274(28)	1.735(63)
Dietary diversity:	orders	1.37	1.43	1.28	1.56	1.19
	families	2.38	2.42	2.24	2.02	2.28
Dietary equitability:	orders	0.63	0.69	0.58	0.71	0.54
	families	0.74	0.77	0.77	0.70	0.74

Table 4. Dietary composition (g dry wt) of Western Meadowlarks at Pantex, 1970. Values in parentheses are percentages of the total prey dry weight. All specimens were collected in PM.

Orders and Families	Total	Sex	
		Male	Female
N	13	2	10
INSECTA			
Hymenoptera			
Formicidae	0.129(2.8)	0.081(12.1)	0.049(1.6)
Apidae	0.004(0.1)	--	0.004(0.1)
Halictidae	0.019(0.4)	0.008(1.3)	0.011(0.4)
Sphecidae	0.146(3.1)	--	0.146(4.7)
Unidentified	0.192(4.1)	0.022(3.3)	0.074(2.4)
Σ	0.490(10.4)	0.111(16.7)	0.283(9.2)
Coleoptera			
Curculionidae	0.100(2.1)	0.007(1.0)	0.093(3.0)
Carabidae	0.041(0.9)	0.006(0.9)	0.035(1.1)
Chrysomelidae	0.004(0.8)	--	0.004(0.1)
Dasytidae	0.001(t)	--	0.001(t)
Scarabaeidae	1.647(35.1)	0.233(35.0)	0.624(20.3)
Tenebrionidae	0.381(8.1)	0.053(7.9)	0.328(10.7)
Σ	2.173(46.3)	0.299(44.9)	1.084(35.3)
Orthoptera			
Acrididae	1.421(30.3)	0.073(11.0)	1.295(42.2)
Gryllidae	0.021(0.5)	--	0.021(0.7)
Σ	1.442(30.8)	0.073(11.0)	1.317(42.9)
Hemiptera			
Coreidae	0.003(0.1)	--	0.003(0.1)
Lygaeidae	0.003(0.1)	--	0.003(0.1)
Miridae	0.017(0.4)	--	0.017(0.6)
Pentatomidae	0.144(3.1)	0.017(2.6)	0.127(4.1)
Phymatidae	0.003(0.1)	--	0.003(0.1)
Unidentified	0.001(t)	--	0.001(t)
Σ	0.172(3.7)	0.017(2.6)	0.155(5.0)
Homoptera			
Cicadellidae	0.047(1.0)	0.007(1.1)	0.040(1.3)
Cicadidae	0.001(t)	--	0.001(t)
Unidentified	0.003(0.1)	--	0.003(0.1)
Σ	0.050(1.1)	0.007(1.1)	0.043(1.4)
Lepidoptera	0.025(0.5)	--	0.025(0.8)
ARACHNIDA			
Araneida	0.160(3.4)	0.010(1.5)	0.137(4.5)
MOLLUSCA			
Gastropoda	0.007(0.2)	--	0.007(0.2)
ANGIOSPERMAE			
Gramineae	0.015(0.3)	0.001(0.1)	0.015(0.5)
Chenopodiaceae	0.004(0.1)	0.001(0.1)	0.003(0.1)
Cruciferae	0.005(0.1)	0.001(0.2)	0.004(0.1)
Unidentified	0.147(3.1)	0.147(22.0)	--
Σ	0.170(3.6)	0.149(22.3)	0.021(0.7)
% Samples with grit	54	50	60
Dry weight per specimen: $\bar{X}$	0.361	0.333	0.307
SD	0.219	0.047	0.148
Total dry weight animal items	4.520(96)	0.518(78)	3.051(99)
Total dry weight plant items	0.170(4)	0.149(22)	0.021(1)
Dietary diversity: orders	1.40	1.44	1.39
families	1.95	1.88	1.94
Dietary equitability: orders	0.64	0.74	0.63
families	0.58	0.70	0.58

Table 5. Dietary composition (g dry wt) of Upland Plovers at Osage, 1970. Values in parentheses are percentages of total prey dry weight. Only males were collected.

Orders and Families		Total	Time of Collection	
			AM	PM
N		3	2	1
INSECTA				
Coleoptera				
Curculionidae		0.148(30.7)	0.097(26.9)	0.051(41.8)
Carabidae		0.085(17.6)	0.064(17.7)	0.021(17.2)
Chrysomelidae		0.005(1.2)	0.002(0.6)	0.003(2.5)
Σ		0.239(49.5)	0.163(45.3)	0.075(61.5)
Orthoptera				
Gryllidae		0.043(8.9)	0.043(11.9)	--
Σ		0.043(8.9)	0.043(11.9)	--
Hemiptera				
Pentatomidae		0.009(1.8)	--	0.009(7.4)
Unidentified		0.004(0.9)	0.004(1.1)	--
Σ		0.013(2.7)	0.004(1.1)	0.009(7.4)
ARACHNIDA				
Araneida		0.039(8.1)	0.017(4.7)	0.022(18.0)
CRUSTACEA				
Isopoda		0.141(29.1)	0.133(36.9)	0.008(6.6)
ANGIOSPERMAE				
Gramineae		0.009(1.8)	--	0.009(7.4)
% Samples with grit		33	50	0
Dry weight per specimen:	$\bar{X}$	0.161	0.180	0.122
	SD	0.067	--	--
Total dry weight animal items		0.475(98)	0.360(100)	0.114(93)
Total dry weight plant items		0.009(2)	--	0.009(7)
Dietary diversity:	orders	1.29	--	--
	families	1.69	--	--
Dietary equitability:	orders	0.72	--	--
	families	0.77	--	--

Table 6. Dietary composition (g dry wt) of Eastern Meadowlarks at Osage, 1970. Values in parentheses are percentages of total prey dry weight.

Orders and Families		Total	Sex		Time of Collection	
			Male	Female	AM	PM
N		10	7	3	4	6
INSECTA						
Hymenoptera						
Formicidae		0.128(2.8)	0.127(3.9)	0.001(0.1)	0.092(5.7)	0.036(1.2)
Unidentified		0.008(0.2)	0.005(0.1)	0.003(0.3)	0.005(0.3)	0.003(0.1)
Σ		0.136(2.9)	0.132(4.0)	0.004(0.3)	0.097(6.0)	0.039(1.3)
Coleoptera						
Curculionidae		0.765(16.6)	0.577(17.3)	0.189(14.6)	0.457(28.5)	0.308(10.2)
Cerambycidae		0.082(1.8)	0.082(2.5)	--	0.055(3.4)	0.027(0.9)
Carabidae		0.331(7.2)	0.222(6.7)	0.109(8.5)	0.091(5.6)	0.241(8.0)
Chrysomelidae		0.003(0.1)	0.002(0.1)	0.001(0.1)	0.001(0.1)	0.002(0.1)
Elateridae		0.043(0.9)	0.007(0.2)	0.037(2.8)	--	0.043(1.4)
Hydrophyllidae		0.039(0.9)	0.039(1.2)	--	--	0.039(1.3)
Scarabaeidae		1.734(37.6)	1.265(38.0)	0.469(36.3)	0.296(18.5)	1.438(47.7)
Σ		2.998(65.0)	2.194(66.0)	0.804(62.3)	0.900(56.2)	2.099(69.6)
Orthoptera						
Acrididae		0.115(2.5)	0.051(1.5)	0.065(5.0)	--	0.115(3.8)
Gryllidae		0.477(10.3)	0.332(10.0)	0.144(11.2)	0.260(16.2)	0.217(7.2)
Σ		0.592(12.8)	0.383(11.5)	0.209(16.2)	0.260(16.2)	0.332(11.0)
Hemiptera						
Coreidae		0.011(0.2)	0.011(0.3)	--	--	0.011(0.4)
Pentatomidae		0.037(0.8)	--	0.037(2.8)	--	0.037(1.2)
Unidentified		0.004(0.1)	0.004(0.1)	--	0.004(0.3)	--
Σ		0.052(1.1)	0.016(0.5)	0.037(2.8)	0.004(0.3)	0.048(1.6)
Lepidoptera		0.759(16.4)	0.538(16.2)	0.221(17.1)	0.307(19.2)	0.452(15.0)
CRUSTACEA						
Isopoda		0.024(0.5)	0.024(0.7)	--	0.024(1.5)	--
ARACHNIDA						
Araneida		0.055(1.2)	0.040(1.2)	0.015(1.2)	0.011(0.7)	0.044(1.5)
% Samples with grit		20	29	0	50	0
Dry weight per specimen:	$\bar{X}$	0.462	0.475	0.430	0.401	0.502
	SD	0.198	0.195	0.245	0.150	0.228
Total dry weight animal items		4.616(100)	3.326(100)	1.290(100)	1.602(100)	3.014(100)
Total dry weight plant items		-- (0)	-- (0)	-- (0)	-- (0)	-- (0)
Dietary diversity:	orders	1.07	1.06	1.06	1.22	0.96
	families	1.89	1.67	1.84	1.86	1.75
Dietary equitability:	orders	0.55	0.54	0.59	0.63	0.54
	families	0.66	0.60	0.74	0.75	0.65

Table 7. Dietary composition (g dry wt) of Dickcissels at Osage, 1970. Values in parentheses are percentages of total prey dry weight.

Orders and Families	Total	Sex		Time of Collection	
		Male	Female	AM	PM
N	11	9	2	2	9
INSECTA					
Hymenoptera					
Apidae	0.007(0.5)	0.004(0.3)	0.004(0.8)	--	0.007(0.6)
Unidentified	0.006(0.4)	0.006(0.5)	--	--	0.006(0.5)
Σ	0.013(0.8)	0.009(0.9)	0.004(0.8)	--	0.013(1.0)
Coleoptera					
Curculionidae	0.136(8.6)	0.106(9.7)	0.029(6.2)	0.005(1.6)	0.131(10.3)
Cerambycidae	0.039(2.5)	0.039(3.5)	--	--	0.039(3.1)
Unidentified	0.017(1.1)	0.003(0.3)	0.014(3.0)	--	0.017(1.3)
Σ	0.192(12.2)	0.148(13.5)	0.044(9.2)	0.005(1.6)	0.187(14.7)
Orthoptera					
Acrididae	0.514(32.7)	0.192(17.4)	0.322(68.3)	--	0.514(40.4)
Gryllidae	0.036(2.3)	0.036(3.3)	--	--	0.036(2.3)
Σ	0.550(35.0)	0.228(20.7)	0.322(68.3)	--	0.550(43.2)
Hemiptera					
Reduviidae	0.008(0.5)	0.008(0.8)	--	--	0.008(0.7)
Scutelleridae	0.002(0.1)	0.002(0.1)	--	--	0.002(0.1)
Unidentified	0.009(0.5)	0.009(0.8)	--	--	0.009(0.7)
Σ	0.019(1.2)	0.019(1.6)	--	--	0.019(1.5)
Lepidoptera	0.161(10.2)	0.117(10.6)	0.044(9.4)	0.093(31.1)	0.068(5.3)
Diptera	0.002(0.2)	--	0.002(0.5)	--	0.002(0.2)
Neuroptera	0.003(0.2)	0.003(0.3)	--	0.003(1.1)	--
ARACHNIDA					
Araneida	0.017(1.1)	0.008(0.7)	0.010(2.1)	0.008(2.5)	0.010(0.8)
ANGIOSPERMAE					
Gramineae	0.534(34.0)	0.488(44.4)	0.046(9.7)	0.191(63.7)	0.343(27.0)
Unidentified	0.081(5.1)	0.081(7.3)	--	--	0.081(6.3)
Σ	0.614(39.1)	0.568(51.7)	0.046(9.7)	0.191(63.7)	0.424(33.3)
% Samples with grit	9	11	0	0	11
Dry weight per specimen: $\bar{X}$	0.143	0.122	0.236	0.150	0.141
SD	0.089	0.074	0.117	0.014	0.099
Total dry weight animal items	0.957(61)	0.531(48)	0.426(90)	0.109(36)	0.849(67)
Total dry weight plant items	0.614(39)	0.568(52)	0.046(10)	0.191(64)	0.424(33)
Dietary diversity: orders	1.39	1.34	1.07	0.86	1.32
families	1.74	1.75	1.13	0.86	1.73
Dietary equitability: orders	0.63	0.64	0.55	0.53	0.64
families	0.63	0.65	0.54	0.53	0.64

Table 8. Dietary composition (g dry wt) of Grasshopper Sparrows at Osage, 1970. Values in parentheses are percentages of total prey dry weight.

Orders and Families		Total	Sex		Time of Collection	
			Male	Female	AM	PM
N		4	2	1	1	3
INSECTA						
Coleoptera						
Curculionidae		0.095(14.5)	0.073(27.8)	0.009(7.8)	0.061(53.7)	0.034(6.2)
Carabidae		0.019(2.9)	0.009(3.3)	--	0.009(7.7)	0.010(1.9)
Dasytidae		0.003(0.4)	0.003(1.1)	--	---	0.003(0.5)
Unidentified		0.003(0.4)	0.003(1.1)	--	0.003(2.6)	--
Σ		0.120(18.3)	0.088(33.3)	0.009(7.8)	0.073(64.0)	0.047(8.7)
Orthoptera						
Acrididae		0.234(35.7)	0.058(21.8)	0.051(44.4)	0.036(31.7)	0.198(36.5)
Σ		0.234(35.7)	0.058(21.8)	0.051(44.4)	0.036(31.7)	0.198(36.5)
Hemiptera						
Pentatomidae		0.056(8.5)	0.012(4.6)	0.043(37.6)	--	0.056(10.2)
Σ		0.056(8.5)	0.012(4.6)	0.043(37.6)	--	0.056(10.2)
Lepidoptera		0.134(20.4)	0.085(32.2)	0.006(5.1)	--	0.134(24.5)
ARACHNIDA						
Araneida		0.024(3.7)	0.009(3.2)	0.004(3.7)	--	0.024(4.4)
ANGIOSPERMAE						
Gramineae		0.087(13.3)	0.013(5.0)	0.002(1.4)	0.005(4.3)	0.082(15.1)
Oxalidaceae		0.002(0.2)	--	--	--	0.002(0.3)
Σ		0.089(13.5)	0.013(5.0)	0.002(1.4)	0.005(4.3)	0.084(15.4)
% Samples with grit		0	0	0	0	0
Dry weight per specimen:	$\bar{X}$	0.164	0.132	0.115	0.114	0.181
	SD	0.077	0.026	--	--	0.085
Total dry weight animal items		0.567(86)	0.251(95)	0.114(99)	0.109(96)	0.458(85)
Total dry weight plant items		0.089(14)	0.013(5)	0.002(1)	0.005(4)	0.084(15)
Dietary diversity:	orders	1.60	1.46	1.26	0.79	1.59
	families	1.74	1.67	1.26	1.12	1.67
Dietary equitability:	orders	0.89	0.82	0.70	0.72	0.88
	families	0.75	0.76	0.70	0.70	0.76

Table 9. Dietary composition (g dry wt) of Long-billed Curlews at Cottonwood, 1970. Values in parentheses are percentages of total prey dry weight.

Orders and Families	Total
N	2
INSECTA	
Hymenoptera	
Formicidae	0.001(t)
Σ	0.001(t)
Coleoptera	
Curculionidae	0.012(t)
Carabidae	0.750(1.9)
Cerambycidae	6.782(17.1)
Scarabaeidae	0.354(0.9)
Tenebrionidae	0.867(2.2)
Unidentified	0.269(0.7)
Σ	9.034(22.7)
Orthoptera	
Acrididae	30.172(75.9)
Gryllidae	0.195(0.5)
Σ	30.367(76.4)
Hemiptera	
Pentatomidae	0.012(t)
Σ	0.012(t)
Lepidoptera	0.299(0.8)
ARACHNIDA	
Araneida	0.032(0.1)
% Samples with grit	100
Dry weight per specimen: $\bar{X}$	19.873
SD	20.153
Total dry weight animal items	39.745(100)
Dietary diversity: orders	0.38
families	0.59
Dietary equitability: orders	0.24
families	0.26

Table 10. Dietary composition (g dry wt) of Horned Larks at Cottonwood, 1970. Values in parentheses are percentages of total prey dry weight.

Orders and Families		Total	Sex		Time of Collection	
			Male	Female	AM	PM
N		24	14	9	5	18
INSECTA						
Hymenoptera						
Formicidae		0.087(1.1)	0.060(1.3)	0.026(0.7)	0.004(0.2)	0.083(1.3)
Apidae		0.003(t)	0.003(0.1)	--	0.002(0.1)	0.002(t)
Σ		0.090(1.1)	0.063(1.4)	0.026(0.7)	0.005(0.4)	0.084(1.3)
Coleoptera						
Curculionidae		0.169(2.1)	0.075(1.7)	0.088(2.5)	0.050(3.5)	0.113(1.7)
Cantharidae		0.008(0.1)	0.008(0.2)	--	0.008(0.6)	--
Carabidae		0.290(3.6)	0.262(5.9)	0.028(0.8)	0.028(2.0)	0.262(4.0)
Chrysomelidae		0.031(0.4)	0.024(0.6)	0.007(0.2)	0.003(0.2)	0.028(0.4)
Histeridae		0.006(0.1)	0.004(0.1)	0.003(0.1)	--	0.006(0.1)
Scarabaeidae		0.102(1.3)	0.102(2.3)	--	--	0.102(1.6)
Unidentified		0.007(0.1)	0.004(0.1)	--	--	0.007(0.1)
Σ		0.613(7.6)	0.479(10.8)	0.128(3.6)	0.090(6.3)	0.517(7.9)
Orthoptera						
Acrididae		0.262(3.2)	0.043(1.0)	0.096(2.7)	0.022(1.5)	0.117(1.8)
Σ		0.262(3.2)	0.043(1.0)	0.096(2.7)	0.022(1.5)	0.117(1.8)
Hemiptera						
Coreidae		0.017(0.2)	--	0.017(0.5)	--	0.017(0.2)
Miridae		0.002(t)	0.001(t)	0.001(t)	0.001(0.1)	0.001(t)
Pentatomidae		0.054(0.7)	0.031(0.7)	0.023(0.6)	0.017(1.2)	0.037(0.6)
Scutelleridae		0.005(0.1)	0.002(0.1)	0.003(0.1)	--	0.005(0.1)
Unidentified		0.007(0.1)	0.007(0.2)	--	0.003(0.2)	0.004(0.1)
Σ		0.085(1.0)	0.042(1.0)	0.043(1.2)	0.021(1.5)	0.064(1.0)
Homoptera						
Cicadellidae		0.022(0.3)	0.011(0.2)	0.012(0.3)	--	0.022(0.3)
Unidentified		0.003(t)	0.001(t)	0.001(t)	--	0.002(t)
Σ		0.024(0.3)	0.012(0.3)	0.012(0.3)	--	0.024(0.4)
Lepidoptera		0.545(6.7)	0.298(6.8)	0.232(6.6)	0.380(26.8)	0.150(2.3)
Diptera		0.003(t)	0.003(0.1)	--	--	0.003(0.1)
Unidentified		0.021(0.3)	0.008(0.2)	0.012(0.3)	--	0.021(0.3)
ARACHNIDA						
Araneida		0.322(4.0)	0.165(3.7)	0.130(3.7)	0.110(7.8)	0.185(2.8)
ANGIOSPERMAE						
Gramineae		5.177(63.7)	2.639(59.8)	2.534(71.8)	0.715(50.5)	4.459(68.3)
Cruciferae		0.009(0.1)	0.009(0.2)	--	0.009(0.6)	--
Leguminosae		0.001(t)	0.001(t)	0.001(t)	--	0.001(t)
Polygonaceae		0.066(0.8)	0.061(1.4)	0.005(0.1)	0.005(0.3)	0.061(0.9)
Unidentified		0.904(11.1)	0.592(13.4)	0.311(8.8)	0.061(4.3)	0.843(12.9)
Σ		6.156(75.8)	3.301(74.8)	2.851(80.8)	0.789(55.7)	5.363(82.1)
% Samples with grit		100	100	100	100	100
Dry weight per specimen:	$\bar{X}$	0.338	0.315	0.392	0.283	0.363
	SD	0.406	0.283	0.580	0.231	0.455
Total dry weight animal items		1.966(24)	1.113(25)	0.679(19)	0.627(44)	1.165(18)
Total dry weight plant items		6.156(76)	3.301(75)	2.851(81)	0.789(56)	5.363(82)
Dietary diversity:	orders	0.96	0.95	0.82	1.20	0.77
	families	1.44	1.53	1.16	1.48	1.29
Dietary equitability:	orders	0.42	0.41	0.37	0.62	0.33
	families	0.44	0.47	0.39	0.53	0.40

Table 11. Dietary composition (g dry wt) of Western Meadowlarks at Cottonwood, 1970. Values in parentheses are percentages of total prey dry weight.

