The Diet and Foraging Behaviour of the Plains-wanderer
Pedionomus torquatus

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The Plains-wanderer *Pedionomus torquatus* has undergone a marked contraction in distribution (Bennett 1983; Blakers *et al.* 1984) but the reasons for this decline are unclear. European pastoral management and cultivation may have been significant influences.

For management purposes it is necessary to know how and where the Plains-wanderer forages, and whether it takes a wide variety of plant and animal foods or specialises on just a few. Only general accounts of the diet of the Plains-wanderer have been published (North 1913; Lea & Gray 1935; Bennett 1983). These indicate that the bird eats seeds, insects and, rarely, leaves.

Study area and methods

Diet

Diet data were collected during 1984-86 on the riverine plain between the Murrumbidgee and Edwards Rivers 60 km (35°S, 145°E) north of Deniliquin in western N.S.W. The vegetation, described by Harrington *et al.* (1984, 1987), has been considerably modified by grazing and clearing. One of my study areas is a grazing property with a stocking rate of one sheep per 1.2-1.6 ha (3-4 acres) and the other, 40 km away, is a stud merino property with approximately two-thirds that stocking rate. Grasslands predominate in both study areas, with greater plant species diversity on the lightly grazed property.

I collected faecal samples from 80 Plains-wanderers captured and banded during nocturnal surveys and from 28 recaptured birds. The birds were placed for about half an hour in a darkened box lined with absorbent paper. Each sample was labelled, dried and kept for later examination. More samples (69%) were collected from the grazing property than the stud property.

The contents of faecal samples are often more fragmented than those of stomachs, making their identification more arduous. However, I rejected stomach-flushing techniques, despite their apparent safety to birds (Brenzing 1977; Ford *et al.* 1982). The status of the Plains-wanderer dictated that the least stressful technique for the birds should be adopted, provided that the data were not unduly compromised. The work of Davies (1976, 1977a, 1977b), Tatner (1983) and Waugh & Hails (1983) found good agreement between faeces contents and the food eaten or stomach contents of several species of insectivorous birds. The agreement held for soft-bodied prey, such as flies, as well as hard insects, such as beetles. Such agreement also seems to hold for granivorous birds (N. Forde pers. comm.).

Each faecal sample was heated and agitated in a clearing solution of 10% sodium hydroxide, stained with toluiodine blue to help distinguish plant from arthropod material, and then washed through a 0.25 mm sieve. The fraction retained in the sieve was mounted in Karo syrup under a cover slip sealed with clear nail varnish on as many slides as was necessary. Whole and ground leaves, seeds and anthropods from a reference collection were treated in the same way. The prepared samples were analysed following the techniques of Hansson (1970), Calver & Wooller (1982) and Lobert (1985). The data are presented as the frequency of occurrence of each food type in the faecal samples. This avoids the bias of weighting data heavily towards a few birds that had eaten large numbers of a very small food item once or twice.

Foraging behaviour

Because of their cryptic colouring and secretive behaviour, foraging by Plains-wanderers could not be studied adequately in the field. Three pairs of Plains-wanderers were taken to Serendip Wildlife Research Station at Lara, west of Melbourne, an area where they were formerly common. There they were placed in 12 × 5 m cages on turf. The turf in the cages was simulated to be fully-grassed, sparsely-grassed and bare ground, with the treatments replicated in a latin-square arrangement of rectangles (1.7 × 2 m each). Once or twice a week for nine months, observations of foraging and other activities were made every five minutes from an elevated hide for 2-4 h periods. Observations were made throughout the day and night. Luminescent 'cyalume' was dabbed on the birds' backs to facilitate nocturnal observations. In addition to the grasses, weeds and arthopods occurring naturally in the cages, the Plains-wanderers were provided with fresh water and given *ad libitum* seed (commercial seed mix for Budgerigars *Melopsittacus undulatus*), and twice-weekly rations of mealworms and aviculturalist's cake (Anon 1985).

Results

Males took slightly greater proportions of insects and grass seeds, but less chenopod and other seeds than did females. The difference between the diets of the sexes is not significant ($\chi^2 = 2.37$; $P > 0.05$) and the data are combined in Table 1. A total of 435 occurences of six Orders of arthropod and 31 species of seed were recorded from 108 faecal samples (Table 1). Samples contained up to eight species of plant seed and insect. Samples often contained grit, but no leaves, stems or plant parts other than those immediately associated with seeds were found. Beetles up to 15 mm long and ants were the major insect foods, being taken throughout the year. Sucking bugs and caterpillars, the next most important insect foods, were taken only in summer and autumn. In all seasons insects comprised about 40% of the diet except in spring when their contribution was slightly higher (56%). Flying insects were not taken, nor were largely nocturnal ground-dwelling insects

such as earwigs and cockroaches, which were very common in pit-fall traps.

