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DIET OF THE KILLDEER AT THE PAWNEE NATIONAL GRASSLAND AND A COMPARISON WITH THE MOUNTAIN PLOVER, 1970-1971

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ABSTRACT

The diet of the killdeer (*Charadrius vociferus*) in shortgrass prairie of Weld County, Colorado, was studied for the summer period, June 16 to July 28. A similar bird, the mountain plover (*Eupoda montana*), also feeds in the same shortgrass prairie during this period, so the two diets were compared to determine the amount of overlap. The food of the killdeer was 99.7% animal in nature and 0.3% plant on the basis of biomass consumed. Types of food eaten in greatest quantities were ground-dwelling beetles (77.0%), aquatic arthropods (13.6%), and crickets (5.0%). The most important family was the Carabidae (33.0%), and the second was the Tenebrionidae (26.3%). The mean length of food items eaten by the killdeer was 8.0 mm, and the mean dry weight was 0.01 g.

The diets of killdeer and mountain plover showed much overlap. Each bird obtained 77.3% of its food biomass from taxa eaten also by the other bird. Most of the overlap was from consumption of ground-dwelling beetles by both birds. The use of aquatic beetles by the killdeer accounted for much of the non-overlapping foods. The similarities in diet resulted mainly from both birds feeding in the dry, upland shortgrass vegetation; the differences resulted from the killdeer feeding frequently at water and on damp ground.

INTRODUCTION

The killdeer (*Charadrius vociferus*) occupies the shortgrass prairie in summer as a nesting bird. Usually it remains at or near wet places by ponds, streams, etc., although the birds may move over the entire area foraging in dry situations as well as the wet. The breeding population at the Pawnee National Grassland appears by casual observation to be considerably smaller than the local breeding population of the mountain plover (*Eupoda montana*).

The food habits of the killdeer have been described in considerable detail in an early work by the U.S. Biological Survey and summarized by Townsend in the Bent life history series (Bent 1929, p. 209). The information from this early work applies to killdeer collected from a wide variety of habitats, and the results can apply to the shortgrass prairie only in a general way. It was found that, in all, 97.2% of the killdeer's food was composed of insects and other animal matter and 2.3% of seeds. Insects found to be prominent in the diet at several habitats included grasshoppers, weevils, caterpillars, May beetles, and crane flies.

The objectives of the present study are to present specific data on the diet of the killdeer at the Pawnee National Grassland and to compare the use of the shortgrass prairie food resources by the killdeer and its relative, the mountain plover. The diet of local mountain plover has been described by Baldwin (1971).

METHODS AND MATERIALS

Foods of the killdeer were studied by the identification of stomach contents, measurement of size (length) of objects eaten, and estimate of biomass consumed by the bird with each item eaten. Biomass estimates were in terms of dry weight; oven-dried specimens of insects and seeds of corresponding taxa and sizes provided the basis for estimates. Numbers of items eaten were determined by counting either whole items or repeated parts. Identification of the insects was accomplished mainly with the use of keys, a local reference collection, and the Colorado State University entomological collection. Data on the mountain plover are cited for comparison with the killdeer in Baldwin (1971).

Four specimens of killdeer collected on the Pawnee National Grassland were available for study. It is believed these afforded an adequate picture of the foods eaten locally during the breeding season. With a larger sample size, it could be expected that the list of food taxa would lengthen and the proportionate representation of some of the taxa in the diet would change.

GENERAL NATURE OF THE DIET

The food of the killdeer at the Pawnee National Grassland was 99.7% animal in nature and 0.3% plant, on a basis of biomass consumed (Table 1). Some 235 food items were recognized and identified; 222 were arthropods, 9 were molluses, and 4 were seeds. In the killdeer, as with the mountain plover, either coarse or fine fibrous plant material was usually present

Table 1. Summer diet of killdeer at Pawnee National Grassland (June 16 to July 28).

Food	Dry Weight (g)	Representation (%)
Arthropods	2.3078	99.3
Molluscs	0.0090	0.4
Seeds	0.0062	0.3
All foods	2.3230	100.0

in trace amounts in the food sample from each bird. The finely divided cellular plant material was certainly released from the gut of herbivorous insects eaten by the plover. These were omitted from the calculations of food biomass.

