NOTORNIS

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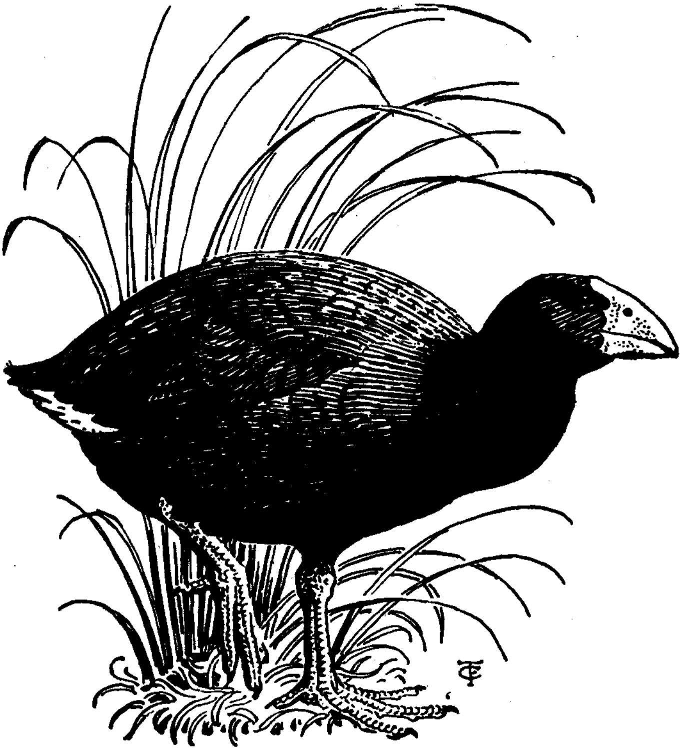

Volume 35 Part 2 June 1988

20th INTERNATIONAL ORNITHOLOGICAL CONGRESS 1990

Second Notice

The 20th International Ornithological Congress will take place in Christchurch, New Zealand, on 2-9 December 1990. The Congress programme will include 6 plenary lectures, 48 symposia, contributed papers (spoken and poster), workshops, discussion groups and films. There will be a mid-Congress excursion day. Longer excursions are planned to interesting ornithological sites in New Zealand before and after the Congress. In late 1990 New Zealand will also host the 20th World Conference of the International Council for Bird Preservation in Hamilton on 21-27 November 1990 and a Pacific Festival of Nature Films in Dunedin on 27 November - 1 December 1990. Photographic and stamp exhibitions will be held in Christchurch in association with the International Ornithological Congress. Requests for the First Circular, which includes information on the above events, should be sent to:

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20th International Ornithological Congress,
Department of Zoology, Victoria University of Wellington,
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LITERATURE AVAILABLE

From all bookshops:

Collins guide to the birds of New Zealand by R. A. Falla, R. B. Sibson and E. G. Turbott	$30.25

From M. Bishop, Maungakura Road, R.D.3, Helensville:

Back numbers of 'Notornis': Parts of Vol. 1-25, $3.00 per part: Vols. 26-29, $5.00 per part; Vols. 30-34, $6.00 per part; all plus 10% for postage and packaging (in NZ).	
Reports and bulletins (1939-1942)	$2.00
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Banding reports, Nos. 8-14, 55¢ each	
Kermadec Expedition, 1964, by A. T. Edgar.	$0.50
Amendments & Additions to 1970 Checklist.	$2.00

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BREEDING BEHAVIOUR OF THE LONG-TAILED CUCKOO ON LITTLE BARRIER ISLAND

By IAN G. McLEAN

ABSTRACT

Long-tailed Cuckoos *(Eudynamys taitensis)* were studied on Little Barrier Island during three summers. The only species of host was the Whitehead *(Mohoua albicilla)*. Rates of brood parasitism on the island were 18.1% overall, 35.7% at altitudes above 250 m, and 5.4% at altitudes below 250 m. The breeding season for cuckoos probably lasted for 4-6 weeks from mid-November, suggesting that early nests of the Whitehead escaped brood parasitism. The available information suggests that the major hosts of the cuckoo are the Whitehead, the Yellowhead, and possibly the Brown Creeper, although other hosts are used occasionally. As adult cuckoos call in small groups during the breeding season, I speculate that Long-tailed Cuckoos may have a lek-type social organisation.

INTRODUCTION

The Long-tailed Cuckoo *(Eudynamys taitensis)* breeds only in New Zealand. Little information is available on its behaviour or breeding, although a range of hosts has been reported, and the cuckoo is said to breed in November and December (Fulton 1904). While in New Zealand from October to February, the Long-tailed Cuckoo gives loud screeching calls from high in the canopy and occasionally (St Paul 1976) is reported to call in small groups. Like many cuckoos (Wyllie 1981), its behaviour is cryptic, and so it is often heard but rarely seen. Males and females are indistinguishable in the field, although juveniles may be identified by white spots on the back and white tail barring.

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Here, I report on the numbers, breeding success, and timing of breeding of Long-tailed Cuckoos on Little Barrier Island. I also review reports of host species and the evidence for brood parasitism of each host and speculate on the breeding system of the species.

METHODS

Long-tailed Cuckoos were studied on Little Barrier Island (36°12'S, 175°7'E) during the summers 1984/85 and 1985/86 and for one week in early January 1987.

Between 26 October 1984 and 19 January 1985, I walked 10 transects at intervals of 1-2 weeks up the Summit Track from sea level to 600 m (just below the summit). I counted all cuckoos heard or seen ahead of me during the transect. To estimate the timing of breeding and breeding success, I noted presence and species of dependent fledglings in flocks of Whiteheads *(Mohoua albicilla)* encountered. Although similar, the begging calls of fledgling Whiteheads and Long-tailed Cuckoos are distinctive (McLean & Waas 1987).

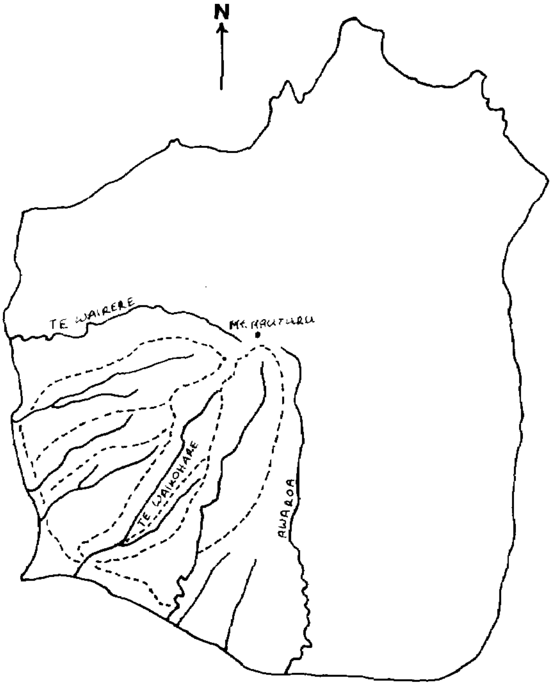

FIGURE 1 — Little Barrier Island, showing the tracks and ridges sampled during three surveys in early January, 1985-1987. Solid lines indicate valley bottoms (creeks). Dotted lines indicate tracks along which surveys were made.

In 1985/86 I searched for groups of calling cuckoos on the upper ridges of the island during late November and early December. Groups were watched until the birds flew off.

In early January 1985, 1986, and 1987, I spent one week surveying about 30% of the island. I traversed all ridges and valleys on the southwestern slopes between track 2 on the western side and track 20 on the southern side (Fig. 1). As I walked, I checked for dependent fledglings in all flocks of Whitehead encountered within a corridor extending 30 m on either side of the track. If I heard no begging calls or saw no fledglings after 5 min, I assumed that the flock contained no fledglings.

All adult cuckoos heard calling were counted during the surveys. Each valley was surveyed once.

Surveys were made in calm or reasonably calm weather with no rain.

To determine the likely host species of the Long-tailed Cuckoo, I surveyed the literature, appealed for observations of fledgling cuckoos in the local Ornithological Society newsletter, and spoke with many ornithologists about the species.

RESULTS

Numbers

The number of cuckoos seen or heard calling during transects up the Summit Track in 1984/85 reached a peak in early January (Table 1). I therefore assumed that the number of cuckoos counted in early January would give the best estimate of the number of cuckoos on the island.

The number of adult cuckoos calling during the surveys in early January was about the same in each year: 81 in 1985, 85 in 1986, and 70 in 1987 (mean 78.6). Assuming that cuckoos are evenly distributed across the island and that I therefore surveyed 30% of the population, these values suggest a minimum of 262 adult cuckoos on the island in January. Fledgling cuckoos were still dependent on their hosts at this time and were not giving adult calls. I do not know whether both sexes of the adults call.

Breeding success

Cuckoo breeding sucess was closely linked with Whitehead breeding success on Little Barrier Island. All 17 cuckoo chicks encountered during surveys between 3 and 12 January were being fed by Whiteheads. The only nestling left the nest 1-2 days after being found.

The proportion of Whitehead flocks with fledglings (Whitehead or cuckoo) varied significantly between years ($\chi^2_2 = 20.29$, $P<0.001$, Table 2; columns 3 and 4 were added together for this test), indicating a significant variation in Whitehead breeding success between years (also see McLean & Gill, in press). One large flock in 1985 contained Whitehead fledglings and a cuckoo fledgling, presumably because it contained more than one Whitehead breeding group. I did not see Whiteheads feeding both Whitehead and cuckoo fledglings at the same time.

Brood parasitism rate was calculated as the proportion of successful Whitehead groups (i.e. those with fledglings) which had a cuckoo fledgling.

TABLE 1 — The number of Long-tailed Cuckoos heard or seen on 10 transects made from sea level to 600 m on the Summit Track, Little Barrier Island.

Date of Transect	No. of Cuckoos	Weather
26/10/84	18	clear, calm
4/11/84	12	clear, calm
10/11/84	14	clear, calm
18/11/84	3	windy, cold
29/11/84	17	clear, calm
14/12/84	12	overcast, mod. wind
20/12/84	17	clear, calm
6/ 1/85	20	clear, calm
12/ 1/85	25	overcast, some rain
19/ 1/85	18	clear, calm

The rate did not vary significantly between years ($\chi^2_2 = 0.04$, n.s.; test conducted on columns 3 and 4, Table 2), indicating that the variation in Whitehead breeding success between years was not directly related to brood parasitism. Mean brood parasitism rate was 16.5% (range 12.9-20.8).

Of the 16 fledgling and one nestling cuckoos found, 14 were above 250 m in altitude and 3 were below 250 m. I assessed the relation between altitude and brood parasitism by recording the altitudes of all Whitehead groups encountered in 1986 and 1987 (Table 3). Brood parasitism rate was significantly higher above 250 m (35.7%) than below 250 m (5.4%) ($\chi^2_2 = 7.88$, $P < 0.05$). The overall breeding success (i.e. including fledgling cuckoos) was not significantly different for Whiteheads above (22.6%) and below (28.7%) 250 m altitude ($\chi^2_2 = 0.80$, n.s). However, the first Whitehead fledglings were encountered above 250 m on 29 November, a full month after the first fledglings were found at sea level (October 26), suggesting that Whiteheads at higher altitudes began breeding later than those at low altitudes.

During an intensive study of Whitehead breeding at low altitude on Little Barrier Island in 1984/85 and 1985/86 (McLean & Gill, in press), no brood parasitism occurred. One colour-banded female known to have bred at 30 m a.s.l. in 1985/86 was feeding a newly fledged cuckoo on 3 January 1987, about 40 m from her 1985/86 nest site, indicating that Long-tailed Cuckoos do occasionally breed at low altitude.

Time of breeding

When a young Long-tailed Cuckoo first leaves the nest, its tail is about one-third the length of an adult's tail, it sits for long periods in one place, and it flies poorly. During the surveys in early January, I saw dependent cuckoo chicks with tails ranging from one-third (i.e. newly fledged) to full adult length. Cuckoo chicks with full-length tails flew well, were hard to approach, and flew up to 200 m in ine flight (with the attendant Whiteheads in pursuit). Their flying ability suggested that they had been out of the nest for several weeks.

It is typical for cuckoos to have shorter incubation and longer nestling periods than their hosts (Payne 1977, Wyllie 1981). These periods are 18.0 and 17.4 days respectively for the Whitehead (McLean & Gill, in press). Thus, to estimate conservatively the timing of breeding for Long-tailed Cuckoos, I assumed that the incubation period was 16 days (the average for 5 species of cuckoo of reasonably similar size to the Long-tailed Cuckoo listed by Payne 1974), that the the nestling period was 21 days (Fulton 1904 reported a Long-tailed Cuckoo which remained in a Robin *Petroica australis* nest for at least three weeks), and that fledgling cuckoos with full-length tails had been out of the nest for at least two weeks.

The oldest and youngest cuckoo chicks found were a fledgling with a full-length tail and flying well on 6 January and a nestling which left the nest on 13-14 January. Given the above assumptions, eggs giving rise to these cuckoos would have been laid on 16 November and 11-12 December respectively. These dates are the extremes during which the eggs giving rise to all cuckoo chicks found during this study would have been laid.