Grass seeds made up 28% of the diet, mainly from the

TABLE 1 The diet of the Plains-wanderer: the number (n) of faecal samples out of a total of 108 in which six orders of arthropod and 31 species of seed were recorded, that number expressed as a percentage (%n) and as the percent frequency of occurrence (%f).

	n	%n	%f
Arthropoda			
Coleoptera — beetles	72	16.6	66.7
Hymenoptera — ants	70	16.1	64.8
Hemiptera — sucking bugs	26	6.0	24.1
Lepidoptera — caterpillars	12	2.8	11.1
Orthoptera — locusts	4	0.9	3.7
Areneae — spiders	1	0.2	0.9
Poaceae			
Stipa scabra	29	6.7	26.8
Sporobolis caroli	18	4.1	16.7
Panicum whiteii	18	4.1	16.7
Panicum decompositum	13	3.0	12.0
Danthonia caespitosa	10	2.3	9.2
Phalaris paradoxa	7	1.6	6.5
Vulpia myuros	7	1.6	6.5
Hordeum leporinum	3	0.7	2.7
Eragrostis cilianensis	3	0.7	2.7
Eragrostis leptocarpa	1	0.2	0.9
Lolium rigidum	1	0.2	0.9
Unidentified	10	2.3	9.2
Chenopodiaceae			
Atriplex semibaccata	21	4.8	19.4
Atriplex leptocarpa	8	1.8	7.4
Maireana excavata	4	0.9	3.7
Maireana pentagona	3	0.7	2.7
Chenopodium pumilo	3	0.7	2.7
Sclerolaena spp.	3	0.7	2.7
Salsola kali	1	0.2	0.9
Unidentified	18	4.1	16.7
Other seeds			
Asperula conferta	15	3.4	13.9
Galium spp.	10	2.3	9.2
Spergularia rubra	6	1.4	5.5
Carthamus lanatus	6	1.4	5.5
Euphorbia drummondii	5	1.1	4.6
Crassula colorata	4	0.9	3.7
Goodenia spp.	4	0.9	3.7
Convolvulus erubescens	3	0.7	2.7
Alternathera denticulata	2	0.5	1.8
Daucus glochidiatus	1	0.2	0.9
Medicago polymorpha	1	0.2	0.9
Rumex tenax	1	0.2	0.9
Teucrium racemosum	1	0.2	0.9
Unidentified	10	2.3	9.2
Total times occurred in 108 faecal samples	435		

genera *Stipa, Panicum, Sporobolis* and *Danthonia*. Most grass seeds were eaten in summer, fewer in autumn and least in winter and spring (Fig. 1). Chenopod seeds comprised 14% of the diet with the seeds of two saltbushes, taken mainly during autumn and winter, making up half of those consumed. All other seeds (16% of the diet) were taken throughout the year, but most often during winter. Seeds taken ranged in size from about 0.5 mm long (*Eragrostis* spp.) to those of the saffron thistle *Carthamus lanatus* (5 mm), but most were under 3 mm long. Despite the numerical abundance and species diversity of members of the daisy family (Asteraceae) in both study areas, few were taken. The main difference in diet between the two study areas was that no creeping saltbush *Atriplex semibaccata* or native millet *Panicum decompositum* were found in samples collected from the grazing property with higher stocking rates. Both plants were rare there but common on the stud property.

Foraging behaviour

Captive Plains-wanderers foraged diurnally and crepuscularly, but not at night. In addition to the artificial food, they regularly took fallen seeds and arthorpods from the ground and from among the tillers at the base of clumps of grass. They avoided areas of bare ground. The fringes of areas of dense grass were mainly sought for concealment by Plains-wanderers when they were alarmed, while the sparse grass was much preferred for foraging and roosting in at night. Plains-wanderers were never seen to take ripe seeds from an erect growing inflorescence even though these were sometimes abundant. On only three occasions were they seen to take the tips of fresh green leaves. Occasionally they hammered on compacted soil with their
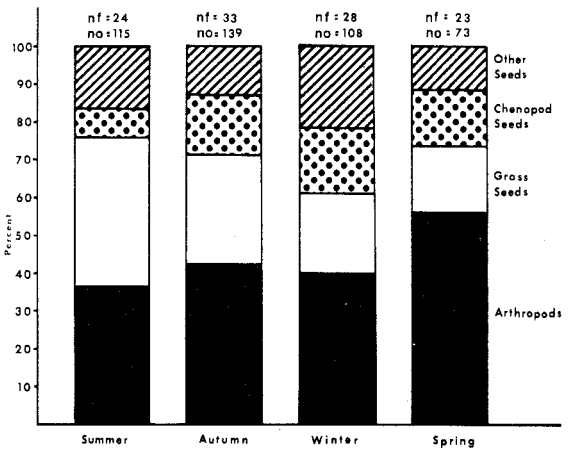

FIGURE 1 Summarised seasonal diet of the Plains-wanderer: the number of occurrences (no) of arthropods and seeds in the number of faecal samples (nf) per season, expressed as a percentage.

bills, sending small lumps of soil flying and picking up any exposed arthropods. The fresh water I provided was rarely used. Rather, when rain or heavy dew gathered as droplets on leaves, the Plains-wanderers busily pecked them up.