TAXONOMIC COMPOSITION OF THE DIET

Forty-five taxa were recognized from the stomach samples of the killdeer and are listed in Appendix I. These taxa were distributed among eight orders and 15 families of arthropods, one order of mollusc, and three families of plants. The order best represented was the Coleoptera, with nine families recorded, representing approximately one-third of all families involved. Hymenoptera was represented by three families, Orthoptera and Lepidoptera by two, and Acarina, Araneida, Diptera, Hemiptera, and Stylomatophora each by one.

BIOMASS PARAMETERS OF THE DIET

Estimates of dry weight biomass are given for all foods in Appendix Table I. Summaries for major food types are presented in Tables 2 and 3.

The Carabidae (ground beetles) was the most important family, as it provided 33% of the food biomass. The Tenebrionidae (darkling beetles) was next and the Hydrophilidae (water scavenger beetles) was third, as these two families supplied 26.3% and 13.3% of the food biomass, respectively. Weevils, scarab beetles, and crickets were fourth, fifth, and sixth, providing 8.3, 7.8, and 5.0%, respectively.

If these foods are summarized according to a more ecological than taxonomic basis, it is seen that ground-dwelling beetles contributed 77%

Table 2. Biomass and percent representation of major food taxa in summer diet of killdeer.

Family (or other)		Total Dry Wt. in Sample (g)	Representation in Diet (%) [a/]
Acarina	Mites	0.0008	< 0.1
Araneida	Spiders	0.007	0.3
Carabidae	Ground beetles	0.760	33.0
Dytiscidae	Water scavenger beetles	0.008	0.3
Chrysomelidae	Leaf beetles	0.007	0.3
Curculionidae	Weevils	0.190	8.3
Histeridae		0.021	0.9
Hydrophilidae		0.305	13.3
Scarabaeidae	Scarab beetles	0.180	7.8
Tenebrionidae	Darkling beetles	0.605	26.3
Diptera	Flies	0.001	< 0.1
Lygaeidae	Lygaeid bugs	0.003	0.1
Formicidae	Ants	0.032	1.4
Other Hymenoptera	Parasites, etc.	0.006	0.3
Lepidoptera	Caterpillars	0.034	1.5
Orthoptera	Crickets	0.116	5.0

[a/] Total dry weight of all foods in sample was 2.3 g.

Table 3. Representation of important arthropod types in diet of killdeer.

Arthropod Type		Total Dry Wt. in Sample (g)	Representation in Diet (%) [a]
Crickets	(1) [b]	0.116	5.0
Caterpillars	(2)	0.034	1.5
Spiders and mites	(3)	0.0078	0.3
Ants	(4)	0.032	1.4
Parasites, etc.	(5)	0.006	0.3
Leaf beetles	(6)	0.007	0.3
Ground-dwelling beetles	(7)	1.772	77.0
Bugs	(8)	0.003	0.1
Flies	(9)	0.001	< 0.1
Aquatic arthropods	(10)	0.313	13.6

[a] Total dry weight of all foods in sample was 2.3 g.

[b] Numbers in parentheses are the key to families included in each category; see Appendix I.

of the food biomass. Aquatic arthropods were second in importance, with 13.6%. Various terrestrial types found on the ground and on vegetation made up the remainder, or 9.4%

SIZE OF FOOD ITEMS

The size of food objects was examined for two aspects; first, the length of the objects and, second, the mass or dry weight. The lengths and weights are summarized in Table 4 and presented graphically in Fig. 1 and 2.

The mean length of food item eaten by the killdeer was 8.0 mm (N = 235). The modal class was 3.0 to 5.9 mm, with 23.8 objects per bird, or 40.8% of all items. The second most popular size was 6.0 to 8.9 mm, with 11.3 items per bird, or 19.3%. Very few items were eaten which were longer than 17.9 mm (2.2%) or shorter than 3.0 mm (4.3%).