During the transects in 1984/85, the first Whitehead fledglings were encountered above 250 m on 29 November. Thus, at altitudes preferred by cuckoos for breeding, Whiteheads began incubation in late October, much earlier than the 16 November estimate above for first laying by cuckoos. No cuckoo fledglings were found during the transects on 29 November, 14 and 20 December, or 6 January, although Whitehead fledglings were seen above 250 m during each of these transects. However, two and one cuckoo chicks (one still in the nest) were found during the 12 and 19 January transects respectively (the chick found on 19 January was assumed to be the same one found in the same location on 12 January). Thus, I believe that 16 November is close to the earliest date at which Long-tailed Cuckoos breed.

I cannot comment further on when cuckoo breeding ends, except to note that I saw two dependent fledglings with adult-length tails on 31 January (McLean 1982) and R. Powlesland (pers. comm.) saw one on 23 February (tail length not recorded but it flew reasonably well). Lovegrove (1985) reported a chick on 8 February on Kapiti I. Wilkinson & Wilkinson (1952) reported a chick being fed until March 31.

Behaviour of adults

Adult Long-tailed Cuckoos are first heard calling on Little Barrier in early October (A. & M. Dobbins, pers comm.). They call throughout summer, usually from a perch high in the canopy. Calling is sometimes accompanied by a display involving tail-fanning, slow wing-flapping, and a hunched posture; the overall effect being to greatly increase the apparent size of the bird. The full call consists of one or several shrieks followed by a series of loud chatters. The full display is always associated with the chatters. Often, only the shriek is given for long periods, particularly if the bird is calling alone. While shrieking, the cuckoo sits in a hunched posture and occasionally partly extends its wings.

TABLE 2 — The number of Whitehead (WH) flocks encountered, and the proportion containing Whitehead and Long-tailed Cuckoo (LTC) fledglings, during three surveys on Little Barrier Island in early January.

Year	No. of WH flocks	No. (%) with WH fledglings	No (%) with LTC fledglings	No of * single WH
1985	116	39 (34%) +	10 (9%) +	28
1986	116	16 (14%)	3 (3%)	34
1987	74	27 (36%)	4 (5%)	15

* These were either singing males, probably representing Whiteheads with a nest, or solitary birds temporarily separated from their flock. This value can be added to column 2 (No. of WH flocks) for the total number of Whitehead groups encountered, but I have excluded it for calculating the parasitism rate because I do not know whether these birds had a nest or what species might fledge from that nest.

\+ One large flock contained Whitehead fledglings and a cuckoo fledgling. Thus a total of 48 flocks was used for calculating the parasitism rate, rather than the 49 implied here.

TABLE 3 — Whitehead (WH) breeding success and brood parasitism in relation to altitude on Little Barrier Island. Data for January 1986 and 1987 combined. LTC = Long-tailed Cuckoo.

	No. of WH flocks without chicks	No. of WH flocks with WH chicks	No. of WH flocks with LTC chicks
Below 250 m	91	35	2
Above 250 m	48	9	5

Occasionally, up to five cuckoos may call together in a group, where birds sit as little as 2 m apart. Twice, I noted an additional non-calling cuckoo sitting 20-30 m from a calling group, apparently watching. Once, on 29 November, a group of four or five birds formed in which there was considerable chasing along with much calling and displaying.

Adult cuckoos may sometimes take an interest in fledgling cuckoos. Of the 16 fledglings found, I saw adult cuckoos within 30 m of six. In two cases the adults were watching the fledgling from 10 m and 15 m away (in three other cases I detected the adult only when it flew off). T. Lovegrove (pers. comm.) watched one fledgling which appeared to be calling back to the calls of adults nearby.

Hosts of the Long-tailed Cuckoo

All 17 cuckoo chicks found during this study were being fed by Whiteheads. Three cuckoos found by T. Lovegrove, R. Powlesland, and a visitor to the island were being fed by Whiteheads (Lovegrove's bird is probably one that I also found). However, Lovegrove (pers. comm.) saw a second cuckoo fledgling which was fed twice by Robins. I located what appeared to be this same bird (based on tail length and location) two days later, and it was being fed by Whiteheads.

During this study I noted cuckoo fledglings begging from a female Stitchbird *(Notiomystis cincta)*, a juvenile and an adult Tui *(Prosthemadera* *novaeseelandiae)*, a juvenile Bellbird *(Anthornis melanura)*, and a Red-crowned Parakeet *(Cyanoramphus novaezelandiae)*. The Stitchbird may have fed the cuckoo, although the true "parents" were Whiteheads which were gathering food nearby.

The Yellowhead *(Mohoua ochrocephala)* (Fulton 1904; Elliott 1986, pers. comm.) and Whitehead (Fulton 1904; Stead 1936; Wilkinson & Wilkinson 1952; this study) are the only known hosts of the Long-tailed Cuckoo for which the reports are better than anecdotal. Elliott found cuckoos in Yellowhead nests in his study area in Fiordland.

The Brown Creeper *(Mohoua novaeseelandiae)* may be a commonly used host. According to descriptions in Stead (1936) and Wilson (1959) they found two creeper nests and one robin nest with cuckoo eggs, and a creeper nest with a nestling cuckoo, on Jacky Lee Island. Stead deposited several complete Brown Creeper clutches containing a cuckoo egg in the Canterbury Museum. The lack of other records of Brown Creeper hosting Long-tailed Cuckoo may be due to the cryptic breeding behaviour of the creeper (Cunningham 1985; pers. obs.).

Fulton (1904) listed many likely hosts of the Long-tailed Cuckoo, but most reports were based on unusual eggs which he *suggested* were laid by the cuckoo, or on observations of birds feeding fledgling cuckoos but with little or no information on the number of feeds seen or the length of observation. Apart from one Whitehead and one Yellowhead report, the only fully acceptable observation in Fulton (1904) is of a cuckoo egg hatched and raised to 21 days by Robins. Fulton's report of a cuckoo nestling in a Tomtit *(Petroica macrocephala)* nest is suspect because he gave no information on how the nest was identified; both he and Prickett (1958) reported cuckoo eggs in abandoned Tomtit nests. Fulton's report of adult cuckoos feeding their own young on the Kermadec Islands, based on observations made by a resident in the 19th century, is intriguing because cuckoos are present on the Kermadecs all year but there are no likely hosts (Merton 1970).

Falla *et. al.* (1978) added the Fantail *(Rhipidura fuliginosa)* to a summary of the lists of hosts given by Fulton and Stead, presumably based on a photograph by Roberts (1963) clearly showing a Fantail feeding a Long-tailed Cuckoo in a Fantail nest.

Two recent observations which I accept are a Long-tailed Cuckoo seen to lay in the nest of a House Sparrow *(Passer domesticus)* on Kapiti Island (P. Jenkins, pers. comm.) and a cuckoo nestling being raised by Silvereyes *(Zosterops lateralis)* in the Waikato (P. Harper, pers. comm.). Fulton (1904) also noted these two species as hosts based on eggs found in nests. Stidolph (1949) reported a cuckoo chick and two cuckoo eggs from three nests of Silvereyes located "within a few chains of each other" in an area of the Tararuas where Whiteheads were scarce. These were probably all laid by the same cuckoo. Both nests with eggs were abandoned and the nest with chick failed because the chick fell through the bottom of the nest. Stead (1936) suspected that Long-tailed Cuckoos laid in nests of introduced species, citing cuckoo-like eggs found in two Song Thrush *(Turdus philomelos)* nests and a Greenfinch *(Carduelis chloris)* nest. As with Stidolph's Silvereyes, these were all found in the same gully and were probably laid by the same cuckoo.

Suggestions that honeyeaters (Tui, Bellbird) are parasitised by Long-tailed Cuckoos (Fulton 1904; Ramsay 1865, in Cunningham 1966) remain unsubstantiated.

Potts (1885), in an ambiguously worded article, suggested that Long-tailed Cuckoos "frequently" parasitised Grey Warblers *(Gerygone igata).* Fulton (1904) disputed this, despite a drawing of a warbler feeding a young Long-tailed Cuckoo in Buller (1888). Oliver (1955) agreed with Fulton that the reports were probably based on confusion with the Shining Cuckoo *(Chrysococcyx lucidus).*

In conclusion, it appears that the Whitehead, the Yellowhead, and probably the Brown Creeper are the usual hosts of the Long-tailed Cuckoo. Other species known or likely to have been parasitised are Robin, Silvereye, Fantail, probably Tomtit, and several introduced species. The cuckoo is known to be raised successfully by Whitehead, Yellowhead, and probably Robin (one observation of a 21-day-old nestling).

DISCUSSION

The breeding system: timing and altitude

The results of this study support earlier anecdotal observations that Long-tailed Cuckoos breed in November and December (Fulton 1904). The pattern of Whitehead breeding on Little Barrier suggests that cuckoos could, in theory, begin breeding as early as late October. My data are not extensive enough to exclude breeding in early November, but they suggest that most occurs after mid-November. Thus, early nests of the hosts probably escape parasitism, as with the Grey Warbler and its brood parasite, the Shining Cuckoo (Gill 1983). Many Whiteheads breed only once in a season (McLean & Gill, in press). With high brood parasitism rates at higher altitudes (36%), there must be strong selection pressure on Whiteheads to begin breeding as early as possible or to breed at lower altitudes.

These observations suggest an explanation for why most Long-tailed Cuckoos breed at higher altitudes on Little Barrier. The peak in Whitehead incubation at low altitudes was in late October and early November (McLean & Gill, in press), whereas the transect data suggest that Whiteheads breed later at higher altitudes. If Long-tailed Cuckoos cannot breed before mid-November (e.g. because they need time to recover from migration), they may breed at higher altitudes because more nests are available there. However, no information is available on whether cuckoos could breed before mid-November, and many other factors may influence their preference for higher altitudes.

Until we know how long Long-tailed Cuckoo fledglings remain with their hosts, it will be difficult to determine when cuckoos stop breeding, particularly as the host species continue to feed their own fledglings for many months (McLean & Gill, in press). However, Whiteheads at low altitudes on Little Barrier (McLean & Gill, in press) and Brown Creepers at low altitudes at Kaikoura (Cunningham 1985) ceased, or virtually ceased, laying in late December. Whiteheads ceased nesting in early December in one year. Thus, the breeding season of the Long-tailed Cuckoo probably ends when the hosts stop breeding and may be only 4-6 weeks long.

The breeding system: social behaviour

Long-tailed Cuckoos do not provide parental care. They are therefore freed from the primary constraint which seems to impose monogamy on about 90% of birds (Welty 1975). Polygyny usually occurs when males monopolise females either by defending female groups directly (mate-defence polygyny) or by defending a resource which is of value to females, thereby forcing them to clump in the defended area (resource-defence polygyny). Polyandry occurs when females monopolise and mate with several males either at the same time (this may also be called mate-defence polygyny) or in sequence, in which case each male is provided with a clutch of eggs which he fathered and incubates. Emlen & Oring (1977), Oring (1982), and Vehrencamp & Bradbury (1984) have discussed the factors underlying mating systems.

There is no evidence that Long-tailed Cuckoos form coherent (i.e. long-term) groups, and so it is unlikely that one sex is monopolised by the other. Nor do Long-tailed Cuckoos occur in pairs, as does the Koel *(E. scolopacea)* (Payne 1977), which suggests that they are not monogamous. The second form of polyandry described above is unlikely because females do not provide males with a clutch of eggs.

I suggest that the Long-tailed Cuckoo breeding system is some form of polygamy. I further suggest that groups of calling cuckoos represent groups of one sex (probably males) attempting to attract and compete for the other sex. The groups are ephemeral, constantly breaking up and reforming at the same or other locations. I observed no obvious defence; the chasing seen was neither rapid nor violent and seemed to be sexual rather than aggressive. The groups cannot therefore constitute a lek in the restricted sense of Oring (1982), in which small "courts" are defended through time. However, individuals come and go from leks in many species (e.g. Sage Grouse *Centrocercus urophasianus*, Gibson & Bradbury 1987), and the display arena may vary in location over short or long time intervals (e.g. Buff-breasted Sandpiper *Tryngites subruficollis*, Prevett & Barr 1976; Sage Grouse, Gibson & Bradbury 1987).

If calling groups of cuckoos are unisexual, and birds seen watching groups of calling cuckoos are of the other sex, the groups may provide a way for the choosing sex to make direct comparisons among the competing sex before copulating with one or several of them, perhaps at some other location (as occurs in Sage Grouse, Gibson & Bradbury 1987). Under this hypothesis, the incredibly loud calling and fearsome display of the cuckoo are equivalent to the tail of the peacock or the booming of the Kakapo *(Strigops habroptilus*, Merton *et al.* 1984). I speculate that Long-tailed Cuckoos are a lekking species.

Long-tailed Cuckoos call and display for reasons other than mating, because many birds call in January. Further work on their social organisation will involve investigating how often calling groups are formed during summer, comparing the behaviour of birds calling alone and in groups, and perhaps playing back tape-recorded calls to test the response of other cuckoos. Most importantly, a field method of sex determination is needed, probably using behaviour.

