

FOODS OF MOUNTAIN PLOVERS WINTERING IN CALIFORNIA<sup>1</sup>

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**Abstract.** Prey items were identified from the stomachs of wintering Mountain Plovers (*Charadrius montanus*) collected in California at the Pixley National Wildlife Refuge and Carrizo Plain Natural Area in 1991, and south of the Salton Sea in 1992. Stomach contents of the 39 birds included 2,092 different food items representing 13 orders and at least 16 families of invertebrates. Diets at each of the three locales differed greatly, with coleopterans and hymenopterans dominating the Carrizo samples, lepidopterans the Pixley samples, and coleopterans and orthopterans the Salton Sea samples. Diets of males and females were similar. These findings counter the current perception that Mountain Plover diets are specialized on coleopterans and orthopterans, and bring the species more in line as a dietary generalist/opportunist as reported for most shorebirds.

**Key words:** *Charadrius montanus*, *food habits*, *Mountain Plover*.

The Mountain Plover (*Charadrius montanus*) is a shorebird that resides primarily in dry upland landscapes. This plover breeds at many locales along the western Great Plains of North America at native sites that include shortgrass prairie, xeric shrubs, and prairie dog (*Cynomys* spp.) towns. Historically the plover wintered in southern Texas, northern Mexico, and California, but few birds are seen in Texas now and the status of the species in Mexico remains uncertain (Knopf 1996a).

The continental population of Mountain Plovers was estimated at approximately a quarter million birds in 1975 (Graul and Webster 1976), although that estimate may have been inflated by a factor of 10 (W. D. Graul, pers. comm.). A recent analysis of Breeding Bird Survey (U.S. Geological Survey, Biological Resources Division) data indicates that the continental plover population declined at an annual rate of 3.2% from 1966-1991 (Knopf 1994). That pattern of decline has continued through 1995 (Knopf 1996b) such that the species declined approximately 67% during the last 30 years. This decline has stimulated much conservation interest, and the species was classified a Candidate Species under the protection of the United States Endangered Species Act in May 1993.

Due to the tendency of Mountain Plovers to spend considerable time on freshly plowed, burned, or harvested fields in California (Grinnell and Miller 1944,

Knopf and Rupert 1995) and throughout the annual cycle (Knopf 1996a, Knopf and Rupert, in press), a total of 40 birds were collected in California for evaluation of organochlorine residues and heavy metals in body tissues in 1991 and 1992. Stomach contents of the collected birds were preserved, and herein I describe the food items of the Mountain Plover during winter. To date, foods have been described in only general contexts by Bent (1929) and Laun (1957), and based upon stomach contents of two adults from California (Stoner 1941) and eight adults plus five juveniles collected on the breeding grounds in Weld County, Colorado (Baldwin 1971).

## METHODS

Wintering Mountain Plovers were collected at two locales in the San Joaquin Valley, California in 1991: 15 birds on 19 February at the Pixley National Wildlife Refuge, Tulare County, and 10 birds on 25 February at the Carrizo Plain Natural Area, San Luis Obispo County. An additional 15 birds were collected on 3 February 1992 from the Imperial Valley in an agricultural field near the town of Imperial, Imperial County. At the time of collection, all birds were actively feeding and many of the identified food items were the highly digestible "immature" forms. Birds were immediately frozen and shipped to the Colorado State Office of the U.S. Fish and Wildlife Service in Golden, Colorado, where they were kept frozen until thawed for analyses. In the laboratory, the esophageal and stomach contents were flushed into a petri dish with 90% ethyl alcohol. The contents were sorted and identified under a dissecting microscope with variable (6× to 40×) magnification. The stomach contents were not useable for one of the plovers collected at Pixley NWR.

Although no reference collection of invertebrates existed from the sites where the birds were obtained, identification was frequently aided by intact and nearly intact invertebrates found in many of the stomachs. Identification of invertebrates was based upon keys and references by Borror et al. (1989), Stehr (1987, 1991), Ralph et al. (1985), and Moreby (1987). Differences in food habits of males and females were evaluated using the Kruskal-Wallis Distribution-Free test.

## RESULTS

The 39 stomachs contained 2,092 different food items representing 13 orders and at least 16 families (Table 1). The relative proportions of invertebrate orders varied among the three locales (Table 2). Almost 90% of

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TABLE 1. Stomach contents of Mountain Plovers collected at the Carrizo Plain, Pixley NWR, and Salton Sea vicinities of California. Values are mean ( $\pm$  SD) number of individuals/stomach by taxonomic group.

Taxon	Carrizo Plain <i>n</i> = 10	Pixley NWR <i>n</i> = 14	Salton Sea <i>n</i> = 15
Nematoda		0.4 $\pm$ 1.0	
Mollusca			
Gastropoda			0.2 $\pm$ 0.4
Arthropoda			
Insecta			
Orthoptera			
Gryllacrididae	0.1 $\pm$ 0.3		
Gryllidae			11.3 $\pm$ 6.3
Other	0.4 $\pm$ 1.2	0.4 $\pm$ 0.6	
Hemiptera		0.1 $\pm$ 0.4	0.4 $\pm$ 0.6
Homoptera		0.1 $\pm$ 0.4	0.4 $\pm$ 0.6
Lepidoptera	0.9 $\pm$ 2.1	54.8 $\pm$ 40.7	2.6 $\pm$ 2.5
Diptera			
Culicidae			0.1 $\pm$ 0.3
Other		0.1 $\pm$ 0.4	
Embiidina		12.6 $\pm$ 16.1	
Hymenoptera			
Formicidae	0.2 $\pm$ 0.4	0.7 $\pm$ 1.1	0.5 $\pm$ 0.9
Ichneumonidae	1.6 $\pm$ 4.8		
Braconidae	0.1 $\pm$ 0.3		
Mutillidae	3.5 $\pm$ 6.2		
Other	0.8 $\pm$ 1.2		
Neuroptera			
Myrmeleontidae			1.4 $\pm$ 1.4
Coleoptera			
Anthicidae			0.1 $\pm$ 0.3
Carabidae	0.1 $\pm$ 0.3	8.6 $\pm$ 6.9	0.2 $\pm$ 0.4
Chrysomelidae			0.1 $\pm$ 0.3
Curculionidae			4.3 $\pm$ 6.3
Melyridae			0.7 $\pm$ 1.4
Tenebrionidae	7.0 $\pm$ 6.9	2.1 $\pm$ 4.2	0.8 $\pm$ 1.5
Arachnida			
Lycosidae		0.1 $\pm$ 0.5	
Thomisidae		0.5 $\pm$ 0.9	
Other	0.2 $\pm$ 0.3	5.6 $\pm$ 5.1	3.4 $\pm$ 2.7
Seeds	0.2 $\pm$ 0.6		