The mean quantity of dry weight biomass ingested per food item by killdeer was 0.010 g. The birds obtained a larger proportion of their food biomass from arthropods 9.0 to 11.9 mm in length than from any other length class, and this amounted to 31.0%. Items from 12.0 to 17.9 mm provided 42.1% of the food biomass. Objects from 3.0 to 8.9 mm supplied 21.2% of the food biomass. Only 4.1% of the food biomass came from items at the upper end of the length range (21.0 to 23.9 mm).

Table 4. Size of food items of adult killdeer in length and in dry weight, June 16 to July 28.

Length of Food Item (mm)	Occurrence by Length		Dry Weight	
	No. of Items per Bird	% of Total No. of Items	Dry Wt. of Items per Bird (g)	% of Total Dry Wt. of Items
21.0 - 23.9	0.8	1.3	0.024	4.1
18.0 - 20.9	0.5	0.9	0.013	2.3
15.0 - 17.9	3.8	6.4	0.156	27.1
12.0 - 14.9	5.8	9.9	0.087	15.0
9.0 - 11.9	10.0	17.2	0.178	31.0
6.0 - 8.9	11.3	19.3	0.062	10.6
3.0 - 5.9	23.8	40.8	0.061	10.6
0 - 2.9	2.5	4.3	0.001	0.2