NOTE: In January and February, 1988, R. Powlesland found two Long-tailed Cuckoo fledglings being fed by Brown Creepers on Codfish Island.

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A RE-EXAMINATION OF THE MOA GENUS *MEGALAPTERYX*

By T. H. WORTHY

ABSTRACT

A re-examination of the moa genus *Megalapteryx* reveals that the two currently accepted species, *M. didinus* (Owen) and *M. benhami* Archey, do not differ in the shape of the bones. They represent small and large specimens in an unbroken size continuum. Specimens from northwest Nelson have a larger mean size than those in a sample from Takahe Valley, Fiordland. A series of ^{14}C dates indicates that the largest '*M. benhami*' are all of Otiran derivation, whereas *M. didinus* bones are from Otiran and Holocene deposits. Therefore *M. benhami* is synonymised with the Upland Moa, *M. didinus* (Owen).

Out of all the New Zealand birds, the moa, or more specifically the group of species included under this name, have the greatest record of taxonomic confusion. This was caused in part by all members of the group being extinct, but mainly by their being much larger than most other birds, resulting in too much emphasis being placed on relatively small size differences between specimens. Thus, many size groups within one 'form' have been considered to represent species and as many as 37 moa species have been recognised (Rothschild 1907). Archey (1941) and Oliver (1949) perpetrated this trend and not until Cracraft (1976) examined moa taxonomy by statistical techniques was this problem adequately tackled. Using covariant statistics Cracraft reduced the observed variation to comparable figures and proposed the synonymy of several pairs of species, leaving just 13. By invalidating *Anomalopteryx oweni* (Haast), Millener (1981) reduced the 13 to 12.

Cracraft had not been able to assess the validity of *Megalapteryx benhami* Archey (1941) because the three specimens available did not allow adequate comparison with *M. didinus*. Thus he retained these two species in his classification.

M. benhami was described by Archey (1941) from a femur and a tibiotarsus from a cave on the Mt Arthur Tablelands, northwest Nelson. Oliver (1949) referred a femur to this species from Wairanga, also in northwest Nelson. In 1980, staff from the Canterbury Museum collected several bones of a moa of this species from Hives Passage in Honeycomb Hill Cave, Karamea. Several bones in the size range of this species were recovered from Honeycomb Hill Cave by P. R. Millener in 1983: a femur, tibiotarsus and tarsometarsus of an individual from Enduro Passage and a tarsometatarsus from Eagle's Roost. In 1987, during further research on the subfossil fauna of this cave, I recovered a great deal of *Megalapteryx* material, including four partial skeletons and odd bones of six more birds, all in the size range of *M. benhami*. This new material contained all skeletal

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elements of *M. benhami*, including the previously unknown sternum, pelvis, vertebrae and cranial elements. In January 1987, further *Megalapteryx* material was collected from a cave in Poverty Basin, Mt Owen, north-west Nelson. With this new material I could re-examine the *M. didinus* versus *M. benhami* problem. In this paper, I compare the bones from each size range, examine the size range of *Megalapteryx* in different sites, and discuss associated faunas and the relative ages of deposits. In Appendix 1, I give a brief morphological description of *Megalapteryx*, comparing it with *Anomalopteryx didiformis* (the most similar species).

Material for the morphological comparision was as follows. For *M. didinus*: National Museum of New Zealand (NMNZ) DM 435-440, 443-449 — Takahe Valley; NMNZ S 23527-23567 — Poverty Basin, Mt Owen; NMNZ S 23700 — Honeycomb Hill; Canterbury Museum (CM) AV 8505, 8507, 8513, 10335, 10336, 10338, 10339 — Takahe Valley; Otago Museum (OM) A52.1-.14 — Takahe Valley; NMNZ S 22689, 22721, 22889-22890, 23027, 23032, 23062, 23086, 23645-7, 23686, 23733, 23736-9, 23740, 23802-807, 23809, 23813, 23824, — Honeycomb Hill Cave.

For *M. benhami*: NMNZ S 22710, 23425-23430, 23575, 23618-23622, Honeycomb Hill.

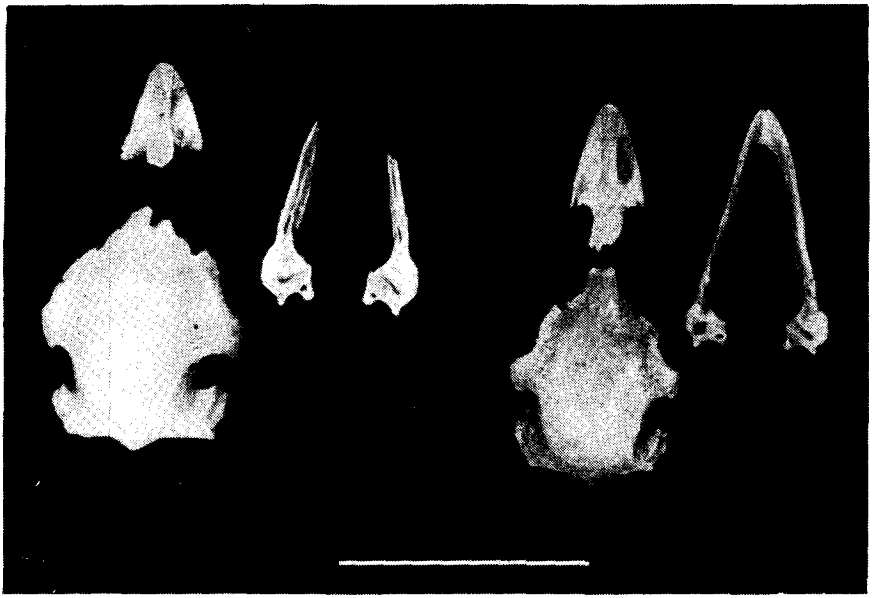

FIGURE 1 — Dorsal views of crania, premaxillae and mandibles of *Megalapteryx*. Left group (NMNZ S23575) typical of *M. benhami*, right group (NMNZ S23700) typical of *M. didinus*. Scale bar = 10 cm

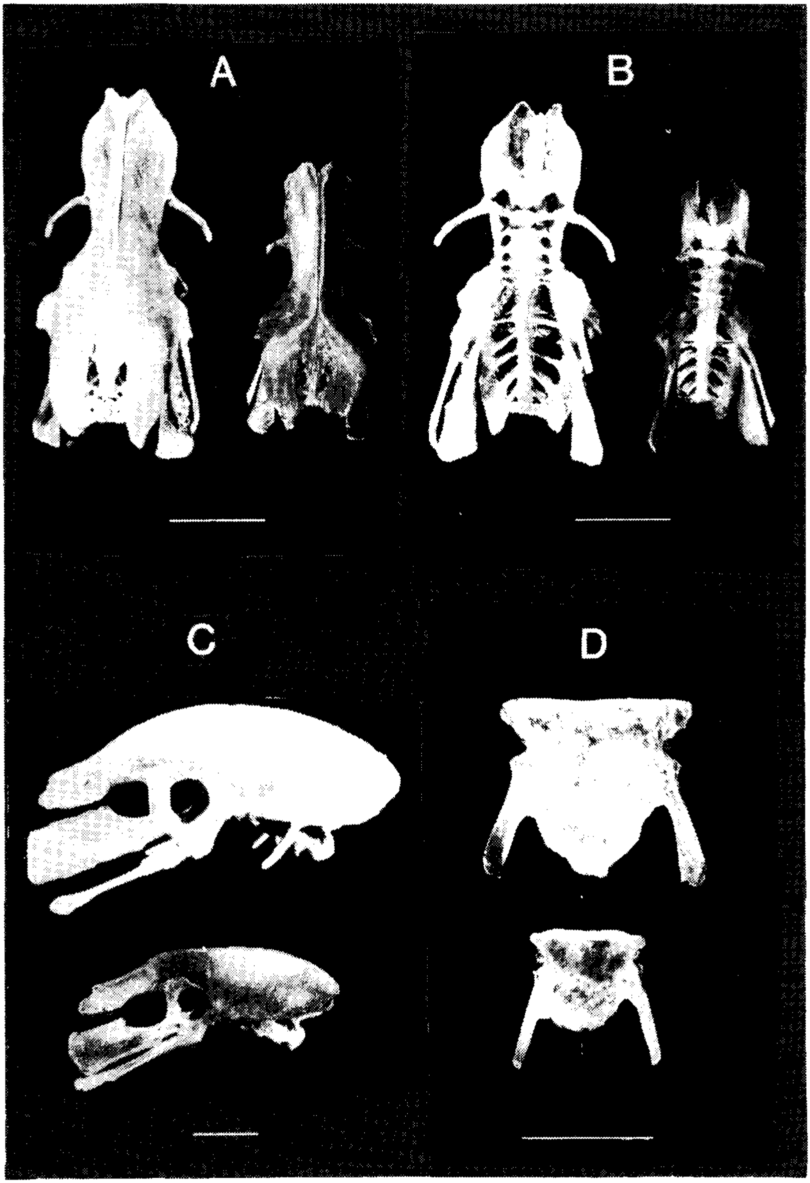

FIGURE 2 — Pelves of *Megalapteryx* in dorsal (A), ventral (B), right lateral (C) views and dorsal view of sterna (D). Larger specimens (NMNZ S23575) typical of *M. benhami*; smaller pelvis (NMNZ S23700) and sterna (NMNZ S443) typical of *M. didinus*. Scale bars= 10 cm

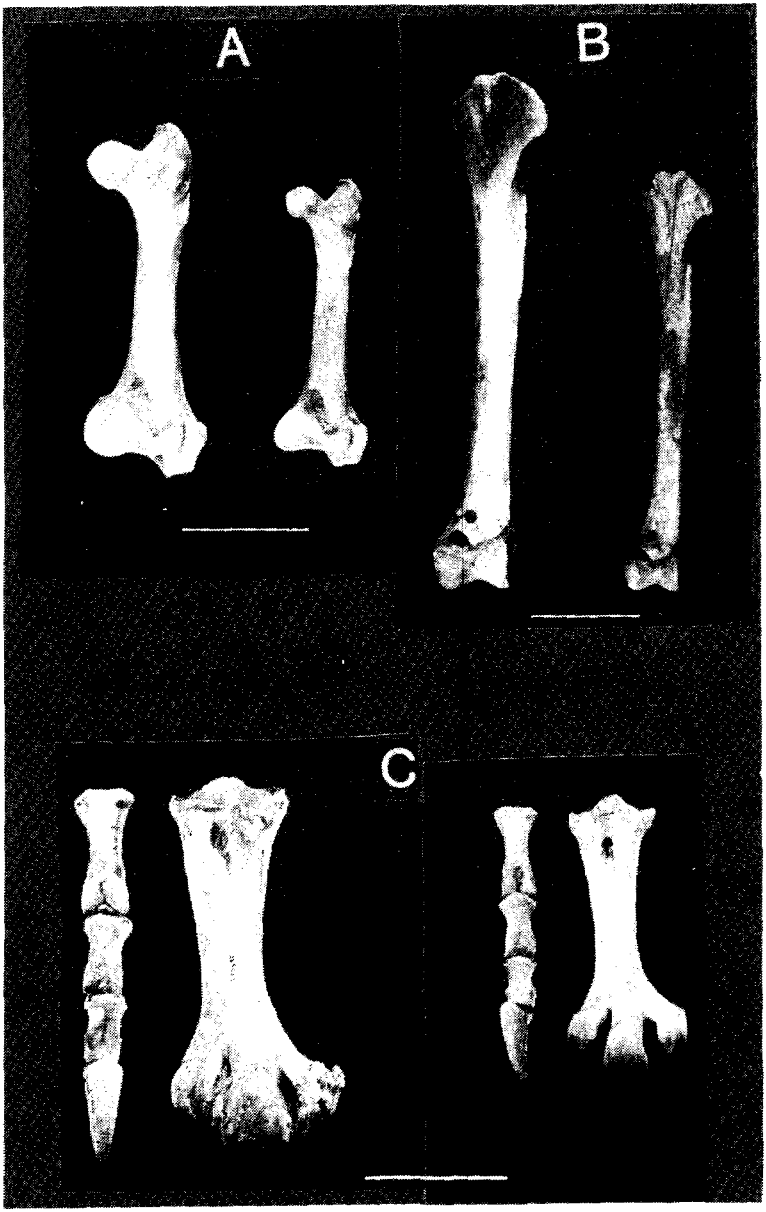

FIGURE 3 — Right femora — ventral view (A), left tibiotarsi — anterior view (B), (larger of each pair NMNZ S23575, smaller NMNZ S23700), right tarsometatarsi and phalanges of digit 3 (larger specimen NMNZ S23430, smaller NMNZ S23700) of *Megalapteryx*. Scale bars = 10 cm

