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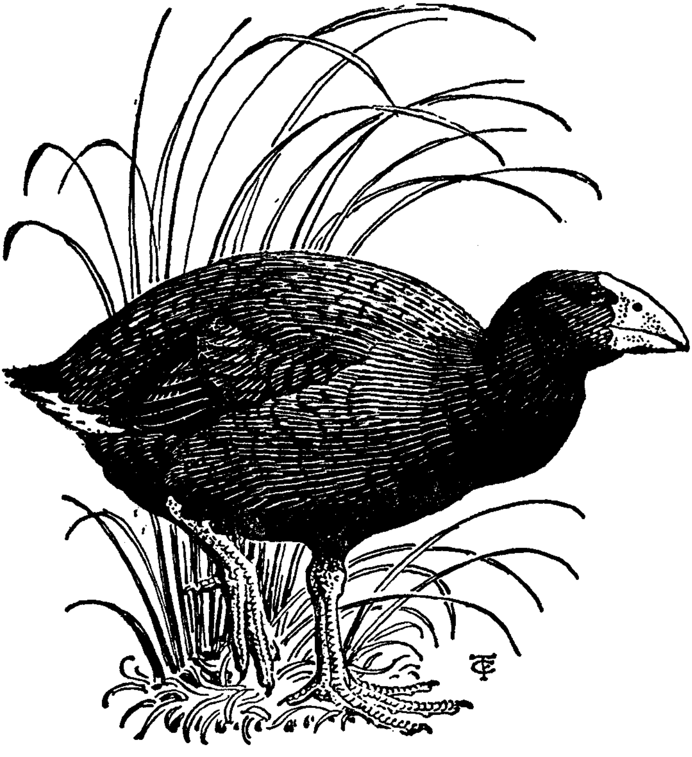
Journal of the Ornithological Society of New Zealand



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THE FORAGING BEHAVIOUR OF THE SOUTH ISLAND ROBIN

By R. G. POWLESLAND

ABSTRACT

The foraging behaviour of the South Island Robin *(Petroica australis australis)* was studied at Kowhai Bush, Kaikoura, from August 1976 to July 1978. Robins spent 90% of their foraging time on and within two metres of the ground. They spent 61.3% of their foraging time gleaning on the ground, 33.8% scanning, 4.5% gleaning amongst vegetation, 0.3% hawking and 0.1% flycatching. The proportion of foraging time devoted to the various foraging methods differed between adult and immature robins. The diurnal patterns of ground gleaning, scanning and above-ground gleaning for adults in the breeding and non-breeding seasons, and for immatures in the non-breeding season are described. Most foraging time was spent searching (93.7%), the rest killing, dismembering and eating prey. Robins relied largely on sight to find prey, but also seemed to stimulate prey movement by foot-trembling and tail- and wing-flicking. Most movements of foraging robins were hops and steps (88%), the rest being flights. About 8% of foraging time was spent flying. The robin's diet consisted of invertebrates, except in summer and autumn when some berries were taken.

INTRODUCTION

The South Island Robin *(Petroica a. australis)* is very suitable for detailed observations of its diet and foraging behaviour because it is approachable and hunts mainly on the forest floor. However, only brief comments on feeding are in the literature. Both Oliver (1955) and Falla *et al.* (1966) commented that robins spend much of their time hopping over the forest floor taking mainly earthworms and insects.

A 5-year study by Flack (1973) on the robins at Kowhai Bush revealed that the population there was almost wholly insectivorous, only occasionally eating berries. Flack (in prep.) reports that most hunting took place on or near the ground but that extended periods of searching at higher levels also occur. He describes robins as having a range of hunting methods including hawking and skilled flycatching. Activities associated with foraging include wing- and tail-flicking and foot trembling.

The present study aimed at describing the robin's foraging methods and feeding stations, and its searching, handling and eating activities. The effects of robin age, season, and time of day on foraging methods are described.

STUDY AREA

Kowhai Bush is a narrow strip of bush 7 km inland from Kaikoura (42°S, 174°E), in coastal south-eastern Marlborough. The bush of 240 ha lies on the north-eastern side of the Kowhai River within the Kowhai River Protection Reserve. It is bounded by riverbed and farmland at 60-150 m a.s.l. The low forest consists of a flood-induced patchwork of successional stages of varying age, structure and species composition often dominated by kanuka *(Leptospermum ericoides)* with a dense understorey (Flack 1973). The history, physical aspects, vegetation, flora and fauna of Kowhai Bush were described by Hunt & Gill (1979).

METHODS AND TERMINOLOGY

Individual robins were followed about their territories, and the time they spent using the various foraging methods, feeding stations and feeding levels was recorded.

Foraging behaviour: This was subdivided as follows:

Gleaning, the " search for prey not in flight by birds not on the wing " (Croxall 1977), was the main method of locating prey. In *ground gleaning,* robins search soil, litter, rotting logs and low-growing vegetation reachable from the ground. In *vegetation gleaning,* birds stand on plants to search their surfaces.

Scanning is the use of a vantage point to look for prey. Limbs, branches and boulders were commonly used perches, but if none was available robins clung vertically to trunks and stems. If no prey was sighted, the birds usually flew a few metres to another perch and repeated the scan. The movement between perches was included in scanning time.

Flycatching is the attempted capture of flying prey by a bird on the wing.

Hawking is the attempted capture of prey not in flight by a bird on the wing. The bird flies to vegetation after seeing prey while scanning and remains in flight to capture it. The bird may flutter briefly to inspect the prey, but never does so to find it first; this sets hawking apart from hovering. Robins were never seen to hover while searching for prey. Usually, they hawked prey from trunks, leaves and terminal shoots, but occasionally took prey from spider webs and caterpillars suspended on silken threads.

The data were analysed to see whether time of day affected foraging methods. To simplify this analysis, the little time spent hawking and flycatching was combined with that spent in vegetation gleaning and called *above-ground gleaning.*

Feeding stations: Gleaning in vegetation was subdivided into five feeding stations:

1. Standing on and searching a branch, a limb, or among vines (B-B, branch to branch).
2. Standing on a branch, limb or vine and searching an adjacent trunk (B-T, branch to trunk).
3. Clinging to and searching a trunk (T-T, trunk to trunk).
4. Standing on and searching the top of a decaying stump (S-S, stump to stump).
5. Standing on and searching foliage and twigs (F-F, foliage to foliage).

Feeding levels: From April to July 1978 the time was noted that robins spent at various heights above ground level gleaning in vegetation. Height intervals of half a metre were used from 0.1 to 5.1 metres, above which all observations were grouped. The height that a bird gleaned from vegetation was recorded and the time spent at each height interval noted.

As well as the time spent searching for prey, foraging time includes that spent handling and eating prey. During the 1978 breeding season (August to December), male robins whose mates were incubating were timed to determine what proportion of their foraging time was spent in searching, handling and eating activities. Robins were timed as involved in handling activity when killing and dismembering prey items greater than 5 mm long. Many small prey (< 5 mm) were eaten, but because such prey were picked up and swallowed immediately this probably went unnoticed much of the time.

To determine any diurnal patterns of foraging activities, each day was divided into six equal periods between sunrise and sunset, although robins were also active in twilight. To adjust the length of the day-periods to allow for the changing daylength, I used official sunrise and sunset data (*The Air Almanac,* USA Govt. Printing Office 1976) to calculate each month's mean daylength and, from that, each month's day-period length. Thus, I could assign observations to the appropriate day-periods and then combine the information from throughout the non-breeding season (January to July) or the entire breeding season.

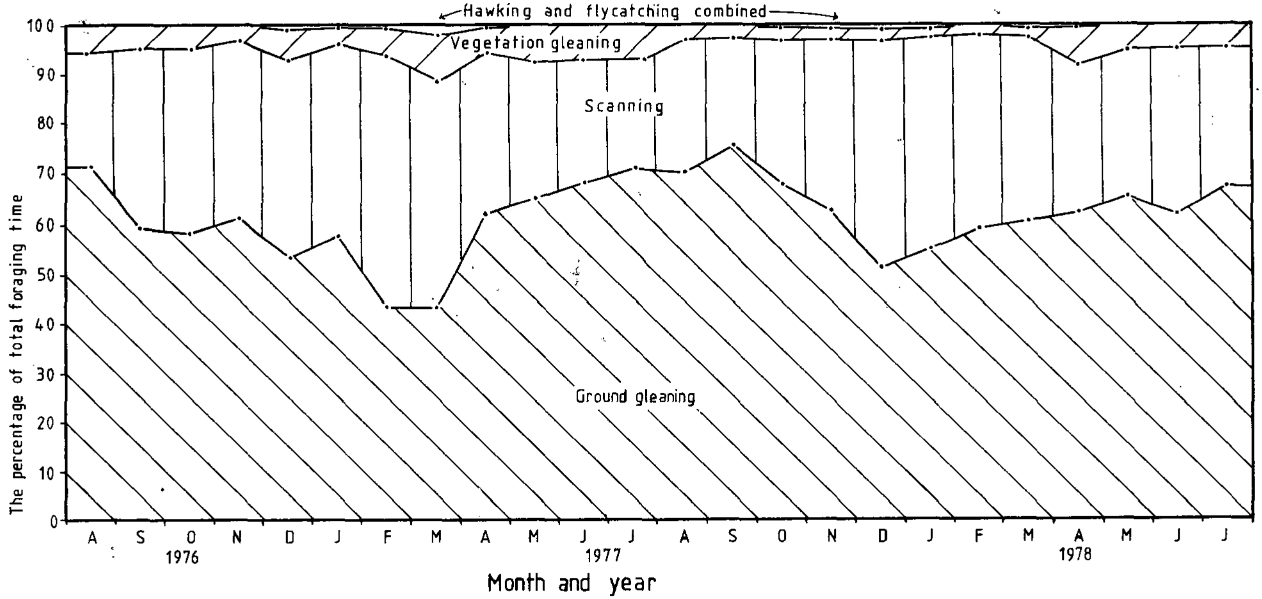

FIGURE 1 — The monthly percentage of foraging times in which robins used five foraging methods from August 1976 to July 1978.

Immature robins were defined as those independent of parental care but not yet of breeding age; that is, from about 4 weeks after leaving the nest up to the start of breeding at the end of July. At first, they were readily distinguished by their streaked crown feathers and their small area of white breast feathers, but by March the growth of more contour feathers made most of them indistinguishable from adults. From then until breeding began, they were recognised as immatures only from their band combinations.

RESULTS AND DISCUSSION

Foraging methods

Figure 1 shows the proportion of time robins devoted to the five foraging methods from 923 hours of observing foraging robins. Overall, 61.3% of foraging time was devoted to ground gleaning, 33.8% to scanning, 4.5% to vegetation gleaning, 0.3% to hawking and 0.1% to flycatching.

In winter, when the soil was moist, robins spent most foraging time gleaning on the ground. Gleaning from vegetation also became more important in winter than during the other seasons. However, the data for this foraging method showed no consistent pattern of seasonal variation: it was used more than usual from April to July in both 1977 and 1978, but also a great deal during the spring of 1976 and summer of 1977. When gleaning from vegetation, birds searched in crevices, fissures, holes, among dead foliage and tangles of vines, and at branch and trunk axils where debris collected. The rough-barked surfaces of trees are important places for insect larvae and pupae to overwinter. Thus, the coarse-textured and flaky bark of kanuka provided many opportunities for robins to find overwintering and sheltering invertebrates. Scanning, hawking and flycatching activities diminished during the course of winter, presumably because aerial and arboreal prey was then less numerous and active. Similarly, South Island Fantails *(Rhipidura fuliginosa fuliginosa)* fed on the ground and in the lower understorey more frequently in winter than in the other seasons (Ude Shankar 1977).

The time spent using the various hunting methods changed markedly from winter-spring to summer. Scanning, hawking and flycatching increased with the increase of aerial and arboreal invertebrates. During late November and December, swarms of March flies *Philia negrostigma* (Bibionidae) were present, which the robins caught by hawking and flycatching. Cicadas, which emerged in January and remained in great profusion until mid-March, were also caught by hawking and flycatching. Caterpillars were hawked from terminal shoots, and a variety of invertebrates, especially moths, was hawked from trunks. In late summer, berries were often taken by hawking because the slender twigs on which they grew did not support a robin's weight. To some extent the increased time spent scanning and hawking during summer was forced on the robins. Low rainfall and dry soil

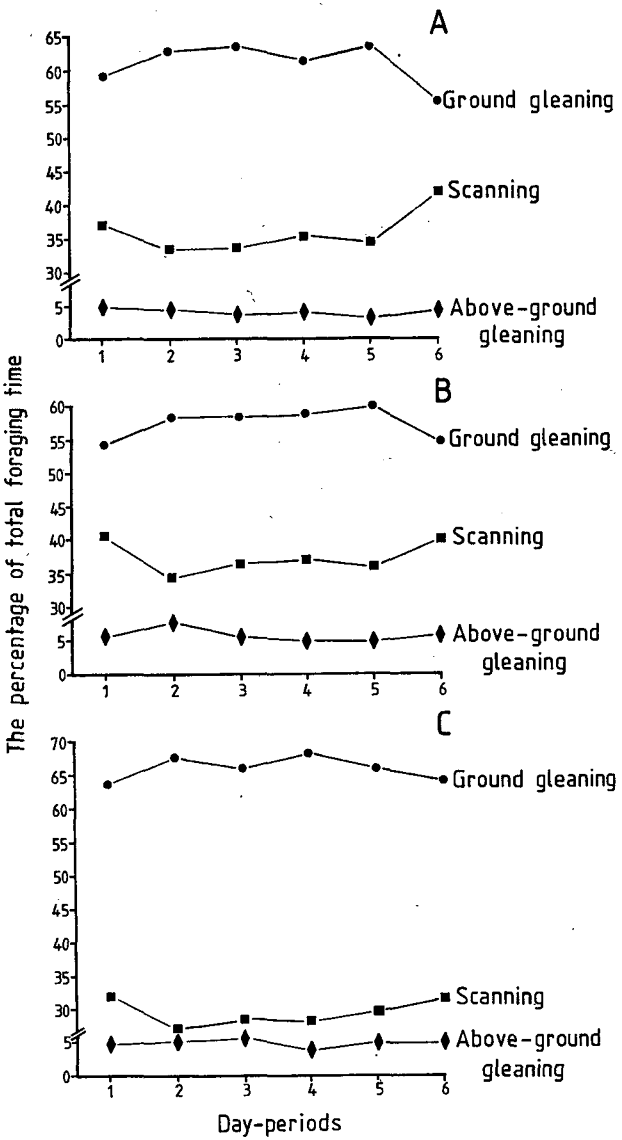

FIGURE 2 — The diurnal patterns of three foraging methods used by:
A. Adults *in the breeding season*
B. Adults in the non-breeding season
C. Immatures in the non-breeding season

Day-periods: The division of the daylight hours into six day-periods of equal length.

conditions meant few prey were active in the upper soil and litter, and so the birds had to turn to arboreal prey. More time was spent fly-catching in summer than at other times of the year, presumably because in the warm calm weather insects flew more.

Adult and immature robins at Kowhai Bush spent different proportions of their foraging time using the various foraging methods (Table 1). In the same year the two age classes of robins devoted significantly different proportions of time to the five foraging methods ($p < 0.01$). Both age classes spent a similar time vegetation gleaning and flycatching, but adults did more scanning and hawking than immatures. Immatures preferred to forage on the ground, perhaps because they were less proficient at finding arboreal prey by scanning than were adults.

Figure 2A and B shows that the diurnal pattern of ground gleaning, scanning and above-ground gleaning was similar for adults in both the breeding and non-breeding seasons. The time spent gleaning above the ground was fairly stable during the course of the day, with a slight increase during mid-morning and late afternoon. Ground gleaning was a relatively constant percentage of foraging time from mid-morning to mid-afternoon inclusive, but was used less in the early morning and late afternoon. For scanning the reverse was true, for the following possible reasons.

While robins avoided open areas, they did venture into sparsely vegetated areas during twilight. Many of their territories bordered on to relatively open habitats such as the edges of the Kowhai River riverbed and grazed parkland covered with scattered trees and a sparse ground cover or pasture. Robins venturing into these areas

TABLE 1 — The percentage of time spent by adult and immature robins using five foraging methods in the non-breeding season (January-July).