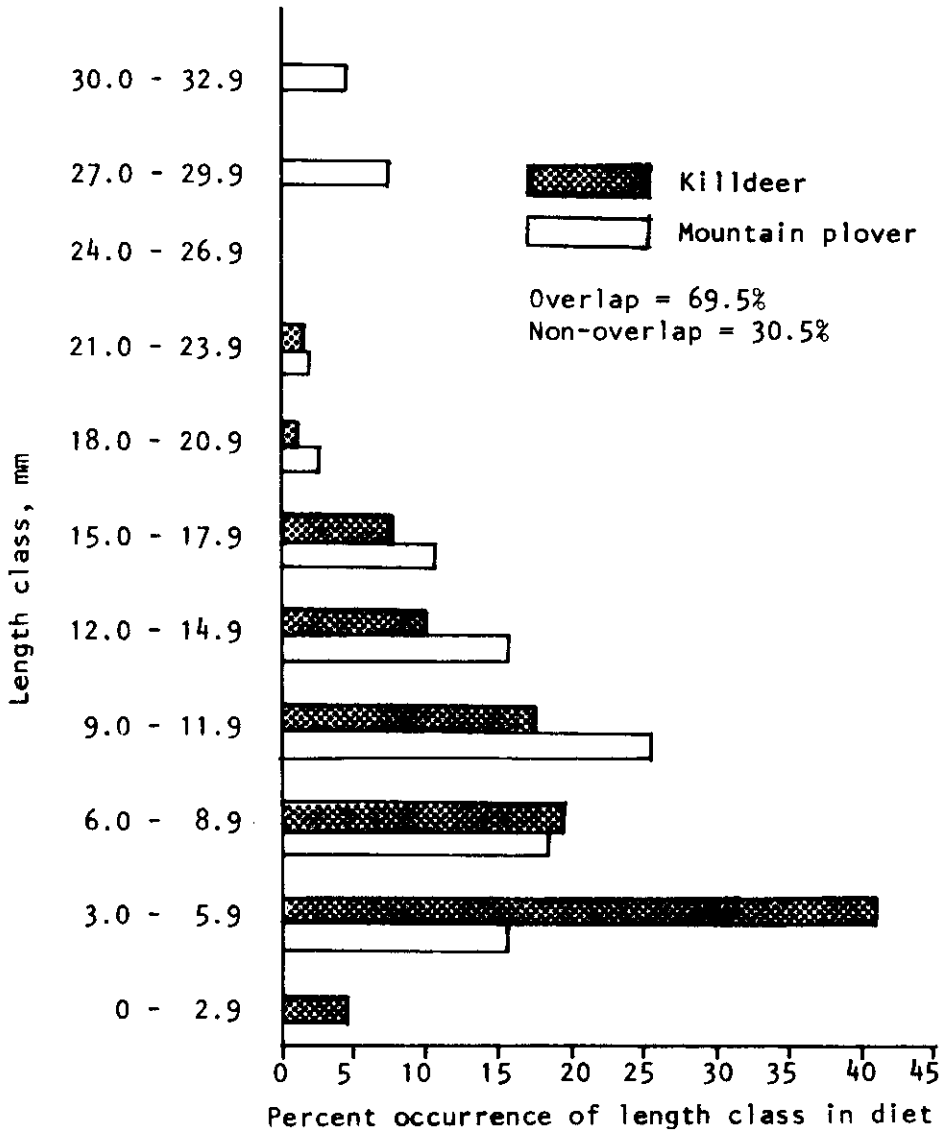

Fig. 1. Comparison of percent composition of killdeer diet and mountain plover diet by length of food items. For killdeer, the sample is four adults collected from June 16 to July 28; for mountain plover the sample is six adults collected from June 16 to July 15.

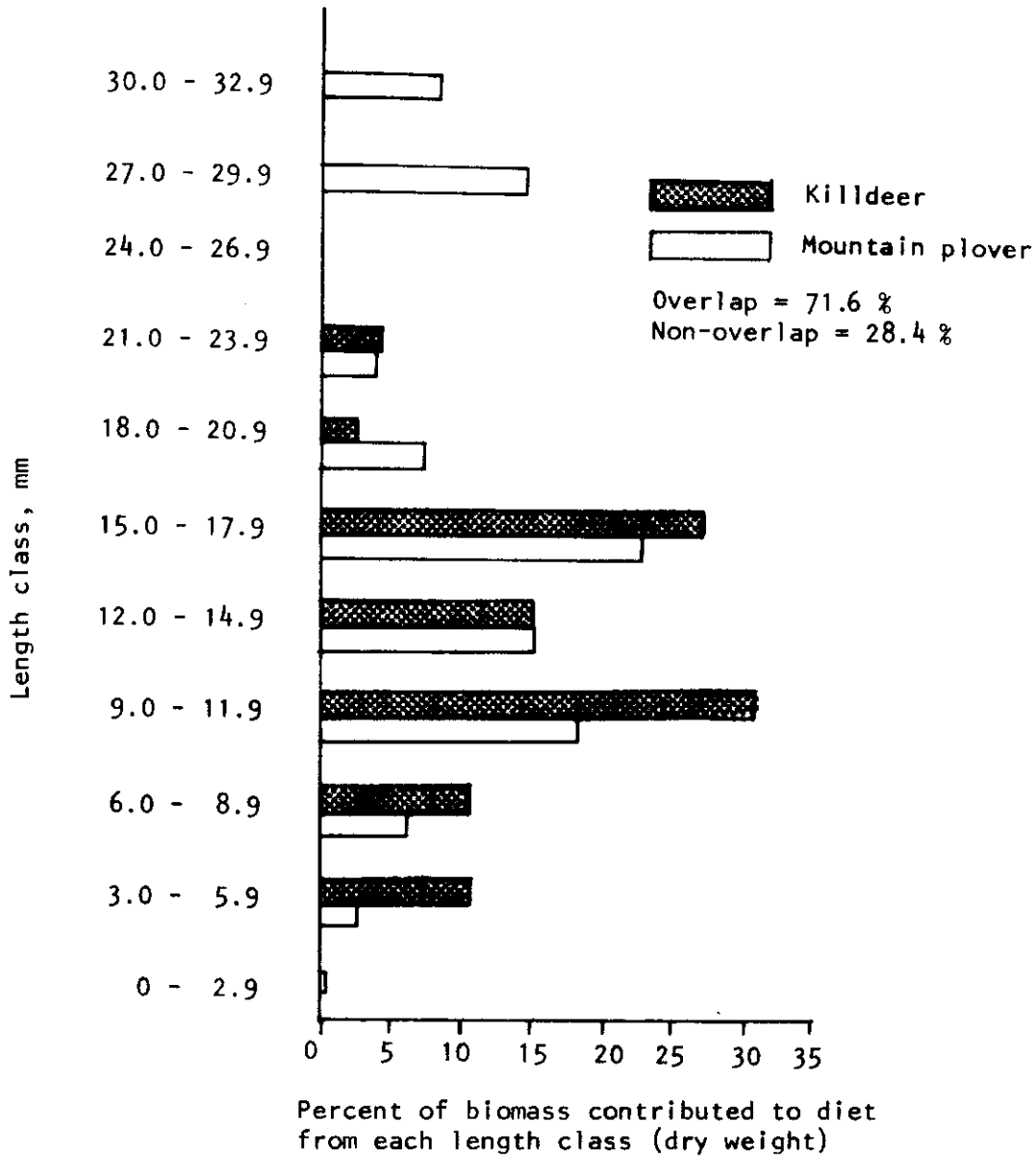

Fig. 2. Comparison of proportions of food biomass contributed to killdeer and mountain plover diets from each size class of food.