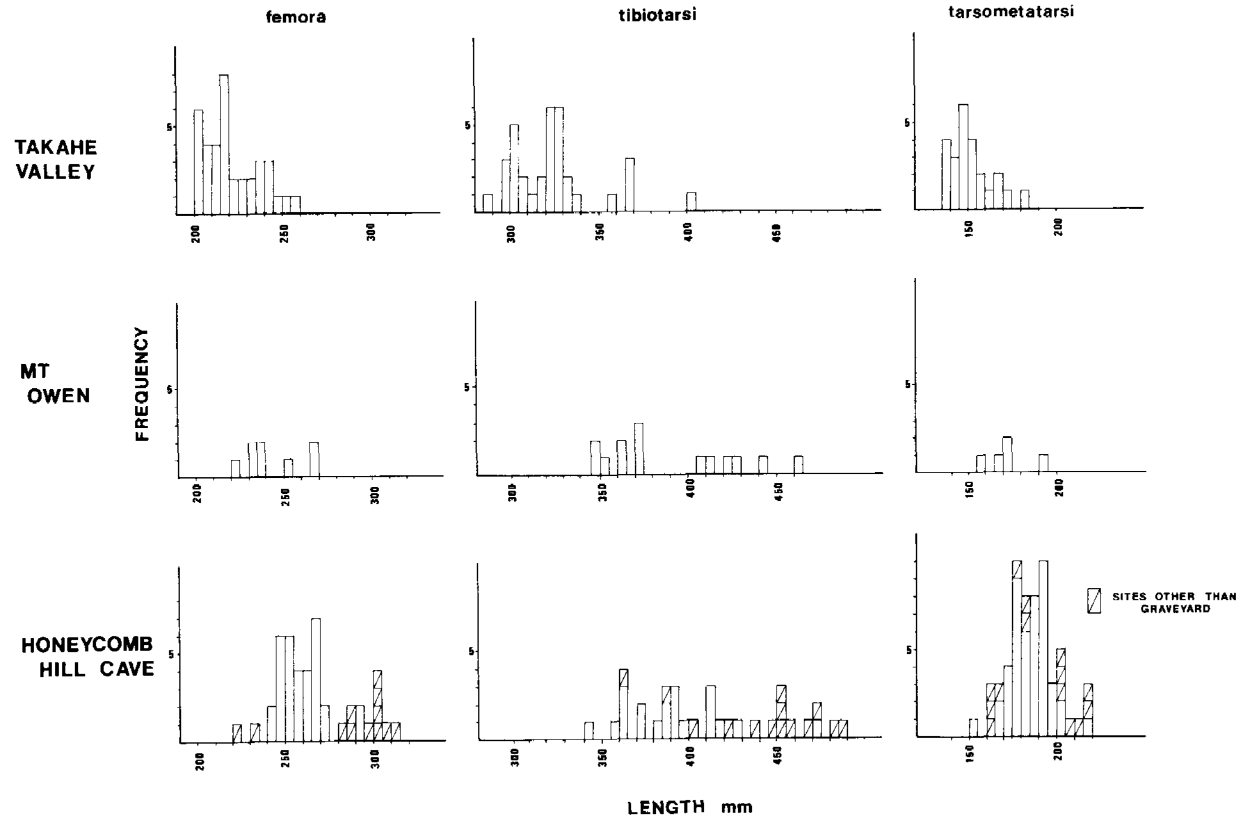

FIGURE 4 — Length frequency histograms of femora, tibiotarsi and tarsometatarsi of *Megalapteryx didinus* at Takahe Valley, Mt Owen and Honeycomb Hill Cave

Morphological comparison of *Megalapteryx* material

A detailed comparison of bones in the size range usually associated with *M. didinus* was made with the larger bones of *M. benhami*. Skeletal elements compared included complete skulls, sterna, coracoid-scapulae, pelves, femora, tibiotarsi, tarsometatarsi and phalanges. In all comparisons, the bones of *M. benhami* were only a larger version of those in *M. didinus*. I could discern no differences in shape or form. (Fig. 1, 2, & 3).

Size range of *Megalapteryx*: The range in absolute size is similar for femora, tibiotarsi and tarsometatarsi from Takahe Valley, Mt Owen and Honeycomb Hill, but it is significant that the bones from Takahe Valley are from smaller birds than those in the northern sites of Mt Owen and Honeycomb Hill Cave (Table 1, Fig 4.). Tibial length appears more variable than femoral or metatarsal length, but the coefficients of variation show that they are similar. These data strongly suggest regional variation of populations, which may be clinal but without examining material from other sites with large numbers of bones I cannot be sure. The data show that to distinguish a species from another solely because of apparent discrete size ranges is inadvisable until the nature of regional variation is well documanted and understood.

TABLE 1 Values of the mean, standard deviation, and number for long bones in various populations of *Megalapteryx*

	Femora	Tibiotarsi	Tarsometatarsi
Takahe Valley-Te Anau	220.6, 14.74 (37)	322.8, 24.06 (34)	150.7, 11.08 (24)
Mt Owen	246.2, 16.15 (9)	388.9, 35.70 (14)	172.0, 10.61 (5)
Graveyard (total)	257.6, 10.72 (36)	392.0, 27.32 (19)	184.5, 10.86 (46)
Honeycomb (total)	264.1, 20.58 (47)	409.7, 40.47 (32)	185.7, 14.07 (60)

When there are enough data for a site, e.g. Takahe Valley, only one mode is discernable within the size range of a bone (Fig. 4). Thus there is no suggestion of either a sexually dimorphic population or two species separated by size, Specimens in the size range of *M. benhami* (Oliver 1949), notably from Honeycomb Hill Cave but also from Mt Owen, represent only individuals in the upper size range of *Megalapteryx* in northwest Nelson.

Faunas associated with material in the size range of *M. benhami*

I collected an associated avifauna from five sites in Honeycomb Hill Cave where material the size of *M. benhami* was found. Other moa species represented were Upland Moa *M. didinus* (5 sites), Little Bush Moa *Anomalopteryx didiformis* (3 sites), Heavy-footed Moa *Pachyornis elephantopus* (2 sites), and Large Bush Moa *Dinornis novaezealandiae* (4 sites). Other birds included Kokako *Callaeas cinerea*, Robin *Petroica australis*, Saddleback *Creadion carunculatus*, Tui *Prosthemadera novaeseelandiae*, and various wrens, kiwis, rails, and parrots. It is notable that

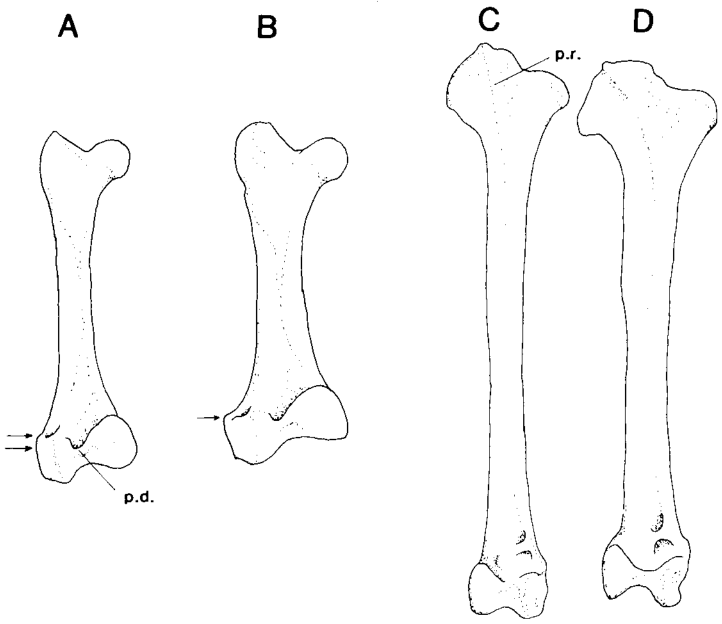

FIGURE 5 — Femora (AB) and tibiotarsi (CD) of *M. didinus* (left of each pair) and *A. didiformis* (right of each pair) from Archey (1941). p.d. = popliteal depression, p.r. = procnemial ridge.

material in the size range of the Upland Moa *M. didinus* and of *M. benhami* was found sympatrically and in the case of the Graveyard at Honeycomb Hill Cave temporal sympatry was also demonstrated. In general these associated species indicate the presence of at least a partially forested habitat. Pollen and faunal analyses show it is probable that, when the Graveyard was being deposited between 20 000 and 14 000 years BP, there was montane forest and subalpine scrubland in the area of the cave (Worthy, unpublished data).

A sizable sample of *Megalapteryx* has now been dated, either directly (Table 2, excluding L27/f108) or indirectly (a minimum number of 73 *Megalapteryx* were excavated from L3 of the Graveyard). Material in the size range of *M. benhami* is found only in the Otiran deposits, where *M. didinus* is found in both the Otiran (Graveyard L3, His and Hers Cave) and Holocene deposits (Graveyard L2, Eagle's Roost).

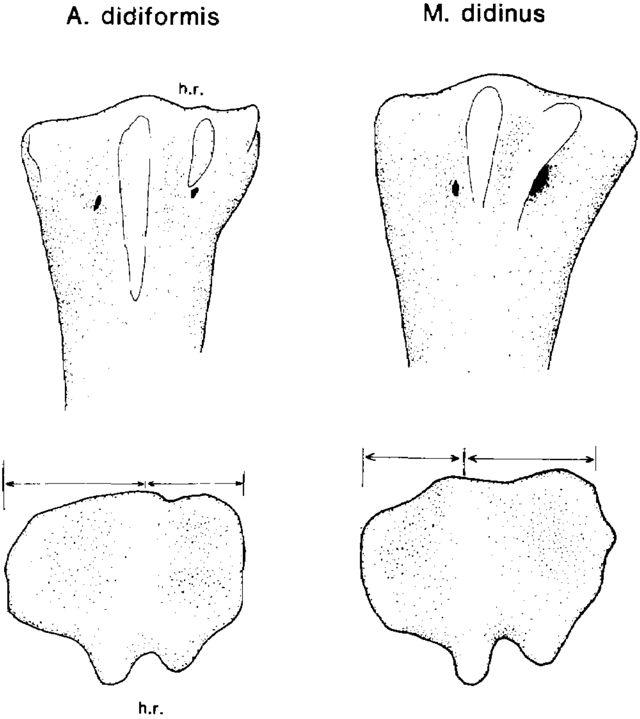

FIGURE 6 — Proximal left tarsometatarsi of *Anomalopteryx didiformis* (NMNZ S23571) and *Megalapteryx didinus* (NMNZ S23575) in posterior view (upper) and proximal view (lower). h.r. = hypotarsal ridges

The faunas from Mt Owen and Takahe Valley must both be post-glacial and probably less than 10 000 years old because the collection sites were ice covered during the Otiran.

It is possible to interpret the data thus: *M. benhami* represents the largest birds in the Otiran population in the northern South Island, and with the transition to the Holocene, the mean size of birds in the population became smaller so that all specimens fell in the size range of *M. didinus*. Such a temporal change has been demonstrated to have occurred in the North Island *Pachyornis mappini* (Worthy, 1987). Even in layer 3 of the Graveyard, dated between 20 000 amd 14 00 years old, material in the size range of *M. benhami* was rare. Of the 73 *Megalapteryx* represented, only 3 were in the size range of *M. benhami*. Therefore the rarity of *M. benhami* in the Graveyard exemplifies the collecting bias towards *M. benhami* in Honeycomb Hill Cave.

TABLE 2 — List of dates for *Megalapteryx* material from Honeycomb Hill Cave. L27/f108 is for a *Dinornis* bone which was associated with the *Megalapteryx* bones by stratigraphy. All other dates were determined by radiocarbon dating of bone collagen calculated using Libby 7½ (5568 yr).

Species	Fossil Record No.	INS Ref.No.	Age ^{14}C Yrs BP
M. didinus (*Eagles Roost*)	L27/f93		11,250±150
M. didinus (L2, Graveyard)	L27/f100	R11411/1	11,200±150
M. didinus (L3, Graveyard)	L27/f101	R11411/2	19,300±400
M. didinus (Graveyard, lag)	L27/f102	R11411/3	10,980±140
M. benhami (Enduro)	L27/f104	R11410/1	14,385±433
M. benhami (Aven)	L27/f105	R11410/2	15,580±702
M. benhami (Eagles Roost)	L27/f106	R11410/3	14,335±351
M. benhami (Wren Wrecker)	L27/f107	R11410/4	14,694±681
M. benhami/didinus (His & Hers)	L27/f108	R11411/5	15,900±240

CONCLUSION

M. benhami Archey is synonymised with *M. didinus* (Owen) because the bones of both share all essential shape characters. Size differences can be explained by a north-south cline combined with temporal variation such that specimens were larger in the north during the Otiran. Similar temporal variation is known for the North Island *Pachyornis mappini* (Worthy 1987). Some of the other 'large' ranges in variation for moa species can probably be explained by similar geographic and temporal analyses.

ACKNOWLEDGMENTS

This study would not have been possible if it were not for the co-operation and assistance of the Department of Conservation (formerly NZ Forest Service), for which I am most grateful. This co-operation resulted in the joint research project between the Department of Conservation and the National Museum of which this study forms a part. I thank Mark Strange for the photography.

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APPENDIX 1

Morphological description of *Megalapteryx didinus* with comparative notes on *Anomalopteryx didiformis*

A. didiformis and *M. didinus* can be confused because both species have leg bones of similar size and relative proportions, and together they differ from the rest of the Anomalopterygidae. Notes in brackets describe the state in *A. didiformis*.