Year	Ground Gleaning	Vegetation Gleaning	Scanning	Hawking	Flycatching	Total Foraging Time (h)
Adult						
1977	56.59	6.76	36.09	0.48	0.08	211.9
1978	58.14	3.65	37.92	0.25	0.04	183.3
Immature						
1977	64.94	6.77	28.03	0.17	0.09	81.1
1978	66.02	3.73	29.97	0.22	0.06	162.7

spent most of their time scanning with brief flights to the ground to catch and eat prey. This behaviour is similar to that of the Yellow-breasted Tit *(Petroica macrocephala macrocephala)* (Falla *et al.* 1966) and Pied Tit *(P. m. toitoi)* (Gibb 1961). Possibly in the low light intensities at dawn and dusk the robin's dull plumage afforded them some protection from predators, so enabling them to use open areas. Kacelnik (1979) found that captive Great Tits *(Parus major)* were less efficient foragers in light intensities comparable with those that occur for one and a half hours after sunrise. Therefore, it is likely that robins, which spent much time foraging on the ground, would also be less successful foragers in the bush at dawn and dusk. Perhaps by venturing out into open habitat while the light was poor in the bush, robins were able to spend a greater proportion of the day foraging profitably.

Robins within the forest also spent more time scanning in the early morning and late afternoon, possibly to find prey which were active at dawn and dusk. Invertebrates damaged during the night, those that had failed to conceal themselves adequately before dawn, and those that became active just before sunrise (e.g. cicadas) would have been most vulnerable then. Scanning would enable the greatest area of territory to be searched quickly.

The diurnal patterns of foraging methods used by adult and immature robins were similar during the non-breeding season, even though immatures scanned less than adults ($p < 0.01$). The peaks of scanning in the early morning and late afternoon were lower for immatures than for adults, probably because immatures ventured less into open habitats.

Feeding stations and feeding levels

Table 2 shows that, when vegetation gleaning, robins spent most time gleaning from branches (39.5%) and trunks (37.97 + 20.27 = 58.2%) of trees. Little time was spent gleaning from decaying tree stumps and amongst foliage and twigs. Perhaps this was because robins were too heavy and lacked the precise agility and balance of

TABLE 2 — The percentage of time robins spent gleaning from five feeding stations on vegetation.

Feeding Stations [a]					Total Foraging Time (h)
B-B	B-T	T-T	S-S	F-F	
39.47	37.97	20.27	2.01	0.28	19.8

[a] B-B = branch to branch; B-T = branch to trunk; T-T = trunk to trunk; S-S = stump to stump; F-F = foliage to foliage.

TABLE 3 — The percentage of time robins spent on vegetation gleaning at various heights.

	Height (m)											Total Time (h)
	0.1 ↓ 0.6	0.7 ↓ 1.1	1.2 ↓ 1.6	1.7 ↓ 2.1	2.2 ↓ 2.6	2.7 ↓ 3.1	3.2 ↓ 3.6	3.7 ↓ 4.1	4.2 ↓ 4.6	4.7 ↓ 5.1	>5.1	
%:	23.8	13.0	18.4	15.1	9.0	7.2	4.6	3.7	1.8	1.8	1.6	29.1

smaller birds. Although capable of clinging to coarse-textured trunks, they preferred to perch on branches while foraging from trunks.

About 70% of time when gleaning amongst vegetation was spent within 2 metres of the ground (Table 3). Little time was spent foraging above 4 metres, even though the bush grew to 7-12 metres. Robins may have gleaned from vegetation mainly within 2 metres of the ground partly because the number of crevices, holes and bark furrows decreases with height up trunks (Travis 1977), and partly because of their wariness of open spaces. Robins were very wary of Bellbirds *(Anthornis melanura)*, magpies *(Gymnorhina tibicen)*, New Zealand Kingfishers *(Halcyon sancta)* and Australasian Harriers *(Circus approximans)*, whose presence often caused them to give alarm calls and to flee into the lower understorey vegetation.

Although the heights of scanning perches were not measured, they seemed similar to those for vegetation gleaning, and so 90% of the robin's foraging time was spent on the ground and within 2 metres of it. Similarly, Gravatt (1971) found that from 43 observations of foraging North Island Robins *(Petroica australis longipes)*, 93% of occasions involved the birds on the ground and within 3 metres of it.

Searching activity

During the incubation stage of the breeding cycle, male robins spent 93.7% (n = 12.8 h) of their foraging time searching for prey. They were never seen systematically turning over an area of litter, as Blackbirds *(Turdus merula)* and wekas (*Gallirallus* spp.) do, but seemed to rely largely on sight. In contrast, Gravatt (1971) described the North Island Robin as raking the litter with its beak and turning over leaves to disturb small animals. In their searching, South Island Robins hopped and stepped over litter and vegetation or scanned from a vantage point. They moved litter and bark aside only to retrieve prey that they had seen retreat underneath them.

Special movements of the feet, wings and tail seemed to stimulate prey to move and to enhance their detection. Flack (1973) and Soper (1976) noted foot-trembling by robins. One foot was placed on the ground slightly forward of the other and vibrated up and down rapidly. This foot movement was either continuous or discrete pulses with the two feet being used alternately. On dry litter a distinct rustle could be heard as the robin's foot vibrated upon it. Robins foot-trembled mainly when on the ground, but occasionally did so while foraging on branches. All foraging robins foot-trembled, and some juveniles made these movements when only 12 days out of the nest.

Foot-trembling by several *Petroica* species has been reported. Hobbs (1954) observed the behaviour in Flame Robins *(P. phoenica)* feeding near Deniliquin, Australia. Best (1975) noted that Black Tits *(P. macrocephala dannefaerdi)* quivered one leg up and down rapidly. Similarly, Kearton (1979) found that Yellow-breasted Tits occasionally foot-trembled on branches. Sparks (1961), making reference to feeding shorebirds, hypothesised that foot movements were adopted " to exploit the properties of intertidal muddy sand, in order to expose or incite movement in cryptic invertebrates of the intertidal zone." Thus, foot-trembling by robins may have been to stimulate movement from hidden prey by transmitting vibrations.

Wing- and tail-flicking made by robins as they foraged on the ground and branches also seemed to flush prey. Wing-flicking " is the quick extension and replacement of the hand and primary feathers out to either side of the body " (Horwich 1965). The tail was similarly flexed to form a fan and sometimes cocked up and down. Few birds tail-flicked, but all wing-flicked. Wing-flicking was very rapid; several flicks were given in quick succession, after which the bird moved a few hops before repeating the action. During 20.3 hours of foraging observations, robins averaged a wing-flick every 51 seconds.

Much controversy exists on the role of wing movements for feeding passerines: for example, wing-flashing in Mockingbirds *(Mimus polyglottos)* (Hailman 1960, Horwich 1965). Wing-flashing is the extension of the wings up to about an 85° angle to the horizontal and completely extending the remiges. Thus, this movement consists of a prolonged extension without any hesitations until the wings are quickly brought down to the sides. Hailman (1960) considered that the flashing of white wing patches startled insect prey into revealing themselves. However, Horwich (1965) noted that 69% of all observations of wing-flashing by Mockingbirds were associated with a situation in which birds showed escape tendencies or ambivalent behaviours such as slight fear or uneasiness. Wing-flicking by robins often took place at sites that could have concealed predators and so been flight intention movements, but they were never given in a crouched stance as though preparatory for flight. Ude Shankar (1977) concluded that the tail fanning, flicking and flashing of foraging South Island Fantails provided maximum thrust during take-off and balance while hopping about on branches and the ground. However, Warham (1956) suggested that the wing- and tail-flicking of Willy Wagtails *(R. leucophrys)* were made to scare " camouflaged prey into revealing flight or movement." Prey startling by robin wing movements may be enhanced by the flashing of a narrow pale band on the underside of the wings. Wing-flicking was seen only from foraging birds, and then usually while they were near or under overhanging vegetation. These wing movements did not seem to be used for balance since both wings were moved equally out from the body and at the same angle to it, hardly balancing movements, which typically are irregular and erratic.

Nearly 88% of foraging movements were hops and steps, the rest being flights (Table 4). This would be expected for a species that spends much of its foraging time on the ground. Sixty-six percent of flights ended with robins landing on branches compared with 30% ending on the ground (Table 4). This was because of the many short flights made by scanning robins from perch to perch. Few flights ended on the ground and trunks where prey items were usually captured. This behaviour was also true of Black Robins *(Petroica traversi)* (Flack MS). Almost all flights (90%, n = 2289) made by foraging robins were over distances of less than 6 metres. Most flights were too brief to time with a stopwatch accurately. However, a one-metre flight took about one second and, multiplying by the number of metres flown, I calculated that nearly 8% of foraging time was spent flying.

Although most pecks were made by robins foraging on the ground (Table 4), this may not indicate the effectiveness of pecking in capturing prey. Most pecks made while robins were on branches and trunks seemed to be at prey, whereas some made while they were on the ground included pecks to move litter aside and to probe into the soil to catch retreating animals. More pecking occurred on trunks than on branches because trunks were more furrowed and so were better sources of food.

Handling and eating activities

The time robins took to kill, dismember and eat prey depended on the prey's size and defensive actions. Of 12.8 hours of foraging time robins spent 6.3% in mainly handling activity and some in eating activity. Small items (< 5 mm long) were swallowed whole and seemed to be killed merely by being crushed between the mandibles. Large invertebrates were killed by quick stabbing and pinching movements of the beak. Once the prey was subdued, it was carried to a protected place for breaking into smaller portions. Such places were on the ground and under vegetation giving seclusion from other birds. Male robins occasionally took prey from their mates during the non-breeding season.

TABLE 4 — The percentage of movements and pecks by robins at three feeding stations.

	Feeding Stations			
	Ground	Branches	Trunks	N
Hops and Steps	86	13	1	16438
Flights	30	66	4	2289
Pecks	94	2	4	6083

TABLE 5 — The time taken by South Island Robins to kill, dismember and eat some prey animals.

Animals and their Length	N	Mean Time (min)	Range	SD
Amphipsalta zelandica (cicada) 3-4 cm	27	2.2	1.0 - 4.0	0.71
Earthworm <4 cm	16	0.3	0.1 - 0.9	0.06
Earthworm 4-14 cm	13	1.3	0.4 - 2.4	0.32
Earthworm >14 cm	14	6.0	3.4 -13.6	11.81
Stick-insect 8-15 cm	25	1.8	0.4 - 4.6	1.32
Slug 2-4 cm	14	2.5	0.4 - 4.8	1.46
Snail 1.5 - 3.0 cm	3	5.1	4.6 - 5.5	0.17
Hemideina femorata (tree weta) 3.5 - 5.0 cm	10	5.0	2.8 - 8.4	3.45

Prey was dismembered by being smashed against a log or the ground. Prey was grasped in the middle or at one end and repeatedly swung from side to side with a downwards and sideways movement of the head, until a portion broke off that was small enough to swallow. Sometimes caterpillars found above ground-level were broken up on a branch. Table 5 shows the mean time taken to kill, dismember and eat some common prey animals. Robins took a lot of time dealing with slugs, snails and large earthworms because of their bulk and sliminess. Before being broken up, slimy prey was thoroughly rubbed on a log or over the ground to remove most of the slime that may otherwise have fouled the robin's plumage. Caterpillars were vigorously bashed until macerated. Many berries were broken up even when they were small enough to be swallowed whole. This apparently separated the indigestible seeds from the fleshy exocarp, although some seeds were also ingested (Powlesland 1979).

Few invertebrates could deter robin attacks. Ground beetles (*Megadromus* and *Mecodema* spp.) were usually ignored, presumably because they emitted an " acrid, pungent and offensive smell when disturbed " (Sharell 1971) and had strong exoskeletons. However, they were seen being eaten on three occasions, two *Megadromus wallacei* being taken by the same robin, which ate only the viscera. Stick-insects occasionally deterred attacking robins by waving their long spiny legs. Similarly, tree wetas *(Hemideina femorata)* were able to ward off robins by raising their large spiny legs. Their vigorous thrashing movements, accompanied by a rasping noise, and their strong exoskeleton combined to deter some robins, especially immatures, from killing them.

Associated with catching soil-burrowing prey such as earthworms, robins used the " head-cock " and " beak-pounce " (Heppner 1965). When a robin sighted a likely hole, it stood still, cocking its head from side to side. If prey was seen the bird straightened its head and jumped forward with both feet off the ground, thrusting its beak into the soil with considerable force and speed. Repeated beak-pounces were made whenever prey retreated out of reach or an earthworm broke in two, leaving a portion in the hole.

Large items of the robin's diet

The robin's diet at Kowhai Bush was almost wholly invertebrates, and some berries. The large invertebrates, which seemed to form the bulk of biomass eaten, included earthworms (Oligochaeta), spiders (Arachnida), wetas (*Hemideina* and *Hemiandrus* spp.), stick-insects (*Acanthoxyla* and *Clitarchus* spp.), cicadas (*Amphipsalta zelandica* and *Kikihia subalpina*), snails and slugs (Mollusca), all stages of moths and butterflies (Lepidoptera), and beetles (Coleoptera). Many small invertebrates were also eaten by robins, but as I was usually several metres away, I could not identify them.

Most food species varied seasonally in the diet. During winter and spring, when the soil was moist, earthworms, slugs, snails and larvae of the March Fly predominated. However, by late spring-early summer, increasing numbers of larval and adult stages of Lepidoptera were eaten. During January, the cicada *(Amphipsalta zelandica)* emerged in profusion, and some adult robins seemed to feed on it almost exclusively. Few cicadas remained by early April, when the robins began feeding on stick-insects, but as soon as autumn rains activated soil-inhabiting invertebrates the stick-insects were largely ignored. In addition, during autumn, mushrooms and toadstools (Agaricales) were broken up by robins to get at the small invertebrates in them.

Many instances of berry eating by robins were seen. The berries of *Astelia fragrans, Coprosma rhamnoides, C. robusta, C. propinqua, Coriaria arborea* and *Cyathodes fasciculata* were most often eaten, but others included *Carpodetus serratus, Corokia cotoneaster, Melicytus ramiflorus, Muehlenbeckia australis, Pittosporum eugenioides, Pseudopanax arboreus* and *Rubus fruticosus.* Most berries were eaten in summer and autumn.

Vegetable matter has a lower nutritive value and poorer digestibility than animal matter. Therefore, the proportion of vegetable food ingested is likely to increase when insufficient animal food is available. This seems to be the main reason for berry eating by robins in summer. Invertebrate prey was scarce in summer when dry conditions inhibited the activity of soil-inhabiting animals and prevented robins from probing into the soil.

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SHORT NOTE

TRANS TASMAN CATTLE EGRETS

Recently I was told that shortly after leaving Sydney on 1 March 1980 seven large white birds were noticed following *Union Hobart.* They stayed with the vessel, intermittently landing on board, until 4 March when a few miles off Farewell Spit. From descriptions and photographs taken atthe time the birds are identifiable as Cattle Egrets *(Bubulcus ibis).*

JOHN JENKINS

BREEDING BEHAVIOUR AND ECOLOGY OF THE AUSTRALASIAN HARRIER (Circus approximans) IN THE MANAWATU-RANGITIKEI SAND COUNTRY, NEW ZEALAND

By D. J. BAKER-GABB

ABSTRACT

During 1976-78, 212 Australasian Harriers *(Circus approximans)* were trapped and individually marked, and a total of 220 retraps and 319 resightings were made. During two breeding seasons the population density averaged one bird per 50 ha.

Seven territories averaged 31 ha each, and the home ranges of four pairs averaged 900 ha each. Some of the behaviour and displays described have not been previously recorded for the Australasian Harrier, including territory-boundary display flights, border patrolling, eviction of intruders, nest inspection, courtship feeding, copulation, and post-fledging behaviour and dispersal. Also described are display soaring, display diving, feeding at plucking stations, aerial food passes and the post-hatching parental division of labour. Nineteen pairs fledged an average of 1.0 young per nest site and 1.8 young per successful nest. Birds observed breeding at Pukepuke Lagoon for a second consecutive season were more successful than new arrivals. Two cases of polygyny were observed.