COMPARISON OF KILLDEER AND MOUNTAIN PLOVER DIETS

The comparison which follows was made with the diets of four adult killdeer collected from June 16 to July 28 and six adult mountain plover collected from June 16 to July 15. All specimens were from shortgrass prairie environment within 15 miles of each other.

The killdeer and the mountain plover had diets showing a high degree of overlap (Fig. 3). A comparison of kinds of foods eaten showed that each bird obtained 77.3% of its food biomass from the same taxa. Non-overlap was 22.7%, indicating that less than one-quarter of the food biomass of each species was obtained from taxa either not eaten or eaten in lesser amounts by the other species. Most of the overlap was, by far, a result of heavy consumption of ground-dwelling beetles by both birds. These beetles were mostly darkling beetles and weevils for the mountain plover but ground beetles and darkling beetles for the killdeer. Grasshoppers and crickets showed a little overlap, although no grasshoppers were recorded for the killdeer; however, it is known that the killdeer does eat grasshoppers in large amounts under other circumstances (Bent 1929, p. 210).

Our data suggest that the lesser amount of ground-dwelling beetles eaten by the mountain plover is made up for by their taking a greater miscellany of insects including caterpillars, spiders, ants, bees, wasps, parasites, bugs, leafhoppers, flies, and leaf and flower beetles. These were eaten in small amounts by the mountain plover, but in even smaller amounts, if at all, by the killdeer.