Orders and Families	Total	Sex		Time of Collection	
		Male	Female	AM	PM
N	11	7	4	4	7
INSECTA					
Hymenoptera					
Formicidae	0.080(1.2)	0.062(1.6)	0.019(0.7)	0.005(0.4)	0.076(1.5)
Apidae	0.019(0.3)	0.019(0.5)	--	--	0.019(0.4)
Halictidae	0.004(0.1)	0.002(t)	0.002(0.1)	0.002(0.1)	0.002(t)
Σ	0.103(1.6)	0.082(2.1)	0.021(0.8)	0.006(0.5)	0.097(1.9)
Coleoptera					
Curculionidae	0.376(5.8)	0.297(7.7)	0.079(3.1)	0.071(5.0)	0.306(6.1)
Cantharidae	0.054(0.8)	0.017(0.4)	0.038(1.4)	0.008(0.6)	0.046(0.9)
Cerambycidae	1.813(28.1)	0.452(11.7)	1.361(52.4)	--	1.813(35.9)
Chrysomelidae	0.017(0.3)	0.010(0.3)	0.007(0.3)	--	0.017(0.3)
Elateridae	0.015(0.2)	--	0.015(0.6)	--	0.015(0.3)
Histeridae	0.001(t)	--	0.001(t)	--	0.001(t)
Scarabaeidae	1.139(17.6)	1.062(27.5)	0.077(3.0)	0.608(42.9)	0.531(10.5)
Tenebrionidae	0.357(5.5)	0.255(6.6)	0.102(3.9)	--	0.357(7.1)
Unidentified	0.003(t)	0.003(0.1)	--	--	0.003(0.1)
Σ	3.775(58.4)	2.096(54.3)	1.679(64.6)	0.687(48.5)	3.088(61.2)
Orthoptera					
Acrididae	0.467(7.2)	0.436(11.3)	0.031(1.2)	0.155(10.9)	0.312(6.2)
Gryllidae	0.490(7.6)	0.289(7.5)	0.201(7.7)	0.102(7.1)	0.389(7.7)
Σ	0.957(14.8)	0.725(18.8)	0.232(8.9)	0.256(18.0)	0.701(13.9)
Hemiptera					
Coreidae	0.003(t)	--	0.003(0.1)	--	0.003(0.1)
Pentatomidae	0.061(0.9)	0.052(1.4)	0.009(0.3)	0.011(0.7)	0.050(1.0)
Phymatidae	0.006(0.1)	0.006(0.2)	--	--	0.006(0.1)
Unidentified	0.004(0.1)	--	0.004(0.2)	--	0.004(0.1)
Σ	0.074(1.2)	0.058(1.5)	0.016(0.6)	0.011(0.7)	0.064(1.3)
Homoptera					
Cocoidae	0.022(0.3)	--	0.022(0.8)	0.022(1.5)	--
Σ	0.022(0.3)	--	0.022(0.8)	0.022(1.5)	--
Lepidoptera	1.167(18.1)	0.641(16.6)	0.526(20.3)	0.391(27.6)	0.776(15.4)
Diptera	0.003(t)	--	0.003(0.1)	--	0.003(0.1)
Odonata	0.148(2.3)	0.148(3.8)	--	--	0.148(2.9)
ARACHNIDA					
Araneida	0.168(2.6)	0.077(2.0)	0.091(3.5)	0.037(2.6)	0.131(2.6)
MOLLUSCA					
Gastropoda	0.006(0.1)	--	0.006(0.2)	0.006(0.4)	--
ANGIOSPERMAE					
Gramineae	0.038(0.6)	0.036(0.9)	0.002(0.1)	--	0.038(0.8)
% Samples with grit	9	0	25	25	0
Dry weight per specimen: $\bar{X}$	0.550	0.492	0.650	0.354	0.661
SD	0.316	0.226	0.457	0.223	0.318
Total dry weight animal items	6.423(99)	3.827(99)	2.597(100)	1.416(100)	5.007(100)
Total dry weight plant items	0.038(1)	0.036(1)	0.002(t)	--	0.038(t)
Dietary diversity: orders	1.32	1.18	1.08	1.26	1.24
families	1.81	1.55	1.62	1.58	1.69
Dietary equitability: orders	0.54	0.55	0.47	0.61	0.55
families	0.56	0.54	0.53	0.63	0.53

Table 12. Dietary composition (g dry wt) of Grasshopper Sparrows at Cottonwood, 1970. Values in parentheses are percentages of total prey dry weight.

Orders and Families	Total	Sex		Time of Collection	
		Male	Female	AM	PM
N	7	5	2	5	2
INSECTA					
Hymenoptera					
Ichneumonidae	0.031(2.1)	0.031(3.5)	--	0.031(3.3)	--
Σ	0.031(2.1)	0.031(3.5)	--	0.031(3.3)	--
Coleoptera					
Curculionidae	0.133(9.0)	0.105(11.9)	0.028(4.8)	0.119(12.6)	0.014(2.7)
Chrysomelidae	0.017(1.1)	0.011(1.3)	0.006(1.0)	0.011(1.1)	0.006(1.2)
Σ	0.150(10.2)	0.116(13.2)	0.034(5.7)	0.129(13.8)	0.020(3.8)
Orthoptera					
Acrididae	0.414(28.1)	0.232(26.4)	0.182(30.7)	0.282(30.0)	0.132(24.7)
Gryllidae	0.036(2.4)	--	0.036(6.1)	--	0.036(6.7)
Σ	0.450(30.5)	0.232(26.4)	0.218(36.7)	0.282(30.0)	0.168(31.5)
Hemiptera					
Scutelleridae	0.002(0.1)	--	0.002(0.4)	--	0.002(0.4)
Unidentified	0.009(0.6)	0.003(0.4)	0.006(1.0)	0.003(0.3)	0.006(1.1)
Σ	0.011(0.8)	0.003(0.4)	0.008(1.4)	0.003(0.3)	0.008(1.6)
Homoptera					
Cicadellidae	0.088(6.0)	0.045(5.1)	0.043(7.2)	0.075(8.0)	0.013(2.4)
Σ	0.088(6.0)	0.045(5.1)	0.043(7.2)	0.075(8.0)	0.013(2.4)
Lepidoptera	0.234(15.9)	0.186(21.1)	0.048(8.1)	0.076(8.1)	0.158(29.6)
Diptera	0.010(0.7)	0.007(0.7)	0.003(0.6)	0.006(0.7)	0.003(0.6)
ARACHNIDA					
Araneida	0.040(2.7)	0.040(4.5)	--	0.033(3.5)	0.007(1.4)
ANGIOSPERMAE					
Gramineae	0.294(19.9)	0.222(25.1)	0.072(12.2)	0.139(14.8)	0.155(29.0)
Unidentified	0.166(11.3)	--	0.166(28.0)	0.166(17.7)	--
Σ	0.460(31.2)	0.222(25.1)	0.238(40.2)	0.305(32.4)	0.155(29.0)
% Samples with grit	100	100	100	100	100
Dry weight per specimen: $\overline{X}$	0.211	0.176	0.296	0.188	0.266
SD	0.087	0.070	0.073	0.095	0.032
Total dry weight animal items	1.014(69)	0.660(75)	0.354(60)	0.636(68)	0.379(71)
Total dry weight plant items	0.460(31)	0.222(25)	0.238(40)	0.305(32)	0.155(29)
Dietary diversity: orders	1.67	1.76	1.38	1.69	1.45
families	1.99	1.80	1.83	1.95	1.65
Dietary equitability: orders	0.76	0.80	0.71	0.77	0.70
families	0.78	0.78	0.76	0.81	0.69

Table 13. Dietary composition (g dry wt) of Chestnut-collared Longspurs at Cottonwood, 1970. Values in parentheses are percentages of total prey dry weight. All specimens collected in PM.

Order and Families		Total	Sex: Male	Sex: Female
N		4	2	2
INSECTA				
Coleoptera				
Curculionidae		0.111(13.0)	--	0.111(18.8)
Chrysomelidae		0.030(3.5)	--	0.030(5.1)
Elateridae		0.020(2.3)	0.003(1.1)	0.017(2.9)
Σ		0.161(18.8)	0.003(1.1)	0.158(26.7)
Orthoptera				
Acrididae		0.055(6.4)	0.022(8.3)	0.033(5.6)
Gryllidae		0.381(44.5)	--	0.381(64.5)
Σ		0.436(51.0)	0.022(8.3)	0.414(70.1)
Hemiptera				
Lygaeidae		0.005(0.5)	--	0.005(0.8)
Σ		0.005(0.5)	--	0.005(0.8)
Homoptera				
Cicadellidae		0.007(0.8)	0.007(2.7)	--
Σ		0.007(0.8)	0.007(2.7)	--
Lepidoptera		0.004(0.4)	0.004(1.4)	--
ARACHNIDA				
Araneida		0.006(0.7)	--	0.006(0.9)
ANGIOSPERMAE				
Gramineae		0.235(27.4)	0.226(85.3)	0.009(1.5)
Unidentified		0.003(0.4)	0.003(1.2)	--
Σ		0.238(27.8)	0.229(86.5)	0.009(1.5)
% Samples with grit		75	100	50
Dry weight per specimen:	$\overline{X}$	0.214	0.132	0.296
	SD	0.139	0.037	0.172
Total dry weight animal items		0.619(72)	0.036(14)	0.583(99)
Total dry weight plant items		0.238(28)	0.229(86)	0.009(1)
Dietary diversity:	orders	1.14	0.54	0.74
	families	1.51	0.61	1.16
Dietary equitability:	orders	0.59	0.34	0.46
	families	0.63	0.34	0.56

Table 14. Summary of dietary composition of breeding bird populations at IBP sites, 1970. Values are percentages of total sample dry weight for each species (see Tables 3-13). Species code: HL = Horned Lark, WM = Western Meadowlark, UP = Upland Plover, EM = Eastern Meadowlark, D = Dickcissel, GS = Grasshopper Sparrow, LC = Long-billed Curlew, CL = Chestnut-collared Longspur.

Order and Families	Site: Pantex		Osage				Cottonwood				
Species:	HL	WM	UP	EM	D	GS	LC	HL	WM	GS	CL
N	25	13	3	10	11	4	2	24	11	7	4
INSECTA											
Hymenoptera											
Formicidae	1	3	--	3	--	--	t	1	1	--	--
Apidae	--	t	--	--	t	--	--	t	t	--	--
Ichneumonidae	--	--	--	--	--	--	--	--	--	2	--
Halictidae	--	t	--	--	--	--	--	--	t	--	--
Sphecidae	--	3	--	--	--	--	--	--	--	--	--
Unidentified	t	4	--	t	t	--	--	--	--	--	--
Σ	1	10	--	3	1	--	t	1	2	2	--
Coleoptera											
Curculionidae	1	2	31	17	9	15	t	2	6	9	13
Cerambycidae	t	--	--	2	3	--	17	--	28	--	--
Scarabaeidae	16	35	--	38	--	--	1	1	18	--	--
Carabidae	--	1	18	7	--	3	2	4	--	--	--
Tenebrionidae	--	8	--	--	--	--	2	--	6	--	--
Chrysomelidae	t	t	1	t	--	--	--	t	t	1	4
Dasytidae	--	t	--	--	--	t	--	--	--	--	--
Elateridae	--	--	--	1	--	--	--	--	t	--	2
Hydrophyllidae	--	--	--	1	--	--	--	--	--	--	--
Histeridae	--	--	--	--	--	--	--	t	t	--	--
Cantharidae	--	--	--	--	--	--	--	t	1	--	--
Unidentified	t	--	--	--	1	t	1	t	t	--	--
Σ	18	46	50	65	12	18	23	8	58	10	19
Orthoptera											
Acrididae	14	30	--	3	33	36	76	3	7	28	6
Gryllidae	1	t	9	10	2	--	t	--	8	2	45
Σ	15	31	9	13	35	36	76	3	15	30	51
Hemiptera											
Coreidae	--	t	--	t	--	--	--	t	t	--	--
Lygaeidae	t	t	--	--	--	--	--	--	--	--	t
Miridae	t	t	--	--	--	--	--	t	--	--	--
Pentatomidae	5	3	2	1	--	9	t	1	1	--	--
Phymatidae	--	t	--	--	--	--	--	--	t	--	--
Reduviidae	--	--	--	--	t	--	--	--	--	--	--
Scutelleridae	--	--	--	--	t	--	--	t	--	t	--
Unidentified	t	t	1	t	t	--	--	t	t	1	--
Σ	5	4	3	1	1	9	t	1	1	1	t
Homoptera											
Cicadellidae	1	1	--	--	--	--	--	t	--	6	1
Cicadidae	t	t	--	--	--	--	--	--	--	--	--
Aphididae	t	--	--	--	--	--	--	--	--	--	--
Coccidae	--	--	--	--	--	--	--	--	t	--	--
Unidentified	--	t	--	--	--	--	--	t	--	--	--
Σ	2	1	--	--	--	--	--	t	t	6	1
Lepidoptera	1	t	--	16	10	20	1	7	18	16	t
Diptera	t	--	--	--	t	--	--	t	t	1	--
Odonata	--	--	--	--	--	--	--	--	2	--	--
Neuroptera	--	--	--	--	t	--	--	--	--	--	--
Unidentified	--	--	--	--	--	--	--	t	--	--	--
ARACHNIDA											
Araneida	4	3	8	1	1	4	t	4	3	3	1

Table 14. (continued).

Order and Families	Site:	Pantex		Osage				Cottonwood				
	Species:	HL	WM	UP	EM	D	GS	LC	HL	WM	GS	CL
CRUSTACEA												
Isopoda		--	--	29	t	--	--	--	--	--	--	--
MOLLUSCA												
Gastropoda		--	t	--	--	--	--	--	--	t	--	--
ANGIOSPERMAE												
Gramineae		11	t	2	--	34	13	--	64	1	20	27
Chenopodiaceae		13	t	--	--	--	--	--	--	--	--	--
Cruciferae		14	t	--	--	--	--	--	t	--	--	--
Compositae		5	--	--	--	--	--	--	--	--	--	--
Portulacaceae		t	--	--	--	--	--	--	--	--	--	--
Oxalidaceae		--	--	--	--	--	t	--	--	--	--	--
Leguminosae		--	--	--	--	--	--	--	t	--	--	--
Polygonaceae		--	--	--	--	--	--	--	1	--	--	--
Unidentified		11	3	--	--	5	--	--	11	--	11	t
Σ		54	4	2	--	39	14	--	76	1	31	28
% Samples with grit		100	54	33	20	9	0	100	100	9	100	75
Dry weight per specimen:	$\bar{X}$	0.148	0.361	0.161	0.462	0.143	0.164	19.873	0.338	0.550	0.211	0.214
	SD	0.106	0.219	0.067	0.198	0.089	0.077	20.153	0.406	0.316	0.087	0.139
% Dry weight animal items		46	96	98	100	61	86	100	24	99	69	72
% Dry weight plant items		54	4	2	--	39	14	--	76	1	31	28
Dietary diversity:	orders	1.37	1.40	1.29	1.07	1.39	1.60	0.38	0.96	1.32	1.67	1.14
	families	2.38	1.95	1.69	1.89	1.74	1.74	0.59	1.44	1.81	1.99	1.51
Dietary equitability:	orders	0.63	0.64	0.72	0.55	0.63	0.89	0.24	0.42	0.54	0.76	0.59
	families	0.74	0.58	0.77	0.66	0.63	0.75	0.26	0.44	0.56	0.78	0.63

patterns of prey consumption, the authors have constructed food-web diagrams for the species of each site, considering only prey taxa which contributed at least 10% of the diet of at least one of the bird species (Fig. 3 to 5). Together, these diagrams suggest that the diets of breeding birds at the three Great Plains grassland sites are largely composed of beetles (Curculionidae, Scarabaeidae, Carabidae, Terebrionidae, and Cerambycidae), grasshoppers and crickets, Lepidoptera larvae, and seeds (especially Gramineae).

Horned Larks were the most highly granivorous of the species sampled, while the shorebirds (Upland Plover and Long-billed Curlew) and meadowlarks were essentially carnivorous in their diet. The diversity of the diet as measured by

$$H = -\Sigma\ p_i\ \log_e\ p_i$$

(where p_i = proportion of the total diet contributed by prey taxon i) showed no relation to the degree of granivorous or carnivorous habits of the species.

Within all species there was considerable individual variation in dietary composition. As a rough gauge of this individual variation, the authors determined the number of prey taxa (not individuals) represented in the stomach contents of individual specimens (Table 15). The mean values for species varied from 4 to 9.5 prey taxa per individual and, in general, were considerably lower than the number of prey taxa recorded for all individual of a species combined. This comparison, however, is hampered by the unequal sample sizes since the number of prey taxa for the species as a whole increases with sample size (Fig. 2). In order to permit a more realistic comparison of the diversity of prey taxa in individual samples and in total species collections, values were considered only for the first 10 specimens collected. This allowed comparisons among six species collections at the three sites (Table 16).

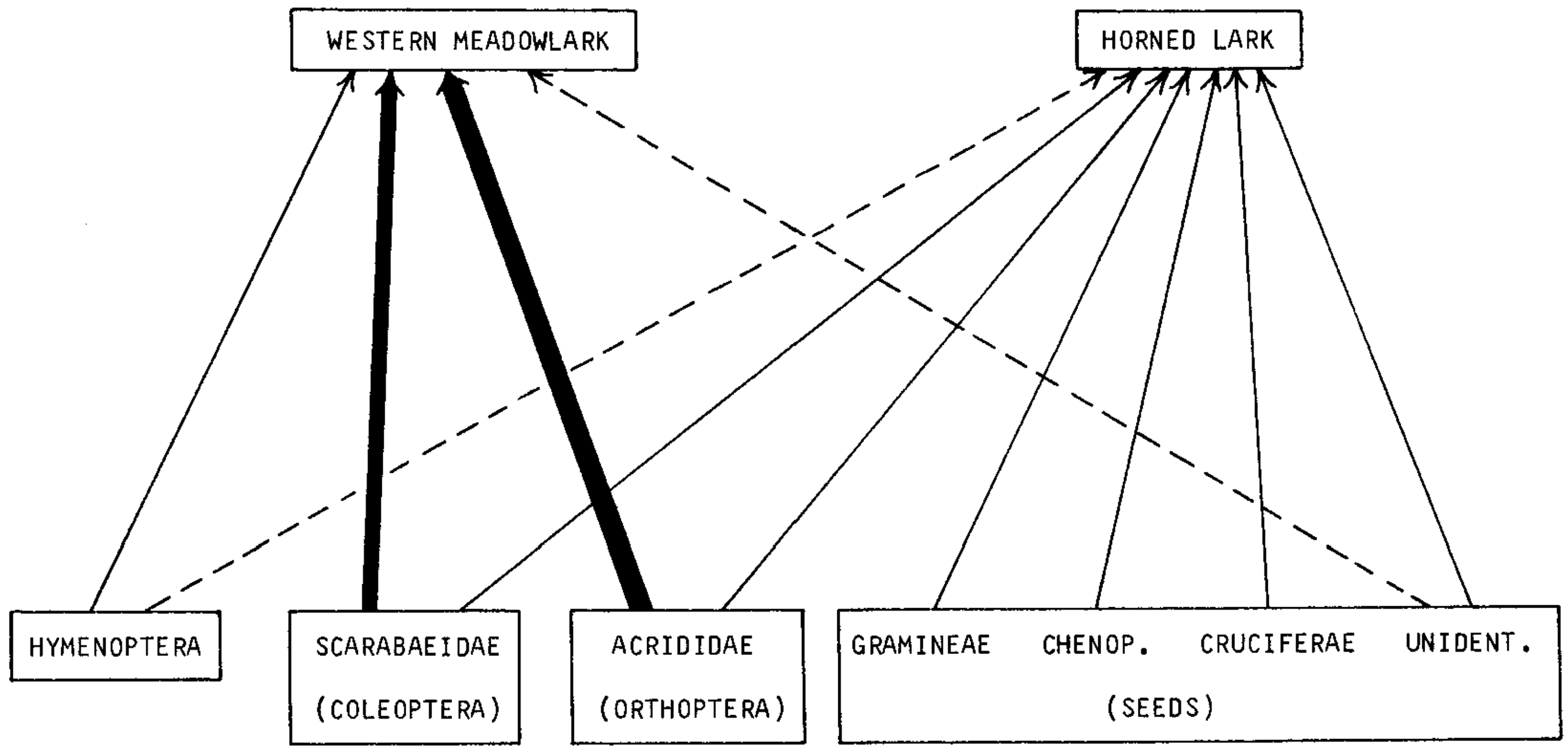


Fig. 3. Generalized food web for the breeding avian community at Pantex, 1970. Arrow widths are roughly proportional to the percentage of the total diet dry weight drawn from a prey taxon; dashed arrows indicate less than 10% of the diet was of the designated prey taxon. Only prey taxa which contributed at least 10% to the total diet of at least one of the bird species are shown.