INTRODUCTION AND METHODS

The Australasian Harrier *(Circus approximans)* is one of only two diurnal raptors resident in New Zealand. It is slightly heavier than its close relative the European Marsh Harrier *(C. aeruginosus),* which is the largest of the European harriers (Brown & Amadon 1968). Throughout its range in Australasia and Oceania the Australasian Harrier is a bird of the open country, where it slowly quarters reeds, rushes, fields of tall grass, and crops. It is common and widespread in New Zealand, but its breeding biology has received little study except for the work of Stead (1932) and Soper (1958), who described some of the displays that occur during the breeding season. Soper also recorded data on clutch size and incubation period.

I studied Australasian Harriers during 1976-1978 as part of a wider investigation of the influence of predators at Pukepuke Lagoon Game Management Reserve (175°15′E, 40°10′S). Pukepuke Lagoon is situated 3 km from the coast near the centre of the Manawatu-Rangitikei sand country, an area of approximately 4200 km^2 on the south-west coast of the North Island. Detailed descriptions of the region can be found in the New Zealand Ecological Society Proceedings (1957), Cowie & Smith (1958) and Cowie *et al.* (1967).

The 1200 ha study area was dominated by rows of vegetated sand dunes, which ranged between 5 and 20 m above sea level. Between these low dunes were extensive sand plains and peaty swamps. Marram *(Ammophila arenaria)* and spinifex *(Spinifex hirsutus)* were the dominant plants on the foredunes and marram and tree lupins *(Lupinus arboreus)* on the moderately well stabilised dunes immediately inland. Pines *(Pinus radiata)* had been planted on some dune ridges and covered about 12% of the study area. On the ungrazed sand plains and peaty swamps, red rush *(Leptocarpus simplex)*, raupo *(Typha orientalis)* and cabbage trees *(Cordyline australis)* were the dominant plants. Intensively grazed and well-drained pastures of introduced grasses covered about 50% of the study area.

Six cage traps adapted from a design by Hollom (1950) and three automatic bownets (Tordoff 1954) were used. They were baited with rabbits *(Oryctolagus cuniculus)* shot by the Manawatu Pest Destruction Council.

Birds were sexed by weighing with a spring balance accurate to 10 g and by examination and measurement of their tarsi, feet and culmen, females being significantly larger for all these measurements (Carroll 1970, Fox 1977). Adults and juveniles were distinguished by moult differences. The rectrices of juvenile harriers *(Circus)* also often contain stress marks (Hamerstrom 1967).

All adults and most juveniles were fitted with individually colour-coded patagial tags similar to those made by Fitzner (1975). All birds were also banded with individually numbered stainless steel bands provided by the New Zealand Wildlife Service.

Trapping locations and sightings of individually marked birds were plotted on maps of the study area so that their home range and territory sizes could be estimated. Within each resident bird's home range was a smaller favourite hunting area where 75% or more of trappings and resightings were made. Observations were usually made from a high vantage point through 7 x 50 binoculars.

Because Australasian Harriers readily desert their eggs and young if disturbed by man (Stead 1932, Soper 1958), I seldom visited nests until after the young had fledged. Hence, I have no data on clutch size, incubation period or hatching success.

Following Newton's (1976) guidelines, I have used the term " nest site " for the nest and its immediate surroundings, " territory " for the area that was defended around the nest site, and " home range " for the area that included the territory and hunting areas of the pair. Birds were considered to be permanent residents if they were seen or trapped regularly for 9 months.

RESULTS

Trapping, resightings, and population density

Of the 212 Harriers trapped, 76 were retrapped a total of 220 times and 56 were resighted a total of 319 times. Nineteen (9%) of the trapped birds were adult males, 81 (38%) juvenile males, 34 (16%) adult females and 78 (37%) juvenile females.

During the 1976-77 and 1977-78 breeding seasons, averages of 18 breeding birds and six juveniles were resident in the 1200 ha study area, giving a population density of one bird per 50 ha.

Territory size, formation, and maintenance

During both breeding seasons the number of breeding birds and

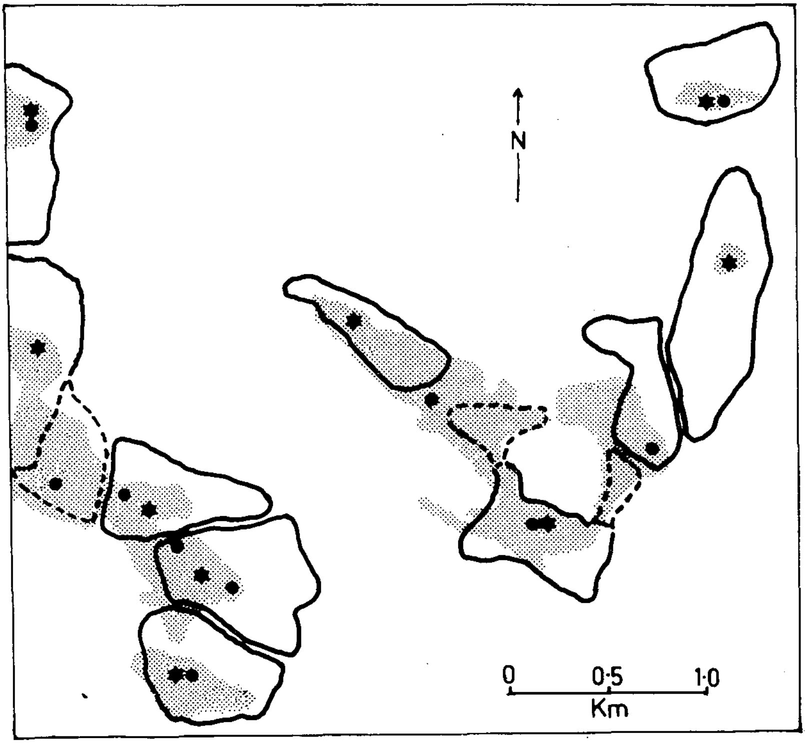

FIGURE 1 — Australasian Harrier territories and nest sites. Light stipple = swampland; unshaded area = open farmland, dune ridges and pine plantations; solid lines = territory boundaries 1976-77; dotted lines = parts of territories not defended after young hatched 1976-77; stars = nest sites 1976-77; dots = nest sites 1977-78.

the number of territories defended (10) in the study area remained constant (Fig. 1). Territory sizes were calculated during the 1976-77 breeding season only. Territory boundaries were clearly demonstrated during border disputes and evictions of intruders. Seven paired birds' territories averaged 31 ha (range 18-55 ha). Two of these decreased in size by about 20% after the young hatched during November, and average territory size was then 27 ha (range 18-42 ha). Neighbouring males then hunted but did not defend the areas that the former territory owners had relinquished. The territory was defended to a height of about 20 m at the boundary and 20-30 m over the nest site. Territory boundaries often corresponded to dune ridges or ecotones such as that between swamp and farmland. All parts of the territory were defended with equal vigour. Males and females defended the same territory, except in cases of polygyny, when each female defended about half the area defended by the male. Co-wives in contiguous territories defended them against each other as well as other intruders.

All adult males and females formed pairs and defended territories, whereas most first-year birds did not. However, two different first-year males established small territories of about 12 ha in August 1976 and 1977. One of the males was paired with a marked adult female for about 6 weeks, but both males' territories were abandoned 3 months after their establishment.

Neighbouring Harriers influenced the size and shape of one another's territories through boundary displays, border patrols and eviction of intruders. In late May the first evictions from incipient territories were seen, and in mid-July the first territorial displays were seen.

Rival males displayed by flying in the same direction on each side of the territory boundary about 10 m apart and at a height of about 15 m. They flew with their wings held at an exaggeratedly high angle and with their bright orange-yellow tarsi thrust straight down. Their flight was slow with very few wing-beats and their pale ventral surfaces and dark underwing bars were conspicuous. Territorial displays were usually silent, the sharp *chit-chit-chit* threat call being voiced only during interspecific territory defence. However, a *kirrk* call similar to the male's courtship call was occasionally heard when both birds landed on prominent trees or knolls in their respective territories. They would remain perched for about 5 minutes and then usually leave the area and begin hunting.

Territory boundaries were not clearly defined until September. Territory display flights were observed as often as six times a day but decreased in frequency as the breeding season progressed. They were replaced by border patrolling, which was characterised by males flying unaccompanied along the contours of their mutual territory boundary but without adopting the territory display flight. One of two neighbouring adult males was seen patrolling 12 times and the other six times during one afternoon in December. Although females often evicted intruders from the territory, they were seen only twice to make territory display flights and twice to fly border patrols. These occurred after they had built nests in October.

Once nest building had started, the rate of observed evictions of intruders from territories increased markedly from two per 100 hours' observation (300 hours of observation) in August and September to 20 per 100 hours' observation (450 hours of observation) from October until the end of December. This change was due to an increased intolerance of intruders rather than increased provocation by them. Until the nest was built, adult males and females usually evicted only birds of their own sex, but after this time they were usually indiscriminate in their evictions. On four occasions, however, males were seen to start courtship diving when females intruded on their territories.

To evict intruders, the defending bird flew fast, low and directly at the intruder, attacking it or pursuing it closely in a fast chase until it either crossed the territory boundary or climbed to at least 20 m. Once the intruder was above this height, female territory owners usually returned to the centre of the territory, whereas males " escorted " the intruder to the boundary, flying below and often ahead of the intruder, which followed him. The male often thrust its tarsi down when it reached the boundary and flew along the boundary for a short way before returning to the centre of the territory or continuing hunting.

Adults usually had no difficulty evicting intruders, but repeated disturbance from other Harriers probably caused at least two pairs that began nest building in a communal roost area to abandon their breeding attempts. The communal roost was used throughout the year by non-breeding birds and occasionally by breeding adult males. The territory owners were unable to evict the birds that came to the roost in the evening, although the males spent about an hour each evening trying to do so.

Home range

In the 1976-77 breeding season, the home ranges of four pairs averaged 900 ha and overlapped those of their neighbours by about 75%. Within each 900 ha were a pair's favourite hunting areas, which totalled about 300 ha. Each bird in a pair sometimes hunted over areas that were regularly hunted by its mate and sometimes over other areas where its mate was rarely seen. Favourite hunting areas varied from one or two large areas of swampland to many small areas of tall vegetation interspersed with open farmland. The four pairs' favourite hunting areas overlapped those of their neighbours by about 25%, but birds from different pairs were seldom seen in the same area at the same time. First-year birds were not usually evicted from a pair's favourite hunting area unless they flew within about 100 m of a hunting adult.

First-year birds' daily home ranges during the breeding season were similar in size to the adults' favourite hunting areas, but the total area they ranged over was much larger. I was uncertain how far they ranged, but reported observations of marked birds and banding returns from outside the study area (Baker-Gabb 1978, Robertson 1978) indicated that usually they did not leave the sand country. This extends 20 km north, 20 km south and 15 km east of Pukepuke Lagoon.

Courtship displays

During June, with increasing frequency, pairs of adult Harriers were seen soaring together on a thermal. When they soared in display their wings were raised high and bent slightly back. The male, which was often the higher bird, occasionally stooped close to the female. The female then sometimes flew on a fast zig-zag course away from the male with him in close pursuit for about 20 seconds. More often, however, she flipped over and thrust her tarsi at the male, a manoeuvre reminiscent of the aerial food-pass seen later in the breeding season. Pairs soared and chased most often late on warm sunny mornings.

Soaring usually preceded display diving. In July, the first shallow undulating display-flights were performed by the male, accompanied by the male's short *kee-a* courtship call. When flying lower than 50 m above the ground, the displaying bird occasionally abruptly reversed its flight direction or " switched-back " (Hamerstrom 1969). If a female was displaying above her mate which was perched near the nest site, she regularly gave a loud *kee-o* call, which the male answered with a soft *kyuck*.

Shallow display flights rapidly progressed into the spectacular diving display, which was performed by both sexes but most often by the male. The full diving display or " sky-dance " (Hamerstrom 1969) consisted of a series of U-shaped dives at heights varying from 50 to 200 metres above the ground. The displaying bird flew with deep exaggerated wing beats as it dived steeply for about 25 m, and then sailed out of the dive on upraised wings and executed a full- or half-barrel roll at the zenith. The courtship call was given during display diving. If the female had been soaring with the male before he made his diving display, she either descended slowly with her wings held high and landed in tall vegetation or she left the area and began hunting. If the female landed, the male continued diving and began twisting like a falling leaf before eventually alighting near her.

No first-year Harriers were seen courting. However, some first-year birds must have been involved in courtship display because one first-year female fledged young from Pukepuke Lagoon. Males were not observed courting and breeding successfully until they obtained paler adult plumage in their second or third year.

Courtship feeding

Courtship feeding usually took place out of sight in tall raupo or red rushes. However, two males were seen to feed their mates regularly at " cock nests," the unlined platforms built by the male from early September onwards. These males flew to the cock nest with prey, raised their wings high, and gave the courtship call. The female, which was usually perched on a cabbage tree nearby, then flew to the cock nest and took the prey. As the female landed, the male left and perched nearby. Males that were not seen at cock nests fed their mates in a similar way on an area of dry ground in their territories. Courtship feeding took place probably once a day for about 6 weeks, beginning in mid-September.

Nests

While looking for a nest site during September, the pair flew low over their territory. When one bird landed, the other continued to soar at a low height. The roles were then reversed. When on the ground, the male frequently gave a short quickly repeated *see-o* call.

Females began nest building in late September and early October. The main nest was built within 50 m of the male's cock nest. Nest building was unobtrusive, the female flying low to areas about 50 m from the nest site to gather material. Nest material was carried in the beak or claws. Nests took about 4 weeks to complete.

Of the 19 nests built in the study area during the two breeding seasons, 11 were in dune-hollow swamps that had been fenced to keep out domestic stock and eight were in raupo swamp. The average distance between each nest site and its nearest neighbour was 910 m (range 300-1600 m).

Ten nests were examined only after the young had fledged. They averaged 80 x 50 cm with the base of the cup 40 cm above ground level or water level. The oval nests commonly consisted of a sturdy base of lupin, thistle, toetoe, and flax stems with cabbage tree leaves, marram and grasses forming a lining. All seven nests examined in dune-hollow swamps were built on red rushes with a toetoe growing beside and to the west of the nest. The three nests examined in raupo swamp were built on sedges *(Carex)*. All ten nests were surrounded by tall vegetation on three sides with an opening to the east. Thus, they were protected from the potentially strong rain-bearing westerly winds that prevail in the study area.

Copulation

I observed copulation on only three occasions, during October. Twice the female was initially soaring high over the male, which was hunting in the territory below. When the male caught a green and golden bell frog *(Litoria aurea)* in a farm drain, the female began a diving-display descent and landed 2 m from the male. He flew 20 m away with the prey and continued feeding. The female's high-pitched soliciting *seee-uh* call was heard as she once again flew to the male. This time he left the frog and flew 3 m away. The male stood side-on to the female with his wings raised. The female was in a crouched posture facing the male and the soliciting call was again given as she pecked at the frog. The male then flew and alighted on her back. Copulation was completed in about 10 seconds with the male flapping to maintain balance. He then flew 30 m away and began preening. The female completed her meal and then bathed in the farm drain. The third copulation was essentially the same, except that the male flew into the territory and presented the female with a small prey item before copulation occurred.

Incubation and the aerial food-pass

Male Harriers were not seen to land at the nest once the females had begun incubating eggs in early November. From this time onwards food was passed from male to female only by the aerial food-pass. Small prey about the size of a house mouse *(Mus musculus)* was transferred on average three times a day. Although aerial food-passes varied, they commonly consisted of the male calling the female from the nest with a quiet *chuck-chuck-chuck* and then flying slightly above and ahead of her. The male then dropped the prey about 2 m to her. The female flipped over to catch the prey in one or both of her feet. On three occasions I saw passes made from claw to claw. The food item was not missed by the female in a total of about 150 aerial food-passes. After the pass the female flew to eat the prey at a plucking station, a regularly used area of dry ground some 30 m from the nest.

Division of labour and post-hatching behaviour

During the 12 weeks between the time nest-site inspection was observed and the time the young were 2 weeks old, all females seldom left their territories, where they were fed by the males. When not incubating, they were often seen perched on prominent cabbage trees for periods of up to an hour, soaring over their territories, or making short flights to collect nest material. The males were away hunting for most of this time.

A change in the female's behaviour in early December indicated that hatching had occurred. She no longer took prey to the plucking station after an aerial pass but returned with it to the nest. When the nestlings were about 1 week old the female began to spend long periods perched within 30 m of the nest, although whenever it rained she returned to the nest to cover the young. The male's behaviour also changed. He no longer perched in the territory after passing prey to the female but usually left the area and continued hunting. If the male had not recommenced hunting by the time the female had fed the young, she often dived at him and chased him from the territory.