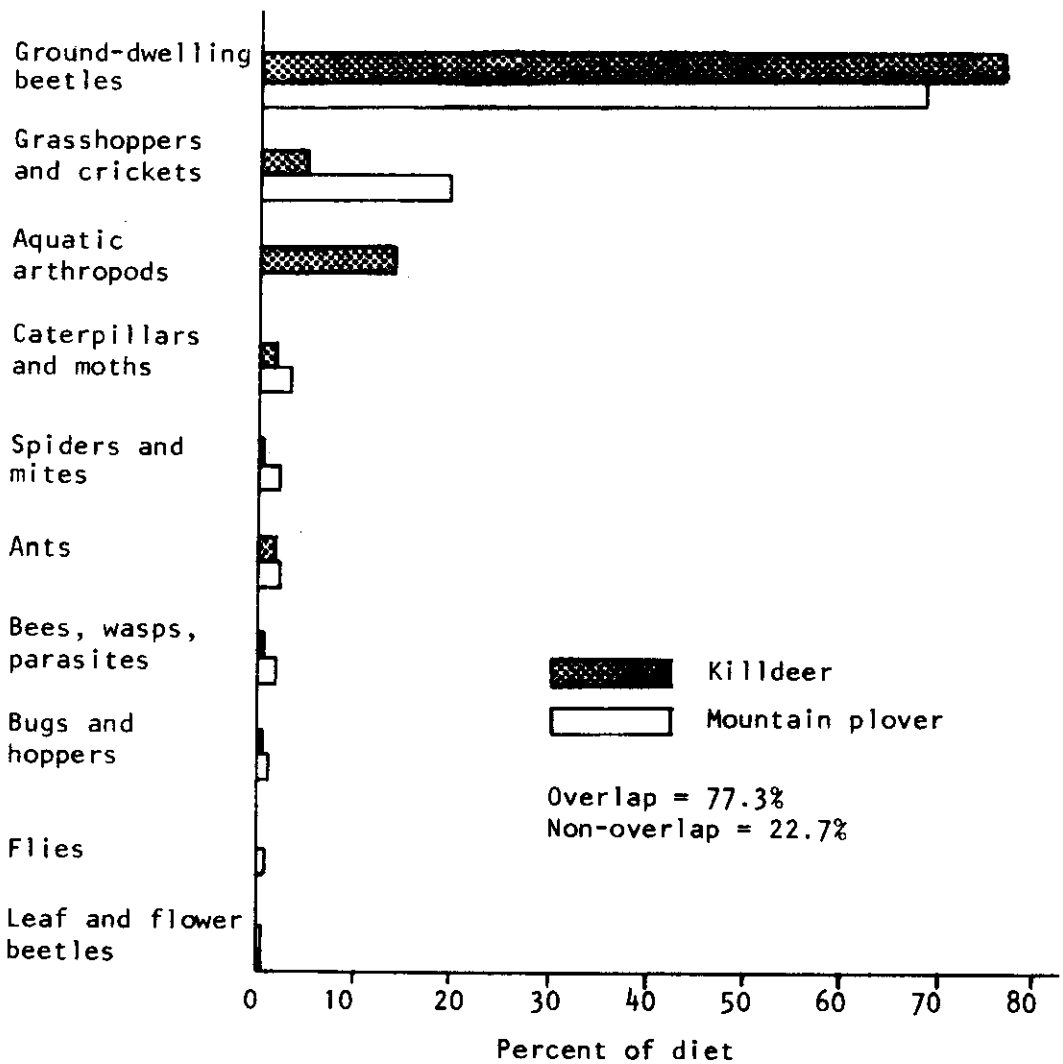

Fig. 3. Comparison of utilization of important food types by killdeer vs. mountain plover. Overlap is calculated as the sum of the smaller components of each pair. The comparison is based on dry weight biomass.

The one striking difference in kinds of food taxa eaten was the definite use of aquatic insects by the killdeer and the absence of aquatics from the mountain plover foods. Thus, the killdeer had 13.6% of its dietary biomass contributed by the water scavenger beetles and larvae and predaceous diving beetles, whereas the mountain plover had none.

The mean length of food item for the killdeer was 8.0 mm and for the mountain plover 12.5 mm (N = 192). In the killdeer the modal class was 3.0 to 5.9 mm, whereas in the mountain plover it was 9.0 to 11.9 mm (Fig. 2). In the killdeer no food items occurred beyond the 21.0 to 23.9 mm length class, while in the mountain plover 10.5% of all items eaten were in classes greater than this. In the killdeer 45.1% of the items were shorter than 6.0 mm, while in the mountain plover only 15.6% were shorter than this.

The mean quantity of biomass ingested per food item by killdeer was 0.010 g (dry wt.), whereas for mountain plovers it was 0.014 g. Both birds obtained most of their food from objects between 9.0 and 17.9 mm (killdeer 73.1%, mountain plover 56.7%) (Fig. 3). The killdeer ate only 6.4% of its food bulk in packages 18.0 mm or longer, while the mountain plover ate 34.3% of its food in these larger items. The killdeer took 21.4% of its food in units less than 9.0 mm long, while the mountain plover took only 9.1%.

All of the foregoing relationships clearly indicate the existence of size differences in food items eaten by killdeer vs. mountain plover. The killdeer obtains its food in a larger number of smaller packages in contrast to the mountain plover, which eats a smaller number of larger units.

The basis for the several differences seen above could be of at least two types. One would be feeding in different habitats in part. Thus, the killdeer feeding in wet areas could take aquatic beetles from the water and ground beetles (33% of diet) from damp places and wet mud. The mountain plover feeding only in drier places would obtain no aquatic beetles and relatively few ground beetles (2% of diet).

The other basis could be size of the bird and its feeding apparatus (bill). The killdeer adults had a mean body weight of 88.2 g and mean bill length (tip to edge of feathers at forehead) of 19.4 mm. The mountain plover had a mean body weight of 101.9 g and a mean bill length of 21.0 mm. Thus differences in the dimensions of the birds were consistent with the differences noted in size of foods eaten.

LITERATURE CITED

Baldwin, P. H. 1971. Diet of the mountain plover at the Pawnee National Grassland. U.S. IBP Grassland Biome Tech. Rep. No. 134. Colorado State University, Fort Collins. 34 p.