the diet of plovers on the Carrizo Plain was coleopterans and hymenopterans. Diets at the other two locales were more diverse, with plovers feeding most heavily on lepidopterans at Pixley NWR and coleopterans and orthopterans at Salton Sea. Dietary overlap for the Carrizo Plain was 43.4% with Pixley NWR and 46.0% with Salton Sea. Diets only overlapped 29.1% between Pixley NWR and Salton Sea.

All plovers were in adult plumage. I compared diets of 24 males and 13 females (2 stomachs had not been labeled by sex). The ratios of males to females at the three sites were Pixley: 7:5, Carrizo Plain: 8:2, and Salton Sea: 9:6. The low proportion of females at Carrizo precluded meaningful comparisons between sexes at individual areas. Treated collectively across areas, males and females selected similarly among the major arthropod orders (Orthoptera  $\chi^2 = 0.77$ ; Lepidoptera  $\chi^2 = 0.20$ ; Embiidina  $\chi^2 = 0.19$ ; Hymenoptera  $\chi^2 = 2.30$ ; Coleoptera  $\chi^2 = 0.12$ ; Arachnida  $\chi^2 = 1.56$ ;  $df = 1$  for each comparison; all  $P > 0.10$ ).

## DISCUSSION

The only major study of Mountain Plovers during the winter reported on flocking habits and habitats of birds in the San Joaquin Valley of California (Knopf and Rupert 1995). That study found that plovers occurred in loosely structured flocks with birds captured together in one flock almost never being relocated together in any other flock. Birds foraged most frequently on agricultural lands, but preferred to forage on alkali flats and grassland areas that were being grazed by domestic herbivores, much like the Carrizo Plain and Pixley National Wildlife Refuge. The plovers collected in the Imperial Valley were foraging on irrigated hayfields that had been harvested and were presently dry and being grazed.

The only study to date to specifically examine the foods of Mountain Plovers was Baldwin (1971). He collected 13 plovers (8 adults, 5 juveniles) during the breeding season east of Nunn, Weld County, Colorado.

TABLE 2. Comparative percentages of major invertebrate orders (by the number of individuals) in the diets of Mountain Plovers collected at the Carrizo Plain, Pixley NWR, and Salton Sea vicinities of California.

Taxonomic order	Carrizo Plain	Pixley NWR	Salton Sea
Orthoptera	3.1	0.3	37.0
Lepidoptera	5.6	47.0	8.5
Embiidina	0	10.8	0
Hymenoptera	43.0	26.4	5.2
Coleoptera	45.6	9.8	30.8
Arachnida	1.3	5.3	11.1
Totals	98.6	99.6	92.6

Stomachs of those birds contained food items from 90 different taxa, 99.7% being arthropods and the remainder incidental plant seeds. Diets of the Colorado birds were dominated by ground-dwelling beetles (Coleoptera, 60%), grasshoppers and crickets (Orthoptera, 25%), and ants (Hymenoptera, 6%). Stoner (1941) reported on stomach contents of two plovers collected in California for museum specimens. Those plovers were shot just north of the San Francisco Bay area near Suisun City in Solano County. One stomach contained 10 mandibles of Jerusalem crickets (*Stenopelmatus*) and the other contained 46 mandibles of that species plus fragments of 2–3 small beetles. Both the Baldwin study and Stoner note have fostered the impression that Mountain Plovers forage preferentially on coleopterans, and to a lesser extent on orthopterans. Olson (1985) reported that densities of these two orders were higher on prairie dog towns where plovers nest in Montana than they were in the contiguous landscape.

My comparison of the diets of plovers from three different sites in California indicates that the species may be more flexible in food items selected than previously believed. Males and females take similar prey items, and a different order of arthropods was the dominant component of the diet at each location. Viewed collectively across the three collection sites, the two predominant food items in the diet were coleopterans (25.9%) and hymenopterans (24.9%). I doubt that the plover forages selectively for these groups. Rather, the diversity of arthropods taken and the dominance of different arthropod orders in the diet across sites argues that this plover appears to be an opportunistic forager on the wintering grounds. Shorebirds, as a group, were recently concluded to be opportunistic foragers at a regional scale (Skagen and Oman 1996).

A previous study (Knopf and Rupert 1995) found that wintering plovers are highly mobile in California and use a diversity of habitats that include alkaline sinks, burned areas, grazed pastures, and cultivated fields. In addition, contaminants have not been found to affect the biology of this species (Knopf et al., unpubl. data). The variety of food items in the diet further supports the earlier conclusion (Knopf and Rupert 1995) that the only limiting resource for plovers in California may be the availability of habitats when birds arrive in October and November when the land-

scape is still predominantly in mature, unharvested croplands.

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