Males landed and deposited food items at four of the five successful nests during the 1976-77 breeding season, but only after the nestlings were at least 2 weeks old. They did not stay long enough to feed the nestlings.

Nesting success and fidelity to breeding area

During the 1976-77 breeding season, nine young were fledged from five of the nine nests, giving an average fledging success of 1.8 young per successful nest, or 1.0 young per nest site. In the 1977-78 season, 11 young were fledged from six of the ten nest sites, giving the same (1.8) average fledging success for successful pairs and 1.1 young fledged per nest site. In both seasons four pairs fledged no young.

Ten of 15 individually marked adults resident at Pukepuke Lagoon during 1976-77 re-established territories during 1977-78, eight of which became resident on their former territories and six of which paired with their mate of the previous breeding season. Breeding success was highest among those adults known to be breeding in the study area for a second consecutive season. Of the ten adults that returned, six had successfully fledged young the previous breeding season but eight were successful in the second observed breeding season. Only four (44%) of the nine new birds in the study area fledged young during 1977-78. The Fisher exact-probability test indicates that returned breeders were not significantly more successful ($p > 0.05$) than birds breeding for the first time, but sample sizes are small.

Polygyny

I observed one case of polygyny in each of the two breeding seasons. Three of the four females and both of the males were individually marked. The observed breeding histories of these six birds are summarised in Table 1.

During 1976-77, male A defended two territories which were not adjacent and where the distance between nest sites was 1300 m. Often, one of two or more wives may be favoured by a male harrier (Balfour

TABLE 1 — Breeding history of polygynous Australasian Harriers at Pukepuke Lagoon

1976-1977	Young fledged
Male A x Female W (polygyny)	0
Male A x Female X (polygyny)	0
Male B x Female Y (monogyny)	2
1977-1978	
Male A x Female X (monogyny)	1
Male B x Female Y (polygyny)	0
Male B x Female Z (polygyny)	2

& Cadbury 1979), but in this case neither of the two females (X and Y) appeared to receive more food from their mate than the other, nor did one begin nest building earlier. No young were fledged from either of the nest sites. The following year, female X again paired with male A, but in a monogynous relationship this time, and fledged one young.

During 1977-78, a second polygynous male (B) defended one territory and the two nest sites were 350 m apart. In this case the females both defended a territory within the male's territory. The first wife (Z) began nest building about 1 month before the other (Y) arrived in the area, and she received more food from the male. The first wife fledged two young, and the less-favoured second wife fledged none. Male B had been paired with the less-favoured second wife (Y) in a monogynous relationship during the previous breeding season, when they had fledged two young.

The average success of the two polygynous matings was 0.5 young fledged per female, or 1.0 young fledged per male. These success rates are lower than the 1.2 young fledged per adult (n = 15) in monogynous matings, but sample sizes are too low for statistical comparisons.

Fledging

The mean fledging dates recorded for the two breeding seasons were 13 and 18 January (range 1-27 January). For the first week after the fledglings left the nest, they remained within their parents' territory and perched together on prominent bushes. Males were more precocious than their larger sisters and accomplished most activities such as leaving the nest site and making their first flight outside the territory about a day earlier. One week after fledging, the young flew strongly after their parents and gave the soliciting call. The adults usually dropped the prey, and the fledglings all dived to catch it before it hit the ground. The first fledgling to see the adult returning to the territory usually secured the food item.

After the young had fledged, two adult males were seen less often over their territories but continued to hunt in their home ranges. In these cases, the females continued feeding the fledglings alone. At the nine other successful nests, both parents fed the fledglings at about the same rate. After fledging took place, adult females were seen up to 2.5 km from the nest site on five occasions, whereas before this time they were not seen more than 1 km from the nest site.

Four weeks after fledging, individually marked fledglings were seen up to 2 km from the territory, but they returned to roost near the nest site in the evenings. During this period they were seen to make their first successful captures of large insect prey, and from then on they were not seen to be fed by their parents, although this may have occurred.

There was a general dispersal of the young away from the study area about 7 weeks after they had fledged, that is, in February and early March. Most of the adults that had successfully fledged young left the study area in March. Their departure was preceded by that of the unsuccessful adult females, which left in December and early January. The adult males that had fledged no young left at the same time as the successful adults in March. Presumably the unsuccessful adult females were not as familiar with the pair's home range as the males, and when they no longer received food from the male, they left in search of areas where food was more readily available.

I do not think any birds were fed by their parents after they had left the study area because the adults left about a week after their young and because the many juveniles that passed through the study area in the ensuing weeks were not seen flying near unmarked adults or soliciting prey from them.

DISCUSSION

Population density and spacing mechanisms

The number of territories was identical in 1976-77 and 1977-78. This stability was probably due to the wide range of live prey and carrion items in the Australasian Harriers' diet (Carroll 1968, Redhead 1969, Douglas 1970, Baker-Gabb 1978). Raptor populations that feed on a wide spectrum of prey items are much more stable than those that are food specialists (Newton 1976). For example, Hen Harrier *(Circus cyaneus)* breeding populations may fluctuate greatly when feeding primarily on small mammals, whose numbers are subject to large fluctuations (Hagen 1969, Galushin 1974, Hamerstrom 1979). When feeding mainly on small birds, rabbits and hares, the density of breeding Hen Harriers is much more stable (Picozzi 1978).

Newton (1979) pooled data from more than 50 studies on 22 raptor species, which demonstrated a linear relationship between female body weight and breeding density for populations in which individual pairs foraged in more-or-less exclusive home ranges. The population density I recorded of one Australasian Harrier per 50 ha and one breeding pair per 120 ha was approximately twice as high as that predicted by Newton's (1979) data. However, home ranges of individual pairs of Australasian Harriers overlapped extensively. If breeding density is considered only in relation to the area in which each pair of Australasian Harriers had exclusive hunting access (about 225 ha), a value within the upper limits of Newton's (1979) data is obtained. The high Australasian Harrier breeding density was probably the result of a favourable distribution of prey and of hunting habitat, and a complete lack of competing raptor species at Pukepuke Lagoon.

Besides the availability of food, both the availability of nesting habitat and territorial behaviour influence the density of breeding raptors (Moore 1957, Southern & Lowe 1968, Newton 1976). The breeding density of Australasian Harriers at Pukepuke Lagoon seemed to be limited by nesting habitat because nests were built only in raupo and red-rush swampland and all the suitable nesting habitat was defended.

Home range

The home range size observed for Australasian Harriers was slightly larger than that recorded for Marsh Harriers in Europe by Schipper (1977). This concurs with observations by Schoener (1968) and Newton (1979), who demonstrated that territory and home range size increase with increase in raptor size.

Breeding behaviour

Some of the behaviour and displays I observed have not been previously described for the Australasian Harrier. These include territory-boundary display flights, border patrolling, eviction of intruders, nest inspection, courtship feeding, copulation, post-fledging behaviour and dispersal. Other workers have noted similar Australasian Harrier behaviour for display soaring (Stead 1932), display diving (Sharland 1932, Stead 1932), feeding at plucking stations (Fletcher 1909, Soper 1958) and the post-hatching parental division of labour (Soper 1958). Soper stated that the female seldom brooded the nestlings once the oldest was 4 days old and the youngest about 24 hours old. From fledging dates, I calculated that the females I observed ceased brooding when the nestlings were 7-10 days old. I did not observe groups of Australasian Harriers display diving during courtship, as noted by Sharland (1932) and Fox (1978).

Descriptions of some behaviour similar to that which I observed have been recorded for other harriers: display diving and aerial food passes by *Circus aeruginosus, C. cyaneus,* and *C. pygargus* (Breckenridge 1935, Robinson 1950, Benson 1958, Hamerstrom 1969, Sondell 1970, Johannesson 1975, Brown 1976, Watson 1977); escorting of territory intruders by *C. aeruginosus* and *C. cyaneus* (Sondell 1970, Watson & Dickson 1972); and feeding at cock nests by *C. aeruginosus* (Witherby *et al.* 1943, Johannesson 1975).

Nesting success

Clutch sizes recorded for the Australasian Harrier vary from two to seven eggs with a mean of 4.4 (Table 2). New Zealand

TABLE 2 — Australasian Harrier clutch size

Reference	Mean	Range	Number of nests
OSNZ nest record scheme	4.6	2-7	25
RAOU nest record scheme	3.7	3-5	11

populations lay significantly more eggs than southern Australian birds ($t = 2.72, p < 0.01$). This is probably due to geographical influences because an increase in clutch size with latitude has been well documented by ornithologists (Moreau 1944, Cody 1966).

From two of 15 nests studied, Soper (1958) concluded that the incubation period was 31-34 days. The mean fledging success I recorded (1.8 young) was similar to the mean of 2.1 young fledged from 13 successful nests in New Zealand (OSNZ nest record scheme) and the same (2.1 young) fledging success from 14 successful nests in southern Australia (RAOU nest record scheme). Comparisons cannot be readily made between my data (1.1 young fledged from 19 nests) and the means of 1.3 and 1.6 young fledged from 20 and 19 nests in the OSNZ and RAOU nest record schemes respectively (Table 3). This is because I included both non-breeding territorial pairs and pairs that laid eggs but failed to fledge young as unsuccessful breeders (Postupalsky 1974), whereas birds were included in the nest record schemes only if they laid eggs.

TABLE 3 — Australasian Harrier fledging success

Reference	Young fledged per nest 0	1	2	3
Pukepuke Lagoon	8	4	5	2
OSNZ nest record scheme	7	2	8	3
RAOU nest record scheme	5	2	8	4

Polygyny

Monogyny is the dominant avian mating system, occurring in more than 90% of the bird species studied (Lack 1968). Although the Australasian Harrier has been previously recorded as monogynous (Sharland 1932, Stead 1932, Soper 1958), I found that it is sometimes polygynous. Polygyny has been recorded in at least 11 other species of diurnal raptor and is most common in the genus *Circus* (Schipper 1977, Newton 1978).

The Australasian Harrier hunts mainly swamplands and open grasslands. This behaviour links it with other polygynous raptor species because Newton (1976) stated that polygyny occurred mainly among diurnal raptors found in open country and was most prevalent in areas or years that were unusually rich in food. Orians (1969) suggested that birds inhabiting marshes were also more likely to be polygynous.

Male Australasian Harriers defended all the available nesting habitat at Pukepuke Lagoon. This was a resource with a patchy distribution (Fig. 1) that seemed to limit the density of breeding birds. As in the Australasian Harrier, links between polygyny and patchy resource distribution have been found in other polygynous birds

(Verner & Willson 1966, Zimmerman 1966, Orians 1969, Martin 1974, Stewart *et al.* 1977). This form of polygyny, whereby some males monopolise an important and spatially clumped or unevenly distributed resource, has been termed " resource defense polygyny " by Emlen & Oring (1977).

By monopolising the available nesting habitat, male Australasian Harriers may have increased their likelihood of being polygynous and thereby fledging more young. Although my sample was too small to provide evidence about the fledging successes of polygynous and monogynous males, Balfour & Cadbury (1979) stated that 87 polygynous male Hen Harriers fledged significantly more young per male than 55 monogynous birds. Similarly, other data on polygynous species (Emlen & Oring 1977) agree with Orian's (1969) prediction that polygyny should be advantageous for males and that there should not be a negative correlation between the number of females mated to a given male and the average reproductive success per female. Where this is not the case (Downhower & Armitage 1971, Elliott 1975), differential survival of independent young of monogynous and polygynous pairs may exist, but this is often more difficult to substantiate.

In the one case in my study area where there were two Australasian Harrier nest sites in one male's territory, the first wife was dominant and favoured by the male. The favoured female had a similar fledging success to monogynous females. Similarly, Balfour & Cadbury (1979) found that polygynous Hen Harrier groups which contained up to six females had a favoured first wife. In such groups the first wife had the same fledging success as monogynous females. The Hen Harrier nests socially (Balfour 1962), whereas the Australasian Harrier does not, and the wives of the polygynous male I observed interacted aggressively along their territory boundary. However, once the first wife was incubating eggs she could do little to exclude the second wife.

To gain a mate and a suitable nesting site, a female Australasian Harrier may sometimes improve her chances of reproductive success if she becomes a second wife and mates with an already mated older male. This may result in lower than average breeding success for the second wife, but at Pukepuke Lagoon the only alternative was to pair with first-year males, which held small territories only briefly. If a female is to be a second wife she should, in theory, select an older male because older males were four times more successful hunters than juveniles (Baker-Gabb 1978) and should therefore provide more food. Both of the polygynous males I observed were older birds, distinguishable from young males by their paler ventral surfaces (Oliver 1955, Baker-Gabb 1978).

No differences were apparent between polygynous and monogynous males in the quality of their territories and hunting areas. Perhaps second wives selected a mate on the basis of courtship feeding, which took place daily for at least 6 weeks before the first wife laid eggs. Courtship feeding would test a male's ability to supply food for himself and his mate or mates and would presumably have a selective advantage for greater egg production. It would also act as a predictor of a male's ability to feed the nestlings adequately. Nisbet (1973, 1977) found that courtship feeding indicated the potential of a male Common Tern *(Sterna hirundo)* as a provider. Males made a substantial contribution to the nutritional requirements of the laying females. The amount of food the males provided was one of the factors limiting the number and size of the eggs and also fledging success.

It has been possible to classify the type of polygyny exhibited by Australasian Harriers and some of its characteristics in this study. However, more data are required on its breeding biology before we can understand what balance of environmental and behavioural selection pressures causes the Australasian Harrier to become polygynous.

Conclusion

The breeding behaviour and ecology of the Australasian Harrier have been shown to be similar to those of other harriers that have been extensively studied in the northern hemisphere. A lack of competing open-country raptors in New Zealand, therefore, appears to have had little effect on these aspects of its biology. All harriers except the Spotted Harrier *(C. assimilis)* nest on the ground and all hunt over open grasslands and marshes (Brown & Amadon 1968). This behaviour has probably influenced the similarly spectacular aerial courtship and territorial displays that are accompanied by vocalisations and are performed by all harriers that have so far been closely studied (Witherby *et al.* 1943, Brown 1976, Watson 1977). These displays are a most effective means of communication in habitats that usually have few conspicuous perches to display from. For the same reason, food transfers from male to female are most effectively accomplished in the air. The hunting and nesting habitat may also have an influence on harrier mating systems, for Orians (1969) predicted that birds that inhabit marshes are more likely to be polygynous. If the availability of nesting habitat is often an important limited resource for other harrier species, as it was found to be for the Australasian Harrier in this study (" resource defense polygyny " of Emlen & Oring 1977), this may further explain why polygyny is so common within the genus *Circus.*

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SHORT NOTE

MIGRATORY MOVEMENT OF SILVEREYES AT FAREWELL SPIT

While working in the 8-10 km part of Farewell Spit on 15 May 1980, we realised that the faint background sounds of Silvereyes *(Zosterops lateralis)* were coming not from the dune vegetation but from high overhead. During this and the next two days, whenever we were away from the sound of wind or surf on the Central Flats of the spit or on the farm at the base, we recorded a daytime passage of small flocks of Silvereyes.

From about 1100 on the 15th, when we first noticed that the calling was from overhead, calls were continuous until nearly 1200. Judging by sound, most flocks comprised 20-30 birds. They were seldom visible to the naked eye, and few were seen even with binoculars. Two flocks of c.30, two of c.60, and one large one of c.100 were seen, all tightly bunched, flying eastwards along the spit about 150-200 m above the ground. Only one flock of c.30 was seen in the dune lupins, the birds calling excitedly and taking off eastwards along the spit.

On the 16th, four small flocks were heard flying high over the base of the spit between 0600 and 0700. At 7 km on the spit, at least 18 flocks passed high overhead between 0815 and 1200, but we spent about an hour of this time within sound of the Ocean Beach surf, and we were travelling and not listening between 0700 and 0815. Flocks passed at intervals ranging 1-20 minutes apart, and four flocks sounded large. The audible passage diminished toward midday, and only occasional small flocks were heard thereafter. The only Silvereyes seen on the dunes were groups of nine and six flying low at the 10 km mark.