Bent, A. C. 1929. Life history of North American shore birds, Part 2. U.S. Nat. Mus. Bull. 146. 412 p.

APPENDIX I

Taxa Eaten by the Killdeer at Pawnee National Grassland and Codes

Food Taxon			Code
Arachnida Acarina Mesostigmata Macrochelidae, sp.	Mite	(3)[a/]	AR AC MES MAC
Paraholaspidae, sp.	Mite	(3)	AR AC MES PAR
Araneida Labidognatha, sp.	Spider	(3)	AR AR LAB
Insecta Coleoptera Adephaga Carabidae Amarini *Amara convexa*	Ground beetle	(7)	IN CO ADE CAR AMA AMA CO
Bembidini *Bembidion bifossulatum*			IN CO ADE CAR BEM BEM BF
Harpalini *Cratacanthus dubius*			IN CO ADE CAR HAR CRA DU
Dicoderus parallelus			IN CO ADE CAR HAR DIS PA
Euryderus grossus			IN CO ADE CAR HAR EUR GR
Harpalus sp.			IN CO ADE CAR HAR HAR
Harpalus opacipennis			IN CO ADE CAR HAR HAR OP
Piosoma setosum			IN CO ADE CAR HAR PIO SE
Dytiscidae, sp.	Predacious diving beetle	(10)	IN CO ADE DYT
Polyphaga, sp.			IN CO POL
Chrysomelidae, sp.	Leaf beetle	(6)	IN CO POL CHR
Eumolpinae, sp.			IN CO POL CHR EUP
Curculionidae Calendrinae *Sphenophorus compressirostris*	Weevil	(7)	IN CO POL CUR CAL SPH CO
Curculioninae *Anthonomus* sp.			IN CO POL CUR CUR ANT
Gerstaeckeria sp.			IN CO POL CUR CUR GER
Hyperodes gripidioides			IN CO POL CUR CUR HYP GR

APPENDIX I (continued)

Food Taxon		Code
Thecesterninae *Thecesternus* sp.		IN CO POL CUR THE THE
Histeridae Histerinae *Hister interruptus*		IN CO POL HIS HIS HIS IN
Spilodiscus sp.	(7)	IN CO POL HIS HIS SPI
Saprininae *Aphelosternus* sp.		IN CO POL HIS SAP APL
Hydrophilidae, sp.	(10)	IN CO POL HYD
Hydrophilinae *Tropisternus ellipticus*		IN CO POL HYD HYD TRO EL
Scarabaeidae Aphodiinae *Aphodius fimetarius*	(7)	IN CO POL SCA APH APH FI
Scarabaeinae *Onthophagus hecate*		IN CO POL SCA SCA ONT HE
Tenebrionidae Tenebrioninae, sp.		IN CO POL TEN TEN
Blapstinus sp.		IN CO POL TEN TEN BLA
Blapstinus metallicus		IN CO POL TEN TEN BLA ME
Eleodes obsoleta		IN CO POL TEN TEN ELE OB
Tentyriinae *Edrotes rotundus*		IN CO POL TEN TNT EDR RO
Diptera Acalyptrata, sp.	(9)	IN DI ACA
Hemiptera Gymnocerata Lygaeidae, sp.	(7)	IN HE GYM LYG
Hymenoptera Apocrita, sp.	(5)	IN HY APC
Ichneumonoidea Ichneumonidae, sp.	(5)	IN HY ICH ICH
Scolioidea Formicidae Formicinae *Formica rubicunda*	(4)	IN HY SCO FOR FOR FOR RU
Myrmicinae *Myrmica sabuleti*		IN HY SCO FOR MYR MYR SA
Lepidoptera Macrolepidoptera, sp.	(2)	IN LE MAC

APPENDIX I (continued)

Food Taxon		Code
Phalaenidae, sp.	(2)	IN LE MAC PHA
Orthoptera Ensifera Gryllacrididae Rhaphidophorinae *Ceuthophilus* sp.	(1)	IN OR ENS GRC RHA CEU
Gryllidae Gryllinae *Gryllus* sp.	(1)	IN OR ENS GRY GRY GRY
Gastropoda Stylommatophora, sp. Land snail		GA ST
Plantae, sp.		000
Boraginaceae *Lappula redowski*		BOR LAP RE
Graminaceae *Buchloe dactyloides*		GRA BUC DA

a/ Numbers in parentheses are the key to families included in important food types; see Table 3.