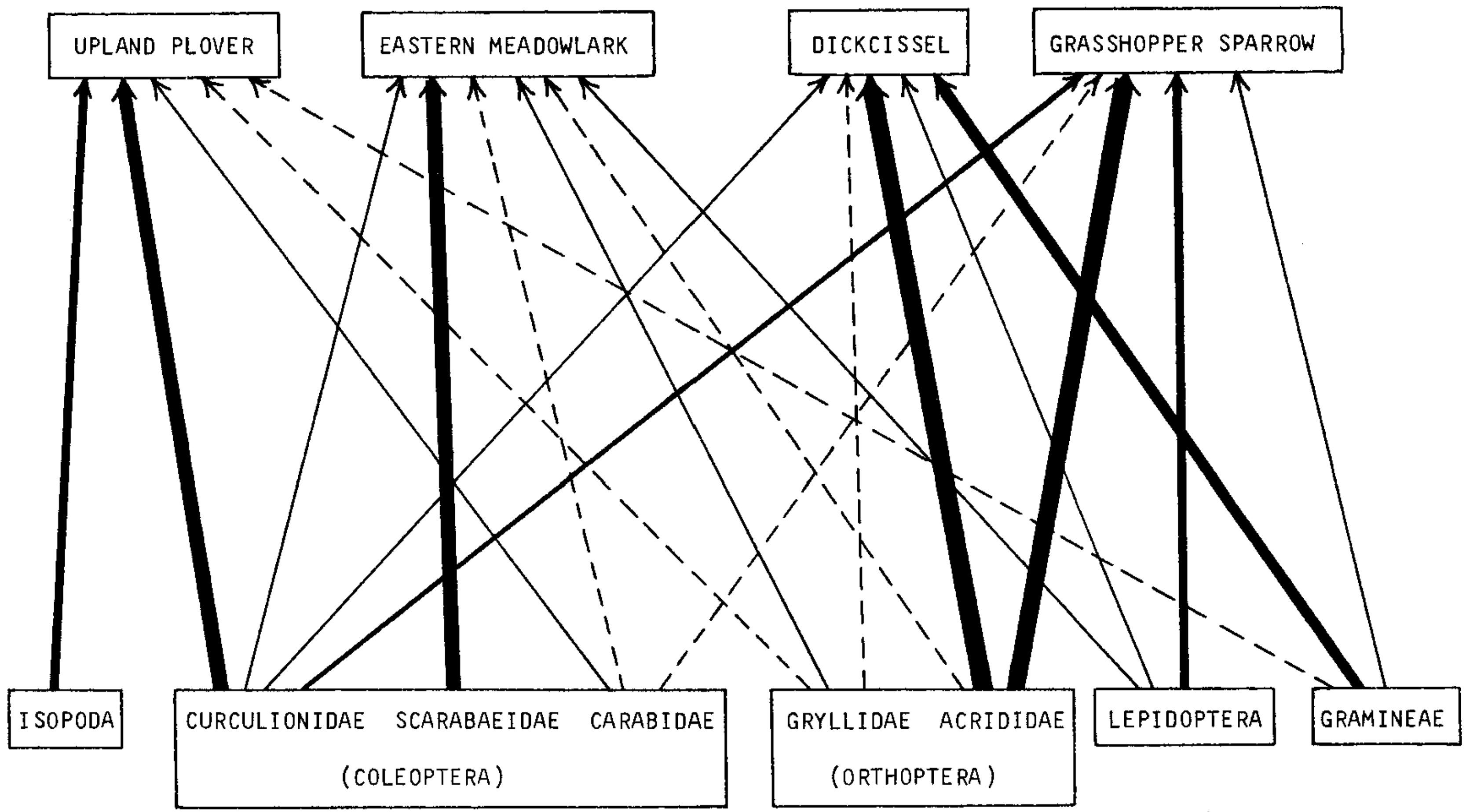


Fig. 4. Generalized food web for the avian community breeding at Osage, 1970. Arrow widths are roughly proportional to the percentage of the total diet dry weight drawn from a prey taxon; dashed arrows indicate less than 10% of the diet was of the designated prey taxon. Only prey taxa which contributed at least 10% to the total diet of at least one of the bird species are shown.

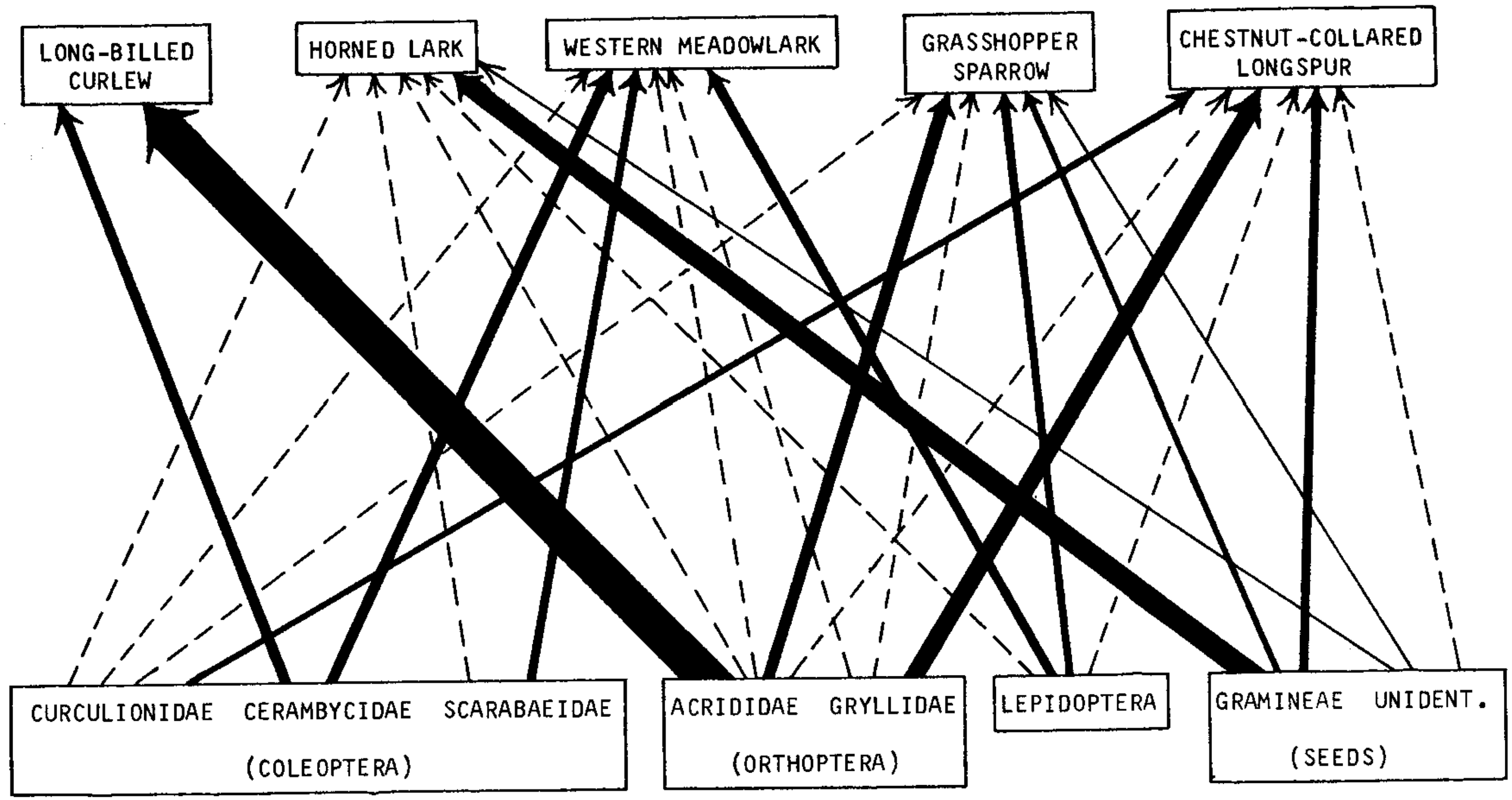


Fig. 5. Generalized food web for the breeding bird community at Cottonwood, 1970. Arrow widths are roughly proportional to the percentage of the total diet dry weight drawn from a prey taxon; dashed arrows indicate less than 10% of the diet was of the designated prey taxon. Only prey taxa which contributed at least 10% to the total diet of at least one of the bird species are shown.

Table 15. Number of prey taxa recorded in entire species samples and in individual specimens at three IBP grassland sites, 1970.

Site	Species	N	Number of Prey Taxa Recorded		
			Entire Sample	Individuals	
				$\bar{X}$	SD
Pantex	Horned Lark	25	25	6.60	2.27
	Western Meadowlark	13	29	8.77	3.03
Osage	Upland Plover	3	9	5.67	1.53
	Eastern Meadowlark	10	17	7.60	2.22
	Dickcissel	11	16	4.00	2.05
	Grasshopper Sparrow	4	10	6.25	0.96
Cottonwood	Long-billed Curlew	2	12	9.50	2.12
	Horned Lark	24	26	7.29	2.18
	Western Meadowlark	11	25	7.82	2.86
	Grasshopper Sparrow	7	13	5.86	1.57
	Chestnut-collared Longspur	4	11	4.00	1.16

Table 16. Number of prey taxa recorded in species samples and in individual specimens for samples of 10 specimens of each species. Only the first 10 specimens collected of each species were used in this analysis. Thus, for all species at all sites, N = 10.

Site	Species	Number of Prey Taxa Recorded			Mean Taxa per Individual ÷ Taxa per Sample
		Entire Sample	Individuals		
			$\bar{X}$	SD	
Pantex	Horned Lark	17	6.60	2.55	0.39
	Western Meadowlark	26	9.50	2.88	0.37
Osage	Eastern Meadowlark	17	7.60	2.22	0.45
	Dickcissel	16	4.10	2.13	0.26
Cottonwood	Horned Lark	19	7.20	2.35	0.38
	Western Meadowlark	22	7.50	2.80	0.34

First, it is apparent that the species differed in the breadth of prey taxa selected by a sample of 10 individuals, Western Meadowlarks consuming almost half again as many types of prey as Horned Larks and Dickcissels. Second, these differences in the numbers of prey types recorded in samples of 10 individuals were generally paralleled by differences in the mean number of prey types per individual, as evidenced by the general similarity of ratios of prey types per individual to prey types per total sample. In terms of niche theory (McNaughton and Wolf 1970) this suggests that while the species differ in their niche breadths with respect to prey taxa, individuals have a niche breadth roughly one-third that of their species as a whole. Dickcissels (10 samples), which as a species consumed the smallest variety of prey taxa, were also individually the most restricted in prey taxa diversity.

Dietary Differences Between Sexes

Tables 3 to 13 present an analysis of the dietary composition of males and females for the collections at each site. These results are best summarized by species. Unfortunately, since dietary composition is expressed in terms of percent dry weight, direct statistical comparisons are not possible; thus the statements which follow must be viewed as observations of apparent differences or similarities rather than statistically-supported conclusions.

Pantex. Horned Lark--Females consumed 7% more seeds (mainly Cruciferae and Chenopodiaceae) and somewhat more grasshoppers than males, while males ate slightly more Hemipterans and spiders. In general, the sexes were quite similar in dietary composition.

Western Meadowlark--Seeds were an important component of male diets (22%) but a minor element in female diets (1%). Males consumed more beetles (especially Scarabaeids) and ants; female diets were dominated by Acridids. (Only two males were collected).

Osage. Upland Plover--(All specimens collected were males).

Eastern Meadowlark--Beetles were the major component of the diet. In general, both sexes had similar diets though males ate somewhat more ants and females slightly more Orthopterans.

Dickcissel--Males consumed proportionately more seeds than females (52% vs. 10%), while females ate more grasshoppers than males. (Only two females were collected).

Grasshopper Sparrow--Sample size (2 males, 1 female) was too small to permit comparisons. Males appeared to consume more beetles and Lepidoptera larvae and fewer Orthopterans and Hemipterans than females.

Cottonwood. Long-billed Curlew--(One female and one juvenile were collected).

Horned Lark--The dietary similarity between the sexes was striking though females consumed slightly more seeds (81% vs. 75%), and males ate somewhat more beetles.

Western Meadowlark--In general, the diets of males and females were similar, but males ate somewhat more Curculionid and Scarabaeid beetles and grasshoppers and fewer Cerambycid beetles than females.

Grasshopper Sparrow--Seeds were considerably more important in the diet of females than in that of males (40% vs. 25%). Males consumed more beetles (especially weevils), Lepidoptera larvae, and spiders, and fewer Orthopterans. (Only two females were collected).

Chestnut-collared Longspur--Male diets were composed almost entirely of seeds (87%), while females ate primarily crickets (65%) and weevils (19%). (Only two specimens of each sex were collected).

(especially Scarabaeids) and ants; female diets were dominated by Acridids. (Only two males were collected).

Osage. Upland Plover--(All specimens collected were males).

Eastern Meadowlark--Beetles were the major component of the diet. In general, both sexes had similar diets though males ate somewhat more ants and females slightly more Orthopterans.

Dickcissel--Males consumed proportionately more seeds than females (52% vs. 10%), while females ate more grasshoppers than males. (Only two females were collected).

Grasshopper Sparrow--Sample size (2 males, 1 female) was too small to permit comparisons. Males appeared to consume more beetles and Lepidoptera larvae and fewer Orthopterans and Hemipterans than females.

Cottonwood. Long-billed Curlew--(One female and one juvenile were collected).

Horned Lark--The dietary similarity between the sexes was striking though females consumed slightly more seeds (81% vs. 75%), and males ate somewhat more beetles.

Western Meadowlark--In general, the diets of males and females were similar, but males ate somewhat more Curculionid and Scarabaeid beetles and grasshoppers and fewer Cerambycid beetles than females.

Grasshopper Sparrow--Seeds were considerably more important in the diet of females than in that of males (40% vs. 25%). Males consumed more beetles (especially weevils), Lepidoptera larvae, and spiders, and fewer Orthopterans. (Only two females were collected).

Chestnut-collared Longspur--Male diets were composed almost entirely of seeds (87%), while females ate primarily crickets (65%) and weevils (19%). (Only two specimens of each sex were collected).

The general impression one gains from this analysis is that dietary similarities between the sexes are more outstanding than are differences. Sexual differences in Horned Lark diets were similar at Pantex and Cottonwood; Western Meadowlarks at these two sites had different patterns of dietary divergences between the sexes.

Another measure of similarity or difference between sexes can be obtained by examination of the values of total prey dry weight per individual bird (Tables 3 to 13). The untransformed data for all male-female pairings within species were subjected to t-tests; significant differences ($p < 0.05$) were indicated between sexes only in Western Meadowlarks at Cottonwood.

Temporal Differences in Diet

By grouping the specimens of each species according to whether they were collected in morning (AM) or afternoon (PM) (pre- or post- 1200 hours), a coarse evaluation of diurnal variations in diet may be possible. Again, the results (Tables 3 to 13) will be summarized by species.

Pantex. Horned Lark--Scarabaeid beetles comprised 36% of the AM diet, while contributing only 9% to the PM diet. As a result, beetles were considerably more important in AM than PM samples. Seeds, on the other hand, were consumed more heavily in PM than AM (63% vs. 28%). The seeds eaten in the AM were primarily Chenopodiaceae, while the PM seed diet was more diverse and was composed primarily of Gramineae and Cruciferae seeds. Consumption of Homopterans was low and almost entirely confined to the AM sample.

Western Meadowlark--(All specimens were collected in PM).

Osage. Upland Plover--The sample was small (two AM, one PM), but seemed to indicate a greater importance of Isopods in the AM diet (37% vs. 7%). Crickets were present only in the AM sample, while the PM sample bird contained mainly beetles (weevils) and spiders.

Eastern Meadowlark--Beetles were somewhat more important in PM than in AM diets (70% vs. 56%). Scarabaeids dominated the PM samples, while weevils comprised half of the beetles consumed in the AM. Lepidoptera larvae, ants, and crickets were somewhat more abundant in AM than in PM samples.

Dickcissel--Consumption of seeds was roughly twice as great in the AM sample than in the PM. Lepidoptera contributed one-third of the AM diet, but only 1/20 of the PM food. Almost all of the beetles eaten, and all of the Orthopterans and Hemipterans eaten were in PM specimens. (Only two AM specimens were collected).

Grasshopper Sparrow--The sample size (one AM, three PM) was too small to permit conclusions. The AM specimen contained primarily beetles (64%), while seeds were more common in the PM sample. Hemipterans, Lepidoptera larvae, and spiders were restricted to the PM sample; consumption of grasshoppers was similar in the two time periods.

Cottonwood. Long-billed Curlew--(Both specimens were collected in the PM).

Horned Lark--Lepidoptera larvae were eaten primarily in the AM (27% vs. 2%), while considerably more seeds were present in the PM sample.

Western Meadowlark--Lepidoptera larvae were consumed in greater quantity in the AM (28% vs. 15%), while more beetles were present in the PM sample. Scarabaeids dominated the beetle component of the AM specimens; the PM beetle list was more diverse, dominated by Cerambycids.

Grasshopper Sparrow--Lepidoptera larvae were more abundant in PM samples (29% vs. 18%), as were grass seeds, while beetles (weevils) were more common in the AM sample. In other respects the diets were generally similar. (Only two PM specimens were obtained).

Chestnut-collared Longspur--(All specimens were PM).

It appears from this rather cursory analysis that temporal differences in diet may be more pronounced than sexual differences among these grassland species.

There are of course marked diurnal changes in the activity or "availability" of prey, especially ground-dwelling insects, and if the birds are at all opportunistic in their foraging, they should respond to these changes in prey activity. These responses should in turn dictate diurnal changes in dietary composition. The data presented here are too sketchy to permit firm conclusions. Still, Horned Larks at both Pantex and Cottonwood concentrated on animal prey in the morning and seeds in the late afternoon and evening.

The pattern of consumption of Lepidoptera larvae is especially intriguing. They were important prey only at Osage and Cottonwood, and at each site all species except Grasshopper Sparrows concentrated their feeding upon larvae in the morning (Grasshopper Sparrows consistently ate more larvae in the afternoon and evening). This difference may be due to differences in the activity patterns of the types of Lepidoptera larvae eaten by the different species, or perhaps to differences in the foraging tactics of the birds.

Significance tests (t-tests) on mean dry weight per bird values for AM and PM samples indicated no significant differences in the various species.

Prey Size

It has become fashionable in avian trophic studies to attach considerable importance to prey size, independent of taxonomic identity, following the suggestion that prey size may be an important and readily divisible niche dimension in birds (Schoener 1965, MacArthur 1972). The size characteristics of prey items for our collections are given in detail in Tables 17 to 27 and are summarized in Fig. 6.

Table 17. Number of prey individuals in size classes of Horned Lark prey at Pantex, 1970.

Prey Type	Length (mm)	Sex		Time of Collection		Total
		Male	Female	AM	PM	
INSECTA						
Hymenoptera						
Formicidae	3	15	1	--	16	16
	4	2	2	2	2	4
	5	--	1	1	--	1
Unidentified	2	--	1	--	1	1
	3	--	1	1	--	1
	5	1	--	--	1	1
	10	--	1	1	--	1
Coleoptera						
Curculionidae	2	--	1	--	1	1
	3	5	2	4	3	7
	4	4	1	2	3	5
	5	1	1	2	--	2
	6	--	1	1	--	1
Cerambycidae	10	1	--	1	--	1
Chrysomelidae	3	--	2	2	--	2
	4	2	3	--	5	5
	5	5	--	--	5	5
Scarabaeidae	7	3	3	6	--	6
	10	4	2	2	4	6
Unidentified	2	2	3	--	5	5
	3	--	2	--	2	2
Orthoptera						
Acrididae	3	11	--	--	11	11
	5	5	3	2	6	8
	6	2	--	--	2	2
	8	1	--	--	1	1
	9	2	--	--	2	2
	10	12	3	5	10	15
	12	--	5	2	3	5
	13	--	1	--	1	1
	15	3	5	2	6	8
	20	--	1	--	1	1
Gryllidae	15	1	--	--	1	1
Hemiptera						
Lygaeidae	3	--	1	--	1	1
	5	--	1	--	1	1
Miridae	5	1	--	--	1	1
Pentatomidae	4	--	1	--	1	1
	5	21	8	1	28	29
	8	3	--	3	--	3
Unidentified	5	2	--	--	2	2
Homoptera						
Aphididae	1	1	--	--	1	1
Cicadellidae	3	--	1	1	--	1
	8	--	4	4	--	4
	9	3	--	3	--	3
	10	1	--	1	--	1
Cicadidae	8	5	--	5	--	5
Lepidoptera	5	13	--	--	13	13
	7	--	1	1	--	1
	15	2	--	--	2	2
	20	--	1	1	--	1
Diptera	7	--	1	1	--	1
	9	--	1	--	1	1

Table 17. (continued).

Prey Type	Length (mm)	Sex		Time of Collection		Total
		Male	Female	AM	PM	
ARACHNIDA						
Araneida	3	--	1	--	1	1
	4	1	--	--	1	1
	5	2	--	--	2	2
	6	2	--	--	2	2
	7	3	2	--	5	5
	8	1	1	--	2	2
	10	1	1	1	1	2
	11	2	--	1	1	2
ANGIOSPERMAE						
Gramineae	1	89	2	2	89	91
	2	106	45	--	151	151
	3	10	20	--	30	30
Chenopodiaceae	1	61	149	37	173	210
	2	112	55	72	95	167
	3	--	30	18	12	30
Compositae	1	5	--	--	5	5
	3	5	8	--	13	13
	4	8	8	3	13	16
	5	4	6	2	8	10
Cruciferae	1	474	589	5	1058	1063
Portulacaceae	2	5	--	--	5	5
Unidentified	1	58	--	--	58	58
	2	8	11	6	13	19
	3	70	29	10	89	99
Plant item length:	$\overline{X}$	3.00	3.00	3.00	3.00	3.00
	SD	1.58	1.58	1.58	1.58	1.58
	N	1015.00	952.00	155.00	1812.00	1967.00
Animal item length:	$\overline{X}$	6.00	8.80	9.20	8.40	8.40
	SD	3.32	5.18	5.12	5.25	5.25
	N	146.00	71.00	59.00	158.00	217.00
Overall mean prey size (mm):		3.38	3.40	4.71	3.43	3.54

Table 18. Number of prey individuals in size classes of Western Meadowlark prey at Pantex, 1970.