Skull: Premaxilla narrow, pointed; post-orbital width greater than width across zygomatic processes (equal); temporal fossa narrow (very wide), not excavated ventrally on anterior margin (ventrally excavated), temporal ridge nearly meets lambdoidal (always meeting); orbital margins of nasal convergent towards premaxilla (parallel); preorbital plate arising from inferior aliethymoid at wide angle; maxillary antrum nearly collapsed (expanded, robust); Fig 1.

Sternum: Anterior margin straight; anterior width slightly greater than length; lateral processes not longer than xiphoid process, diverging, tips further apart than distance between coracoid articular facets; coracoid depressions shallow, indistinct (prominent); precostal processes tapering, blunt; pneumatic foramina in shallow depressions each side of midline; Fig. 2.

Scapulocoracoid: Very reduced, coracoidal segment longer than scapular.

Pelvis: Narrow, ilia meeting anterior to acetabulum in curved arch, arch continuous to posterior of acetabulum; base of ischium and pubis forming ventral part of acetabulum, meeting with synsacra at abrupt, square angle (rounded in *A. didiformis*); Fig. 2.

Femur: Length 64% tibiotarsus length; rotular depression narrow (wide); popliteal depression and fossa superior to fibular articular surface at unequal levels (level); lateral and medial distal condyles parallel to each other, together, not diverging widely from shaft (subparallel to shaft); Fig. 3, 5.

Tibiotarsus: Shaft straight, slender; proximal and distal ends not much expanded (more so); procnemial ridge straight (curved); medullarterial orifice usually proximal to distal end of fibular articular surface (distal to); Fig. 3, 5.

Tarsometatarsus: Length 45% tibial length; in proximal aspect medial and articular surface wider than lateral (lateral wider); lateral hypotarsal ridge more prominent than medial in proximal view, but of equal length (lateral more prominent and longer than medial); foramen adjacent to medial hypotarsal ridge in distinct, sharply angled depression (on sloping surface at base of hypotarsal ridge); shaft variably robust, less robust in small individuals, more in large; Fig. 2, 6.

Digits: Phalanx formula 3:3:4:5; third digit longer than metatarsus (shorter), ungual phalanx long, slender, width 0.3 x length (distinctly broader, width 0.45 x length).

SIZE VARIATION IN THE SNOW PETREL *Pagodroma nivea*[1]

By SVEIN HAFTORN, FRIDTJOF MEHLUM and CLAUS BECH

ABSTRACT

A colony of breeding Snow Petrels (*Pagodroma nivea*) in the Mühlig-Hofmann Mountains, Queen Maud Land, on the Antarctic continent was visited in January-February 1985. The birds were nesting under large boulders on the north-faced, ice-free hillside of Svarthamaren (71°53'S, 5° 10'E), about 200 km from the open sea. The colony was roughly estimated to contain 500 pairs (Mehlum *et al.* 1985). Hatching took place in mid-January.

The Snow Petrels at Svarthamaren were on average significantly smaller than those breeding elsewhere in the Antarctic. The irregular geographical distribution of breeding birds of varying size does not immediately provide any support for a subspecific division of the species into one large and one small form, leaving the systematic and evolutionary status of the species unclear. It remains to be established whether inland breeding selects for relatively small birds.

INTRODUCTION

As stated by Cowan (1981), it has long been known that Snow Petrels vary greatly in size. Bonaparte (1856) described two subspecies, a larger one (*Pagodroma nivea major*) and a smaller one (*P. n. minor*). This view was followed by Prevost (1969) and Isenmann (1970). The latter pointed out that the large form is characterised by a great variability in size, whereas the small form shows little variability. Isenmann (1970) argued that the two forms were geographically imperfectly isolated and showed some genetic mixing. The distribution of the large form was mainly on Adelieland and adjacent regions, while the small form is thought to breed elsewhere. Cowan (1981), however, claimed that variability in size does not correlate with geographical distribution and questioned the existence of two subspecies. Croxall (1982) suggested that "the true status of the so-called large and small forms of the species can best be resolved by comparing birds of known sex and status." According to him, the sexual dimorphism in weight in the Snow Petrel is among the greatest found in the Procellariiformes and might be a result of natural selection in favour of an extension of the sound frequency of vocalisations.

Recently, Jouventin & Viot (1985) reanalysed the previously known data, together with some fresh information, and concluded that a separation into two subspecies is probably valid. They proposed the idea that during the Quaternary glaciations no refugia existed for the species on the Antarctic

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[1] Publication No. 92 of the Norwegian Antarctic Expeditions (1984-85)

continent. When the climate last ameliorated the continent was invaded by birds from two refugia, "a low latitude one inhabited by small birds *Pagodroma nivea nivea,* and one in higher latitudes characterized by large birds *P. n. major.* Reproductive isolation broke down, and a hybridization zone was created." In this paper we present data which show that the Snow Petrels breeding in the Mühlig-Hofmann Mountains are among the smallest hitherto described.

METHODS AND MATERIAL

Altogether 35 incubating birds were caught on their nests during the period 17-26 January 1985 for biometrical measurements. Of these, 10 were killed and were sexed after autopsy.

All birds were weighed and measured. Wing length: maximal length of flattened wing measured on a ruler fitted with a zero-stop. Bill length: distance from bill tip to the start of feathering. Bill-nares: distance from bill tip to the nares. Bill + skull length: distance from bill tip to the hindmost point of the head, on the occiput. A slide caliper was used for making the last measurements. Fat content was estimated by weighing all visible subcutaneous and intestinal fat.

RESULTS

The biometric data from all birds captured at Svarthamaren are shown in Table 1. Only 10 of the birds were sexed. The males were on the average larger than the females, but, probably due to the small sample size, the differences in body weight and wing length were statistically insignificant,

TABLE 1 — Measurements of the petrels from Svarthamaren, Mühlig-Hofmann Mountains in Queen Maud Land. Weight and visible fat in grams; other measurements in millimetres, mean ± SD (range in parenthesis)

	Males	Females	Unsexed	Total
N	5	5	25	35
Weight	258.2±19.54 (237-278)	229.8±32.76 (200-283)	258.5±36.10 (212-343)	254.3±34.56 (200-343)
Wing	258.3±3.87 (253-263.5)	253.3±5.26 (245-258)	255.9±6.56 (246-267)	255.9±6.10 (245-267)
Bill length	20.0±0.37 (19.4-20.4)	18.8±0.38 (18.4-19.4)	19.9±0.96 (18.0-21.7)	19.8±0.92 (18.0-21.7)
Bill-nares	16.5±0.68 (15.8-17.5)	15.5±0.46 (15.0-16.0)	14.1±0.88 (12.3-15.6)	14.6±1.21 (12.3-17.5)
Bill + skull length	68.0±1.15 (66.6-69.5)	65.4±0.92 (64.2-66.6)	67.8±1.81 (64.3-71.2)	67.5±1.83 (64.2-71.2)
Visible fat	9.2±3.7 (5.3-13.9)	4.0±0.97 (3.1-5.4)	-	-

whereas the bill and skull measurements showed significant sex differences ($p < 0.025$, one-tailed t-test). It is also noteworthy that the males contained significantly more fat that the females ($p = 0.008$, Mann-Whitney U-test), although they were all captured on the same day (26 January).

DISCUSSION

Because of the marked sexual size dimorphism in the Snow Petrel, morphometric comparisons between different populations need to be made with care (cf. Croxall 1982). Thus, histograms for the birds measured at Svarthamaren (35 birds, of which only 10 were sexed) clearly indicate a two-topped distribution, probably due to sexual dimorphism (Fig. 1). The sexual dimorphism indexes (female/male x 100) of the individuals at Svarthamaren are within the extremes found for other localities: weight 89 (73-95), wing 98 (95-98) and bill length 94 (84-95) (data in parentheses taken from Croxall 1982, Tables 1 and 4).

Unexpectedly, we found that the males at Svarthamaren contained significantly more subcutaneous and intestinal fat than the females, although all birds were caught on their nests on the same day. This pattern might indicate sexual differences in energetic investment, for example, in incubation effort. However, the data given by Brown (1966) for the division of labour between the sexes during the incubation period do not indicate that the females on average spend more time on the nest than the males. The only reasonable explanation we can provide for the low fat content in the female is egg production.

Based on a comparison of wing length data for 21 localities spread around the Antarctic continent, Jouventin & Viot (1985) suggested a cline with a peak at the Balleny Islands, which seem to be inhabited by a homogeneous population of the large form *Pagodroma n. major*. They considered that the proportion of this form in any colony decreases roughly with the distance away from the Balleny Islands, whereby Adelieland, Casey, South Orkneys, Cape Hunter, South Sandwich Islands and "undoubtedly other localities" represent a vast hybridisation zone between the large form *major* and the small form *minor*. However, when the available morphometric data for birds of known sex are compared, no clear size trend or consistent pattern appears, except that related to sexual dimorphism (Fig. 2, see map Fig. 3). Statistically significant size differences (wing length, body weight) are to be found even between adjacent breeding colonies, as for example between Adelieland and Cape Denison (two-tailed t-test; $p < 0.001$). Furthermore, the birds on Signy Island (Orkney Islands), almost on the diametrically opposite side of the Antarctic continent to the Balleny Islands, are also relatively large (Fig. 2), as are those on the South Sandwich Islands (Cowan 1983). This is especially interesting in view of the relatively small size of the birds at Svarthamaren, which is the nearest breeding locality surveyed to Signy Island. In fact, the birds at Svarthamaren are on average significantly smaller than those from all other colonies hitherto described (Table 2.)

Different colonies are certainly to some extent exposed to different selection pressures. Thus, birds breeding far inland, but still entirely dependent on marine food, are presumably constrained by factors of a different nature and strength than those breeding close to the open sea. It would be interesting to know whether the small size of birds at Svarthamaren is a characteristic of inland colonies. Some Snow Petrel colonies on Queen Maud Land are more than 300 km inland from the

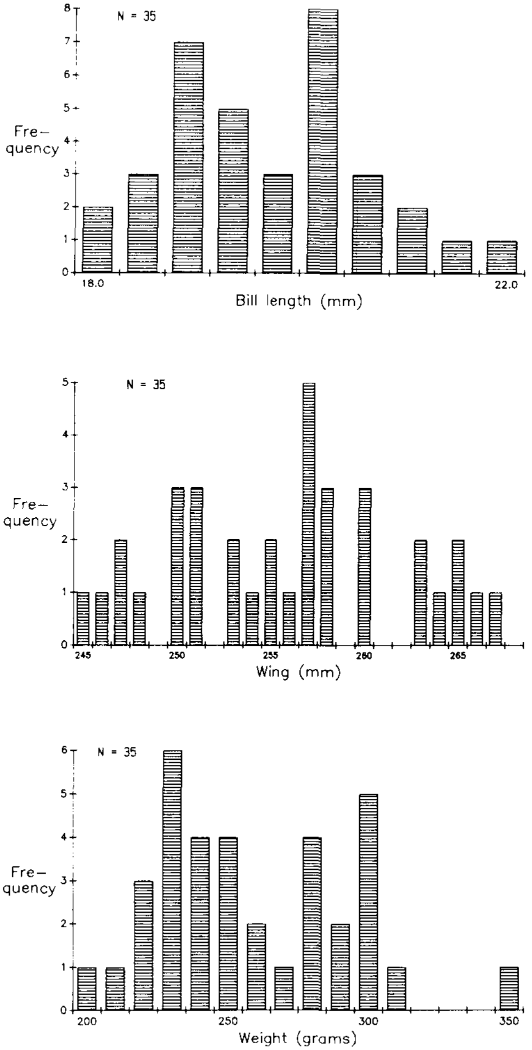

FIGURE 1 — Histograms of the bill length, wing length and body weight data of Snow Petrels from Svarthamaren, Queen Maud Land