APPENDIX II

APPENDIX TABLE

Appendix Table 1. Biomass as dry weight and percent representation in killdeer diet of dietary taxa. Sample is four killdeer collected from June 16 to July 28, 1970 and 1971.

Food Taxon	Total No. of Individuals in sample	Total Estimated Biomass Eaten, Dry Weight (g)	Proportion in Diet (%) a/
AC MES MAC	6	0.0006	< 0.1
AC MES PAR	1	0.0002	< 0.1
AR LAB	1	0.007	0.3
CO ADE CAR AMA AMA CO	8	0.055	2.4
CO ADE CAR BEM BEM BF	1	0.007	0.3
CO ADE CAR HAR CRA DU	16	0.368	16.0
CO ADE CAR HAR DIS PA	4	0.032	1.4
CO ADE CAR HAR EUR GR	3	0.144	6.3
CO ADE CAR HAR HAR	1	0.006	0.3
CO ADE CAR HAR HAR OP	9	0.117	5.1
CO ADE CAR HAR PIO SE	1	0.031	1.3
CO ADE DYT	1	0.008	0.3
CO POL	2	0.032	1.4
CO POL CHR	1	0.002	0.1
CO POL CHR EUP	2	0.005	0.2
CO POL CUR CAL SPH CO	11	0.154	6.7
CO POL CUR CUR ANT	1	0.001	< 0.1
CO POL CUR CUR GER	3	0.014	0.6
CO POL CUR CUR HYP GR	2	0.008	0.3

Appendix Table 1 (continued)

Food Taxon	Total No. of Individuals in Sample	Total Estimated Biomass Eaten, Dry Weight (g)	Proportion in Diet (%) a/
CO POL CUR THE THE	1	0.013	0.6
CO POL HIS HIS HIS IN	1	0.005	0.2
CO POL HIS HIS SPI	3	0.013	0.6
CO POL HIS SAP APL	2	0.003	0.1
CO POL HYD	1	0.007	0.3
CO POL HYD HYD TRO EL	21	0.298	13.0
CO POL SCA APH APH FI	52	0.156	6.8
CO POL SCA SCA ONT HE	3	0.024	1.0
CO POL TEN TEN	4	0.065	2.8
CO POL TEN TEN BLA	10	0.030	1.3
CO POL TEN TEN BLA ME	10	0.030	1.3
CO POL TEN TEN ELE OB	12	0.480	20.9
DI ACA	1	0.001	< 0.1
HE GYM LYG	2	0.003	0.1
HY APC	1	0.004	0.2
HY ICH ICH	1	0.002	0.1
HY SCO FOR FOR FOR RU	6	0.018	0.8
HY SCO FOR MYR MYR SA	8	0.014	0.6
LE MAC	2	0.004	0.2
LE MAC PHA	2	0.030	1.3

Appendix Table 1 (continued)

Food Taxon	Total No. of Individuals in Sample	Total Estimated Biomass Eaten, Dry Weight (g)	Proportion in Diet (%) [a/]
OR ENS GRC RHA CEU	1	0.038	1.7
OR ENS GRY GRY GRY	2	0.078	3.4
GA ST	9	0.009	0.4
OOO	1	0.002	0.1
BOR LAP RE	1	0.012	0.1
GRA BUC DA	2	0.003	0.1

[a/] Total dry weight of all foods in sample was 2.3 g.

APPENDIX III

Killdeer Specimens Used in This Study

The specimens used in this study were collected from shortgrass prairie 12 to 15 miles east and northeast of Pierce, Weld County, Colorado. They were near wet places but freely moving onto the prairie beyond the wet spots to forage.

Serial No.	Date Obtained	Age	Sex	Hour (MST)
KD-1	June 23, 1970	Adult	Female	0953
KD-2	June 30, 1970	Adult	Male	0750
KD-3	July 28, 1970	Adult	Male	0858
KD-4	June 16, 1971	Adult	Female	0817