On the 17th, more birds were seen in the dune lupins, several small flocks of 15-20 at 7 km, and one of 100+, which was disturbed from the lupins by a Harrier *(Circus approximans)* and flew eastward along the spit. At the lighthouse (22 km along the spit), no birds were heard overhead, and only a few were in the trees and lupins about the lighthouse settlement. At Mullet Creek, 15 flocks were heard on passage between 0815 and 0915, six of which sounded large. Thereafter, flocks were fewer but sounded large.

Birds were not gathering in the trees and scrub at the base of the spit in the evening or early morning, and no night-flying flocks were heard, although listening checks were made.

These observations, although inadequate to estimate numbers, show that a strong movement of Silvereyes occurred eastward along Farewell Spit from the south during 15-17 May and presumably before and after those dates. The main movement seemed to last throughout the morning, diminishing towards noon. After noon, flocks were fewer, though often quite large, and ceased about mid-afternoon. Most birds were flying very high in small tight flocks, almost beyond the range of hearing, and others may well have been higher still and beyond range. The line of the spit was being followed at least to Mullet Creek, but not to the tip. Presumably, the birds were heading to the North Island with a landfall somewhere between Mt Egmont (visible even from the ground in fine weather) and Manawatu because, if they followed the curve of the spit to its tip at the lighthouse, they would be directed back to the South Island, an absurd manoeuvre.

This is not the first account of mass movements of Silvereyes in New Zealand. Buller (1888, *History of the birds of New Zealand,* 2nd ed.), by his description of the appearance of Silvereyes in the North Island indicated that a regular migration from the South Island took place, for they appeared in six winters before they started nesting. Stead (1932, *Life histories of New Zealand birds*) noted that a considerable seasonal migration began about the middle of April, and for one month Silvereyes could be heard flying north over Christchurch at almost any hour of the night. Dawson (1961, *Notornis* 9: 200) reported an east-to-west movement at night high over Christchurch on 11-12 April 1961 of small flocks judged by sound to contain at least 20 birds. Grant (1970, *Notornis* 17: 322-323) reported a West Coast passage past Greymouth of up to 2000 birds per hour, mainly in the morning and late afternoon in early June 1970. The flocks, which ranged from 10 to 100, travelled close to the ground, settling in bush and scrub for the night.

If, as at Farewell Spit, flocks travel high, they will not be noticed easily, except in unusually quiet conditions, and so what may well be an annual event in the April-June period can easily pass unnoticed. No reports exist for a similar return movement.

M. D. DENNISON, B. D. HEATHER, H. A. ROBERTSON

SPECIFIC AND SEXUAL DIFFERENCES IN BODY MEASUREMENTS OF NEW ZEALAND HONEYEATERS

By JOHN L. CRAIG, MURRAY E. DOUGLAS,
ANNE M. STEWART, and C. RICHARD VEITCH

ABSTRACT

Morphometric measurements of the three New Zealand honeyeaters show that Stitchbirds and Bellbirds are of a similar size and both are markedly smaller than Tuis. Males are larger than females in all three species but few measurements appear reliable discriminators of sex. Some implications of these differences are discussed briefly.

INTRODUCTION

Body measurements of birds can be used to determine sex and also to help assess the degree of competitive overlap between similar species. For example, bill size is often used to predict range of food sizes eaten (Keast 1968, Schoener 1974) while sizes of other body characteristics have been related to feeding site (Ford & Patton 1976), to range size (Schoener 1968) and to interspecific dominance rank (Stiles & Wolf 1970, Ford & Patton 1976, Feinslinger & Colwell 1978).

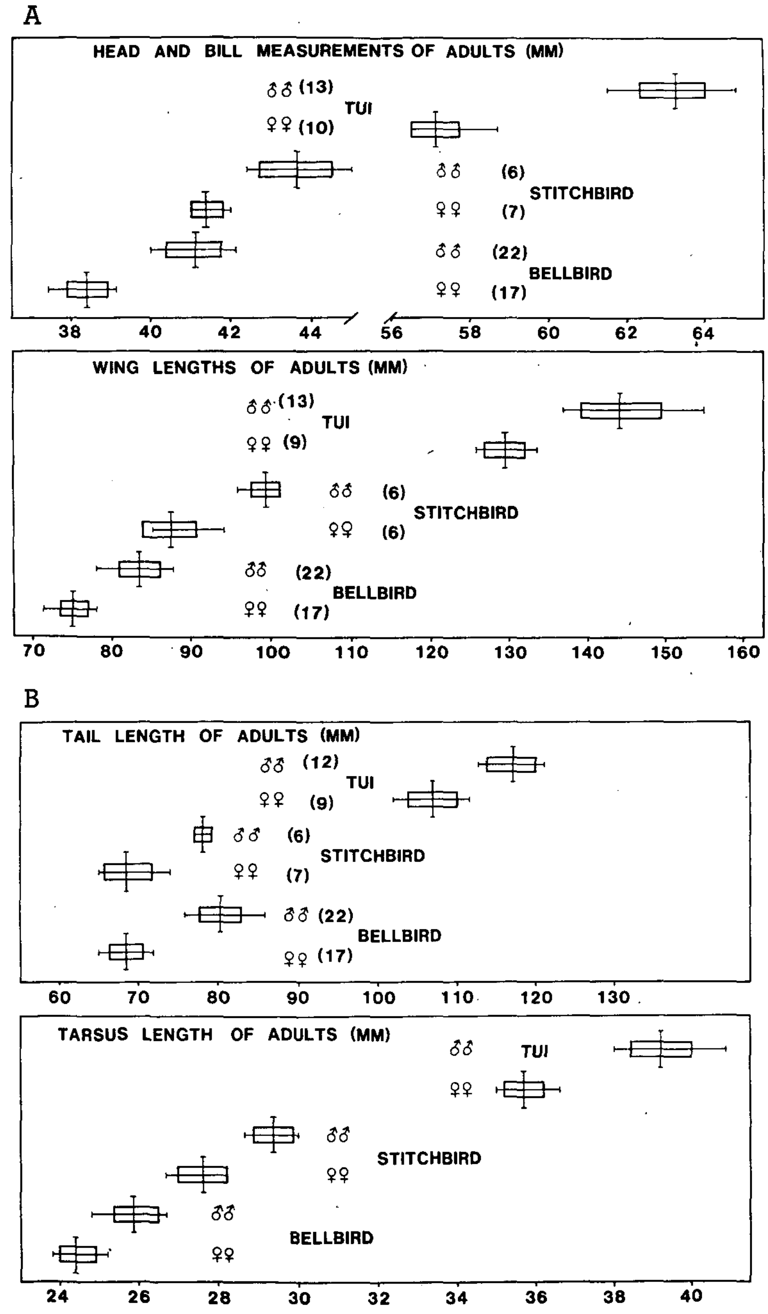
This paper presents preliminary data on the body measurements of the three New Zealand honeyeaters. These species, the Tui *(Prosthemadera novaeseelandiae)*, the Bellbird *(Anthornis melanura)*, and the Stitchbird *(Notiomystis cincta)* all feed on nectar, insects and fruit. There is conflicting data on the relative proportion of these items in their diets (Craig, Stewart & Douglas 1981) and comparative body measurements are required to assess predictions related to body size. Dimensions of beaks are available (Gravatt 1970, 1971) but not of other body characteristics. Adult Bellbirds and Stitchbirds are sexually dimorphic in plumage, but the sex of Tuis and of juvenile Bellbirds and Stitchbirds is not easy to determine visually. Body measurements that best distinguish sex are required for each species.

METHODS

All measurements were taken from live birds caught in mist nets. Tuis and Bellbirds were measured between 1974 and 1979 on Tiritiri Matangi Island and the adjacent Whangaparaoa Peninsula. The Stitchbirds measured were caught in April 1980 on Little Barrier Island for release on Hen Island.

All birds were classified as adult, juvenile, or unknown by their

NOTORNIS 28: 121-128 (1982)


A
HEAD AND BILL MEASUREMENTS OF ADULTS (MM)
♂♂ (13)
TUI
♀♀ (10)
♂♂ (6)
STITCHBIRD
♀♀ (7)
♂♂ (22)
BELLBIRD
♀♀ (17)
38
40
42
44
56
58
60
62
64
WING LENGTHS OF ADULTS (MM)
♂♂ (13)
TUI
♀♀ (9)
♂♂ (6)
STITCHBIRD
♀♀ (6)
♂♂ (22)
BELLBIRD
♀♀ (17)
70
80
90
100
110
120
130
140
150
160
B
TAIL LENGTH OF ADULTS (MM)
♂♂ (12)
TUI
♀♀ (9)
♂♂ (6)
STITCHBIRD
♀♀ (7)
♂♂ (22)
BELLBIRD
♀♀ (17)
60
70
80
90
100
110
120
130
TARSUS LENGTH OF ADULTS (MM)
♂♂
TUI
♀♀
♂♂
STITCHBIRD
♀♀
♂♂
BELLBIRD
♀♀
24
26
28
30
32
34
36
38
40

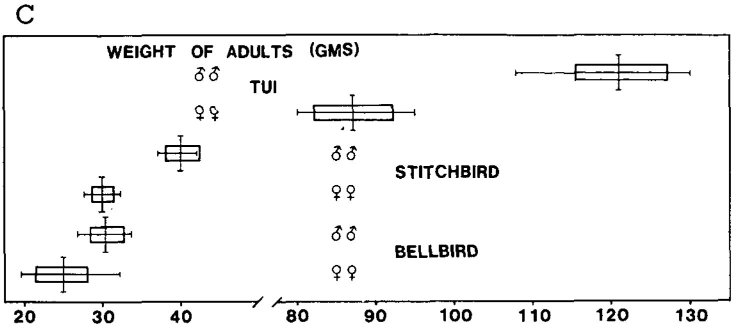


FIGURE 1 — Measurements of adult male and female honeyeaters. Horizontal lines indicate the range of observed values; vertical lines designate the mean; open rectangles enclose one s.e. above and below the mean. Sample sizes are as for Head + Bill Length unless otherwise stated. 'Tarsus' = tarsometatarsus.

plumage. Adult Bellbirds and Stitchbirds could be separated into male and female by plumage, whereas the sex of Tuis was determined by observation of mated pairs. The sex of juvenile Bellbirds was determined by song and subsequent observations of the birds as adults. Juvenile Stitchbirds were tentatively assigned as male if they had yellow feathers on the wing as in adult males. Juveniles lacking these feathers were presumed to be female.

Because many workers were involved, only those body measurements which have minimum operator error were used. These measurements are (i) head plus bill length — the maximum length from the tip of the bill to the back of the skull, including depressed feathers; (ii) wing length; (iii) tail length; (iv) modified tarsometatarsus length — from the notch to the edge of the bent-over foot; (v) weight.

The data were not analysed statistically because of the small samples and because we wanted to find absolute measures for determining sex, i.e. those for which there is no overlap.

RESULTS

Tuis are markedly larger than Stitchbirds and Bellbirds for all measurements (Fig. 1). Except in tail length, Stitchbirds tended to be larger than Bellibrds, although the measurements overlapped considerably.

Males were larger than females in all measurements and in all three species. Using the summed difference between means, the difference between the sexes was 16% for Tui, 14% for Stitchbird, 13% for Bellbird. Overlap between the sexes occurred for some measurements for each species, the degree of overlap being greatest in the Bellbird. In contrast, the Stitchbird and Tui appear markedly dimorphic for most measurements, perhaps because of too small a sample size.

Those body characters in which the ranges of males and females do not overlap may be useful for determining the sex of captured birds. However, to determine the real value of any body character as an indicator of sex, results for all birds of all ages must be used. The ideal character is one in which there is a bimodal distribution of measurements and no overlap. If overlap occurs, principal component analysis may be required to determine which characters or sets of characters best discriminate between the sexes (cf. Craig, McArdle & Wettin 1980). Each honeyeater is considered separately and results are summarised in Table 1.

TABLE 1 — Measurements that can be used to discriminate the sex of honeyeaters

	Male	Female
(a) Tui		
head + bill length*	≥ 60.0 mm	< 59.5 mm
'tarsometatarsus' length	≥ 38.0 mm	< 38.0 mm
weight	≥100 g	<100 g
(b) Stitchbird		
head + bill length	≥ 42.5 mm	< 42.5 mm
'tarsometatarsus' length	≥ 28.5 mm	< 28.5 mm
wing length	≥ 90.0 mm	< 90.0 mm
(c) Bellbird		
head + bill length*	≥ 40.0 mm	< 40.0 mm
tail length*	≥ 74.0 mm	< 72.0 mm

* reliable discriminator

Bellbird (Fig. 2): Using measurements of birds of all ages, head + bill length and tail length retain disjunctive distributions and so can be used to discriminate reliably the sex of any Bellbird. Tarsometatarsus and wing length are strongly bimodal, but overlap does occur. Thus, Bellbirds with a head + bill length exceeding 40 mm and a tail length exceeding 72 mm are male. Smaller birds are female (Table 1).

Stitchbird (Fig. 3): There is some overlap between the sexes for all measurements of Stitchbirds of all ages. The least overlap occurs for head + bill length, tarsometatarsus length, and wing length. As the sex of juveniles was doubtful, some misplacement of individuals was likely. Thus, if the single odd individual is omitted, males can be taken as those with a head + bill length of 42.5 mm or more, a tarsometatarsus of 28.5 mm or more, and a wing length of 90.0 mm or more. Smaller birds are considered female (Table 1).

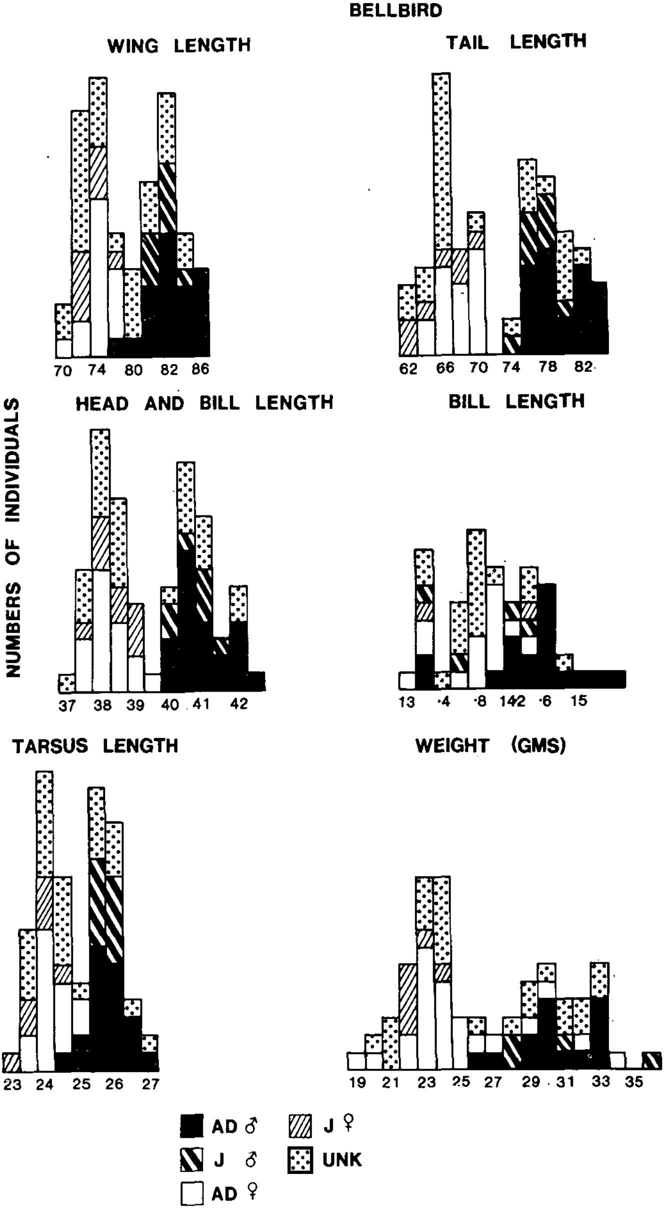


FIGURE 2 — Size frequency distribution of selected Bellbird measurements according to sex and age. Lengths are in mm. 'Tarsus' = tarsometatarsus.