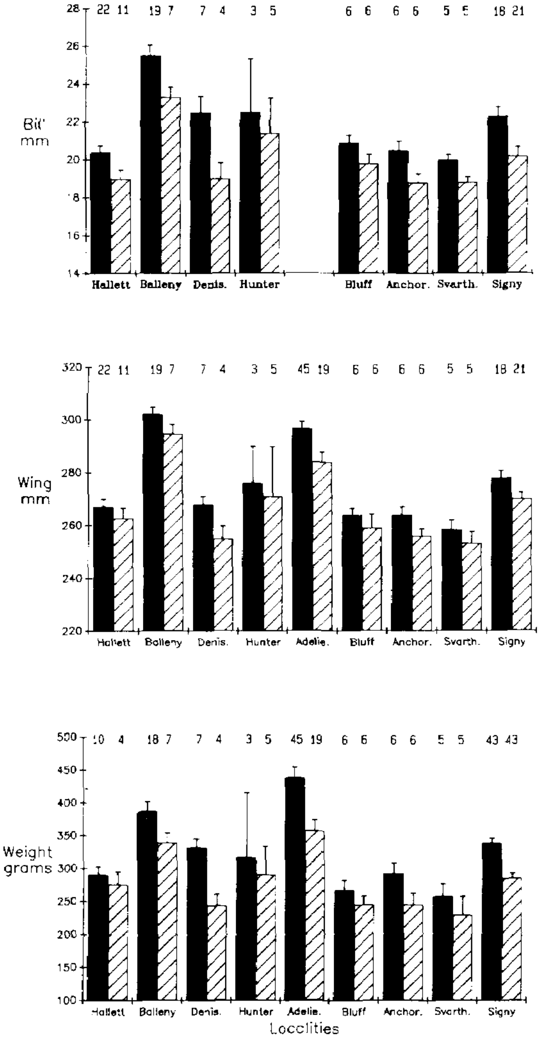

FIGURE 2 — Biometric data (means+2SE) for Snow Petrels of known sex from different breeding localities (data from the Balleny Islands, and bill and wing data from Cape Hallett refer to specimens held at National Museum in Wellington, New Zealand; the other data are taken from Croxall 1982, Jouventin & Viot 1985, and present study; the weight data for Signy Island refer to sample no. 3 in Croxall 1982, Table 2). Full names of the localities are: Cape Hallett, Balleny Islands, Cape Denison, Cape Hunter, Adelieland, Bluff Island, Anchorage Island, Svarthamaren, Signy Island (South Orkney Islands). Numbers on top of the histograms indicate sample size. Black columns = males, hatched columns = females

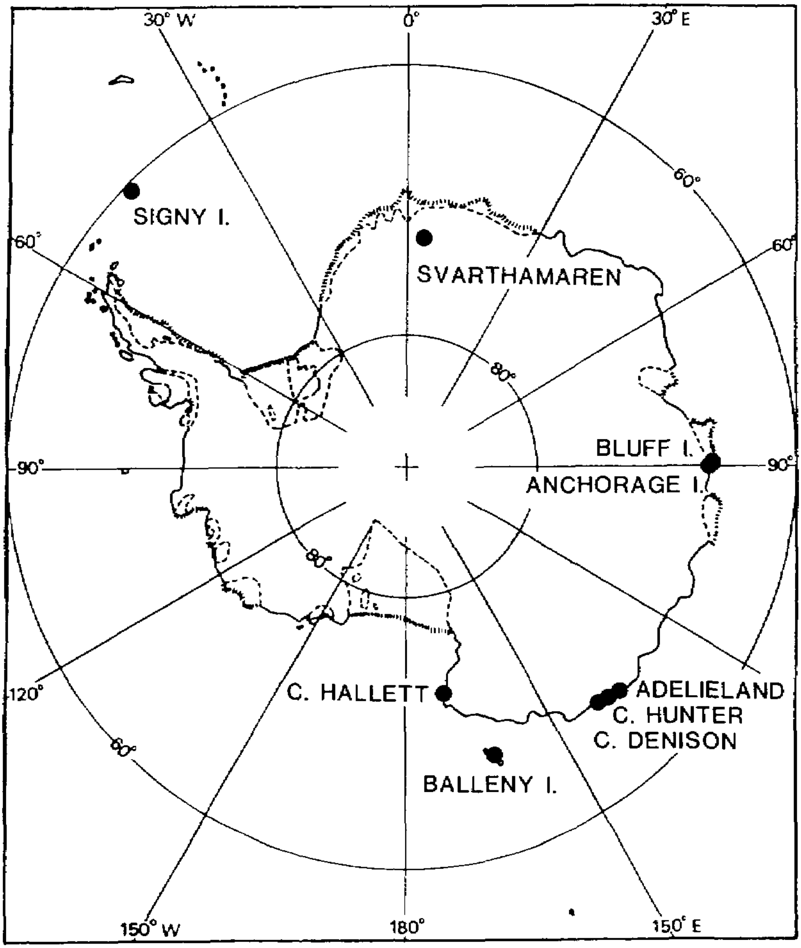

FIGURE 3 — Localities throughout Antarctica at which Snow Petrels of known sex have been measured

coast (Vestfjella, Sømme 1977), but unfortunately the size of these birds is still unknown.

In conclusion, more data for birds of known sex are needed before the systematic and evolutionary status of the Snow Petrel, and thus the validity of the two forms *P. n. major* and *P. n. minor*, can be settled. The existence of statistically significant size differences between birds from breeding colonies lying relatively close to one another, as for example Svarthamaren and Signy Island, indicate a fairly low gene flow.

TABLE 2 — Snow Petrels from Svarthamaren, Queen Maud Land (5 ♂, 5♀) were on the average smaller than those from other localities (one-tailed t-test; * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$, ns = not significant $p > 0.05$). Data from Balleny Islands, and wing and bill data from Cape Hallett refer to specimens held at National Museum in Wellington, New Zealand; the others are taken from Croxall (1982) and Jouventin & Viot (1985)

	Weight		Wing		Bill length	
	♂	♀	♂	♀	♂	♀
Cape Hallett (10♂ 4♀)	**	*	-	-	-	-
Balleny Islands (18-19♂ 7♀)	***	***	***	***	***	***
Cape Denison (7♂ 4♀)	***	ns	***	ns	***	ns
Cape Hunter (3♂ 5♀)	ns	*	*	*	*	*
Adelieland (45♂ 19♀)	***	***	***	***	-	-
Bluff Island (6♂ 6♀)	ns	ns	**	ns	**	**
Anchorage Island (6♂ 6♀)	**	ns	*	ns	ns	ns
Signy Island (18♂ 21♀)	***	***	***	***	***	***

ACKNOWLEDGEMENTS

We are debt to C. J. R. Robertson for critically reading the manuscript and for providing biometric data of specimens held at National Museum in Wellington, New Zealand. Ph. Tallantire kindly improved the English.

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SHORT NOTE

Red-billed Gulls feeding on ngaio at the Mokohinau Islands

During a visit to the islands of the Mokohinau group, Hauraki Gulf, from 26 November to 2 December 1987, I observed Red-billed Gulls *(Larus novaehollandiae)* hovering over, landing on and apparently feeding from ngaio *(Myoporum laetum)* bushes on Burgess and Atihau (Trig) Islands. Upon careful observation it became clear that the gulls were feeding on the unripe berries of the plant.

On most days, gulls were seen on ngaio bushes in the morning up to 09.00 and from late afternoon to about dusk. On Burgess, birds were seen to fly directly from the breeding colony (c.450 pairs) to the bushes, and after feeding, some at least returned directly to the colony. Most nests contained eggs or recently hatched chicks. The gulls congregated over, and on, the bushes in groups of up to 30 birds. Birds sometimes pulled berries off while still on the wing; otherwise they landed on the vegetation (usually making several abortive landings until they found supportive branches) before delving into the foliage for the berries. On occasion, on Burgess Island, several flocks of gulls were in sight foraging on different ngaio bushes at the same time.

Red-billed Gulls have previously been recorded feeding on the berries of taupata *(Coprosma repens)* and puka *(Meryta sinclairii)* (Oliver 1955) but although Sandager (1889) described them driving cicadas from ngaio bushes and feeding on them I know of no previous records of the berries being eaten.

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FOREST BIRD COMMUNITIES IN WESTERN SAMOA

By MARK BELLINGHAM and ALISON DAVIS

ABSTRACT

The birds of Upolu and Savai'i, Western Samoa, were surveyed in August 1984. Birds were counted along a 2 km transect in O le Pupu-Pu'e National Park and 5-minute bird index counts were used in upland and lowland Savai'i.

There was a significant difference in the composition and density of bird communities between partly logged and unmodified tava *(Pometia pinnata)* forest. The composition of bird communities differed at varying altitudes both in the national park and in Savai'i. There were more species at higher altitudes on Savai'i, and rare species were recorded at only the higher altitudes on Upolu and Savai'i. The relative abundance and occurrence of threatened bird species were noted, and possible sightings of Puna'e, the Samoan Woodrail, in upland Savai'i were recorded.

INTRODUCTION

Savai'i and Upolu, the largest of the Samoan island group (Fig. 1), have the most diverse bird fauna of this group, with 32 species of native birds (Watling 1982). All 11 endemic Samoan birds are on Savai'i, including one Western Samoan endemic, the Samoan White-eye.

The morphology, taxonomy and distribution of Western Samoan bird species have been reviewed in Mayr (1945), Ashmole (1963), du Pont (1972), Muse & Muse (1982), and Watling (1982). These authors also have commented on the breeding, foraging and status of rare bird species. Recent observations on the distribution of birds and the status of rare birds have been made by Yaldwyn (1952), Dhondt (1976), Child (1979), Reed (1980), and Lovegrove (1984). The only published work on the distribution of bird communities in Samoa is Amerson *et al.* (1982). However, this work was confined to American Samoa, which has fewer land bird species than Western Samoa.

We studied forest bird communities during a visit to Western Samoa on 14-31 August 1984. Birds were surveyed in different forest types and at a range of altitudes.

The forests in Western Samoa are under threat from forestry and agriculture. On Savai'i native forest logging has severely depleted the forest habitat of most of the endemic birds, particularly in the lowlands. This has continued on both Upolu and Savai'i, despite the development of exotic plantation forestry. Slash and burn gardening on both islands threatens large areas of upland forests, as farmers use forestry roads to gain access to formerly inaccessible land.

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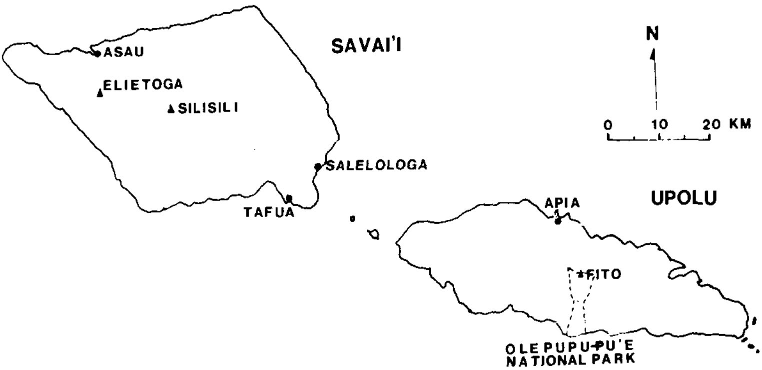

FIGURE 1 — Western Samoa. Locations referred to in the text are shown.

Bird habitat

O le Pupu-pu'e National Park

The distribution of the vegetation, landforms and vertebrates of the national park were broadly surveyed by Ollier *et al.* (1979). The national park ranges from sea level to 1100 metres, on Mt Fito. The park has four major landforms: uplands, wide valley systems, the O le Pupu lava field, and the coastal cliffs. Forest communities on these landforms, respectively, are maotea mea montane forest, mamalava and mafoa foothill forest, tava lowland forest, and littoral vegetation.

Maotea mea forest has a variable canopy height, from 6 m on the upper crater rims to 18 m on the upland plateaux. The dominant tree is maotea mea *(Dysoxylum huntii)*. There are a dense ground cover and shrub layer and abundant epiphytes. This forest has a taller canopy at its lower altitudinal limit.

Mamalava forest dominates the foothills in the park. The canopy varies from 20 to 30 m. This is the most diverse forest type in Samoa. Although it has many tree species it is dominated by mamalava *(Planchonella torricelliensis)*. There are a moderate ground cover and sparse shrub and subcanopy layers.

Unmodified tava lowland forest has an irregular canopy, up to 30 m high on the O le Pupu lava plain. The dominant tree is tava *(Pometia pinnatia)*. Mamalava'asi *(Syzygium inophylloides)*, ma'ali *(Canarium samoense)* and tavai *(Rhus taitensis)* are also common. The ground cover is dense, especially in clearings, and the shrub and subcanopy layers are moderate to dense. Some of the tava forest within the national park has been selectively logged for canopy species. This partly logged forest has a lower canopy, a denser understorey and more clearings than unmodified tava lowland forest.

The littoral vegetation along the coastal cliffs has a number of plant communities that become taller and more diverse away from the coast. Whistler (Ollier *et al.* 1979) described four littoral vegetation communities at O le Pupu-Pu'e National Park: *Lepturus* strand vegetation, *Scaevola* littoral scrub, *Pandanus* littoral forest and *Calophyllum* littoral forest.

Upland Savai'i

Upland Savai'i is covered in continuous cloud forest and receives over 6000 mm of annual rainfall. Despite this high rainfall, the ground seems to be relatively free-draining and the soil and ground layers retain little moisture. The forest canopy is generally less than 18 m tall and has abundant epiphytes (Whistler 1979). In this *Spiraenthemum – Dysoxylum* forest, the largest trees are *Reynoldsia pleiosperma* and *Homalanthus accuminatus.*

Wild cattle and pigs have browsed the understorey and groundcover along the main range. Vegetation is unmodified on the flanks of the many craters along the main range.

Tafua

The Tafua peninsula area is a broad, flat lava flow with many collapsed lava tubes. There is almost no soil cover and little moisture is retained.

This lowland area (less than 60 m a.s.l.) is the largest area of lowland tava forest on Savai'i. Although there are small clearings through this forest in various stages of regeneration, most of the forest is unmodified.