Prey Type	Length (mm)	Sex		Total
		Male	Female	
INSECTA				
Hymenoptera				
Formicidae	3	--	51	51
	4	65	3	68
Apidae	8	--	1	1
Halictidae	7	2	3	5
	8	1	1	2
Sphecidae	6	--	1	1
	15	--	2	2
Unidentified	6	--	2	2
	8	5	6	15
	10	--	5	5
	17	--	--	1
Coleoptera				
Curculionidae	4	--	7	7
	5	--	5	5
	6	1	1	2
	7	--	3	3
	8	--	1	1
Carabidae	6	1	--	1
	8	--	4	4
Chrysomelidae	4	--	1	1
	5	--	1	1
Dasytidae	3	--	1	1
Scarabaeidae	3	--	1	1
	10	4	9	15
	12	--	1	4
	13	--	--	5
Tenebrionidae	7	--	2	2
	8	--	2	2
	11	1	--	1
	12	--	5	5
	13	1	5	6
Orthoptera				
Acrididae	6	--	7	7
	7	3	15	18
	8	--	5	5
	9	1	1	2
	10	3	26	31
	11	--	5	5
	12	--	13	14
	13	--	2	2
	15	1	14	16
	17	--	2	2
	18	--	1	1
	20	--	5	5
Gryllidae	15	--	1	1
Hemiptera				
Coreidae	5	--	2	2
Lygaeidae	5	--	2	2
Miridae	3	--	1	1
	6	--	8	8

Table 18. (continued).

Prey Type	Length (mm)	Sex		Total
		Male	Female	
Hemiptera (Cont.)				
Pentatomidae	4	--	1	1
	5	--	1	1
	7	2	2	4
	8	--	5	5
	9	--	1	1
	10	--	1	1
Phymatidae	7	--	1	1
Unidentified	4	--	1	1
Homoptera				
Cicadellidae	9	1	1	2
	10	--	3	3
Cicadidae	8	--	1	1
Unidentified	3	--	4	4
Lepidoptera	8	--	1	1
	10	--	1	1
	15	--	1	1
	20	--	1	1
ARACHNIDA				
Araneida	5	--	2	2
	6	--	2	2
	7	--	6	6
	8	1	2	3
	9	--	--	1
	10	--	3	3
MOLLUSCA				
Gastropoda	1	--	1	1
	3	--	7	7
ANGIOSPERMAE				
Gramineae	1	1	--	1
	2	--	9	9
Chenopodiaceae	1	1	6	7
Cruciferae	1	2	7	9
Unidentified	6	17	--	17
Plant item length:	$\overline{X}$	3.50	1.50	3.00
	SD	3.54	0.71	2.65
	N	21.00	22.00	43.00
Animal item length:	$\overline{X}$	9.60	9.40	9.90
	SD	3.46	5.37	5.61
	N	93.00	283.00	396.00
Overall mean prey size (mm):		8.47	8.83	9.22

Table 19. Number of prey individuals in size classes of Upland Plover prey at Osage, 1970.

Prey Type	Length (mm)	Time of Collection AM	Time of Collection PM	Total
INSECTA				
Coleoptera				
Curculionidae	6	--	1	1
	7	1	--	1
	8	3	--	3
	9	3	--	3
	12	--	1	1
Carabidae	8	--	1	1
	10	2	1	3
	12	1	--	1
	13	1	--	1
Chrysomelidae	5	1	1	2
Orthoptera				
Gryllidae	15	2	--	2
Hemiptera				
Pentatomidae	7	--	1	1
Unidentified	8	1	--	1
ARACHNIDA				
Araneida	5	--	1	1
	7	1	1	2
	8	1	1	2
CRUSTACEA				
Isopoda	7	--	2	2
	8	2	--	2
	10	4	--	4
	12	3	--	3
ANGIOSPERMAE				
Gramineae	6	--	1	1
Plant item length:	$\overline{X}$	--	6.0	6.00
	SD	--	--	--
	N	--	1.0	1.00
Animal item length:	$\overline{X}$			9.40
	SD			3.36
	N			37.00
Overall mean prey size (mm):				9.30

Table 20. Number of prey individuals in size classes of Eastern Meadowlark prey at Osage, 1970.

Prey Type	Length (mm)	Sex		Time of Collection		Total
		Male	Female	AM	PM	
INSECTA						
Hymenoptera						
Formicidae	3	42	1	28	15	48
	4	8	--	8	--	8
	5	46	--	33	13	46
Unidentified	5	--	2	--	2	2
	8	1	--	1	--	1
Coleoptera						
Curculionidae	4	--	1	--	1	1
	5	11	--	--	11	11
	7	2	11	--	13	13
	8	41	7	37	11	48
Cerambycidae	12	3	--	2	1	3
Carabidae	8	5	7	1	11	12
	9	1	--	1	--	1
	12	6	1	4	3	7
	15	2	1	--	3	3
Chrysomelidae	4	2	1	1	2	3
Elateridae	7	1	--	--	1	1
	10	--	3	--	3	3
Hydrophyllidae	7	6	--	--	6	6
Scarabaeidae	4	--	1	--	1	1
	5	1	--	1	--	1
	6	1	--	1	--	1
	10	4	1	2	3	5
	12	5	5	--	10	10
	15	1	--	1	--	1
	20	2	--	--	2	2
Orthoptera						
Acrididae	15	--	3	--	3	3
	20	1	--	--	1	1
Gryllidae	13	1	--	--	1	1
	15	4	1	3	2	5
	18	5	2	4	3	7
	20	1	1	1	1	2
Hemiptera						
Coreidae	3	14	--	--	14	14
Pentatomidae	8	--	3	--	3	3
Unidentified	8	1	--	1	--	1
Lepidoptera	10	1	--	1	--	1
	15	5	--	3	2	5

Table 20. (continued).

Prey Type	Length (mm)	Sex		Time of Collection		Total
		Male	Female	AM	PM	
INSECTA						
Lepidoptera (Cont.)	17	1	2	1	2	3
	20	2	--	1	1	2
	30	2	2	--	4	4
	35	1	--	1	--	1
CRUSTACEA						
Isopoda	8	4	--	4	--	4
ARACHNIDA						
Araneida	3	1	--	1	--	1
	5	2	--	2	--	2
	6	1	--	--	1	1
	7	--	2	--	2	2
	8	1	--	--	1	1
	9	1	--	--	1	1
Animal item length:	$\overline{X}$	13.50	12.40	12.50	13.30	13.30
	SD	9.36	7.95	8.75	7.37	9.12
	N	240.00	58.00	144.00	154.00	298.00
Overall mean prey size (mm):		13.50	12.40	12.50	13.30	13.30

Table 21. Number of prey individuals in size classes of Dickcissel prey at Osage, 1970.

Prey Type	Length (mm)	Sex		Time of Collection		Total
		Male	Female	AM	PM	
INSECTA						
Hymenoptera						
Apidae	8	1	1	--	2	2
Unidentified	4	1	--	--	1	1
	8	1	--	--	1	1
Coleoptera						
Curculionidae	5	3	1	1	3	4
	7	2	--	--	2	2
	8	6	2	--	8	8
Cerambycidae	14	1	--	--	1	1
Unidentified	4	--	1	--	1	1
	5	1	--	--	1	1
	7	--	2	--	2	2
Orthoptera						
Acrididae	10	--	1	--	1	1
	15	1	--	--	1	1
	17	--	1	--	1	1
	23	2	--	--	2	2
	30	--	1	--	1	1
Gryllidae	18	1	--	--	1	1
Hemiptera						
Reduviidae	10	1	--	--	1	1
Scutelleridae	5	1	--	--	1	1
Unidentified	8	2	--	--	2	2
Lepidoptera	10	2	5	1	6	7
	15	2	3	1	4	5
	20	2	1	1	2	3
	28	1	--	1	--	1
Diptera	6	--	1	--	1	1
Neuroptera	7	1	--	1	--	1
ARACHNIDAE						
Araneida	7	1	--	1	--	1
	8	--	1	--	1	1
ANGIOSPERMA						
Gramineae	2	297	28	116	209	325
Unidentified	2	49	--	--	49	49

Table 21. (continued).

Prey Type	Length (mm)	Sex		Time of Collection		Total
		Male	Female	AM	PM	
Plant item length:	$\overline{X}$	2.00	2.00	2.00	2.00	2.00
	SD	--	--	--	--	--
	N	346.00	28.00	116.00	258.00	374.00
Animal item length:	$\overline{X}$	13.80	13.00	14.20	13.60	14.60
	SD	7.82	8.35	8.70	7.87	8.48
	N	33.00	21.00	7.00	47.00	54.00
Overall mean prey size (mm):		3.03	6.70	2.69	3.79	3.59

Table 22. Number of prey individuals in size classes of Grasshopper Sparrow prey at Osage, 1970.

Prey Type	Length (mm)	Adult		Time of Collection		Total
		Male	Female	AM	PM	
INSECTA						
Coleoptera						
Curculionidae	7	3	1	3	1	4
	8	1	--	--	2	2
	9	2	--	2	--	2
Carabidae	8	1	--	1	--	1
	9	--	--	--	1	1
Dasytidae	5	1	--	--	1	1
Unidentified	5	1	--	1	--	1
Orthoptera						
Acrididae	7	--	--	--	1	1
	9	--	1	--	1	1
	10	--	1	--	1	1
	12	--	1	--	1	1
	15	1	1	--	2	2
	18	1	--	1	--	1
	25	--	--	--	1	1
Hemiptera						
Pentatomidae	7	--	5	--	5	5
	8	1	--	--	1	1
Lepidoptera	12	--	--	--	1	1
	15	--	1	--	1	1
	20	3	--	--	3	3
	25	1	--	--	2	2
ARACHNIDA						
Araneida	5	2	1	--	3	3
	6	--	--	--	2	2
ANGIOSPERMAE	2	8	1	3	51	54
Plant item length:	$\overline{X}$	2.00	2.00	2.00	2.00	2.00
	SD	--	--	--	--	--
	N	8.00	1.00	3.00	51.00	54.00
Animal item length:	$\overline{X}$	13.40	10.20	9.40	11.70	12.30
	SD	7.19	3.70	5.03	6.50	6.45
	N	18.00	12.00	8.00	30.00	38.00
Overall mean prey size (mm):		9.89	9.57	7.38	5.59	6.25

Table 23. Number of prey individuals in size classes of Long-billed Curlew prey at Cottonwood, 1970.

Prey Type	Length (mm)	Total
INSECTA		
Hymenoptera		
Formicidae	4	1
Coleoptera		
Curculionidae	8	1
Carabidae	29	2
Cerambycidae	28	15
Scarabaeidae	18	2
Tenebrionidae	15	17
Unidentified	25	3
	30	3
Orthoptera		
Acrididae	10	3
	15	2
	20	2
	50	12
Gryllidae	18	4
	20	1
Hemiptera		
Pentatomidae	8	1
Lepidoptera	10	4
	12	1
	15	4
	35	1
ARACHNIDA		
Araneida	6	1
	9	2
Animal item length:	$\overline{X}$	21.80
	SD	12.73
	N	82.00
Overall mean prey size (mm):		21.80

Table 24. Number of prey individuals in size classes of Horned Lark prey at Cottonwood, 1970.

Prey Type	Length (mm)	Sex		Time of Collection		Total
		Male	Female	AM	PM	
INSECTA						
Hymenoptera						
Formicidae	3	11	5	--	16	16
	4	13	12	--	25	26
	5	3	1	2	2	4
	6	12	2	--	14	14
Apidae	6	2	--	1	1	2
Coleoptera						
Curculionidae	2	4	2	3	3	6
	3	--	6	1	5	6
	4	9	6	1	14	15
	5	1	2	--	3	3
	6	5	6	6	5	12
Cantharidae	8	1	--	1	--	1
Carabidae	7	--	1	1	--	1
	9	--	2	2	--	2
	27	1	--	--	1	1
Chrysomelidae	3	1	--	--	1	1
	4	--	1	--	1	1
	5	4	2	1	5	6
	10	1	--	--	1	1
Histeridae	3	7	5	--	12	12
Scarabaeidae	14	1	--	--	1	1
Unidentified	2	2	--	--	2	2
	3	--	2	--	2	2
	4	--	2	--	2	2
	5	1	--	--	1	1
Orthoptera						
Acrididae	5	4	2	--	6	6
	7	1	--	--	1	1
	8	--	2	--	2	2
	10	--	2	--	2	2
	15	1	1	1	1	2
	18	--	1	--	1	3
	20	--	--	--	--	1
Hemiptera						
Coreidae	3	1	--	--	1	1
	5	--	10	--	10	10
Miridae	4	1	--	--	1	1
	5	--	1	1	--	1
Pentatomidae	3	1	--	--	1	1
	5	1	1	1	1	2
	6	--	1	--	1	1
	8	2	1	1	2	3
Scutelleridae	3	--	2	--	2	2
	5	--	1	--	1	1
	6	1	--	--	1	1
Unidentified	1	4	--	1	3	4
	3	1	--	1	--	1
	5	1	--	1	--	1
	7	1	--	--	1	1
Homoptera						
Cicadellidae	10	1	1	--	2	2
Unidentified	1	3	--	--	3	3
	4	--	1	--	1	1
Lepidoptera	6	3	--	3	--	3
	10	2	3	--	5	5
	15	10	3	4	9	13
	20	10	11	18	3	22
	25	2	1	2	1	3

Table 24. (continued).

Prey Type	Length (mm)	Sex		Time of Collection		Total
		Male	Female	AM	PM	
Diptera	7	1	--	--	1	1
Unidentified	8	1	--	--	1	1
	10	--	1	--	1	1
ARACHNIDA						
Araneida	3	--	1	--	1	1
	4	2	--	2	--	2
	5	1	4	2	3	5
	6	9	--	6	3	9
	7	1	9	2	8	10
	8	3	3	2	4	7
	9	5	1	2	4	6
	10	--	--	--	--	1
ANGIOSPERMAE						
Gramineae	2	3	--	--	3	3
	3	719	748	211	1256	1468
	6	23	--	--	23	23
Cruciferae	1	17	--	17	--	17
Leguminosae	1	1	1	--	2	2
Polygonaceae	2	37	3	3	37	40
Unidentified	1	--	2	--	2	2
	2	173	169	37	325	362
	3	89	--	--	89	89
	5	1	--	--	1	1
Plant item length:	$\bar{X}$	3.40	2.00	2.00	3.40	3.40
	SD	2.07	1.00	1.00	2.07	2.07
	N	1064.00	943.00	268.00	1739.00	2007.00
Animal item length:	$\bar{X}$	10.10	10.20	8.80	9.90	10.90
	SD	8.43	7.17	7.48	7.46	8.13
	N	153.00	121.00	69.00	205.00	282.00
Overall mean prey size (mm):		4.24	2.93	3.39	4.09	4.32

Table 25. Number of prey individuals in size classes of Western Meadowlark prey at Cottonwood, 1970.

Prey Type	Length (mm)	Sex		Time of Collection		Total
		Male	Female	AM	PM	
INSECTA						
Hymenoptera						
Formicidae	3	34	1	--	35	35
	4	10	5	--	15	15
	7	--	2	--	2	2
	8	4	1	1	4	5
Apidae	7	8	--	--	8	8
Halictidae	6	1	--	1	--	1
	7	--	1	--	1	1
Coleoptera						
Curculionidae	4	4	--	--	4	4
	5	5	4	3	6	9
	6	10	--	--	10	10
	7	17	4	3	18	21
	8	2	2	1	3	4
	9	1	--	1	--	1
Cantharidae	8	2	2	1	3	4
	9	--	2	--	2	2
Cerambycidae	25	--	1	--	1	1
	28	1	1	--	2	2
	30	--	1	--	1	1
Chrysomelidae	4	4	1	--	5	5
	5	2	2	--	4	4
Elateridae	5	--	1	--	1	1
	10	--	1	--	1	1
Histeridae	3	--	1	--	1	1
Scarabaeidae	12	--	1	1	--	1
	18	6	--	3	3	6
Tenebrionidae	15	5	2	--	7	7
Unidentified	5	1	--	--	1	1
Orthoptera						
Acrididae	8	1	--	1	--	1
	10	1	1	2	--	2
	15	2	1	2	1	3
	18	1	--	1	--	1
	20	2	--	1	1	2
	25	2	--	--	2	2
Gryllidae	12	--	5	--	5	5
	15	2	4	--	6	6
	18	4	--	--	4	4
	20	2	1	2	1	3
Hemiptera						
Coreidae	5	--	2	--	2	2
Pentatomidae	5	1	--	1	--	1
	6	1	--	1	--	1
	7	2	1	--	3	3
	8	2	--	--	2	2
Phymatidae	7	2	--	--	2	2
Unidentified	3	--	1	--	1	1
	7	--	1	--	1	1
Homoptera						
Coccidae	9	--	3	3	--	3
Lepidoptera	7	2	1	2	1	3
	10	4	3	4	3	7
	15	12	6	7	11	18
	18	1	2	1	2	3
	20	6	2	6	2	8
	23	--	2	--	2	2
	25	9	7	6	10	16
	30	1	1	--	2	2
Diptera	7	--	1	--	1	1
Odonata	30	1	--	--	1	1
ARACHNIDA						
Araneida	5	4	--	2	2	4
	6	--	2	2	--	2
	7	3	1	1	3	4
	8	2	2	1	3	4
	10	1	3	--	4	4

Table 25. (continued).

Prey Type	Length (cm)	Sex: Male	Sex: Female	Time of Collection: AM	Time of Collection: PM	Total
MOLLUSCA						
Gastropoda	1	--	4	4	--	4
	2	--	6	6	--	6
ANGIOSPERMAE						
Gramineae	2	--	1	--	1	1
	4	7	--	--	7	7
Plant item length:	$\bar{X}$	4.00	2.00	--	3.00	3.00
	SD	--	--	--	1.41	1.41
	N	7.00	1.00	0.0	8.00	8.00
Animal item length:	$\bar{X}$	13.40	12.60	10.60	13.90	12.60
	SD	9.25	9.33	7.15	8.96	9.33
	N	188.00	99.00	71.00	216.00	287.00
Overall mean prey size (mm):		13.06	12.49	10.60	13.51	12.34

Table 26. Number of prey individuals in size classes of Grasshopper Sparrow prey at Cottonwood, 1970.

Prey Type	Length (mm)	Sex		Time of Collection		Total
		Male	Female	AM	PM	
INSECTA						
Hymenoptera						
Ichneumonidae	13	1	--	1	--	1
Coleoptera						
Curculionidae	3	--	3	3	--	3
	4	5	--	5	--	5
	5	2	3	2	3	5
	6	1	1	2	--	2
	7	8	--	8	--	8
Chrysomelidae	3	1	2	--	1	1
	4	6	--	6	--	6
	5	--	--	--	2	2
	6	1	--	1	--	1
Orthoptera						
Acrididae	9	--	1	--	1	1
	10	--	1	1	--	1
	13	--	2	--	2	2
	14	--	2	2	--	2
	15	2	1	1	2	3
	16	--	3	3	--	3
	17	1	--	1	--	1
	18	3	--	3	--	3
	20	1	--	--	1	1
Gryllidae	18	--	1	--	1	1
Hemiptera						
Scutelleridae	6	--	1	--	1	1
Unidentified	7	1	2	1	2	3
Homoptera						
Cicadellidae	3	1	--	--	1	1
	5	1	--	--	1	1
	9	--	6	6	--	6
	10	4	--	3	1	4
Lepidoptera	5	1	--	1	--	1
	6	--	5	--	5	5
	9	--	3	--	3	3
	10	2	--	1	1	2
	12	--	3	--	3	3
	15	3	2	2	3	5
	20	4	1	4	1	5
	30	1	--	--	1	1
Diptera	7	2	1	2	1	3
ARACHNIDA						
Araneida	4	1	--	1	--	1
	5	1	--	1	--	1
	7	2	--	1	1	2
	10	1	--	1	--	1
ANGIOSPERMAE						
Gramineae	3	45	1	41	5	46
	6	8	8	--	16	16
Unidentified	3	--	49	49	--	49
Plant item length:	$\bar{X}$	4.50	4.50	3.00	4.50	4.50
	SD	2.12	2.12	--	2.12	2.12
	N	53.00	58.00	90.00	21.00	111.00
Animal item length:	$\bar{X}$	9.70	9.50	9.10	10.00	9.50
	SD	6.00	5.29	3.36	3.93	3.36
	N	57.00	44.00	63.00	38.00	101.00
Overall mean prey size (mm):		7.19	6.66	5.51	8.04	6.88

Table 27. Number of prey individuals in size classes of Chestnut-collared Longspur prey at Cottonwood, 1970.