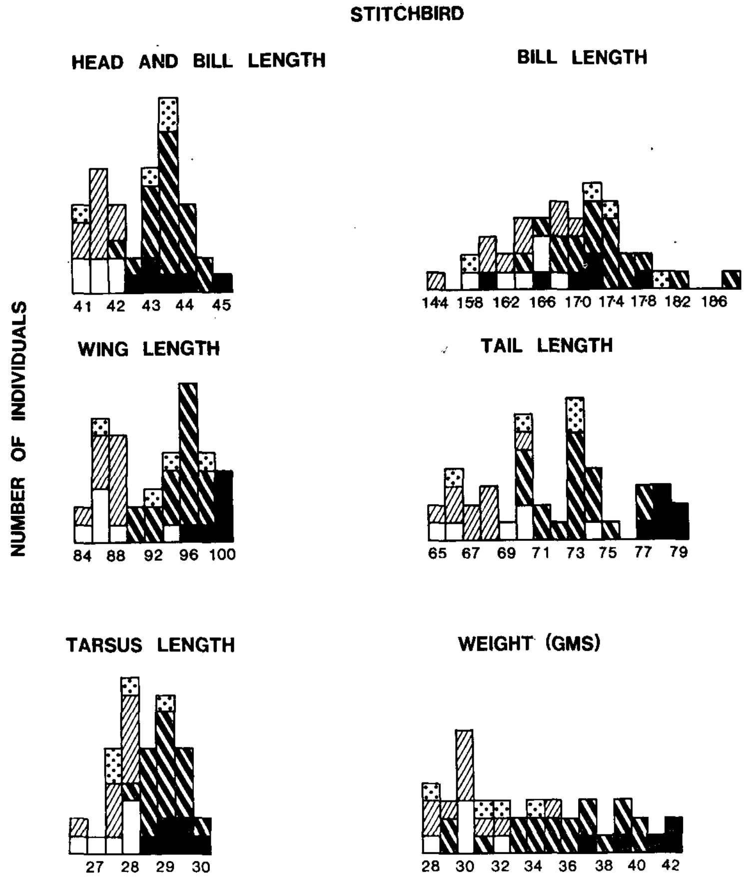


FIGURE 3 — Size frequency distribution of selected Stitchbird measurements according to sex and age. Key as in Fig. 2.

Tui (Fig. 4): Head + bill length, weight, and tarsometatarsus length appear to be good discriminators of the sex of Tuis of all ages. Tarsometatarsus length is strongly bimodal, but the presence of individuals of unknown sex in every size class makes minor overlap a possibility. Head + bill length is the best measurement for discriminating sex. Thus, males have a head + bill length greater than 60.0 mm and a tarsometatarsus of 38.0 mm or more. Females are smaller (Table 1).

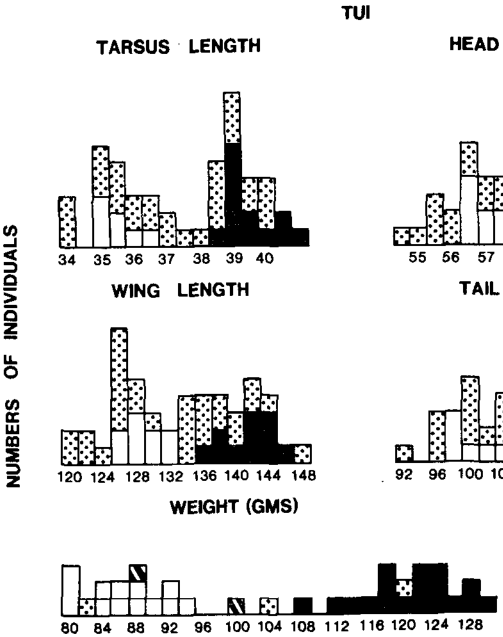


FIGURE 4 — Size frequency distribution of selected Tui measurements according to sex and age. Key as in Fig. 2.

DISCUSSION

The three New Zealand honeyeaters are all dimorphic for many body characteristics. In our samples, weight appeared to be a possible discriminator of sex for Tui and possibly Stitchbird, but sample sizes are small and weight is variable in many birds. This is true for Bellbirds where repeated measuring of individually colour-banded birds showed marked individual changes (Craig & Douglas, unpub.). For example, RW-AW (♀) on 12 May 1977 was 24.0 g. By 23 June 1977, she weighed 29.5 g and on 28 February 1978, 34.2 g. A-YRG (♀) weighed 32.0 g on 16 March 1977 but only 24.3 g on 12 April 1978. Many smaller changes are known and can be related to the demands of breeding or to local variations in food supply. Body weight is therefore unreliable, and its use is not recommended for any species.

The Tui is much larger than Stitchbird and Bellbird, which suggests that they differ in many aspects of their biology. Taken with the 60% larger bill size (Gravatt 1970) Tuis can presumably take larger-sized food items than the other two species, but their greater size and weight presumably exclude them from feeding within small enclosed feeding stations or on fine plant parts. Comparable separation is unlikely to occur between Bellbird and Stitchbird. Some difference between these latter species is predicted as a result of competition (see Craig, Stewart & Douglas 1981). Gravatt (1970, 1971) showed that both Bellbirds and Stitchbirds use the shrub to canopy layers of the forest but his claimed differences in food and feeding station of these similar sized honeyeaters result, at least in part, from recording the species unequally in different habitats and seasons. Further work on such microhabitat differences is required.

The competition avoidance hypothesis states that sexual dimorphism in size is favoured where it reduces the competition between males and females (e.g. Selander 1966, 1972). There is strong competition between individuals of all three honeyeater species, especially in winter, and the sexual dimorphism demonstrated in many measurements for these species may serve to reduce competition between the sexes (see Craig, Stewart & Douglas 1981, for further comments).

ACKNOWLEDGEMENTS

We are grateful to the Little Barrier Stitchbird party, Tim Lovegrove, Gay Craig, Ross Weber, and many others for assistance in the field. The Hauraki Gulf Maritime Park Board gave permission to work on Tiritiri and Little Barrier Islands and the Ministry of Transport assisted with travel. Financial support was provided by the Auckland University Research Committee and the National Provident Fund. Mrs Mutch allowed access to her Whangaparaoa property. We are grateful to Ian McLean and Malcolm Crawley for comments on the manuscript.

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NEW ZEALAND DOTTEREL (Charadrius obscurus) — AN ENDANGERED SPECIES?

By SYLVIA M. REED

The scheme for individual banding of New Zealand Dotterel *(Charadrius obscurus)* was started by H. R. McKenzie in 1950. From 1950 to 1974 only fledglings were banded. Juvenile mortality is high. The colour bands at first used wore off in a very short time (McKenzie, 1978, *Notornis* 25: 186-194).

The scheme is a continuing project with the aim of learning more about this species' breeding biology, distribution and population trends. Much has yet to be learned.

The main difficulties have been to catch enough birds to band, and then to follow them up. Until the 1970s, observers were few and many areas infrequently visited. Even now, with the best of conditions, it is not easy to read band combinations accurately without the aid of a telescope. The birds seem to like to play a game of hiding their legs behind a ridge of shell or sand, or of running off with fast twinkling steps the moment you have sharply focused on their legs. They favour areas not too far from brackish water where it meets the shore. No birds are found on long stretches of completely dry sand or shell.

The first adult to be banded was a female caught on a nest at Mangawhai on 2/11/74; males are more difficult to catch as they do not normally incubate. Subsequent catching of adults has taught that, although the birds are quiet and easy to handle once caught, individual temperaments vary considerably. Nest trapping has not resulted in any nests being deserted. During 1980 and up to March 1981, 14 birds have been caught in nets (cannon and clap) in late summer and autumn when they are in small flocks. (Here, may I insert a plea for the use of the collective noun "trip"? It is both apt and distinctive.)

Behaviour of marked birds: Banded birds seen repeatedly and often in the same place become personal friends. Many have acquired names that help you remember the colour-band combination. For example, Gerald (GR-M) and his mate Gabbie (M-GB) are known to have bred together on the same territory from 1975 to 1981. They are excellent parents, rearing one or two chicks each year. Unfortunately none of the five chicks banded has been seen after its first winter. A fine example is Wimble (WB-M), the oldest known inhabitant who was last seen on 12/11/80, being then 30 years old (McKenzie, *ibid*). In spring 1978, his partner Wardle (WR-M) disappeared, and she has not been seen since. On subsequent sightings, Wimble has been on territory but without a mate until 12/11/80 when he seemed loosely associated with another banded bird but apparently was not breeding. Wimble's temperament is as befits a placid old gentleman. In contrast is Regal (RG-M), banded as a chick at Mangere Airport on 15/12/74, who attempted to breed at the Mangere Oxidation Ponds in 1977. A feckless, flighty, restless type, she laid one egg, deserted it, laid another in a different area, deserted that, returned to the original area

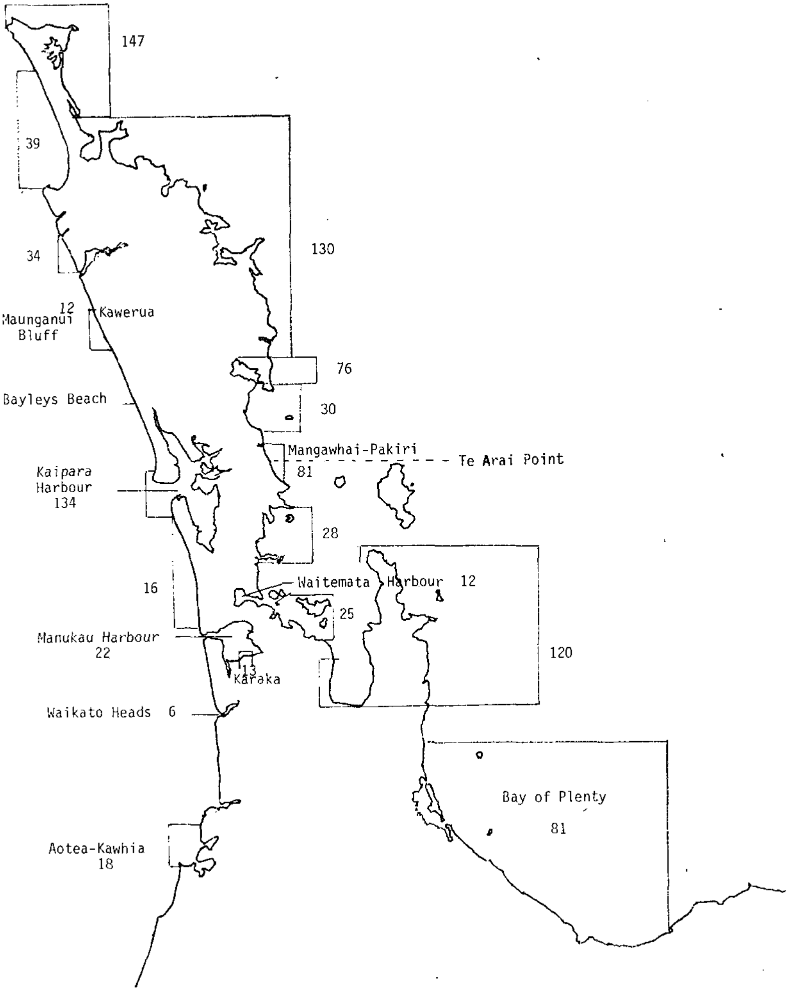

FIGURE 1 — Distribution and population of New Zealand Dotterels in the North Island. Coast not bracketed is either unsuitable as dotterel habitat or not recently surveyed.

and gave up ideas of any more breeding that season. In 1978-79 she turned up at Mangawhai but there was no evidence of her breeding there. She was last seen at Karaka on 26/1/81.

The area most consistently studied to date is Mangawhai-Pakiri (approx. 20 km of coastline). The population there remains fairly static at 70-80 birds. Except for Te Arai Point, this used to be one long stretch of beach backed by sand dunes, but in July 1979 a big storm created an island of the tip of Mangawhai Spit. Between 1974 and 1981, 33 birds (16 chicks, 14 adult females, 3 adult males) have been banded in the area. Few have wandered far. A count on 25/4/81 gave a total of 81 birds, 17 of which were banded. All these 17 had been banded in the area, which besides being a flocking area is also a favourite breeding ground. Although a Refuge, it is subject to a good deal of disturbance from dogs, motorbikes, and innocent beach users who are unaware of the damage they can cause when they wander and play close to the well-camouflaged nests.

The shellbanks at Karaka (see Fig. 1) have been a known breeding area for many years. Three females, banded when adult, are frequently seen there; one of them (Bluey, BY-M) commutes regularly between there and Waikato Heads, and she has attempted to breed in both places. One day she beat an observer back from the Heads to Karaka ! At Karaka, rats have been troublesome — controlled later by poisoning. Breeding success has remained low, and only two chicks are known to have fledged in the past three seasons. One permanent resident, Whitley (WY-M) has not managed to rear a chick since she was banded in 1976, and in the last two seasons, though paired, did not make any known attempt at nesting. Are some birds intermittent breeders ?

The Waitemata Harbour population, though small (c.12 birds) has had better breeding success. Pairs are widely scattered in different arms of the harbour, but in one season (1979-80) three pairs nested in the comparatively small area of shellbank and short mangroves at Shoal Bay while traffic on the main north highway roared past only about 100 m away. The females of each pair are banded and are often seen on an adjacent beach during the non-breeding season.

Although the banded birds are few in relation to total population, study of them has led to the following tentative conclusions:

1. Birds remain paired for life and can live up to 31 years.
2. Once established on a breeding ground, they return to the same area each year.
3. The flocking period is short, lasting approximately from February to early May, but some birds remain in pairs all the year round.

Plumage changes: An attempt has been made to follow plumage changes of breast and belly colour through the seasons, using the following code:

1 = pure white underparts
2 = some sparse smudges of colour
3 = colour more generally spread but still patchy
4 = well diffused, evenly spread over most of the underparts
5 = rich glowing chestnut, outstandingly bright from throat to belly

Only colour-banded birds are recorded. The broad conclusions from this survey are

1. In late April-May most birds are in category 1.
2. The degree of colour developed in the breeding season reaches the same category for the same individual each year.
3. Comparatively few males attain category 5.
4. For a short period, late in the breeding season, both male and female can have the same degree of colour.
5. Chicks also have their individual degrees of breast colour. Usually all colour is lost soon after they are flying. They may develop considerable colour in their first summer but it is unlikely that they breed until at least 2 years old.

Population: The best time to make a count is during the flocking season. This is possible within about 60 miles of Auckland City but difficult further north where observers are few and access is not easy; hence, breeding season figures are used in a few places. It is known that many breeding grounds are deserted in the flocking season.

Numbers on the map, taken from records made 1979-1981, show reliable counts for areas south of Whangarei; north of there, a few records are older. In assessing the population figure, the few sightings of birds south of the map area have been ignored as they would make little difference to the total. Numbers on the map add up to 1024. A. T. Edgar's estimate for the North Island was 1114 (Edgar, 1969, *Notornis* 16: 85-100). Allowing for birds missed from counting and areas not surveyed, the population appears fairly static.

The most recent report from the far south is of 21 birds at Awarua Bay, Southland, on 29/3/80, but the whole Stewart Island (or southern) population could be some 200 birds. In the south, the problem is lack of observers in the right place at the right time and very difficult access. The origin of the few birds which occasionally appear at Farewell Spit remains a mystery as no banded bird has been seen there.

A species with a total population of fewer than 1400 is surely entitled to be classed as " endangered."

I am indebted to many OSNZ members for records supplied, especially to Graeme Peterson and Russell Thomas for their meticulous observations and their help and suggestions. My thanks go also to R. B. Sibson for checking over this article.

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SHORT NOTES

WHITE-FACED HERON FLEDGLING WITH A DEFORMED BILL

On 30 October 1980, during routine observations as part of a study of the White-faced Heron *(Ardea novaehollandiae)* near Tangimoana, Manawatu, I found a heron nest containing two live young and an infertile egg. Judging by the growth rates of chicks in other nests I estimated these birds to be about 4 weeks old; the fledging period is about 6 weeks (Falla *et al.* 1979, *A new guide to the birds of New Zealand*). One chick appeared to be normal, but the less well-developed chick had a distinctively deformed bill (Fig. 1). As far as I know, this has not previously been recorded for the species in New Zealand. On a second visit to the nest (6 November 1980), both chicks were still present, although the more advanced bird flew away quite strongly as I approached. This bird was not seen on 13 November, when the deformed chick was found dead beneath the nest. Neither parent was seen on any visit, although one or both presumably were attending the nest up to at least 6 November.