As one approaches the coast, the forest type changes from tava forest through to *Pandanus* forest, and *Hibiscus tilliaceous* becomes more common, together with occasional *Callophyllum* trees. Landward from the *Pandanus* screen along the coast is a mixed forest of *Barringtonia, Hernandia, Pisonia* and many large *Asplenium nidus* ferns and Polynesian arrowroot *(Tacca leontopetalloides).*

METHODS

Transect in the national park: We spent the first 5 days becoming familiar with the identification of forest birds in the national park. We were assisted by national park staff, particularly with the bird calls.

Ten transects (two per day) were run along a 2 km track, from the O le Pupu-Pu'e National Park headquarters towards the Pe'ape'a Caves. The first kilometre of the transect was in partly logged tava forest and the second kilometre in unmodified tava forest.

The transects were started between 0700 and 0830, the second observer starting out an hour after the first to minimise dependent data and bird disturbance. The transect lines were walked slowly, covering 0.8-1.0 km per hour. All birds seen and heard within 10 m on either side of the track were recorded.

A multivariate analysis of variance (manova) was used to compare differences in the composition and density of species between partly loggged and unmodified forest. The eight commonest species were used in the analysis i.e. Wattled Honeyeater, Samoan Whistler, Samoan Broadbill, Samoan Starling, Cardinal Honeyeater, Samoan Fantail, White-throated Pigeon, Scarlet Robin. White-rumped Swiftlets were not used in the analysis because their numbers varied widely between counts.

Bird distribution in the national park: Bird distribution and relative abundance were recorded throughout the national park at different altitudes. A day was spent in each of these forest types: coastal fringe, mamalava foothill forest, tall montane forest, low montane forest and exotic plantation. We recorded all birds seen and heard, taking care not to record them more than once. At the end of the day, we added the numbers of each species to get a crude estimate of abundance of bird species in each forest type. Bird abundances in tava lowland forest were derived from the transects described above.

Five-minute bird index counts on Savai'i: These were used to get an indication of the species present and relative bird numbers within and between upland and lowland forest. All birds seen and heard for a 5-minute period were recorded. We took care not to count birds more than once. We attempted to standardise our index counts by counting at similar times of the day and in similar weather conditions. We used bird index counts when our time was limited and we were unable to set up transects.

RESULTS

Transect in the national park

We recorded 21 bird species, 18 in partly logged and 20 in unmodified tava forest. The total number of birds in each forest type was similar, the mean number of birds per transect (± standard error) was 35.4 ± 2.31 in partly logged forest and 33.6 ± 1.38 in unmodified forest.

The manova showed significant difference in the bird composition and density between partly logged and unmodified forest. The Hotelling-Lawley trace statistic for the manova was $f\ (8,2) = 103.08$, $p < 0.0096$.

Partly logged forest differed from unmodified forest in having higher numbers of Samoan Starling, Cardinal Honeyeater, White-rumped Swiftlet and Polynesian Triller. Samoan Fantail, White-throated Pigeon, Red-headed Parrotfinch and Crimson-crowned Fruit Dove had higher numbers in unmodified forest. There were only slightly higher numbers of Pacific Pigeon and Polynesian Starling in partly logged forest, and of Wattled Honeyeater and Scarlet Robin in unmodified forest. Mao were found only in unmodified forest. Samoan Whistler, Samoan Broadbill and Flat-billed Kingfisher had very similar numbers in both forest types. The most common bird in both forest types was the Wattled Honeyeater, which was twice as common as any other bird. Some of the 21 species recorded were rarely encountered on the transects.

Bird distribution in the national park

We found 21 bird species within the national park. Six of these species were in the coastal fringe, 16 in the tava lowland forest, 13 in the mamalava/mafoa foothill forest, 10 in the tall maotea mea montane forest, and 14 in the low maotea mea montane forest (including craters). Six species were recorded in the exotic forest plantation adjacent to the national park. The number of species in the tava lowland forest may be higher because we spent longer there.

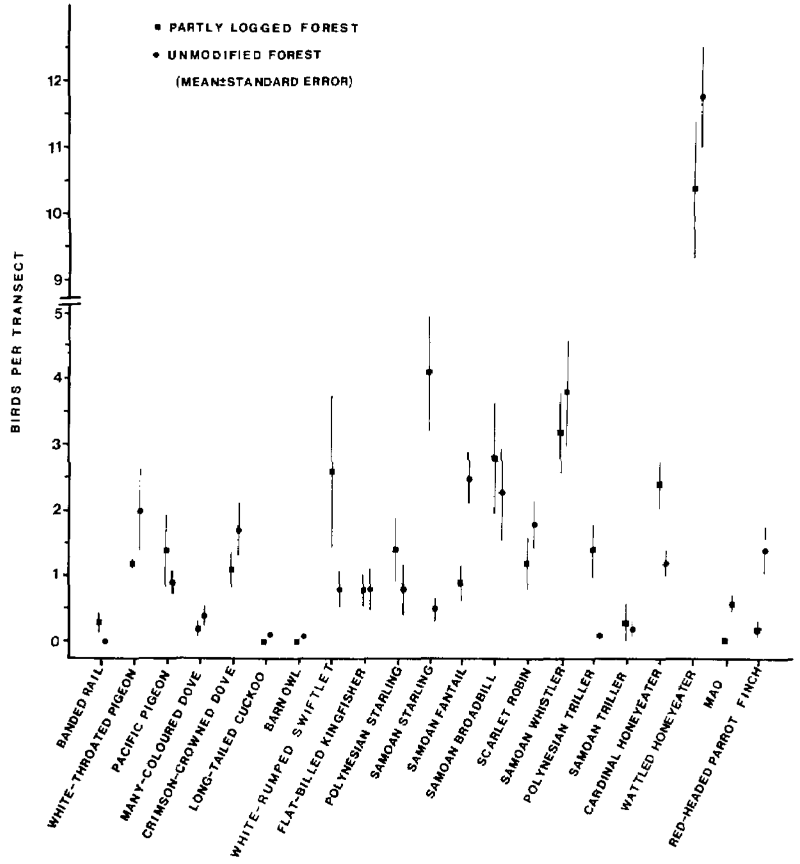

FIGURE 2 — Bird transects in partly logged and unmodified forest, O le Pupu-Pu'e National Park, Upolu

Neither pigeon species was found in the coastal fringe, Pacific Pigeon was found up to the highest-altitude forests where its abundance increased, whereas White-throated Pigeon reached only the tall montane forest. The two dove species also showed quite different distributions. The Many-coloured Fruit Dove was seen in the coastal fringe and tava lowland forest, whereas the Crimson-crowned Fruit Dove was at higher altitudes.

The three honeyeaters had different distribution patterns. The Cardinal Honeyeater was at all altitudes, decreasing in abundance in the montane forest, the Wattled Honeyeater was abundant at all altitudes, and the Mao was only in foothill and montane forest, being particularly common in the craters at high altitude.

	Coastal Fringe	Tava Lowland Forest	Mamalava Foothill Forest	Tall Montane Forest	Low Montane Forest	Exotic Plant-ation
Pacific Black Duck				•✱		
Banded Rail						•
White-browed Rail						•
Sooty Rail				•✱		
Purple Swamphen						•
White-throated Pigeon		●	•		●	
Pacific Pigeon		●	•		⬤	•
Many-coloured Fruit Dove	•	●				
Crimson-crowned Fruit Dove			●	●		
Long-tailed Cuckoo		•				
Barn Owl		●				●
White-rumped Swiftlet	⬤	●		●		
Flat-billed Kingfisher	•	•	•		●	
Island Thrush			●	•	•	
Polynesia Starling	•			●		
Samoan Starling	⬤	●	●			⬤
Samoan Fantail		●	●	●	●	
Samoan Broadbill		●	●			
Scarlet Robin		●	•	●	●	
Samoan Whistler		●	•	•	•	
Polynesian Triller		●				●
Samoan Triller		•			•	
Cardinal Honeyeater	●	●	●	•	•	
Wattled Honeyeater		⬤	⬤	⬤	⬤	
Mao			●	●		
Red-headed Parrot Finch		•				
Total Number of Species	6	17	13	12	10	7

Key:
⬤ Abundant
● Common/Frequent
• Occasional/Rare
✱ Crater lake in montane forest

FIGURE 3 — *Relative abundance of bird species distributed across the altitudinal* vegetation sequence in O le Pupu-Pu'e National Park

The Polynesian Starling was common only at the highest altitude, whereas the Samoan Starling was abundant in the coastal fringe and forest clearings, decreasing markedly at higher altitudes. The Polynesian Triller had a similar distribution pattern to the Samoan Starling. The Samoan Triller was in tava lowland and tall montane forest, but was nowhere common. It lives in the shrub forest layer and is inconspicuous.

The Samoan Whistler, Samoan Fantail, Samoan Broadbill and Scarlet Robin were found at all altitudes except the coastal fringe. Samoan Whistler and Samoan Broadbill were commonest in the tava lowland forest, whereas the Samoan Fantail and Scarlet Robin were commonest at higher altitudes.

The Island Thrush was uncommon in foothill and montane forest. The Red-headed Parrot Finch was rare and very limited in distribution, being seen only in tava lowland forest. The White-rumped Swiftlet and Flat-billed Kingfisher ranged from the coastal fringe to tall montane forest, but the kingfisher was common only in tall montane forest. The Sooty Rail, White-browed Rail and Pacific Black Duck were found in the crater wetlands at the highest altitudes.

In exotic forest plantations adjacent to the national park, the Samoan Starling and Polynesian Triller were common. Also seen there were Barn Owl, Banded Rail, White-browed Rail and Purple Swamphen.

Upland and lowland Savai'i

In the 5-minute bird counts, we recorded 18 species in upland Savai'i and 14 species in lowland Savai'i. There was a minor difference in overall bird numbers; the upland forest had 21.33 ± 1.38 birds per 5 minutes and the lowland forest had 17.92 ± 1.7 birds per 5 minutes.

We observed similar numbers of Wattled Honeyeater, Pacific and White-throated Pigeons, and Crimson-crowned Fruit Dove in both areas. Several birds had higher numbers in the lowland forest – Flat-billed Kingfisher, Samoan Whistler, White-rumped Swiftlet and Polynesian Starling, and in particular Samoan Broadbill, which was six times more common than in upland forest. However, Samoan Fantail, Scarlet Robin and Cardinal Honeyeater were found in higher numbers in upland forest, and Mao, Tooth-billed Pigeon, Samoan White-eye and possibly the Samoan Woodrail were encountered only in upland forest.

The most common bird in both lowland and upland forest was the Wattled Honeyeater. The next most common were Samoan Broadbill, Crimson-crowned Fruit Dove and Samoan Whistler in lowland and Crimson-crowned Fruit Dove and Cardinal Honeyeater in upland forest.

Rare birds

Samoan Woodrail: We had two possible sightings of this bird in the upland forests of Savai'i, 1 km west of Mount Elietoga, while on a traverse from the end of the Asau forestry road towards Mt Silisili. On 22 August, National Parks Officer Kolati Poai briefly saw a bird like a small Purple Swamphen. It had a yellow forehead and was dark grey on the back and wings, with red legs.

On 23 August, MB flushed a small ground bird from a crater floor. It scrambled and fluttered across the thick vegetation away from him into dense

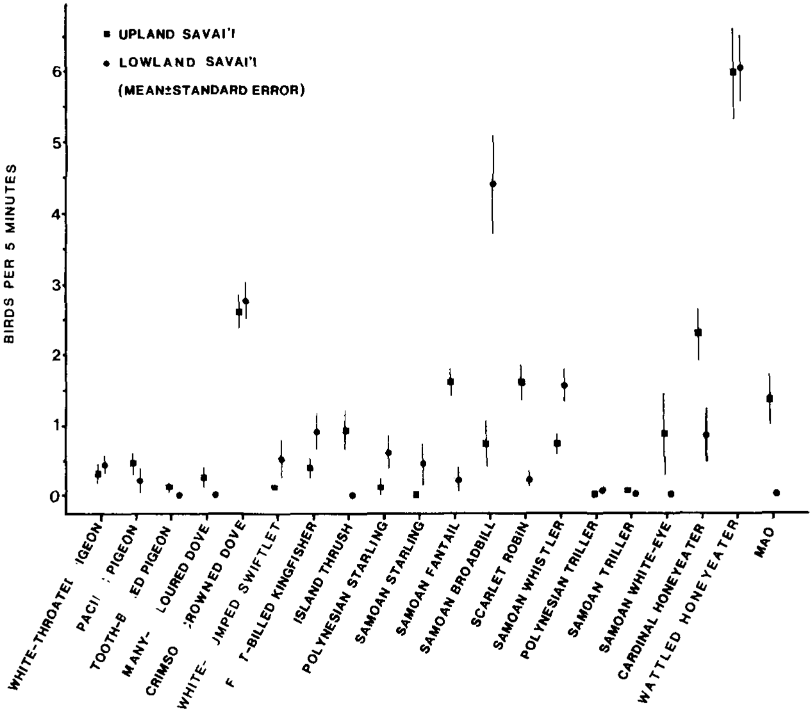

FIGURE 4 — Bird transects in upland and lowland forest on Savai'i.

undergrowth and disappeared. It had long red legs, was slightly larger than a Banded Rail, and had a dark grey back and wings with a lighter grey rump.