Prey Type	Length (mm)	Sex		Total
		Male	Female	
INSECTA				
Coleoptera				
Curculionidae	8	--	9	9
Chrysomelidae	4	--	27	27
	5	--	1	1
Elateridae	5	1	6	7
Orthoptera				
Acrididae	5	--	3	3
	10	1	--	1
	12	1	--	1
	15	--	1	1
Gryllidae	12	--	2	2
	20	--	7	7
Hemiptera				
Lygaeidae	4	--	4	4
Homoptera				
Cicadellidae	9	1	--	1
Lepidoptera	9	2	--	2
ARACHNIDA				
Araneida	3	--	1	1
	4	--	1	1
ANGIOSPERMAE				
Gramineae	3	3	--	3
	6	25	1	26
Unidentified	2	2	--	2
Plant item length:	$\overline{X}$	3.70	6.00	3.70
	SD	2.08	--	2.08
	N	30.00	1.00	31.00
Animal item length:	$\overline{X}$	9.00	9.60	9.60
	SD	2.94	6.35	5.50
	N	6.00	62.00	68.00
Overall mean prey size (mm):		4.58	9.54	7.75

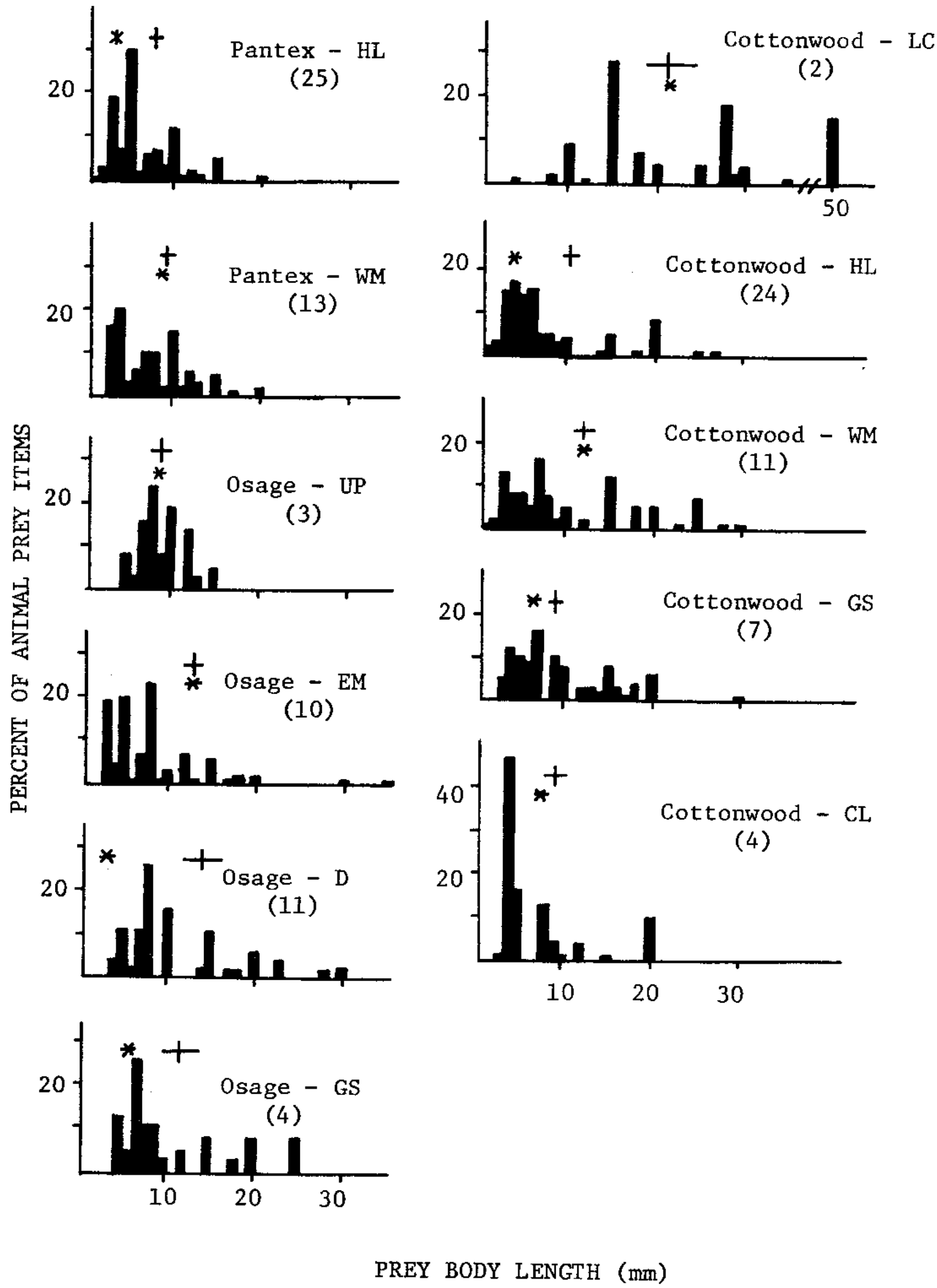


Fig. 6. Frequency distributions of the proportions of animal prey items in different prey body length categories for the 1970 species samples. Vertical line indicates the mean animal prey length for each sample, while the horizontal line includes two standard errors on either side of the mean. The asterisk indicates the mean overall prey size (animals and seeds). The number in parentheses is the number of bird specimens included in the sample. Species abbreviations as in Table 14.

In general, the overall mean prey size was strongly influenced by the importance of seeds in the diet, since seeds rarely exceeded 5 mm in length. Thus, the species with the smallest overall mean prey size (Horned Lark, Dickcissel) were the most highly granivorous species. There were no significant differences in the sizes of animal or plant prey between sexes or between times of collection (AM or PM) for any of the species. The frequency distributions for animal prey items (Fig. 6) indicate that for almost all species most prey individuals were less than 10 mm in length. Interspecific differences in prey size distributions will be discussed in some detail below.

The "conventional wisdom" of avian ecology has long dictated that the size of prey consumed should be related to the body or bill size of the consumer, larger birds or larger-billed birds eating larger prey as well as a greater range of prey sizes. To examine these relationships, we used measures of bill size, body weight, and tarsus length for each sex of the species considered in our dietary analysis. These morphological measurements (Table 28) were obtained from the same specimens from which the dietary samples were taken. The morphological measures are not independent of course, bill measures and tarsus length being linear functions of body weight (Fig. 7). However, in a preliminary coarse search for patterns the authors used a simple linear regression model to relate the dry weight of food per individual, the mean size of animal prey, and the mean total prey size to each of the five morphological features. The shorebirds (Upland Plover and Long-billed Curlew) were omitted from this analysis. The coefficients for these regressions are given in Table 29, and some of the relationships are plotted in Fig. 8 and 9. In general, the best fits to the regression model were obtained between the mean size of prey consumed and the various morphological

Table 28. Morphological characteristics of bird species collected at IBP grassland sites, 1970. "Bill length" is measured from the tip of the bill to the anterior edge of the nares; "bill width" is measured at the middle of the nostril; "mouth area" is the cross-sectional area of the base of the bill, calculated by $A = \pi ab$, where a = bill width, b = bill height. All measures except body weight (g) are in mm.

Site	Species	Sex	N	Bill Length		Bill Width		Mouth Area		Tarsus Length		Body Weight	
				$\overline{X}$	SD	$\overline{X}$	SD	$\overline{X}$	SD	$\overline{X}$	SD	$\overline{X}$	SD
Pantex	Horned Lark	♂	16	9.55	0.37	4.15	0.27	13.56	1.16	21.38	0.73	32.33	1.32
		♀	9	8.91	0.57	4.02	0.36	12.63	1.63	20.67	0.74	32.07	2.15
	Western Meadowlark	♂	2	20.60	1.27	6.95	0.35	43.16	3.74	38.40	1.41	106.75	0.49
		♀	10	19.79	0.81	5.92	0.29	30.77	2.19	35.56	1.15	90.39	9.50
Osage	Eastern Meadowlark	♂	7	22.47	1.33	6.81	0.38	39.54	2.68	38.60	1.17	111.24	6.82
		♀	3	19.93	0.78	6.17	0.49	32.40	4.51	35.60	0.82	84.93	10.67
	Dickcissel	♂	9	9.51	0.43	5.62	0.36	32.48	2.56	21.78	0.74	29.46	1.79
		♀	2	9.05	0.07	5.40	0.00	28.63	0.90	20.70	0.42	25.50	0.71
	Grasshopper Sparrow	♂	2	6.90	0.00	4.80	0.00	21.11	1.07	18.80	0.57	16.70	0.71
		♀	1	7.20	--	4.40	--	15.55	--	18.50	--	17.00	--
Cottonwood	Horned Lark	♂	14	9.98	0.67	3.82	0.57	11.22	2.83	21.39	1.04	32.35	1.62
		♀	9	8.59	0.56	3.62	0.42	10.33	2.28	19.88	0.59	31.29	1.60
	Western Meadowlark	♂	7	22.27	0.70	6.99	0.41	43.85	5.05	36.97	0.92	111.71	6.37
		♀	4	21.02	0.80	6.20	0.73	36.73	4.10	35.52	0.74	89.90	7.81
	Grasshopper Sparrow	♂	5	7.62	0.58	5.00	0.42	21.85	3.23	19.64	0.55	16.72	1.28
		♀	2	7.35	1.06	4.70	0.57	12.50	0.00	19.65	1.06	18.20	0.57
	Chestnut-collared Longspur	♂	2	7.20	0.00	4.45	0.21	14.55	2.42	18.75	0.07	19.35	0.78
		♀	2	7.05	0.35	4.35	0.78	13.35	4.53	18.00	0.28	17.85	0.78

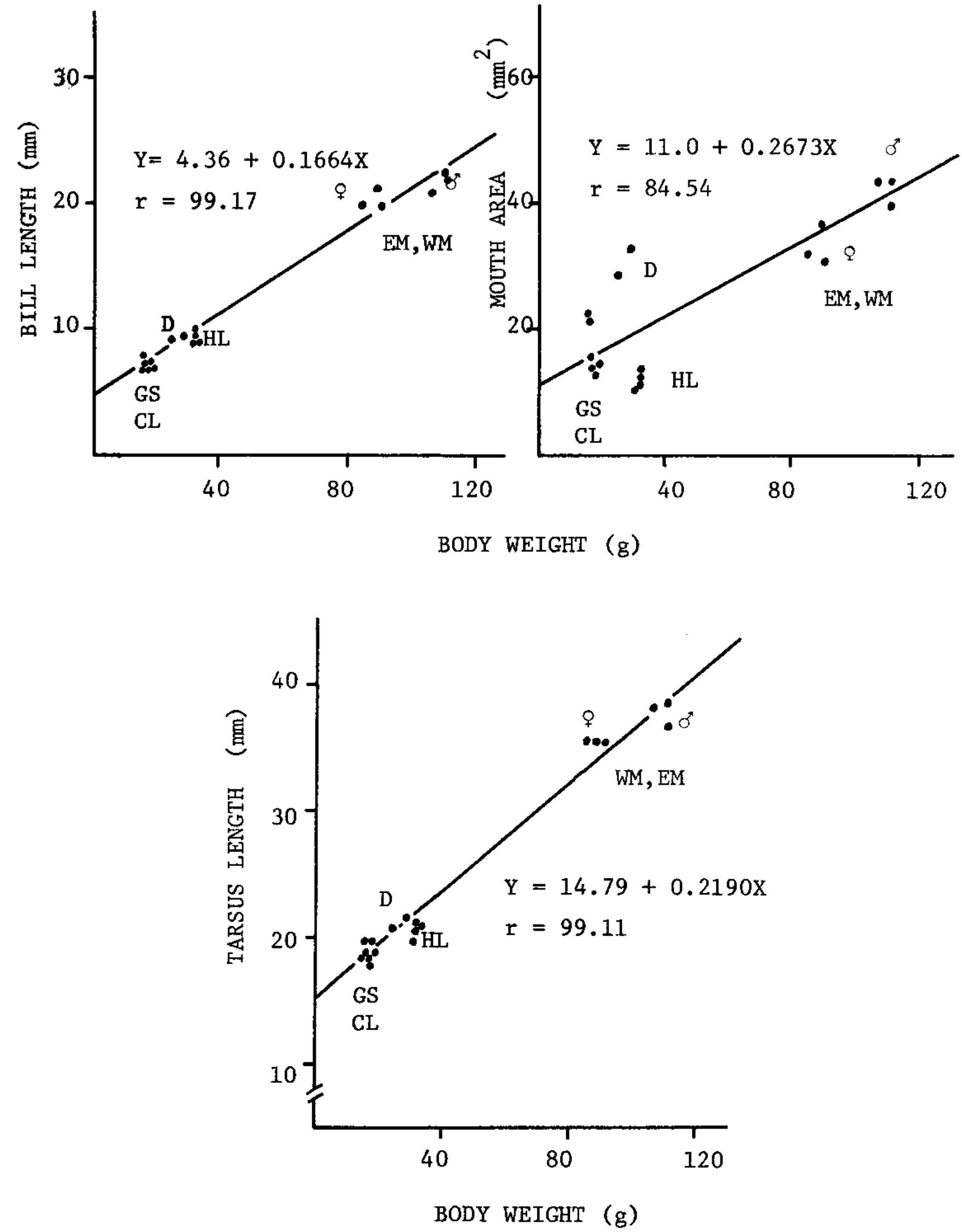


Fig. 7. Relations between body weight (x) and three other morphological measures (y) for bird specimens. Species abbreviations as in Table 14.

Table 29. Values for linear regressions of avian morphological features (x) and diet characteristics (y) for grassland passerines, from the data of Tables 14, 17-27, and 28. The regression model is of the form y = a + bx. Significance levels of r (** = p < 0.01, * = p < 0.50) determined by t-test (Rohlf and Sokal 1969, Table Y).

Variables Compared		a	b	r
x	y			
Bill length	Diet dry weight per individual	0.042	0.019	0.762**
Bill width	Diet dry weight per individual	-0.145	0.083	0.573*
Mouth area	Diet dry weight per individual	0.103	0.007	0.556*
Body weight	Diet dry weight per individual	0.130	0.003	0.733**
Tarsus length	Diet dry weight per individual	-0.075	0.014	0.728**
Bill length	Mean animal prey size	9.205	0.127	0.368
Bill width	Mean animal prey size	5.081	1.101	0.562*
Mouth area	Mean animal prey size	8.077	0.112	0.615**
Body weight	Mean animal prey size	9.836	0.019	0.336
Tarsus length	Mean animal prey size	8.466	0.091	0.347
Bill length	Mean total prey size	2.834	0.395	0.679**
Bill width	Mean total prey size	-4.545	2.375	0.718**
Mouth area	Mean total prey size	2.907	0.202	0.653**
Body weight	Mean total prey size	4.658	0.063	0.649**
Tarsus length	Mean total prey size	0.193	0.297	0.671**

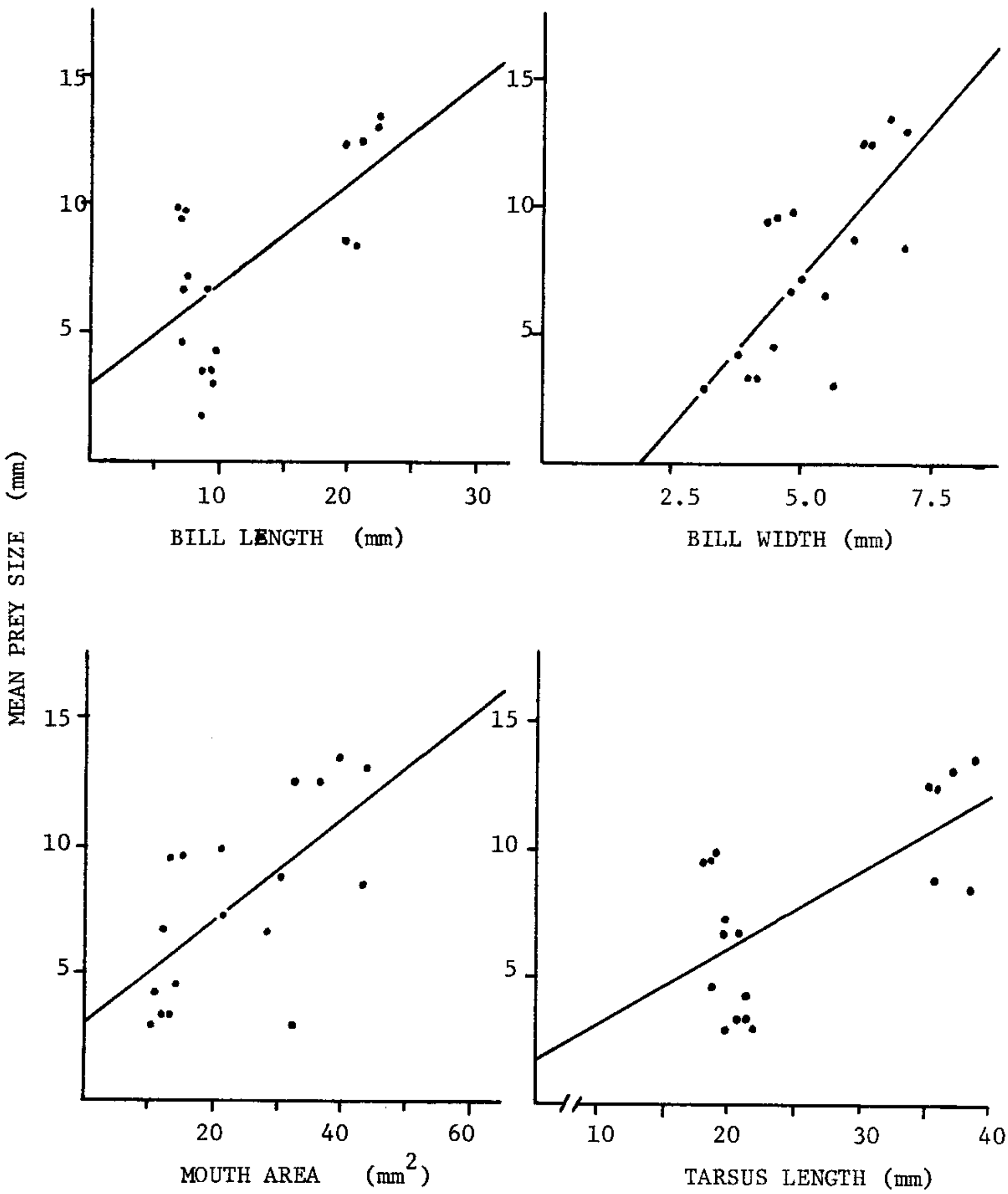


Fig. 8. Relations between several morphological features of bird specimens and the mean size of animal and seed prey combined. Regression equations are given in Table 29.

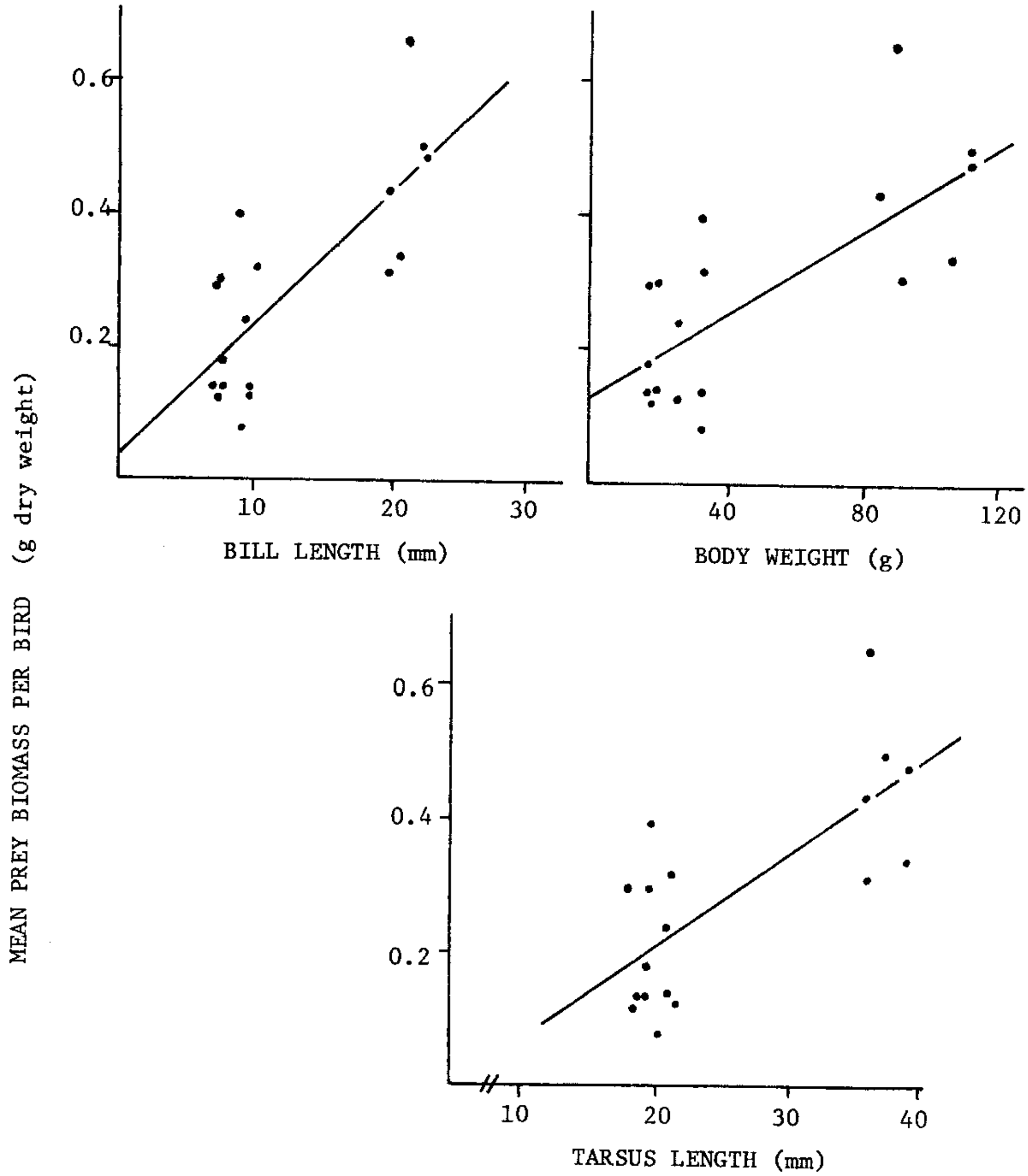


Fig. 9. Relations between several morphological features of bird species and the mean estimated total dry weight of stomach contents per individual specimen. Regression equations are given in Table 29.

features, and between body weight, tarsus length, and bill length and the mean dry weight of prey consumed per individual. Relationships were weak between the size of animal prey and the size of consumers or their bills. The relationships to bill length and tarsus length are somewhat equivocal since all the species sampled fell into two bill or tarsus length categories (Fig. 7). Bill width, mouth area, and body weight were more variable among the species sampled; the most obvious relationships were between body size and prey dry weight and between bill width and prey size. Generally poor relationships between bill or body size and the size of animal prey taken are especially interesting, for they suggest that when animal prey were taken, they came from roughly similar size ranges by most species (see Fig. 6, and below). Smaller species thus apparently tend to eat proportionately more small seeds than do larger species, rather than eating smaller insects. More data are necessary to clarify the details of these relationships.