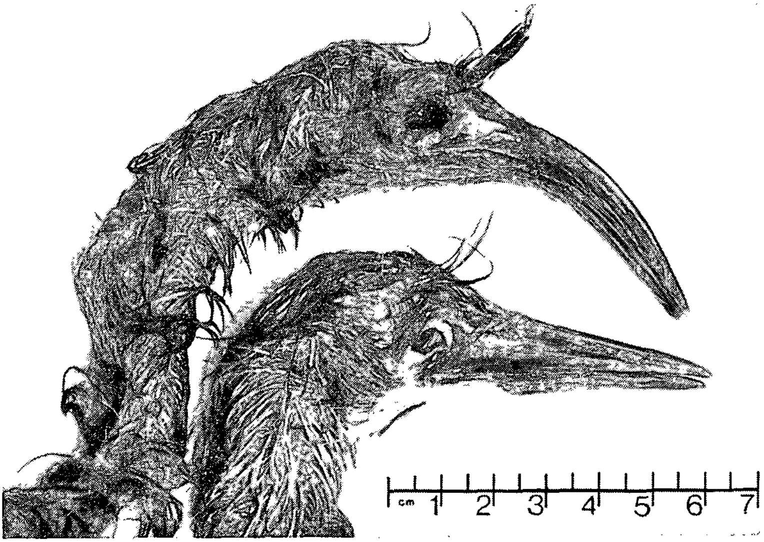

FIGURE 1 — Comparison of a normal White-faced Heron chick, about 3 weeks old, with the deformed chick.

Photo: B A. Campbell

NOTORNIS 28: 133-143 (1981)

It is interesting to speculate to what extent (if any), the misshapen bill retarded growth in the deformed chick. Although both chicks appeared similar in size, the plumage of the normal chick was further advanced than that of the deformed chick. From observations of other White-faced Heron nests, siblings from about 2 weeks of age onwards appear to be equally developed. This suggests that the bill deformity did have a detrimental influence upon the chick, perhaps in the success with which food was transferred from parent to young.

PETER L. LO, *Department of Botany and Zoology, Massey University, Palmerston North*

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INTEGRITY OF DIAGNOSTIC CHARACTERS FOR HUTTON'S SHEARWATER

Not all the problems in differentiating *Puffinus huttoni* from *P. gavia* in beach-washed specimens arise from their incompleteness or state of decay. Harrow (*Notornis* 23: 269-288), working on the breeding grounds of *P. huttoni,* noted a few to have faint white tips to the axillaries.

During January 1981, Lindsay Davies, Bob Creswell and I examined the diagnostic features of 100 *P. huttoni* at an upper Kowhai colony. Like Harrow, we found several with faintly white-tipped axillaries, but in addition at least one had very obvious white tips. One bird had an aberrant axillary that had one vane with alternate brown and white barring. The bars were 1 mm wide and ran the full length of the vane.

In *P. huttoni,* the lateral under tail-coverts have black or grey markings, sometimes filling the outer vane (Serventy *et al.* 1971, *The Handbook of Australian Sea-birds,* p. 137). However, three (3%) of the birds examined had all their under tail-coverts pure white, as does *P. gavia.* These birds had the dark under wing-coverts of *P. huttoni* and, being in the *P. huttoni* colony, presumably were *P. huttoni.* Apparently, then, just as measurements alone need not be diagnostic for these two species, no one plumage character, by itself, is sufficient for identification either.

M. K. TARBURTON

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UNUSUAL WANDERING OF A SPOTTED SHAG

On 8 December 1979 I patrolled Papa Aroha and Hautapu beaches, about 9 kilometres north-west of Coromandel township. A strong westerly wind was blowing, and had been for at least 24 hours.

Just south of Opouri Point I found a Spotted Shag *(Stictocarbo punctatus punctatus)* asleep half-way up a clay bank above the high-tide mark. As I approached the bird I noticed it had a red plastic band on its right leg. I caught the bird before it was aware of my presence, and found it had a metal band 0-20838 on its left leg. The bird was very weak and died about an hour later.

The bird was a female. Measurements in millimetres were: culmen 56.5, wing 253, tail 107, tarsus 60.6, mid-toe and claw (2nd from outer edge of foot) 75.4. Its weight was 0.12 kg. The tenth (last) primary on the right wing was only half grown.

The shag had been banded as a chick on 27 July 1979 on Somes Island, Wellington, by R. W. Benfell.

The banding location greatly surprised me. Spotted Shags are common in the Hauraki Gulf; there is a colony about 7 km from where I found the bird, and I assumed it had been banded locally, although I was unaware of any Spotted Shag banding programme. The bird had travelled a straight-line distance of 500 km, but by the most likely coastal route, via East Cape, the distance is closer to 1100 km.

Although Spotted Shags formerly bred at Cape Kidnappers, and have been reported at Rurima Rocks, Bay of Plenty (Oliver, 1955, *New Zealand birds*), they are now apparently absent from at least 1000 km of this coastline.

Admittedly little can be concluded from a single recovery, but such a movement has interesting implications involving population isolation in an apparently sedentary species. I would be very pleased to know if readers have other records of the wandering of Spotted Shags or to know whether this species is seen along the East Coast of the North Island and in the Bay of Plenty.

— Colin Miskelly

At Somes Island in Wellington Harbour, the Spotted Shag nests on Shag Rock, an outcrop of rocks at the south-west corner of Somes Island. Since I took up employment on the island in July 1972 and we found our first Spotted Shag eggs (3) in November 1973, my wife and I have banded 165 young shags, reaching peaks of 41 in 1979 and 28 in 1980. When we found that banded birds were starting to nest, we decided to use a colour for each year; so far red in 1979, blue in 1980, and yellow in 1981, so that we can easily tell the age of first nesting.

For two years, the shags have nested in two periods of the year, June to August and November to January, and in the 1980-81 summer, young birds have even built unused nests on the north-west corner of Somes Island itself. Out of 17 recoveries, the only other record away from the Wellington area was from the southern Wairarapa.

— Ray Benfell

COLIN MISKELLY, 3 *Castleton Drive, Howick, Auckland;* R. W. BENFELL, *Somes Island, P.O. Box 38155, Petone.*

NESTING SEASON OF THE FIJI GOSHAWK

A common misconception that the Fiji Goshawk *(Accipiter rufitorques)* nesting season extends roughly over the first half of the year traces back to Ernst Mayr's (1945: 127) statement that the season lasts from February to June. Mayr apparently drew on Layard's (1875a: 424) firsthand records of " fresh eggs in February and May, and hard set ones in the same months," and (1875b: 29) " young with down on them in May."

While Layard clearly recorded nesting in February and May of one year, this appears to have been exceptional, occurring outside the usual peak breeding season of Fiji Goshawks. My own experience and all other records I know of indicate the usual nesting season as extending from July or August through to November or December, most eggs being laid in September and October. Some pairs may occasionally nest at other times of year, but I suspect that Layard's records may have been of a late renesting, perhaps following disruption of the usual nesting season by hurricane.

Layard himself found evidence of the usual breeding season, regarding eggs brought to him in September (1875b: 29) as " probably a second laying." In August and September he found the hawks " breeding freely " in forests on Taveuni Island, and in October he collected an egg on Ovalau Island (Oates 1902: 246).

September and October egg dates and nest records dominate other literature. MacGillivray (Oates 1902: 246) collected eggs in October 1856. Wood (1926: 109) found a nest with a lone egg on Vanua Levu on 3 October 1923, and Brown & Amadon (1968: 513) give an October egg date. Blackburn (1971: 154) reported nesting on Taveuni and in the Nausori Highlands of Viti Levu in August and September 1970. Two nests were seen on Taveuni in August and September 1973 (B. D. Heather, pers. comm.) and another was found on Vanua Levu, while Bill Beckon (pers. comm.) photographed a Taveuni fledgling with considerable down remnants in mid-November 1976. Working mainly in the Sigatoka Valley of Western Viti Levu, R. J. Watling (pers. comm.) saw nests, three of which had birds incubating in September, another in October.

On Taveuni, which supports a very high goshawk population, I found nine occupied nests between 20 September and 13 October 1972. Three nests were in raintrees *(Samanea saman)* on coconut plantations, four in selectively logged forest, one on the forest verge, and one in a large forest clearing. Incubation was definitely in progress at four of the nests, two of which were within 400 metres of each other. Old abandoned nests were found within 100 metres of two occupied nests, suggesting pairs may return to established nesting territories.

Further evidence of a September-October nesting season peak comes from central Viti Levu. Near Nadrau, at the headwaters of the

Sigatoka River (Clunie 1979), I recorded a nest with two chicks in mid-October 1979, at Tatuba further downstream on the Sigatoka River I saw a nest attended by a pair of adults in mid-September 1971, and several kilometres upstream, on 1 October, I watched an adult male displaying over grassy hills. He made long, shallow but fast dives at a clump of trees on a hill top, with a sudden jerk down and fling up at the end of each dive, eventually crossing the river at great height to hills further upstream. Here he repeated the manoeuvre 10 times, diving at trees on a ridge crest and making a violent undulation over them. Blackburn (1971: 155) recorded similar display flights with " dives and abrupt upward swoops."

Circumstantial evidence for a nesting season late in the year comes from Suva city. Goshawks all but disappear from the city in late August, reappearing slowly from the end of December with a sudden remarkable influx of young birds in February. The hawks presumably leave the city to breed. Parents and young may associate for a considerable time after leaving the nest, juveniles in company with adults being often seen in February and March. Pairs of apparent siblings also are quite often seen as late as March, playing and roosting together.

Further support for an August to December nesting season is found in the gonads of adult goshawks I have seen dissected. A female killed near Suva in mid-February 1975 was not in breeding condition. The testes of a male on Ono (Kadavu) in mid-May 1975 were slightly swollen and the ovaries of two females showed early signs of development. On Vanua Levu in June 1974, the testes of two males were slightly swollen but the ovaries of a female were not advanced. Testes of a Viti Levu male in August 1973 were markedly swollen and the ovaries of a female were well developed. On Taveuni in September 1972, a female with advanced ovaries and a large naked brood-patch was dissected, two other females having the ovaries less advanced. Three adult males and a male in moult from juvenile to adult plumage were all in full breeding condition.

The Fiji Goshawk nesting season therefore seems to be from August to November or December, records from February to May perhaps being unusually late nests, or renesting due to disruption of the normal nesting cycle.

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FERGUS CLUNIE, *Fiji Museum, P.O. Box 2023, Suva, Fiii.*

KERMADEC STORM PETREL

In October 1980, MV *Holmdale* was to relieve the personnel and to deliver stores to the station at Raoul Island. At Wellington I discussed with Peter Nesfield, who was to sail in the ship, the need to watch for the rarely reported Kermadec Storm Petrel *(Pelagodroma marina albiclunis)*.

At 1900 on 15 October 1980, when the ship was near Curtis Island, Peter was fortunate to get one of these birds on board. It was kept until the next day, when he photographed and released it. The distinctive white rump was immediately noticeable.

Previous records up to 1967 are given in Merton (1970, *Notornis* 17: 147-199). Subsequently it was reported by Jenkins (1980, *Notornis* 27: 97).

JOHN JENKINS

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HUDSONIAN GODWIT IN FIJI

A Hudsonian Godwit *(Limosa haemastica)* was seen by NJS at low tide on the sand and mud flats at Suva Point on 2 and 3 May 1981, and identification was confirmed by both of us on 9 May. This seems to be the first definite record for this wader for Fiji, although there were local reports of a black-tailed godwit seen at Suva Point in 1980.

On all occasions, the bird was associating with two or three Eastern Bar-tailed Godwits *(Limosa lapponica)* and we could closely compare the two species. The Hudsonian Godwit was about the same size as *L. lapponica* but seemed slightly more slender in build. It was in non-breeding plumage, with dull brown upperparts, darker and less mottled than the Bar-tailed Godwits. There was a distinct line of demarcation between the brown upper chest and the white underparts. The bill had a slight upward curvature towards the tip, was pink at the base and black tipped, and about twice as long as the width of the head. There was an indistinct pale eyestripe, less marked than in *L. lapponica.* In flight, the terminal black band on the tail and the white rump were conspicuous. There was a narrow but distinct white bar at the base of the primaries, and the underwing was blackish. Both the absence of a broad white wing-bar (Condon & McGill 1974) and the underwing colour (Falla *et al.* 1970) enable this species to be distinguished in the field from the Asiatic Black-tailed Godwit *(Limosa limosa melanuroides)*, which migrates regularly to the Australian region and with which we are both familiar.

The Hudsonian Godwit breeds in arctic Canada and perhaps locally in Alaska (Peterson 1961) and its main summering grounds in the southern hemisphere are in the southern third of South America. It seems, however, to be a regular summer visitor in small numbers to New Zealand (Falla *et al.* 1970, Condon & McGill 1974), where it has been noted as " single birds attached to flocks of Bar-tailed Godwits."

Although it is too soon to be certain, the Hudsonian Godwit observed at Suva Point is probably overwintering in the southern hemisphere. Smart (1971) noted that the main passage at Suva seems to be over by the end of the first week of May, and certainly all godwits seen by us at this time are in non-breeding plumage. The possible migration route of this Hudsonian Godwit is still speculative, since there are no records elsewhere in Australasia and SE Asia (Slater 1970) and we are not aware of other published records for Pacific Islands, nor for the western rim of the Pacific.

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★

DUNDAS ISLAND, AUCKLAND ISLANDS, 1980

During the morning of 29 December 1980, a small party landed on Dundas Island from A. J. Black's *Acheron.* We were on the island for about one hour, and while the main reason for landing was to count the sea lions *(Phocarctos hookeri),* the following birds were noted.

GIANT PETREL *Macronectes halli*

Three well-grown chicks were in nests in the vegetation just above the beach, and six adults were on the beach among the sea lions.

AUCKLAND ISLAND TEAL *Anas aucklandica aucklandica*

Two birds seen on the beach.

TURNSTONE *Arenaria interpres*

Six were on the rocks near where we landed, and a flock of 50+ flew off the rocky beach on the south side of the island as we approached them.

SOUTHERN SKUA *Stercorarius skua lonnbergi*

In the sea lion rookery 62 were counted, and a further 20+ were spread around the island. No sign of nests or young birds.

SOUTHERN BLACK-BACKED GULL *Larus dominicanus*

A total of 24 birds was counted. Of these, only one was in brown juvenile plumage, five appeared to be 2-3 year olds and the rest were adults. No signs of breeding.

BLACKBIRD *Turdus merula*

One was seen on the edge of the low vegetation in the centre of the island.

Previous counts of birds on Dundas Island are given in R. A. Falla, R. H. Taylor, & Colleen Black, 1979, *Survey of Dundas Island, Auckland Islands, with particular reference to Hookers Sea Lion (Phocarctos hookeri)* NZ J. Zoo. 6: 347-355.

There was no sign of burrows in the consolidated sand banks where Falla recorded South Georgian Diving Petrels breeding during 1943. These banks were badly worn by sea lions crossing them, as Falla *et al.* found in 1978.

JOHN JENKINS

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SMALL GREBES IN THE FAR NORTH

The Australian Little Grebe *(Tachybaptus novaehollandiae)* seems to be spreading in the Far North. On 15 July 1980, I saw two in breeding plumage at Lake Rotokawau, near Waipapakauri. They were associating with a group of duckshooter's decoys and so were much more approachable than usual.

On 24 August 1980, I recorded Australian Little Grebes on two lakes near Ngataki — Lake Half and a small 3-ha lake west of Lake Half. I heard one on Lake Half, and on the small lake I saw two in breeding plumage and may have heard two more; however, it was difficult to keep the two birds in sight while others called, and so I could not be absolutely sure that extra birds were calling.

Three species of small grebe have now been recorded on the lakes near Ngataki — New Zealand Dabchick *(Podiceps rufopectus)*, Hoary-headed Grebe *(P. poliocephalus)*, and Australian Little Grebe. On the Far North lakes, Dabchicks are much fewer than on the Dargaville and Pouto lakes further south. This may explain why Australian Little Grebes seem to be spreading in the Far North but not in the Dargaville area, where they have been present since August 1972.

PAT MILLER, 25 *Third Avenue, Whangarei*

★

FOODS OF THE NEW ZEALAND KINGFISHER
(Halcyon sancta vagans)

I have collected information on the foods of Kingfishers on three occasions.