Discussion

This study confirms that the diet of the Plains-wanderer is mainly insects and seeds. Similarly, samples from four Plains-wanderers I captured in autumn in south-western Queensland (24°S, 141°E) all contained button grass *Dactyloctenium radulans* seeds, and two contained *Galium* spp. seeds and beetles (unpubl. data). Seasonal changes in the diet of the Plains-wanderer in the Riverina reflect the seasonal flowering and availability of seeds as detailed by Cunningham *et al.* (1981). The switch to more insects at the onset of the growing season (spring, Fig. 1) is characteristic of some granivorous birds (Wiens & Johnston 1977). At this time most of the remaining seeds germinate and thus become difficult to obtain until the new crop is produced. Unlike their closest relatives, the seedsnipe *Thinocorus* spp. of South America (Olson & Steadman 1981), which often eat leaves but not insects (McLean 1969), Plains-wanderers rarely eat plant parts other than seeds. My observations showed that Plains-wanderers at Serendip were inactive at night and these observations, together with the lack of common nocturnal insects in their diet, contradict Schodde & Tidemanns' (1986) claim that the Plains-wanderer is nocturnal.

Although Plains-wanderers have a broad and varied diet in all seasons, their foraging behaviour restricts the types of grassland they can inhabit successfully. Harrington *et al.* (1987) noted that Plains-wanderers had difficulty negotiating dense pasture, but they did not explain adequately why Plains-wanderers in the Riverina were more often in areas of past erosion where the red clay subsoil does not support dense pasture growth under any seasonal conditions. These areas contain about 50% bare ground and the more robust plants of the flora are generally spaced 10-20 cm apart. My observations suggest that such areas are necessary for a species that eats fallen seeds and ground-dwelling arthropods if it is to walk and forage with ease. If the grass cover was dense then fallen seeds could become unavailable to Plains-wanderers, as is sometimes the case for some species of Australian and African finches that feed on the ground (Immelmann 1977; Wiens & Johnston 1977). These findings illustrate the need to integrate ecological and behavioural studies if the objective is to apply the results to the practical problems of wildlife management.

Acknowledgements

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Methods for sexing and ageing the Bell Miner *Manorina melanophrys*

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In the course of behavioural studies of several marked colonies of the Bell Miner *Manorina melanophrys* at Bundoora, 16 km NNE of Melbourne, Victoria (see Smith & Robertson [1978] for site details), methods for determining the sex and age of individuals were developed.

The plumage of Bell Miners is sexually monomorphic, as is typical of meliphagids. Both sexes possess brood patches and neither cloacal examination nor laparotomy were found to be useful in sexing individuals. Before this study an individual's sex could be determined only if it were observed copulating or performing the strictly female behaviours of building a nest, incubating eggs or brooding nestlings (Swainson 1970).

Similarly, before this study, it was not possible to reliably determine the age of a Bell Miner whose date of leaving the nest was unknown. Swainson (1970) defined three age-classes in Bell Miners based upon the colour of the patch of skin behind the eye. He (p. 183) recorded that 'in juveniles up to three months old this skin was olive-yellow, and then slowly became orange until the birds were six to eight months old, when it changed to red.' Birds with orange eye-patches were classified as immatures and those with red as adults. This paper presents the results of accurately monitoring these changes in eye-patch colour as birds aged.

Methods

Determining sex

Morphometric methods   No single measurement was found which could be used to reliably differentiate between the sexes (Table 1). Measurements were taken of the closed wing, culmen, tail, tarsus

and total body length (Disney 1974). The maximum vertical depth of the culmen (Fig. 1) and the total head length from the tip of the bill to the cerebellar prominence on the back of the head (Rogers *et al.* 1986) were also measured. The head and tarsus measurements were taken with calipers to 0.1 mm. The wing, tail and total length were measured with a ruler to 1 mm. Weight was too seasonally variable to be of value in discriminating between the sexes (see Rogers *et al.* 1986).

Rogers *et al.* (1986) attempted to discriminate between the sexes of birds using differences in the length of the wing between the sexes, using a method based on a curve-fitting approach (Mac-Donald & Pitcher 1979). They identified two distributions among their measurements of wing lengths of birds of unknown sex. Means and confidence limits for each of the two distributions were then estimated. One of the distributions was taken to represent males and the other females, based on their similarity to measurements obtained from known-sex birds held in museum collections. Only 38.5% of birds could be accurately sexed using this method (Rogers *et al.* 1986).

Discrimination using only one measurement is limited by the degree of overlap between the sexes for that measurement. There
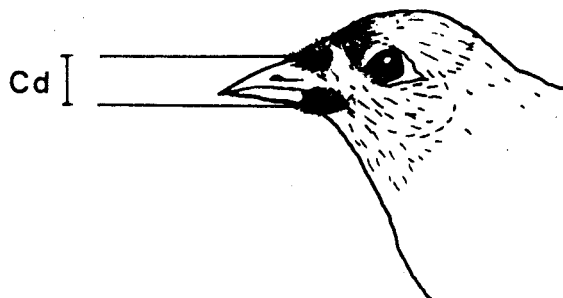

FIGURE 1 Culmen depth (Cd) was defined as the maximum vertical depth of the culmen, and measured to 0.1 mm using calipers.