DIETARY DIFFERENCES BETWEEN SPECIES

It is widely held that food is a critical resource in natural communities and that competition related to food limitation should produce trophic divergence among coexisting community members (e.g., Lack 1971). Thus, the dietary data gathered in our studies may provide basic information about the patterns of energy flow to bird populations in grassland ecosystems. It may also allow examinations of the trophic relationships among species and contribute to clarifying the determinants of avian community organization in grasslands (Wiens, in prep.). We may consider trophic relationships at two levels: among the various species occupying single sites, and between populations of the same or similar species at different sites. The comparisons are based upon the dietary data presented in Tables 3 to 13. In addition, the values of Table 14 are used to assess the overall similarity of diets between species pairs, using Horn's (1966) R_o similarity index. The results of this analysis are presented in Tables 30 and 31. Some idea of dietary overlap among species can also be obtained from Fig. 3 to 5.

Within-site Comparisons

Pantex--Horned Larks and Western Meadowlarks at Pantex had only moderately similar diets (Table 30). Considering diets in terms of three major components (beetles, other animals, and seeds), it is apparent that Horned Larks, while individually variable, preyed chiefly upon seeds with other animals comprising less than a third of the diet, and beetles (Scarabaeids) even less still (Fig. 10). Meadowlarks, on the other hand, consumed mainly beetles (Scarabaeids, Tenebrionids) with other animal taxa (especially Acridids) virtually completing the diet. Only one specimen contained greater than 20% plant material in its diet (Fig. 10). Western Meadowlark individuals included significantly more prey taxa in their diet ($p < 0.01$; Table 14) and selected significantly larger animal prey ($p < 0.01$; Tables 17, 18) than Horned Lark individuals.

Osage--Dietary similarity among the species breeding at the Osage Site was greatest between Dickcissels and Grasshopper Sparrows (Table 30), although Dickcissels were notably more granivorous than Grasshopper Sparrows and ate fewer Lepidoptera larvae and beetles (especially weevils). Eastern Meadowlarks were entirely carnivorous, and Upland Plovers almost so; these species thus had very low similarity index values when compared to Dickcissels and intermediate values with respect to Grasshopper Sparrows. Their similarity

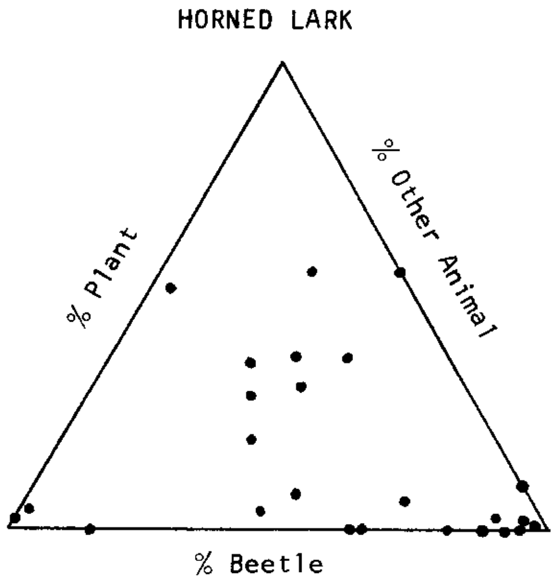
Table 30. Dietary similarity among bird species at three IBP grassland sites, 1970. Similarity was gauged by Horn's (1966) R_o index, in which a value of 1.0 indicates complete equality in both the occurrence and relative proportions of prey taxa, while a value of 0.0 indicates complete dietary exclusion between the compared species.

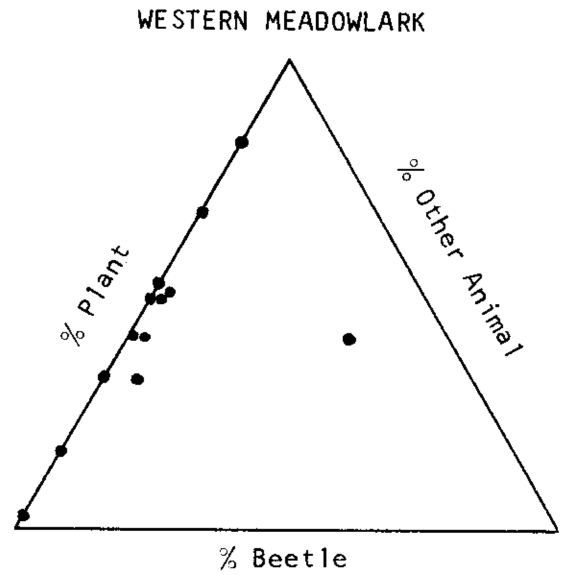
Site	Species Compared	Similarity Index, R_o
Pantex	Horned Lark - Western Meadowlark	0.593
Osage	Upland Plover - Eastern Meadowlark	0.463
	Upland Plover - Dickcissel	0.270
	Upland Plover - Grasshopper Sparrow	0.407
	Eastern Meadowlark - Dickcissel	0.394
	Eastern Meadowlark - Grasshopper Sparrow	0.500
	Dickcissel - Grasshopper Sparrow	0.815
Cottonwood	Long-billed Curlew - Horned Lark	0.151
	Long-billed Curlew - Western Meadowlark	0.477
	Long-billed Curlew - Grasshopper Sparrow	0.464
	Long-billed Curlew - Chestnut-collared Longspur	0.155
	Horned Lark - Western Meadowlark	0.304
	Horned Lark - Grasshopper Sparrow	0.688
	Horned Lark - Chestnut-collared Longspur	0.483
	Western Meadowlark - Grasshopper Sparrow	0.464
	Western Meadowlark - Chestnut-collared Longspur	0.360
	Grasshopper Sparrow - Chestnut-collared Longspur	0.568

Table 31. Dietary similarity of avian species populations at different sites, 1970. As in the analysis of Table 30, Horn's (1966) R_o index was used to measure dietary similarity.

Species	Sites Compared	Similarity Index, R_o
Horned Lark	Pantex - Cottonwood	0.525
Meadowlarks[a/]	Pantex - Osage	0.567
	Pantex - Cottonwood	0.538
	Osage - Cottonwood	0.747
Grasshopper Sparrow	Osage - Cottonwood	0.803

a/ Western and Eastern Meadowlarks were combined in this analysis.





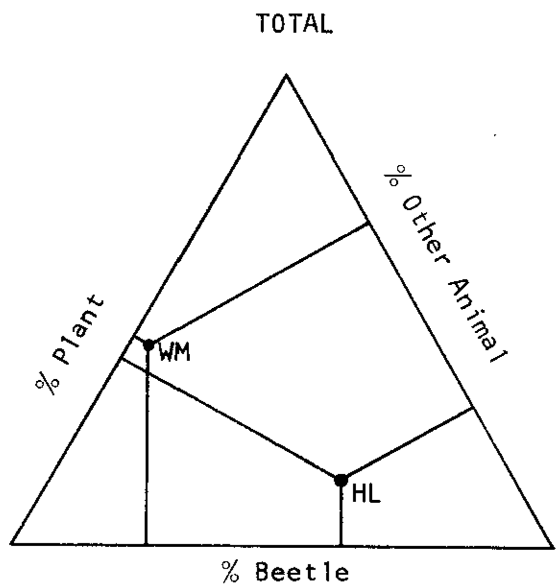


Fig. 10. Proportions of seeds, beetles, and other animal prey taxa in the diets of individual specimens of Horned Larks and Western Meadowlarks, and the mean proportions for each species at Pantex, 1970. The perpendicular distance from one side of the triangle is proportional to the percent contribution of that prey category to the diet. Thus a point at the lower right corner of a triangle would indicate a specimen (or species) in which the diet was entirely seeds; a point exactly in the middle of a triangle would denote a specimen or species with a diet composed of one-third of each prey category.

to each other, however, was relatively low, largely because meadowlark diets were dominated by beetles (especially Scarabaeids) and Lepidoptera larvae; the few plover specimens collected contained somewhat fewer beetles (largely weevils and carabids) and Isopods (Fig. 11, Table 14). Western Meadowlark individuals consumed significantly more prey taxa than Dickcissels ($p < 0.01$; Table 15) as did Grasshopper Sparrows ($0.1 > p > 0.05$; Table 15); meadowlark stomachs contained significantly more prey taxa than Dickcissels ($p < 0.01$; Table 14), Grasshopper Sparrows ($p < 0.05$), or Upland Plovers ($p < 0.05$). Upland Plovers, despite their greater body size, apparently selected smaller animal prey items than meadowlarks ($p < 0.01$), Dickcissels ($p < 0.01$), or Grasshopper Sparrows ($p < 0.05$; Tables 19 to 22). Other species comparisons for these features were not statistically significant.

Cottonwood--Highest similarity index values were obtained in the comparisons of Horned Larks and Grasshopper Sparrows and of Grasshopper Sparrows and Chestnut-collared Longspurs (Table 30). These species consumed large quantities of seeds, and the importance of beetles in Horned Lark and Grasshopper Sparrow diets was the lowest recorded for any of the species at any of the sites. Both consumed moderate quantities of Lepidoptera larvae, while the longspurs ate hardly any larvae but did ingest beetles (primarily weevils) and captured crickets rather than grasshoppers (Fig. 12, Table 14). Long-billed Curlews and Western Meadowlarks had extremely low to intermediate dietary similarity to the above three species, and were only moderately similar to each other (Table 30). Both were essentially carnivorous; curlews consumed mainly grasshoppers, with beetles (Cerambycids) completing the diet, while meadowlarks ate more beetles (Ceramaycids and Scarabaeids), fewer Orthopterans, and more Lepidoptera larvae (Fig. 12, Table 14). The number

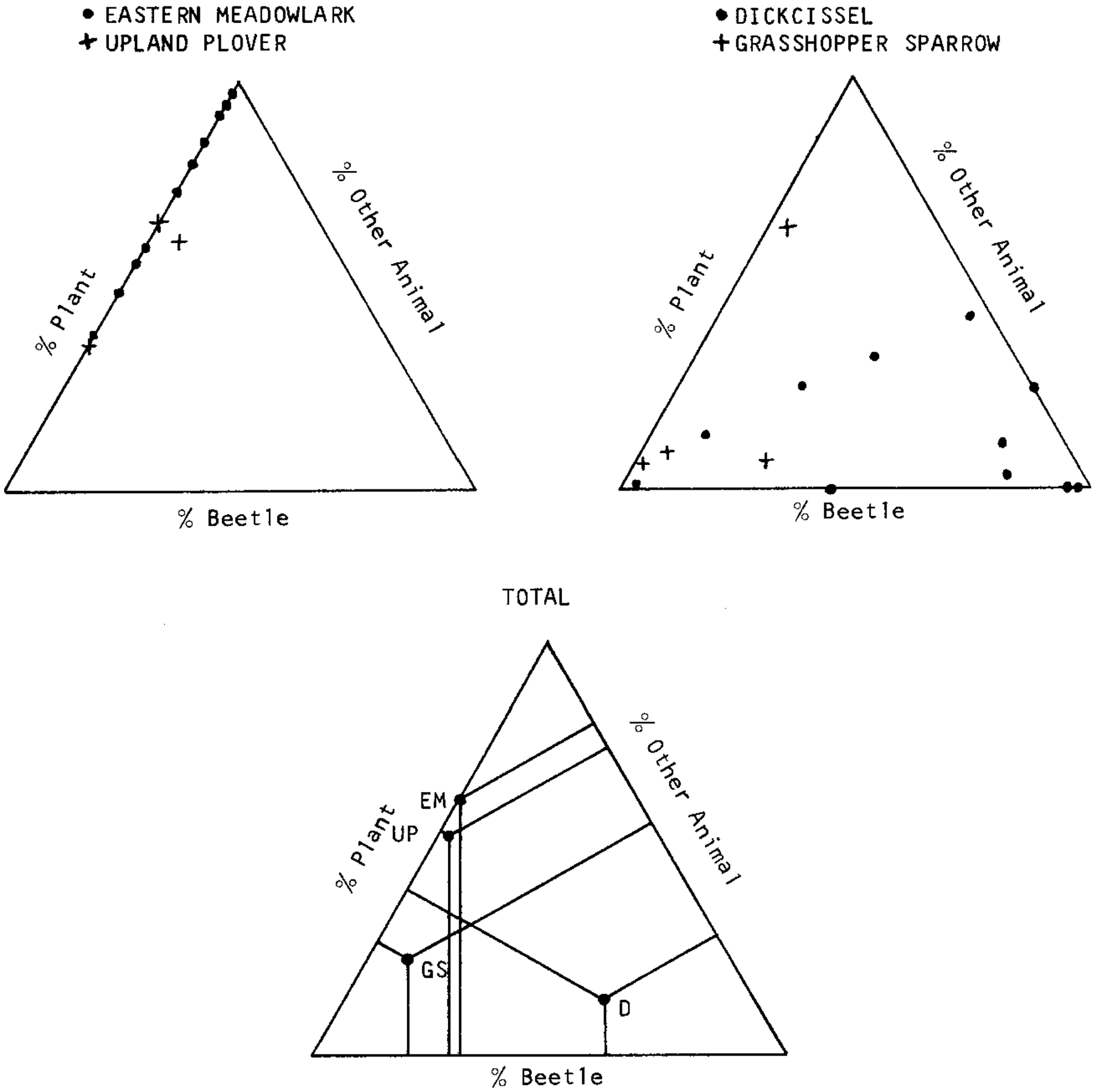


Fig. 11. Proportions of three general prey categories in the diets of individual Eastern Meadowlarks, Upland Plovers, Dickcissels, and Grasshopper Sparrows, and the mean proportions for each species at Osage, 1970. The perpendicular distance from one side of the triangle is proportional to the percent contribution of that prey category to the diet.

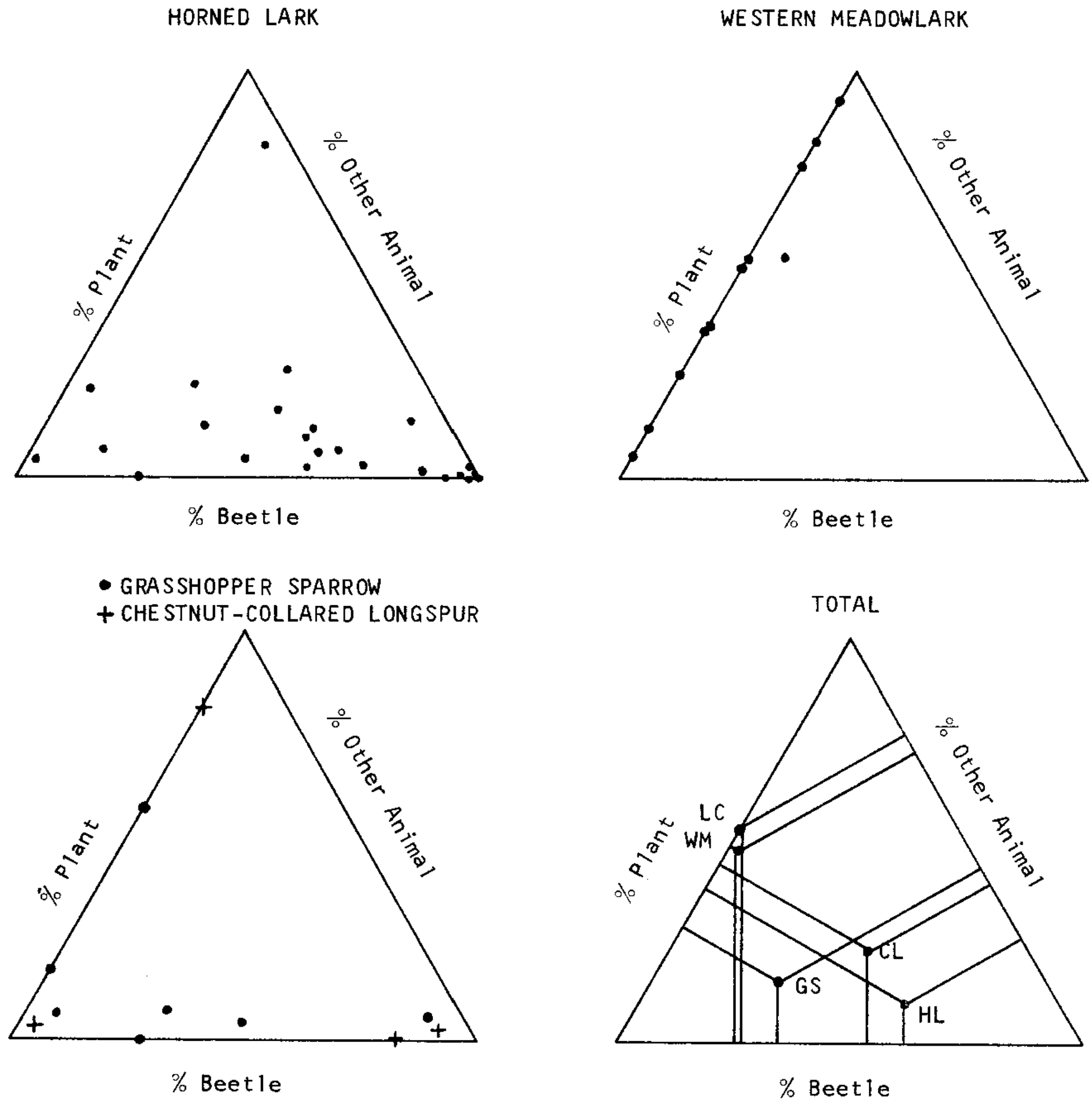


Fig. 12. Proportions of three general prey categories in the diets of individual Horned Larks, Western Meadowlarks, Grasshopper Sparrows, and Chestnut-collared Longspurs at Cottonwood, 1970, and the mean proportions of these prey categories in the diets of all species sampled. The perpendicular distance from one side of the triangle is proportional to the percent contribution of that prey category to the diet.

of prey taxa occurring in individual Long-billed Curlew samples was significantly greater than that in Grasshopper Sparrow samples ($p < 0.05$) or Chestnut-collared Longspur stomachs ($p < 0.01$); Horned Larks ($p < 0.01$), Western Meadowlarks ($p < 0.05$), and Grasshopper Sparrows ($0.10 > p > 0.05$) all contained more prey taxa per sample than longspurs (Table 15). The average prey biomass in curlew stomachs was significantly greater ($p < 0.01$) than in all other species, while meadowlarks, the next largest species, contained more prey biomass than the smallest species, the Grasshopper Sparrow ($p < 0.05$). Curlews also selected larger animal prey than all other species; meadowlarks ate larger animal prey items than Horned Larks ($p < 0.05$), Grasshopper Sparrows ($p < 0.01$), and longspurs ($p < 0.05$; Fig. 6). Among the granivorous species, Horned Larks selected significantly smaller seeds than Grasshopper Sparrows ($p < 0.01$) but did not differ from longspurs in this respect.

Between-site Comparisons

We may compare the diets of Horned Larks, the meadowlarks (both species combined), and Grasshopper Sparrows across the three sites, although in the latter case the sample size is very small. Horned Larks occurred at Pantex and Cottonwood. The index of dietary similarity between these sites was only moderate (Table 31), reflecting the greater consumption of beetles and grasshoppers at Pantex and the greater importance of seeds, especially Gramineae, at Cottonwood. The two samples did not differ in the number of prey taxa recorded per individual, but at Pantex, individuals contained significantly less prey biomass ($p < 0.05$; Table 14) and consumed significantly smaller plant and animal prey items ($p < 0.01$) than at Cottonwood.

Meadowlark diets were most similar between the Osage and Cottonwood populations; among all sites there was at least moderate similarity undoubtedly because of the primarily carnivorous habits of these species. Beetles, especially Scarabaeids, dominated the diet at all three sites, while Lepidoptera larvae were important prey at Osage and Cottonwood. Orthopterans and Hymenopterans were important only at Pantex. The number of prey taxa per specimen did not differ between the sites, but at Pantex, birds contained somewhat less prey biomass than at Cottonwood ($0.10 > p > 0.05$; Table 14). Pantex birds also ate significantly smaller prey than individuals at Osage ($p < 0.01$) or Cottonwood ($p < 0.01$; Fig. 6).

The dietary composition of the Grasshopper Sparrows collected at Osage was generally quite similar to that of the Cottonwood specimens (Table 31). Osage birds consumed somewhat more beetles, grasshoppers, Hemipterans, and Lepidoptera larvae and less seed biomass than the Cottonwood population (Table 14); the two samples did not differ in the number of prey taxa per individual or the prey biomass per individual. However, significantly larger animal prey items were consumed at Osage than at Cottonwood ($p < 0.01$).

PROBLEM AREAS IN AVIAN DIETARY STUDIES

The data and analyses presented above should be useful in two ways. First, they should contribute to an understanding of the role of bird populations in the energy flow patterns of grassland ecosystems and the effects this predation may have upon prey populations. Second, they may provide some insight into niche or competitive relationships among coexisting populations. However, direct application of the data to these ends is hampered by several problems. Most important, perhaps, is the limited temporal perspective of our sampling.