1. *Ianthe State Forest, Westland:* In November 1977, I saw a Kingfisher diving into a stream and catching five freshwater crayfish

(Paranephrops planifrons). In the same area, it caught a giant dragonfly (Petaluridae: *Urcpetala carovei*) on the wing.

2\. *Nelson:* In December 1979, a road-killed Kingfisher was dissected. The proventriculus contained one nursery-web spider (Pisauridae: *Dolomedes minor*), one unidentified mygalomorph spider (carapace length 6 mm), and one unidentified spider (Araneae) with a 5-mm long carapace.

3\. *Oruatapu Scenic Reserve, Taumarunui district:* In February 1981, the remains of 14 food pellets (mean size 15 mm x 10 mm) were collected. They had been cast by nestling Kingfishers from a roadside nest hole adjacent to a podocarp-dominant bush remnant. The pellets contained a total of 61 food items, as listed in the table.

Species	Number	Approx Length (mm)
Crustacea		
Freshwater crayfish	6	30-70
Insecta		
Giant dragonfly	1	90
Gray's dragonfly (Corduliidae: **Procordulia grayii**)	2	55
Spiny stick insect (Phasmatidae: **Acanthoxyla prasina**)	1	100
Clapping cicada (Cicadidae: **Amphipsalta cingulata**)	3	40
Carabid beetle sp. (Carabidae)	11	20
Carabid beetle sp. (Carabidae)	3	25
Green cockchafer (Scarabaeidae: **Stethaspis longicornis**)	17	25
Huhu (Cerambycidae: **Prionoplus reticularis**)	1	40
Longhorn beetle (Cerambycidae: **Hexatricha pulverulenta**)	5	20
Longhorn beetle sp. (Cerambycidae)	1	10
Click beetle (Elateridae: **Metablax acutipennis**)	1	20
Click beetle (Elateridae: **Thoramus wakefieldi**)	1	30
Click beetle (Elateridae: **T. laevithorax**)	5	15
Weevil sp. (Curculionidae)	1	8
Weevil sp. (Curculionidae)	1	15
Reptilia		
Skink (**Leiolopisma** sp.)	1	Jaw length 8

I thank Peter Johns (University of Canterbury) for identifying *Hexatricha*.

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AUSTRALIAN COOT IN MARINE ENVIRONMENT

At 1030 on 11 October 1980, I noticed an Australian Coot *(Fulica atra australis)* swimming in the sea near Karehana Bay, Plimmerton. The sea was calm with a light south-easterly wind, and the bird was swimming among rocks beside the road. After about 30 minutes, it moved to a crevice in a large rock at the sea edge, and it remained in this crevice, standing or sitting, for most of the day. At 1730 I thought it had gone, but after a few moments it came swimming out from behind some other rocks, and eventually stood on a seaweed-covered ledge with gentle waves washing over its feet. On the morning of 12 October, I could not find it.

The bird's plumage was immaculate and there was no sign of any injury. I observed it for long periods at fairly close range and it appeared unafraid; just content to sit and rest.

I cannot find any reference to Coots being seen in a salt-water environment in New Zealand, but Macdonald (1973, *Birds of Australia*) includes " brackish estuaries " as one of the bird's habitats in Australia. In Cramp *et al.* (1980, *The Birds of the Western Palearctic,* Vol. 2), the European subspecies is said to be " regular on reservoirs and even quiet inshore seawaters," and " Not marine, but will shift *in winter* to estuarine and other saline waters."

This also appears to be the first published record of the species in the immediate area of Greater Wellington.

J. C. R. CLARIDGE, *17 Moana Road, Plimmerton*

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THE GADFLY PETREL SKULL AND DIVING PETRELS FROM MACQUARIE ISLAND

In his most useful note on the smaller petrels of Macquarie Island, Jones (1980) mentions two issues requiring more discussion. In the first place he lists without comment the identification by Keith & Hines (1958) of a medium-sized gadfly petrel skull found in 1956 as the Mottled Petrel *(Pterodroma inexpectata)*. In the past, I have had occasion to examine the skulls of most members of the genus *Pterodroma* and in point of fact have already questioned this identification (Bourne 1967). While the alternative which I suggested there, the Kerguelen Petrel *(P. brevirostris),* in fact normally has a larger orbit and narrower bill, there is still room for confusion, and it is much greater with the skull of the Soft-plumaged Petrel *(P. mollis),* which is virtually identical with that of the Mottled Petrel. I suspect that this identification was initially based on grounds of supposed geographical probability, which looks rather different now that the Soft-plumaged Petrel has been found at both Antipodes Island and Macquarie Island. I suggest that it may be advisable to refer old records of the occurrence of the Mottled Petrel at Macquarie and Antipodes Islands to the Soft-plumaged Petrel in future until there is better evidence that they occur together there.

Secondly, while the occurrence of two species of diving petrel at Macquarie Island has been questioned, there appear to be specimens of both of them. During the course of a tour of Australasian museums in 1974, I looked for any additional information to that summarised in my previous note on this group (Bourne 1968). While unfortunately I did not have time to go through the Macquarie material kept out of circulation for so long in Wellington, I did manage to locate six specimens from the island in Melbourne. I thought that three of them, B4726 collected on 3 May 1949, and two females M56/8/123-4 collected on the Isthmus on 25 September 1956, were South Georgian Diving Petrels *(Pelecanoides georgicus)*, and the other three, B4727-8 collected on the Isthmus on 25 April 1950 and 25 January 1953 and 37724 collected on 14 October 1960, belonged to the small southern form of Common Diving Petrel *(Pelecanoides urinatrix exsul)* from their bill characters, though their dimensions fall within the wide zone of overlap between these two species.

It would appear that, whatever may be the position with the gadfly petrels, two species of diving petrel as well as two species of giant petrel *Macronectes* (Bourne & Warham 1966) have been occurring together undetected at Macquarie Island, as they also did until very recently at South Georgia (Bourne 1968, Payne & Prince 1979). This raises again the question whether the large and small forms of Common Diving Petrel found in the New Zealand area may also breed alongside each other anywhere, notably in the Chatham Islands, in which case they would also have to be regarded as distinct species *P. urinatrix* and *P. berard.* But surely it is impossible that two species of *Pelecanoides* could nest in the same area undetected in such a well-known country as New Zealand ?

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REVIEWS

Birds of Africa, by John Karmali. 1980. Collins. pp. 191. NZ retail price $45.00.

Despite the all-embracing title, this book covers some of the bird-life of East Africa. The subtitle of the book is " A bird photographer in East Africa."

The introduction briefly describes the physical characteristics of both the Palaearctic and Ethiopian zoogeographical regions, across parts of which the continent of Africa lies. These descriptions are supported by relief and vegetation maps.

The birds are presented in 37 chapters, which follow classification order. About 75 species are selected for discussion and the summaries are informative and interesting. The amount of text for each species varies. For example, ostriches get two pages, whereas other species get only a few lines.

However, the real purpose of this book are its illustrations. There are 72 colour photographs and over 140 monochrome illustrations. The colour photographs, mainly portrait studies, are excellent. The monochromes illustrate bird activity, sometimes being presented as a series of time-lapse shots.

The layout of the book is good, except that many of the colour plates have been spread across two pages. In some cases the centre fold cuts the illustrated species in half, and in other plates only sky, water or leaves are printed on one half of the spread. At least 19 plates are of the latter sort and I would rather see single-page portraits and a few more species included on extra colour plates. At the end of the book the colour plates are repeated as monochromes in reduced form and notes are given about each. Some of these notes are of help to bird photographers.

It is pleasing that Collins have decided to publish these fine photographs by Karmali. However, as few of the species covered are known to New Zealand ornithologists or are likely to occur here, I doubt if many will decide to add this book to their libraries, also bearing in mind the price. I note that the UK price is quoted at £12.50 (approx. NZ$37.00) and so the publication may find wider appeal there.

JOHN FENNELL

A field guide to the birds of Australia, by Graham Pizzey, illustrated by Roy Doyle. 1980. Pp. 460, 56 col. plates, 32 b/w plates. Collins. Aus$25.00.

Graham Pizzey's one-volume field guide has been worth waiting for. All Australia's 700 or so species are covered in a 900-gram book, which is sure to replace in users' affections the current edition of Slater's two-volume 1200-gram guide.

Roy Doyle's illustrations are attractive and excellently reproduced, are generally accurate in detail, and capture the " jizz " of the birds. On each plate the scale is clearly shown and field marks indicated by lines on the R. T. Peterson style. These plates are inserted in the centre of the book but a particular illustration is readily located from the text.

Not all Australia's birds are illustrated: even regular visitors like the Streaked Shearwater and Royal and Buller's Albatrosses are unrepresented, although covered in the species' accounts. For the grebes, penguins, petrels, cuckoo-shrikes, wood-swallows and magpies reliance has been placed on monochrome reproductions, but in some other groups like the ducks and waders colour plates of the birds at rest are supplemented by black and white ones of them in flight. Immature and non-breeding plumages are often shown as well as those of the breeding condition.

There are small and useful maps towards the end of the book stated to show breeding distributions, although these actually seem to depict the total Australian ranges. For example, the Australasian Gannet is shown as reaching Shark's Bay, Western Australia, whereas it is not known as a breeder in that state.

The text gives scientific and a whole range of vernacular names (some quite archaic) and, typically, 5-10 lines on field marks, 2-3 on voice, 1 on habitat, 3-6 on breeding and 2-3 on range and status. Key features are emphasised by italics, always a helpful system. The text coverage is adequate for most species but too brief and imprecise to permit identification of difficult birds like prions and diving petrels found among beach wrecks.

Peter Slater's work scores in some ways — his silhouettes of petrel and gull bills and his head-on flight outlines of raptors, for example, are valuable — but Pizzey's book, though not faultless, must now take over at least for the time being as the bird guide for Australians and for visitors to that country. Many New Zealanders will envy the Australians in having access to such an excellent work, which will also be very useful for identifying Australian strays that reach our shores. Finally, this book is excellently bound and despite its bulk should stand up well to the wear and tear of field use. In a new edition random errors should be corrected, some additional material could be worthwhile such as colour illustrations of the two giant petrels, and revisions to the non-passerine nomenclature arising since the 1975 RAOU Checklist could be incorporated.

JOHN WARHAM

The Birds of The Gambia — An annoted check-list and guide to localities in The Gambia, by J. V. Jensen and J. Kirkeby. 1980. Aros Nature Guides.

About a quarter of this book is devoted to two introductory chapters and the rest mainly to the systemic list. The first chapter is largely a potted geography illustrated with sketch maps and diagrams; the second a description of the better known bird-watching localities with bird lists and habitat photographs; and the last the list of species with concise notes on status, habitat, breeding and range, a distribution map for each species and numerous black-and-white photographs, the majority by the authors themselves.

The book succeeds as a check-list in so far as it includes many recent records and considerably extends the number of species described for this area in previous publications. Not surprisingly a good proportion of the additions are migrants, or birds with other extensive movements, and many of the records are the authors' own. Older records, however, seem to have been only superficially researched and are often omitted. Mackworth-Praed & Grant, whose work was virtually finished by the late fifties, acknowledge about six hundred sources; Jensen and Kirkeby about a hundred and twenty, and only eight of these the fifties. Of the older classic works, Swainson's *Birds of West Africa* 1837, Hartlaub's *System der Ornithologie Westafricas* 1850, and Bates's *Handbook of the Birds of West Africa* 1930 are not mentioned in the list of references.

To my mind the check-list contains many questionable inclusions and exclusions.. The Emerald Cuckoo, for example, is specifically stated by both Bannerman (1930-51) and Praed & Grant (1970)to occur in The Gambia, but is excluded here without comment. The Pink-headed Dove is excluded:" due to lack of specimens "; yet other species are admitted (no doubt justifiably) on the strength of single sight records. The Black and White-casqued Hornbill, not previously described as occurring nearer than Ghana, a true forest species conspicuously ill-equipped for long distance flight, is admitted on the strength of a single record from the wharf area ! Similarly *Accipiter toussenelii* (there seems to be some confusion about its vernacular name), not elsewhere stated to occur north of lower Guinea (Brown & Amadon 1968), is included, perhaps correctly, but with no supporting evidence.

A check-list worth its salt should also be taxonomically up to date. This is an esoteric business and I can do no better than to refer to the taxonomy in current use in East and South Africa, which are probably most advanced in these matters. The discrepancies between these and the work under discussion are numerous: the Dwarf Bittern is now placed in *Ixobrychos* (not *Ardeirallus*), the Lappet-faced and Hooded Vultures are now members of the genera *Aegypius* and *Neophron* respectively (not *Torgos* and *Necrosyrtes*), Blackhead and Spur-winged Plovers are now both *Vanellus* (not *Hoplopterus*), and the Jack Snipe is *Gallinago* (not *Lymnocryptes*), to quote the first half-dozen that come to notice.

The vernacular nomenclature is often unconventional and is littered with unnecessary adjectives: *Northern* Gannet, *Great* Cormorant, *Great* White Pelican, and *Grey* Heron among the first twelve species alone. Generally this is no more than irritating, but when all the larger Plovers become Lapwings, or worse *Accipiter toussenelii* becomes the West African Goshawk (the usual vernacular for *A. macrosceledes*) instead of Red-chested Goshawk, real confusion arises.

A number of minor arrors remain, presumably from carelessly corrected proofs, but not, I suspect, as many as in other books in this Danish series.

The introductory chapter presents a good concise picture of what a visitor might expect The Gambia to be like. Not enough, however, is made of its changing nature. The arid zone is extending southwards and illegal bush-burning continues on a large scale up-river, seriously affecting the ecology: many snakes, for example, have disappeared from areas in which they were recently common. The second chapter on localities is excellent, and acceptable for a country where pressure on these localities due to bird-watchers is unlikely to cause significant harm.

The notes and distribution maps in the main list section are good and would surely prove useful although they are based mainly on recent information. Unlike the habitat shots, I find the bird photographs in this section, with the exception of some flight photographs showing underwing patterns, neither useful nor ornamental. They are all in monochrome and many are badly reproduced.

In conclusion, this is not a definitive check-list (the one planned by the British Trust for Ornithology for publication this year should fulfil this role), but would nevertheless prove a valuable addition to a field-guide for a first visit to this country. The bird photographs add little but cost.

J. SQUIRE

LETTER

13 February 1981

The Editor,
Sir,

In *Notornis* 27: 297-298, W. R. P. Bourne has queried the recent statement by Warham & Bell (*Notornis* 26: 121-169) that the Whitney South Sea Expedition collected four prions on 15 February 1926 near the Antipodes Islands. I have looked into this apparent discrepancy and find that Warham and Bell were essentially correct in their original statement, the only difference being that the specimens were collected on 16 February. In Rollo Beck's journal there are entries for 15 and 17 February, but not for 16 February; thus the entry under 15 February covers two days. My interpretation is that the ship anchored on the 15th and that Beck collected, before breakfast on the 16th, the four prions and other birds.

In the American Museum catalog there are four prions collected on the 16 February in 49°S 179°W. The 179° West longitude was obviously a slip of the pen for 179°E, and was made consistently on specimens collected at that date. The four prions are in the collection, three identified as *Pachyptila turtur* and one as *P. desolata.* Details are given below.

It will be noted that specimens No. 334605 and No. 334606 were listed by Bourne as having been collected 1 February. This was an error, as they were collected 16 February. I have remeasured these specimens and my measurements are almost exactly those of Bourne. The specimen listed by Bourne as No. 211790 is not the specimen so catalogued; the specimen bearing that number is a specimen of *P. turtur,* sex ?, collected 8 March 1926 in 44°S 176°W, at Round Island, near Chatham I. (Beck journal vol. D, p. 132). Similarly, data given for No. 334610 are incorrect; the specimen bearing that number is identified as *P. desolata* but was collected 2 March 1926 in 46°S 180° near Bounty Island.

AMNH No.	Date	Identity	Sex	Wing	Tail	Culmen		Tarsus	Toe
						Length	Width		
211791	16 Feb.1926	P. turtur	♀	180	--	22	10.5	32.5	39
334605	"	"	♂	179	88	21.5	10	32	38.5
334606	"	"	♀	171	86	20.5	10	30	37
334604	"	P. desolata	♂	188	90	28	14	32	36

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