Samples were collected in 3 to 5 day intervals during the breeding season at each site. Also, when a specimen is collected, its digestive tract contains the remains of food items gathered by the bird over some unknown but finite time interval prior to collection. It must be assumed that the stomach contents are a random sample of the diet actually selected by an individual over some longer time interval. Different prey types, however, are undoubtedly digested at different rates; the hard parts of large ground-dwelling beetles, for example, may be digested very slowly, if at all, and may thus remain in the digestive tract considerably longer than, say, remains of soft-bodied Lepidoptera larvae or Dipterans. Thus our estimate of beetle numbers in a stomach may be based upon counts of remains of individuals gathered by the bird over a much longer time period prior to collection than the remaining evidences of Lepidoptera larvae on which we base our count. In other words, the data are biased toward prey types having longer "half-lives" in the digestive tract. Laboratory tests, perhaps using radioactivity-labeled prey items, are necessary to determine the "digestive half-life" of various prey types; in the absence of such tests there is no way to adjust for this bias in the collections.

These collections, of course, provide detailed information only on the composition of the diet--they offer no suggestions (other than the measure of prey biomass per individual sample) of the total amount or quantity of each prey type consumed over some defined time period. Such information is virtually impossible to obtain in the field, yet it is essential to meet the objectives stated above. The authors' tactic has been to couple the information on dietary composition with estimates of the energy demands of the population based upon metabolic considerations (Wiens 1971*a*). A simulation model to project avian populations dynamics and energy demands has been developed (Wiens and Innis, in prep.) and will be used to estimate the total drain imposed by avian consumers on various prey populations (e.g., Risser 1972).

Once estimates of the total energy or biomass consumed from various prey categories are available, attempts to draw meaningful conclusions from the data are thwarted by the nagging problem of prey availability. Minimally, we require estimates of the standing crop of the various prey types present in an area over the time period considered, and ideally, some idea of the standing crops actually available to the birds--active when the birds are active, present where the birds forage, and compatible to their morphology, physiology, and stimulus perception. As it stands now (1972), no estimates of seed standing crops are available for any of the sites, and the determinations of insect standing crops are general, at best (McDaniel 1971). Attention should be given, in invertebrate sampling, to diurnal activity patterns and to the frequency distributions of body sizes in various insect taxa.

ACKNOWLEDGMENTS

Paul Baldwin of Colorado State University was extremely helpful during the formative stages of this study and contributed data to the sets from which the body length-dry weight regressions were calculated. John Lattin and Loren Russell, Oregon State University, assisted in the identification of particularly troublesome insect fragments. The dietary similarity analysis was undertaken by Bill Grant (CSU); Jerry Peltz programmed the analysis of the odds and ends of dietary information. Without the help of these individuals, even less would be known.

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APPENDIX I

SCIENTIFIC NAMES OF BIRD SPECIES MENTIONED IN TEXT

Upland Plover	*Bartramia longicauda*
Long-billed Curlew	*Numenius americanus*
Horned Lark	*Eremophila alpestris*
Eastern Meadowlark	*Sturnella magna*
Western Meadowlark	*Sturnella neglecta*
Dickcissel	*Spiza americana*
Grasshopper Sparrow	*Ammodramus savannarum*
Chestnut-collared Longspur	*Calcarius ornatus*

APPENDIX II

DIETARY DATA

An example of the format for input of dietary data, and the program used to analyze these data.

IBP

GRASSLAN BIOME

U.S. INTERNATIONAL BIOLOGICAL PROGRAM

LABORATORY DATA SHEET--AVIAN DIET SAMPLES

Data Type	Site	Initials	Date: Day	Date: Month	Date: Year	Treatment	Replicate	Plot Size	Group	Genus	Species	Subspecies	Sex	Development	Collection Time	Ecological Type	Specimen Number	Food Type	Food Item Characteristics: Class	Order	Family	Genus	Species	Life Stage	Ecological Type	Total Number	Total Dry Weight	Net Weight	Number per Size Class	Size Class	Number per Size Class	Size Class	Continuation
1-2	3-4	5-7	8-9	10-11	12-13	14	15	16-19	21	22-23	24-25	26	27	28	29-32	33	34-37	38	39-41	42-44	45-47	48-49	50-51	52	53	54-57	58-61	62-65	68-71	72-73	74-77	76-79	80
27																																	

Group
0 Waterfowl
1 Falconiform
2 Galli- and Gruiform
3 Charadriiform
4 Doves, owls, nighthawks, woodpeckers
5 Flycatchers, swallows, jays, titmice, wrens
6 Thrashers, bluebirds, gnatcatchers, pipits
7 Shrikes, starlings, vireos
8 Icterids
9 Fringillids

Sex
0 Unknown
1 Male
2 Female

Development
0 Not Noted
1 Nestling
2 Fledgling
3 Juvenile
4 Adult

Food Type
0 Unknown
1 Plant
2 Animal
3 Mineral

Life Stage
0 Unknown
1 Egg or Seed
2 Larva
3 Pupa
4 Adult

Site
01 ALE
02 Bison
03 Bridger
04 Cottonwood
05 Dickinson
06 Hays
07 San Joaquin
08 Jornada
09 Osage
10 Pantex
11 Pawnee
12

Treatment
1 Ungrazed
2 Lightly grazed
3 Moderately grazed
4 Heavily grazed
5 Ungrazed current year only
A Diet light
B Diet moderate
C Diet heavy
D ESA - O
E ESA - W
F ESA - N
G ESA - WN

PROGRAM EXTRACT CDC 6400 FTN V3.0-P308 OPT=1 09/13/72 09.40.33. PAGE 1

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      PROGRAM EXTRACT
     -(TAPE,
     -INPUT,OUTPUT,TAPE1=500B,TAPE2=500B,TAPE3=500B,TAPE4=500B,TAPE5=
     -500B,TAPE6=500B,TAPE7=500B,TAPE8=500B,TAPE9=500B,TAPE10=500B
     -,TAPE11=TAPE)
C         TAPES 1 THRU 7 CONTAIN RAW DATA FOR THE VARIOUS ANALYSIS REQUESTED;
C         RESPECTIVELY, TOTAL SAMPLE]  ADULT MALES] ADULT FEMALES]
C         ADULTS COLLECTED BEFOR 1400] ADULTS COLLECTED AFTER 1400]
C          JUVENILES AND NESTLINGS.
C         TAPE 8 CONTAINS INTERMEDIATE DATA FOR DIET ANALYSIS IN SUBR ANAL.
C         TAPE 9 CONTALNS THE LISTED OUTPUT.
C         TAPE 10 CONTAINS FORTRAN READABLE OUTPUT FOR THE BANK
C         TAPE 11 CONTAINS RAW DATA  FOR INPUT TO THE PROGRAM.
C
C          THE DATA MUST BE SORTED BY SITE, BIRD SPECIES , AND DATE ..
      INTEGER CARD(8),SITE,BSPEC,DATE
      GO TO 3
    1 BACKSPACE 11
C         INITIALIZE SITE, DATE, AND BSPEC
    3 READ(11,100)SITE,DATE,BSPEC
  100 FORMAT(2X,I2,3X,I6,8X,A4)
      IF(EOF(11).NE.0.)STOP
      BACKSPACE 11
C         READ A DATA CARD
    2 READ(11,101)CARD
  101 FORMAT(8A10)
C         IF(END OF DATA) PROCEED TO ANALYSIS SECTION
      IF(EOF(11).NE.0.)GO TO 99
C         PICK OUT THE APPROPRIATE PARAMETERS FOR SORTING THE CARDS.
      DECODE(32,102,CARD)ISITE,IBSPEC,ISEX,IDVLP,ITIME
  102 FORMAT(2X,I2,17X,A4,1X,2I1,I4)
C         CHECK FOR CHANGE OF SITE OR BSPEC
      IF(SITE.NE.ISITE.OR.BSPEC.NE.IBSPEC)GO TO 99
C         PUT THIS CARD ON THE APPROPRIATE FILES.
      WRITE(1,101)CARD
      IF(ISEX.EQ.1.A.IDVLP.EQ.4)WRITE(2,101)CARD
      IF(ISEX.EQ.2.A.IDVLP.EQ.4)WRITE(3,101)CARD
      IF(IDVLP.EQ.4.A.ITIME.LE.1400)WRITE(4,101)CARD
      IF(IDVLP.EQ.4.A.ITIME.GT.1400)WRITE(5,101)CARD
      IF(IDVLP.EQ.3)WRITE(6,101)CARD
      IF(IDVLP.EQ.1)WRITE(7,101)CARD
      GO TO 2
C         ANALYSIS
   99 DO 10 I=1,7
      REWIND I
      CALL BTD(I)
   10 CONTINUE
      GO TO 1
      END
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      SUBROUTINE BTD(ITP)
      COMMON/B1/TTWT,TSDWT,TANWT,TSDIT,TANIT
      COMMON /B2/ IFMT(7,4),IPTR
      DIMENSION SIZE(2),NUM(2),SIZESTK(20,4),IDATE(3)
      REAL NUM
      INTEGER SITE,DATE(3),BSPEC,BSPC,PREYNM,DATYP,DVLPMT,CTIME,SERNO,
     -FDTYP,PREYID,GRITN,FDTP,FIND
      COMMON TOTWT,SEEDWT,ANIMWT,SEEDIT,ANIMIT,SPECNUM
      SQTOTWT=0.
      TOTWT=SEEDIT=ANIMIT=SEEDWT=ANIMWT=0.
      SPECNUM=1.
      TTWT=TANIT=TSDIT=TANWT=TSDWT=0.
      IEF=0
      GRITN=0 $ IPG=1
      IPTR=ITP
      DATA ((IFMT(I,J),J=1,4),I=1,7)/
     -10HTOTAL SAMP,10HLE ANALYSI,1HS,1H ,
     -10HANALYSIS F,10HOR ADULT M,10HALES ONLY ,1H ,
     -10HANALYSIS F,10HOR ADULT F,10HEMALES ONL,1HY,
     -10HANALYSIS F,10HOR ADULTS ,10HCOLLECTED ,10HBEFOR 1400,
     -10HANALYSIS F,10HOR ADULTS ,10HCOLLECTED ,10HAFTER 1400,
     -10HANALYSIS F,10HOR JUVENIL,7HES ONLY,1H ,
     -10HANALYSIS F,10HOR NESTLIN,7HGS ONLY,1H /
      DO 10 I=1,2
   10 SIZE(I)=NUM(I)=0.
      DO 11 I=1,20
   11 SIZESTK(I,1)=SIZESTK(I,2)=SIZESTK(I,3)=SIZESTK(I,4)=0.
      I=1
      READ(ITP,100)DATYP,SITE,INVES,(IDATE(L),L=1,3), BSPEC,ISEX,DVLPMT,
     -ITEMNO,FDTP,PREYNM,LFSTG1
      IF(EOF(ITP).EQ.0.)GO TO 32
      WRITE(9,400)BSPEC,ISITE,(IFMT(ITP,J),J=1,4)
      WRITE(9,504)
      RETURN
  504 FORMAT(///T30,*NO ANALYSIS DONE, DATA OF THIS TYPE IS NOT PRESENT*
     -)
   32 BACKSPACE ITP
      ISITE=FIND(SITE)
      WRITE(9,400)BSPEC,ISITE,(IFMT(ITP,J),J=1,4)
      WRITE(9,401)IDATE
      WRITE(9,402)
    1 READ(ITP,101)(DATE(L),L=1,3),BSPC,SERNO,FDTYP,PREYID,LFSTG,(NUM(L),
     -,SIZE(L),L=1,2)
      IF(EOF(ITP).EQ.0.)GO TO 3
    2 IEF=1
      GO TO 6
    3 IF(PREYID.NE.9RGRIT     )GO TO 4
      GRITN=GRITN+1
      GO TO 1
    4 IF(SERNO.NE.ITEMNO)GO TO 6
      IF(PREYNM.NE.PREYID)GO TO 6
   13 DO 30 J=1,2
      IF(SIZE(J).EQ.0.)GO TO 30
      IF(I.EQ.1)GO TO 22
      DO 20 K=1,I
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      IF(SIZE(J).EQ.SIZESTK(K,1))GO TO 21
   20 CONTINUE
   22 SIZESTK(I,1)=NUM(J)
      SIZESTK(I,2)=SIZE(J)
      I=I+1
      GO TO 30
   21 SIZESTK(K,1)=SIZESTK(K,1)+NUM(J)
   30 CONTINUE
      GO TO 1
    6 CALL DRYWT(PREYNM,SIZESTK,I-1)
      I=I-1
      IF(I.EQ.1)GO TO 41
      II=I-1
    7 ISW=0
      DO 40 J=1,II
      IF(SIZESTK(J,2).LE.SIZESTK(J+1,2))GO TO 40
      ISW=1
      DO 39 K=1,4
      TEMP=SIZESTK(J,K)
      SIZESTK(J,K)=SIZESTK(J+1,K)
      SIZESTK(J+1,K)=TEMP
   39 CONTINUE
   40 CONTINUE
      IF(ISW.EQ.1)GO TO 7
      IF(I+IPG.LT.52)GO TO 41
      WRITE(9,400)BSPEC,ISITE,(IFMT(ITP,J),J=1,4)
      WRITE(9,402)
      IPG=1
   41 II=I
      DO 50 J=1,II
      WRITE(8,500)ITEMNO,BSPEC,FDTP,PREYNM,LFSTG1,(SIZESTK(J,K),K=1,4)
      WRITE(9,501)ITEMNO,FDTP,PREYNM,LFSTG1,(SIZESTK(J,K),K=1,4)
C        ***** BANK OUTPUT *****
      IF(ITP.EQ.1)WRITE(10,1100)DATYP,SITE,INVES,DATE,BSPEC,ISEX,DVLPMT,
     -ITEMNO,FDTP,PREYNM,LFSTG1,(SIZESTK(J,K),K=1,4)
 1100 FORMAT(I2,R2,R3,3I2,8X,R4,1X,2(I1,5X,I4,I1,R9,4X,I1,1X,2(F5.0,1X),
     -2(F6.4,1X))

      IPG=IPG+1
   50 CONTINUE
      IF(IEF.EQ.1)GO TO 14
      IF(SERNO.EQ.ITEMNO)GO TO 9
      SPECNUM=SPECNUM+1.
   14 TTWT=TTWT+TOTWT $ TANIT=TANIT+ANIMIT $ TSDIT=TSDIT+SEEDIT
      TANWT=TANWT+ANIMWT $ TSDWT=TSDWT+SEEDWT
      SQTOTWT=SQTOTWT+TOTWT**2
      WRITE(9,502)ITEMNO,SEEDIT,SEEDWT,ANIMIT,ANIMWT,TOTWT
C        ***** BANK OUTPUT *****
      IF(ITP.EQ.1)WRITE(10,1101)DATYP,SITE,INVES,DATE,BSPEC,ISEX,DVLPMT,
     -ITEMNO,SEEDIT,SEEDWT,ANIMIT,ANIMWT,TOTWT)
 1101 FORMAT(I2,R2,R3,3I2,8X,R4,1X,2I1,5X,I4,1X,*TOTAL*,10X,F5.0,F6.4,
     -1X,F6.0,1X,F6.4)
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      IPG=IPG+4
      IF(IEF.EQ.1)GO TO 12
      IF(IPG+4.LT.52)GO TO 42
      WRITE(9,400)BSPEC,ISITE,(IFMT(ITP,J),J=1,4)
      WRITE(9,402)
      IPG=1
   42 WRITE(9,401)DATE
      IPG=IPG+1
      TOTWT=ANIMWT=SEEDWT=ANIMIT=SEEDIT=0.
      ITEMNO=SERNO
    9 PREYNM=PREYID
      LFSTG1=LFSTG
      FDTP=FDTYP
      DO 60 J=1,20
   60 SIZESTK(J,1)=SIZESTK(J,2)=SIZESTK(J,3)=SIZESTK(J,4)=0.
      I=1
      IDATE(1)=DATE(1) $ IDATE(2)=DATE(2) $ IDATE(3)=DATE(3)
      GO TO 13
   12 REWIND 8
      PERSD=(TSDWT/TTWT)*100.
      PERAN=(TANWT/TTWT)*100.
      PERCG=(GRITN/SPECNUM)*100.
      AVESPWT=TTWT/SPECNUM
      SDASPWT=SQRT((SQTOTWT-TTWT*TTWT/SPECNUM)/(SPECNUM-1.))
      WRITE(9,400)BSPEC,ISITE,(IFMT(ITP,J),J=1,4)
      WRITE(9,503)SPECNUM,PERCG,TTWT,AVESPWT,TANIT,TANWT,PERAN,TSDIT,
     -TSDWT,PERSD,SDASPWT
C    ***CALL ANAL
      CALL ANAL(BSPEC,ISITE,DATE)
      RETURN
  100 FORMAT(I2,R2,R3,3I2,8X,R4,1X,2I1,5X,I4,I1,R9,4X,I1)
  101 FORMAT(7X,3I2,8X,R4,8X,I4,I1,R9,4X,I1,15X,2(F4.0,F2.0))
  400 FORMAT(1H1/44X,*IBP AVIAN DIET ANALYSIS FOR JOHN WIENS.*,/,
     -41X,*SPECIES *,R4,* COLLECTED AT THE *,R10,* SITE.*/46X,4A10)
  401 FORMAT(10X,*THE FOLLOWING SPECIMEN COLLECTED ON *,2(I2,*/*),I2,*.*
     -)
  402 FORMAT(/,9X,*SPECIMEN*,7X,*FOOD*,9X,*TAXON*,9X,*LIFE*,6X,
     -*NUMBER PER*,10X,*SIZE CLASS*,10X,*INDIVIDUAL*,12X,*TOTAL*,/,
     -8X,*SERIAL NUM.*,5X,*TYPE*,23X,*STAGE*,5X,*SIZE CLASS*,30X,
     -*DRY WEIGHT*,10X,*DRY WEIGHT*)
  500 FORMAT(4X,I4,2X,R4,2X,I1,2X,R9,1X,I1,1X,4(F9.4,1X))
  501 FORMAT(10X,I4,11X,I1,8X,R9,9X,I1,9X,F5.0,15X,F5.0,13X,F10.4,10X,
     - F10.4)
  502 FORMAT(48X,*SUMMARY FOR SPECIMEN NUMBER *,I4,*.*,
     -/,46X,*ITEMS SEED*,F5.0,* TOTAL WEIGHT*,F10.4,
     -/     ,46X,*ITEMS ANIM.*,F4.0,* TOTAL WEIGHT*,F10.4,
     -/     47X,*TOTAL DRY WEIGHT, ALL ITEMS,*,F10.4)
  503 FORMAT(/,57X,*SAMPLE SUMMARY*,//,
     -6X,*NUMBER OF*,3X,*PERCENT*,4X,*TOT. DRY WT.*,4X,*SPECIMEN*,6X,
     -*ITEMS*,4X,*DRY WT.*,4X,*PERCENT*,4X,*ITEMS*,4X,*DRY WT.*,5X,
     -*PERCENT*,/,6X,*SPECIMENS*,4X,*GRIT*,21X,*AVE DRY WT.*,4X,*ANIM.*
     -4X,*ANIMAL*,5X,*TOT WT.*,4X,*SEED*,6X,*SEED*,7X,*TOT WT.*,/,
     -(8X,F4.0,7X,F4.0,7X,F10.4,4X,F10.4,5X,F4.0,3X,F10.4,2(5X,F4.0),3X,
     -F10.4,5X,F4.0)/44X,*STD. DEV.*/43X,F10.4)
      END
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      SUBROUTINE DRYWT(PREYNM,SIZES,NOSIZES)
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
*     THIS SUBROUTINE CALCULATES DRY WEIGHT FROM INPUTS OF LENGTH (SIZES(K,1))
C     , BY MATCHING THE  INPUT SPECIMEN NAME PREYNM WITH A LIST OF PREY-NAMES
C     DEFINED IN PREY(1,I) WHERE I=1,2,...,LNGTH.
C     PREY(2,I) CONTAINS AN INDEX REF. THE COEFF. VECTORS A AND B FOR USE IN THE
C     REGRESSION MODEL FOR THIS SPECIMEN.
C     PREY(3,I) CONTAINS AN INDEX TO THE MODEL USED; 1 IF LINEAR AND 2 IF
C     EXPONENTIAL.

      DIMENSION SIZES(20,4),A(18),B(18)
      INTEGER PREY(3,56),PREYNM,PREYNM1
      COMMON TOTWT,SEEDWT,ANIMWT,SEEDIT,ANIMIT
      DATA((PREY(I,J),I=1,3),J=1,19)/
     -9RANG      ,1,1,                                                   001
     -9RARA      ,4,2,                                                   002
     -9RCRU      ,14,2,                                                  003
     -9RGAS      ,14,2,                                                  004
     -9RINS      ,2,1,                                                   005
     -9RINSCOL   ,2,1,                                                   006
     -9RINSCOLBUP,2,1,                                                   007
     -9RINSCOLDAS,2,1,                                                   008
     -9RINSCOLDRS,2,1,                                                   008.5
     -9RINSCOLCAR,6,2,                                                   009
     -9RINSCOLCAN,2,1,                                                   010
     -9RINSCOLCER,3,2,                                                   011
     -9RINSCOLCHR,2,1,                                                   012
     -9RINSCOLCUR,7,2,                                                   013
     -9RINSCOLERO,2,1,                                                   014
     -9RINSCOLELA,2,1,                                                   015
     -9RINSCOLHIS,2,1,                                                   016
     -9RINSCOLHYD,2,1,                                                   017
     -9RINSCOLMEL,2,1/
      DATA((PREY(I,J),I=1,3),J=20,38)/
     -9RINSCOLNIT,2,1,
     -9RINSCOLSCA,5,2,                                                   020
     -9RINSCOLTEN,11,2,                                                  021
     -9RINSDIP   ,12,2,                                                  022
     -9RINSDIPASI,12,2,                                                  023
     -9RINSHEM   ,10,2,                                                  024
     -9RINSHEMCIM,10,2,                                                  025
     -9RINSHEMCOR,10,2,                                                  026
     -9RINSHEMLYG,10,2,                                                  027
     -9RINSHEMMIR,15,2,                                                  028
     -9RINSHEMSCU,10,2,                                                  029
     -9RINSHEMPEN,13,2,                                                  030
     -9RINSHEMPHY,10,2,                                                  031
     -9RINSHEMRED,10,2,                                                  032
     -9RINSHEMROP,10,2,                                                  033
     -9RINSHOM   ,10,2,                                                  034
     -9RINSHOMAPH,10,2,                                                  035
     -9RINSHOMCDL,15,2,                                                  036
     -9RINSHOMCIC,16,2/
      DATA((PREY(I,J),I=1,3),J=39,56)/
     -9RINSHOMCIX,12,2,
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      -9RINSHOMCOC,15,2,                                               039
      -9RINSHYM    ,12,2,                                              040
      -9RINSHYMAPI,17,2,                                               041
      -9RINSHYMICH,17,2,                                               042
      -9RINSHYMFOR,18,2,                                               043
      -9RINSHYMHAL,17,2,                                               044
      -9RINSHYMPOM,17,2,                                               045
      -9RINSHYMSPH,17,2,                                               046
      -9RINSLEP    ,8,2,                                               047
      -9RINSNEU    ,12,2,                                              048
      -9RINSODO    ,12,2,                                              049
      -9RINSODOZYG,12,2,                                               050
      -9RINSORT    ,9,2,                                               051
      -9RINSORTACR,16,2,                                               052
      -9RINSORTGRY,16,2,                                               053
      -9RREP       ,16,2,                                              054
      -9RREPSQUIGN,16,2/                                               055
       DATA(A(I),I=1,18)/
      --.00185,-.00645,.00335575,.001042733,
      -.01455952,.002077645,.000951244,.00034117,
      -.001638392,.000297904,.001674468,.000352388,
      -.00080058,.00035,.00018,.000179,
      -.00012,.00032/
       DATA(B(I),I=1,18)/
      -.001746,.001862,.175115,.281753,
      -.138791,.179167,.320545,.189976,
      -.171716,.333062,.227754,.317526,
      -.340113,.352978,.409211,.129508,
      -.426578,.338648/

       LNGTH=56
       CALL GCHARS(PREYNM,1,4,PREYNM1)
       DO 9 J=1,4
       IF(PREYNM1.EQ.PREY(1,J))GO TO 1
     9 CONTINUE
       DO 10 J=5,LNGTH
       IF(PREYNM.EQ.PREY (1,J))GO TO 1
    10 CONTINUE
       WRITE(9,400) PREYNM
   400 FORMAT(10X,*THIS SPECIMEN NOT DEFINED FOR REGRESSION EQUNS.*,R10)
       RETURN
     1 IPT=PREY(3,J)
       GO TO (2,3)IPT
     2 DO 20 K=1,NOSIZES
       SIZES(K,3)=A(PREY(2,J))+B(PREY(2,J))*SIZES(K,2)
       IF(SIZES(K,3).LT.0.)SIZES(K,3)=.0005
       SIZES(K,4)=SIZES(K,3)*SIZES(K,1)
       IF(J.NE.1)GO TO 4
       SEEDWT=SEEDWT+SIZES(K,4)
       SEEDIT=SEEDIT+SIZES(K,1)
       GO TO 19
     4 ANIMWT=ANIMWT+SIZES(K,4)
       ANIMIT=ANIMIT+SIZES(K,1)
    19 TOTWT=TOTWT+SIZES(K,4)
    20 CONTINUE
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      RETURN
    3 DO 30 K=1,NOSIZES
      SIZES(K,3)=A(PREY(2,J))*(EXP(B(PREY(2,J))*SIZES(K,2)))
      IF(SIZES(K,3).LT.0.)SIZES(K,3)=.0005
      SIZES(K,4)=SIZES(K,3)*SIZES(K,1)
      ANIMWT=ANIMWT+SIZES(K,4)
      ANIMIT=ANIMIT+SIZES(K,1)
      TOTWT=TOTWT+SIZES(K,4)
   30 CONTINUE
      RETURN
      END
```

FUNCTION FIND CDC 6400 FTN V3.0-P308 OPT=1 09/13/72 09.40.33. PAGE 1

```
      INTEGER FUNCTION FIND(IST)
      DIMENSION ISITES(11,2)
      DATA((ISITES(I,J),I=1,11),J=1,2)
     1/2R01,2R02,2R03,2R04,2R05,2R06,2R07,2R08,2R09,2R A,2R B,
     13RALE,5RBISON,
     27RBRIDGER,10RCOTTONWOOD,9RDICKINSON,4RHAYS,7RHOPLAND,7RJORNADA,
     35ROSAGE,6RPANTEX,6RPAWNEE/
      DO 1K=1,11
      IF(IST.EQ.ISITES(K,1))GO TO 2
    1 CONTINUE
      FIND=9RNOT FOUND
      IF(IST.EQ.2R10)FIND=ISITES(10,2)
      IF(IST.EQ.2R11)FIND=ISITES(11,2)
      RETURN
    2 FIND=ISITES(K,2)
      RETURN
      END
```

```
      SUBROUTINE ANAL(BSPEC,ISITE,DATE)
C$    DEBUG
C$    STORES(I,LPTR,LNSTK,NUMLW,WTSTK,LWPTR)
      COMMON/B1/TTWT,TSDWT,TANWT,TSDIT,TANIT
      COMMON /B2/ IFMT(7,4),IPTR
      INTEGER BSPEC,DATE,TXSTK(60),TXPTR,TXN,LWPTR(60)
      REAL LNSTK(30,60),WTSTK(60),NUMLW(30,60),NOSIZE,PCTOTWT(60)
      DIMENSION SEEDLN(30,2),ANIMLN(30,2)
      LINE=10
      IPASS=1
  999 CONTINUE
      NOPRTPS=0
      DIVR=0.
      TXPTR=1
      DO 10 I=1,60
      TXSTK(I)=10R
      WTSTK(I)=0.
      PCTOTWT(I)=0.
   10 LWPTR(I)=1
    1 CONTINUE
      IF(IPASS.EQ.2)GO TO 3
C     PASS 1 ANALYSIS BY CLASS , ORDER.
    2 READ(8,100)TXN,NOSIZE,SIZE,DWT,TWT
  100 FORMAT(19X,R6,6X,4(F9.4,1X))
      GO TO 4
C     PASS 2 ANALYSIS BY CLASS , ORDER , FAMILY.
    3 READ(8,101)TXN,NOSIZE,SIZE,DWT,TWT
  101 FORMAT(19X,R9,3X,4(F9.4,1X))
    4 IF(EOF(8))11,5
    5 IF(TXPTR.EQ.1)GO TO 6
      DO 111 I=1,TXPTR
      IF(TXSTK(I).EQ.TXN)GO TO 7
  111 CONTINUE
    6 TXSTK(TXPTR)=TXN
      NOPRTPS=NOPRTPS+1
      I=TXPTR
      TXPTR=TXPTR+1
    7 IF(LWPTR(I).EQ.1)GO TO 8
      LPTR=LWPTR(I)-1
      DO 20 J=1,LPTR
      IF(LNSTK(J,I).EQ.SIZE)GO TO 9
   20 CONTINUE
    8 LNSTK(LWPTR(I),I)=SIZE
      NUMLW(LWPTR(I),I)=NOSIZE
      WTSTK(I)=WTSTK(I)+TWT
      LWPTR(I)=LWPTR(I)+1
      GO TO 1
    9 NUMLW(J,I)=NUMLW(J,I)+NOSIZE
      WTSTK(I)=WTSTK(I)+TWT
      GO TO 1
C$    OFF(STORES)
   11 TXPTR=TXPTR-1
      DO 30 J=1,TXPTR
      LWPTR(J)=LWPTR(J)-1
      DIVR=DIVR-(WTSTK(J)/TTWT*ALOG(WTSTK(J)/TTWT))
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```
   30 PCTOTWT(J)=WTSTK(J)/TTWT*100.
      EQU=DIVR/ALOG(FLOAT(NOPRTPS))
C     SORT TXSTK, WTSTK, PCTOTWT
      LL=TXPTR
      IFS=2
   12 ISW=0
      IF(LL.EQ.1)GO TO 41
      LL=LL-1
      IST=IFS-1
      IF(IST.LT.1)IST=1
      DO 40 L=IST,LL
      IF(TXSTK(L).LT.TXSTK(L+1))GO TO 40
      IF(IFS.EQ.IST+1)IFS=L
      ITX=TXSTK(L)
      TXSTK(L)=TXSTK(L+1)
      TXSTK(L+1)=ITX
      WT=WTSTK(L)
      WTSTK(L)=WTSTK(L+1)
      WTSTK(L+1)=WT
      PCWT=PCTOTWT(L)
      PCTOTWT(L)=PCTOTWT(L+1)
      PCTOTWT(L+1)=PCWT
C     ALSO INTERCHANGE CORRESPONDING COLS IN LNSTK, NUMLW, ALONG WITH POINTERS.
************************
C     FIND LONGEST COL IN LNSTK OF TWO BEING SWITCHED.
      LGST=L $ LSHT=L+1
      IF(LWPTR(L+1).LT.LWPTR(L))GO TO 21
      LGST=L+1 $ LSHT=L
   21 LN=LWPTR(LGST)
      DO 45 LJ=1,LN
      DLN=LNSTK(LJ,LGST)
      LNSTK(LJ,LGST)=LNSTK(LJ,LSHT)
      LNSTK(LJ,LSHT)=DLN
      DNUM=NUMLW(LJ,LGST)
      NUMLW(LJ,LGST)=NUMLW(LJ,LSHT)
   45 NUMLW(LJ,LSHT)=DNUM
      LWP=LWPTR(L)
      LWPTR(L)=LWPTR(L+1)
      LWPTR(L+1)=LWP
      ISW=1
   40 CONTINUE
   41 CONTINUE
      IF(ISW.EQ.1)GO TO 12
C     NOW SORT EACH COL. OF LNSTK AND THE CORRESPONDING COL OF NUMLW.
      DO 50 L=1,TXPTR
      LN=LWPTR(L)
      IFS=2
   13 ISW=0
      IF(LN.EQ.1)GO TO 56
      LN=LN-1
      IST=IFS-1
      IF(IST.LT.1)IST=1
      DO 55 M=IST,LN
      IF(LNSTK(M,L).LT.LNSTK(M+1,L))GO TO 55
      IF(IFS.EQ.IST+1)IFS=M
```

```
      DLN=LNSTK(M,L)
      LNSTK(M,L)=LNSTK(M+1,L)
      LNSTK(M+1,L)=DLN
      DNUM=NUMLW(M,L)
      NUMLW(M,L)=NUMLW(M+1,L)
      NUMLW(M+1,L)=DNUM
      ISW=1
   55 CONTINUE
      IF(ISW.EQ.1)GO TO 13
   56 CONTINUE
   50 CONTINUE
      IF(IPASS.EQ.2)GO TO 14
      WRITE(9,200)
  200 FORMAT(10X,*DIET ANALYSIS SUMMARY, BY ORDER.*//)
      GO TO 15
   14 WRITE(9,400)BSPEC,ISITE,(IFMT(IPTR,J),J=1,4)
      WRITE(9,207)
      WRITE(9,201)
  201 FORMAT(10X,*DIET ANALYSIS SUMMARY, BY FAMILY.*//)
      LINE=7
   15 DO 60 I=1,TXPTR,11
      LN=I+10
      IF(TXPTR.LT.11)LN=TXPTR
      IF(I+10.GT.TXPTR)LN=TXPTR
      WRITE(9,202)(TXSTK(L),L=I,LN )
      WRITE(9,203)(WTSTK(L),L=I,LN)
      WRITE(9,204)(PCTOTWT(L),L=I,LN)
      WRITE(9,207)
   60 CONTINUE
      WRITE(9,210)DIVR,EQU
  210 FORMAT(T3,*DIVERSITY INDEX FOR THIS SAMPLE,*,F12.4,/
     -T3,*EQUITABILITY INDEX FOR THIS SAMPLE,*,F12.4)
C     WRITE FREQ. DIST. OF LENGTHS FOR EA. ITEM.
      LINE=51
      DO 65 I=1,TXPTR
      IF(LINE.LE.50)GO TO 29
      WRITE(9,400)BSPEC,ISITE,(IFMT(IPTR,J),J=1,4)
      WRITE(9,207)
      LINE=6
   29 IF(IPASS.EQ.2)GO TO 18
      IF(LINE.GT. 7)GO TO 16
      WRITE(9,205)
  205 FORMAT(T3,*BIRD DIET SUMMARY; FREQUENCY OF LENGTHS BY ITEM ORDER.*//
     -//T20,*  TAXON*,T40,*SIZE CLASS*,T60,*NO. PER SIZE*)
      GO TO 16
   18 IF(LINE.GT.7)GO TO 16
      WRITE(9,206)
  206 FORMAT(T3,*BIRD DIET SUMMARY; FREQUENCY OF LENGTHS BY ITEM FAMILY.
     -*//T20,*  TAXON*,T40,*SIZE CLASS*,T60,*NO. PER SIZE*)
   16 LN=LWPTR(I)
      DO 70 J=I,LN
      IF(LINE.LT.50)GO TO 17
      WRITE(9,400)BSPEC,ISITE,(IFMT(IPTR,K),K=1,4)
      WRITE(9,207)
  207 FORMAT(///)
```

```
      WRITE(9,209)
  209 FORMAT(1H+,T20,*  TAXON*,T40,*SIZE CLASS*, T60,*NO. PER SIZE*)
      LINE=6
   17 WRITE(9,208)TXSTK(I),LNSTK(J,I),NUMLW(J,I)
  208 FORMAT(T20,R10,T40,F10.4,T61,F10.4)
      LINE=LINE+1
   70 CONTINUE
      WRITE(9,207)
      LINE=LINE+3
   65 CONTINUE
      IF(IPASS.EQ.2)GO TO 99
      LNGRS=0
      IF(TXSTK(1).NE.6RANG   )GO TO 31
      LNGRS=LWPTR(1)
      DO 75 I=1,LNGRS
      SEEDLN(I,1)=LNSTK(I,1)
   75 SEEDLN(I,2)=NUMLW(I,1)
   31 LNANIM=1
      DO 90 I=2,TXPTR
      LN=LWPTR(I)
      DO 85 J=1,LN
      IF(LNANIM.EQ.1)GO TO 32
      DO 80 K=1,LNANIM
      IF(ANIMLN(K,1).EQ.LNSTK(J,I))GO TO 33
   80 CONTINUE
   32 ANIMLN(LNANIM,1)=LNSTK(J,I)
      ANIMLN(LNANIM,2)=NUMLW(J,I)
      LNANIM=LNANIM+1
      GO TO 85
   33 ANIMLN(K,2)=ANIMLN(K,2)+NUMLW(J,I)
   85 CONTINUE
   90 CONTINUE
      REWIND 8
      IPASS=2
      GO TO 999
   99 WRITE(9,400)BSPEC,ISITE,(IFMT(IPTR,J),J=1,4)
      WRITE(9,207)
      IF(LNGRS.EQ.0)GO TO 34
      WRITE(9,220)
  220 FORMAT(T3,*BIRD DIET SUMMARY; FREQUENCY OF LENGTHS AMONG PLANT ITEMSS
     -MS.*,//T40,*SIZE CLASS*,T60,*NO. PER SIZE*,T80,*PERCENT TOTAL*)
      AVELNG=SDG=0.
      DO 1000 I=1,LNGRS
      AVELNG=AVELNG+SEEDLN(I,1)
      SDG=SDG+SEEDLN(I,1)**2
      PCTLNS=SEEDLN(I,2)/TSDIT*100.
      WRITE(9,211)(SEEDLN(I,J),J=1,2),PCTLNS
 1000 CONTINUE
      SDG=SQRT((SDG-AVELNG*AVELNG/FLOAT(LNGRS))/FLOAT(LNGRS-1))
      AVELNG=AVELNG/FLOAT(LNGRS)
      WRITE(9,212)AVELNG,SDG
  211 FORMAT(T40,F10.4,T60,F10.4,T80,F10.4)
  212 FORMAT(//,T30,*AVERAGE LENGTH OF PLANT ITEMS*,F10.4,/,T50,*STD. DEV.
     -V.*,F10.4)
   34 IF(LNGRS.EQ.0)GO TO 35
```

```
      WRITE(9,400)BSPEC,ISITE,(IFMT(IPTR,J),J=1,4)
      WRITE(9,207)
   35 WRITE(9,213)
  213 FORMAT(T3,*BIRD DIET SUMMARY; FREQUENCY OF LENGTHS AMONG ANIMAL ITEMS.*//
     -EMS.*//T40,*SIZE CLASS*,T60,*NO. PER SIZE*,T80,*PERCENT TOTAL*)
      AVELNA=SDA=0.
      LNANIM=LNANIM-1
      DO 110 I=1,LNANIM
      AVELNA=AVELNA+ANIMLN(I,1)
      SDA=SDA+ANIMLN(I,1)**2
      PCTLNA=ANIMLN(I,2)/TANIT*100.
      WRITE(9,211)(ANIMLN(I,J),J=1,2),PCTLNA
  110 CONTINUE
      SDA=SQRT((SDA-AVELNA*AVELNA/FLOAT(LNANIM))/FLOAT(LNANIM-1))
      AVELNA=AVELNA/FLOAT(LNANIM)
      WRITE(9,215)AVELNA,SDA
  215 FORMAT(// T30,*AVERAGE LENGTH OF ANIMAL ITEMS.*,F10.4,/T52,*STD.
     -DEV.*,F10.4)
      REWIND 8
      RETURN
  202 FORMAT(T3,*TAXON*,T11,11(R10))
  203 FORMAT(T3,*DRY WT.*,T11,11(F10.4))
  204 FORMAT(T3,*PERC. TOT*,T11,11(F10.4))
  400 FORMAT(1H1/44X,*IBP AVIAN DIET ANALYSIS FOR JOHN WIENS.*,/,
     -41X,*SPECIES *,R4,* COLLECTED AT THE *,R10,* SITE.*/46X,4A10)
      END
```

APPENDIX III

FIELD DATA

Avian diet sample data was taken at ALE, Cottonwood, Osage, and Pantex during the summer of 1971 and reported on data form NREL-27. (See Appendix II for sample of data form.) The NREL data set classification is A2U20A. A sample of the data follows.

EXAMPLE OF THE DATA

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

2701JAW070571         9AMBE 141930 02142INSLEP          2 0013         001007000310
2701JAW070571         9AMBE 141930 02142INSCOL          2 0002         000210
2701JAW070571         9AMBE 141930 02142ARAARA          4 0002         000204
2701JAW070571         9AMBE 141930 02142INSDIP          4 0001         000107
2701JAW070571         9AMBE 141930 02142INSHYMFOR       4 0005         000503
2701JAW070571         9AMBE 141930 02143
2701JAW070571         8STNE 141945 02152INSCOLCAR       4 0017         001707
2701JAW070571         8STNE 141945 02152INSCOLCUR       4 0014         0001050012072
2701JAW070571         8STNE 141945 02152INSCOLCUR       4 0014         000109      3
2701JAW070571         8STNE 141945 02152INSCOL          2 0002         000210
2701JAW070571         8STNE 141945 02152INSLEP          2 0001         000120
2701JAW070571         8STNE 141945 02152INSCOLSCA       4 0001         000112
2701JAW070571         8STNE 141945 02152INSHYMFOR       4 0001         000108
2701JAW070571         8STNE 141945 02152INSNEURAP       4 0002         000210
2701JAW070571         5ERAL 141915 02161ANG             1 0001         000103
2701JAW070571         5ERAL 141915 02162INSHYMFOR       4 0012         001004000205
2701JAW070571         5ERAL 141915 02162INSCOLCUR       4 0025         002004000506
2701JAW070571         5ERAL 141915 02162INSORTACR       4 0001         000110
2701JAW070571         5ERAL 141915 02162ARAARA          4 0001         000104
2701JAW070571         5ERAL 141915 02162INSLEP          2 0002         000212
2701JAW070571         5ERAL 141915 02162INSCOL          2 0001         000115
2701JAW080571         9AMBE 140945 02171ANGGRAGRA       1 0002         000102000108
2701JAW080571         9AMBE 140945 02172INSCOLCUR       4 0011         0001020009052
2701JAW080571         9AMBE 140945 02172INSCOLCUR       4 0011         000107      3
2701JAW080571         9AMBE 140945 02172INSHYMFOR       4 0002         000103000105
2701JAW080571         9AMBE 140945 02172INSORTACR       4 0002         000212
2701JAW080571         9AMBE 140945 02172INSHYMICH       4 0001         000115
2701JAW080571         9AMBE 140945 02172INSLEP          2 0001         000112
2701JAW080571         9AMBE 140945 02172INSNEURAP       4 0001         000110
2701JAW080571         9AMBE 240945 02182INSCOLCUR       4 0020         0003030003042
2701JAW080571         9AMBE 240945 02182INSCOLCUR       4 0020         001405      3
2701JAW080571         9AMBE 240945 02182INSLEP          2 0002         000120000122
```