Unfortunately neither sighting was verified by other members of the party.

Friendly Quail Dove: We did not see this bird on Upolu or Savai'i. It apparently has not been seen for at least 35 years. Although du Pont (1972) stated that this bird was found in dense forest above 1100 m, the last recorded sighting in Western Samoa is in Yaldwyn (1952), who stated that it "appears to be rare; occasionally seen on the ground at Vaitpoto (D. V. Cobcroft)".

Tooth-billed Pigeon: We heard this pigeon occasionally in upland Savai'i but saw it only rarely, in the lower forest tiers. It has been seen recently in upland Upolu (Kolati Poai, pers. comm.) and at Tiavi Falls, Upolu, by Dhondt (1976).

Samoan White-eye: Noisy flocks of 15-20 birds were not uncommon, feeding in the canopy of the upland forests of Savai'i.

Mao: We saw and heard the Mao in the upland and foothill forests of Upolu and Savai'i. It seemed to have a good population in the area we traversed in upland Savai'i. It dominated the early dawn and dusk choruses, being particularly vocal in the craters surrounding Mt Fito, in O Le Pupu-pu'e National Park, and on upland Savai'i. Mao has also been recorded at Tiavi Falls (Orenstein 1976 and Dhondt 1976) and at Pe'ape'a Cave in the national park (Lovegrove 1984).

Pacific Black Duck: We saw this duck in the marsh in Vaivai Crater, on the main range in the national park. It is rare in Western Samoa, and in American Samoa (Amerson *et al.* 1982), where freshwater and coastal wetlands are few and small.

Sooty Rail: Sooty Rail were heard in Vaivai crater. It is rare in Samoa, not even having a local name.

Notes on other birds

Blue-crowned Lory: Lories were commonly seen feeding on coconut flowers in the agricultural plantation adjacent to the national park. They were also seen on the southern foothills of Savai'i feeding in flocks on *Elaeocarpus ulianus* flowers growing between newly established agricultural plantations.

White-rumped Swiftlet: Swiftlets were often seen emerging from lava caves, especially in Tafua forest, where collapsed lava caves are common. Swiftlets were seen nesting in Pe'ape'a Cave in the national park, more than 300 m from the nearest cave opening.

Exotic birds: Jungle Fowl was the only exotic bird we saw in forests on Upolu and Savai'i. Jungle Myna and Red-vented Bulbul were in open areas and plantations but not in natural forests. Jungle Myna was seen only on Upolu.

DISCUSSION

Partial logging of lowland tava forest has changed the species composition and the density of individual bird species, although the total bird numbers were similar in partly logged and in unmodified forest, except for Banded Rail. The Mao was found only in unmodified forest and the Red-headed Parrot Finch was restricted mainly to that type. More than half the species had higher numbers in unmodified forest. White-throated Pigeon, Crimson-crowned Fruit Dove, and Samoan Fantail were much more numerous in unmodified forest. Samoan Starling, Polynesian Triller, Cardinal Honeyeater and White-rumped Swiftlet were more common in partly logged forest, where they were often found in canopy gaps. Blue-crowned Lory, Samoan Starling, Polynesian Triller, and Banded and White-browed Rails also were commonly found in forestry and agricultural plantations.

Amerson *et al.* (1982) noted that lowland rain forest on Tutuila, American Samoa, contained large numbers of birds, particularly nesting Crimson-crowned Fruit Dove, Wattled Honeyeater, Polynesian Starling and White-tailed Tropicbird. They also found that Cardinal Honeyeater, White-rumped Swiftlet, Pacific Pigeon and Blue-crowned Lory had higher densities in secondary forest than in rain and ridge forests.

In upland and lowland Savai'i, the forest bird communities had similar total bird numbers and number of species, but the species composition differed. Samoan Broadbill and Flat-billed Kingfisher were found predominantly in lowland forest and Samoan Fantail mainly in upland forest.

Mao, Tooth-billed Pigeon, Samoan White-eye and Island Thrush were found only in upland forest on Savai'i at the time of our survey.

Our survey was undertaken only in one part of the year and does not take into account any seasonal bird movements between unmodified forest and modified habitats and between different altitudes. Blue-crowned Lory were found mainly in coconut plantations. They probably use forest areas at other times of the year, when trees are in bloom (Amerson *et al.* 1982).

Our results concurred with previous observations on the commoner forest bird species by Yaldwyn (1952), Dhondt (1976), Child (1979), Reed (1980), and Muse & Muse (1982). However, it is difficult to assess the status of the rarer birds in Western Samoa from the sparse information available on population size, distribution and habitat requirements. However, past records are anecdotal and often conflicting. The Tooth-billed Pigeon is a good example; Yaldwyn (1952) noted it was "not as common as it was", while Dhondt (1976) said it was rare and also "not so rare in the forest". Reed (1980) considered it rare and endangered. Of these authors, Reed (and her party) were the only observers to have spent time in the upland forests of Savai'i, the major area of Tooth-billed Pigeon habitat.

From our observations in a wide range of forest types in Western Samoa, the habitat of Tooth-billed Pigeon, Mao and Samoan White-eye is now restricted to prime upland forests. The Scarlet Robin, Samoan Triller and Island Thrush, being found mainly at higher altitudes and in low numbers in modified forests, may also be threatened.

The Friendly Quail Dove appears to be an enigma: it is common in Fiji and some of the northern Tongan islands (Watling 1982), and present on Ofu and possibly Olosega Islands in American Samoa (Amerson *et al.* 1982). It may have always been in low numbers in Western Samoa, where its population could be subject to periodic extinction and reinvasion from Tonga.

Lovegrove and his party saw Tooth-billed Pigeon, Mao and Samoan White-eye at their camp near Mt Elietonga (Lovegrove 1984). When we visited this site two years later, it had been cleared for a forestry plantation. None of these three birds were found in forestry plantations on Savai'i by Lovegrove (pers. comm.).

It is imperative that a range of representative habitats be preserved in Western Samoa. This is urgently needed in Savai'i, where there are no reserves to represent unique habitats and endemic flora and fauna. The upland forests support populations of the rare Tooth-billed Pigeon, the Mao, the endemic Samoan White-eye and possibly the Samoan Woodrail. The Tafua forest area had large numbers of birds in unmodified lowland and coastal forest, with adjoining mangrove habitats.

There has been little research into the population size, distribution and ecology of any Samoan birds. Research priorities in Western Samoa must include Samoan White-eye, Tooth-billed Pigeon and Mao. Further searching for the Samoan Woodrail and Friendly Quail Dove on Savai'i may yet be fruitful. This research is necessary for the preservation of the rare bird species and for the design of reserves in Western Samoa.

APPENDIX

SAMOAN NAME **(K.Poai)**	**ENGLISH NAME**	**SCIENTIFIC NAME**
Toloa	Pacific Black Duck	*Anas superciliosa pelewensis*
Moa'aivao	Jungle Fowl	*Gallus gallus*
Ve'a	Banded Rail	*Gallirallus philippensis*
Vai	White-browed Rail	*Poliolimnas cinereus tannensis*
-	Sooty Rail	*Porzana tabuensis tabuensis*
Manuali'i	Purple Swamphen	*Porphyrio porphyrio*
Puna'e	Samoan Woodrail	*Pareudiastes pacificus*
Fiaui	White-throated Pigeon	*Columba vitiensis*
Tu'aimeo	Friendly Ground Dove	*Gallicolumba stairii*
Lupe	Pacific Pigeon	*Dacula pacifica pacifica*
Manume'a	Tooth-billed Pigeon	*Didunculus strigirostris*
Manuma	Many-coloured Fruit dove	*Ptilinopus perousii*
Manutagi	Crimson-crowned Fruit dove	*Ptilinopus porphyraceus*
Segavao	Blue-crowned Lory	*Vini australis*
'Aleva	Long-tailed Cuckoo	*Eudynamis taitensis*
Lulu	Barn Owl	*Tyto alba lulu*
Pe'ape'a	White-rumped Swiftlet	*Collocalia spodiopygia*
Ti'otala	Flat-billed Kingfisher	*Halcyon recurvirostris*
Manu palagi	Red-vented Bulbul	*Pycnontus cafer bengalensis*
Tutulili	Island Thrush	*Turdus poliocephalus samoensis*
Miti tai	Polynesian Starling	*Aplonis tabuensis brevirostris*
Fuia	Samoan Starling	*Aplonis atrifusca*
Se'u	Samoan Fantail	*Rhipidura nebulosa*
Tolai fatu	Samoan Broadbill	*Myiagra albiventris*
Tolai ula	Scarlet Robin	*Petroica multicolor*
Vasavasa	Samoan Whistler	*Pachycephala flavifrons*
Miti vao	Polynesian Triller	*Lalage maculosa*
Miti tai	Samoan Triller	*Lalage sharpei*
-	Samoan White-eye	*Zosterops samoensis*
Segasegamau'u	Cardinal Honeyeater	*Myzomela cardinalis*
Iao	Wattled Honeyeater	*Foulehaio carunculata*
Ma'oma'o	Mao	*Gymnomyza samoensis*
Manu ai pa'u la'au	Red-headed Parrot Finch	*Erythrura cyaneovirens*

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MOULTS OF RECTRICES AND BODY PLUMAGE OF BLUE-EYED AND KING SHAGS (*Phalacrocorax atriceps* AND *P. albiventer*) AND PHENOLOGY OF MOULTS

By PAMELA C. RASMUSSEN

ABSTRACT

In Blue-eyed and King Shags (*Phalacrocorax atriceps* and *P. albiventer*), moult of the rectrices is irregular but not random. R1 (Rectrix 1) was usually the first to be replaced in subadult Blue-eyed Shags but not in adults. In Blue-eyed Shags, moulting rectrices were most often separated by one or two non-moulting rectrices. When two adjacent rectrices were moulting in adult Blue-eyed Shags, one was usually over half grown before the other began moulting, or both were about the same length or missing. Up to six rectrices moult simultaneously in subadults and up to eight in adults. Moult of rectrices is usually not symmetrical in Blue-eyed Shags. In adults, the number of moulting feathers and the number of waves are correlated among flight feathers. In flight feathers of subadults, the number of moulting feathers is not correlated but the number of moulting waves and the number of retained juvenile flight feathers are correlated. Most moult of flight and body feathers takes place after breeding, but a limited amount occurs during breeding and in winter.

INTRODUCTION

Cormorants (Phalacrocoracidae) are one of the few groups of birds that, in addition to undergoing a heavy prebasic moult into basic (non-breeding) plumage in the late summer and early autumn, moult to a limited extent during breeding and in winter (Witherby *et al.* 1940; Falla 1932; Stead 1932; Turbott 1956; Rand 1960; Palmer 1962; Potts 1971; Watson 1975; Berry 1976; Bernstein & Maxson 1981; Crawford *et al.* 1982; Ginn & Melville 1983; Cooper 1985; Rasmussen in press *a*, in press *b*).

Primaries moult by continual stepwise moult ("*Staffelmauser*", Stresemann & Stresemann 1966; "serially descendent moult", Ginn & Melville 1983). Several authors have suggested that stepwise moult of primaries allows slow moult and thus permits limited moult during stressful times (*i.e.* winter and breeding). However, most cormorants moult body and tail feathers as well as remiges during breeding, and it is not clear how stepwise moult of remiges makes moult of other feather groups any less stressful.

No detailed analyses of moult of rectrices in cormorants have been published. Moult of rectrices is said to be irregular in cormorants by some investigators (Owre 1967, Berry 1976, Cramp & Simmons 1977, Bernstein & Maxson 1981), or centripetal and alternating (Verheyen 1953, Crawford *et al.* 1982). Stresemann & Stresemann (1966) stated that cormorants tend

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to moult rectrices alternately, and that a 1-6-4-2-3-5 pattern of tail moult is typical of members of the family. Other pelecaniforms are thought to have irregular moult of rectrices as well (Gurney 1913, Dorward 1962, Stonehouse 1962, De Korte & De Vries 1978, Nelson 1978*a*, *b*).

Blue-eyed and King Shags (*Phalacrocorax atriceps* and *P. albiventer*) are large black and white cormorants, each represented by several subspecies, in southern South America, the Falkland Islands, the Antarctic Peninsula, the Prince Edward Islands, Marion Island, the Crozet Islands, Heard Island, South Georgia, and Macquarie Island (Murphy 1916, 1936; Behn *et al.* 1955; Watson *et al.* 1971; Watson 1975; Devillers & Terschuren 1978; Williams & Burger 1979). These probably conspecific (Devillers & Terschuren 1978, Rasmussen 1986) cormorants have moult of primaries that appears irregular (Murphy 1916), but occurs by stepwise moult (Bernstein & Maxson 1981, Rasmussen in press *b*), as is typical of cormorants (Stresemann & Stresemann 1966). The first prebasic (post-juvenile) moult (PB1, Humphrey & Parkes 1959) begins at Primary 1 (P1) and proceeds distally; stepwise moult begins when PB2 starts before the completion of PB1 (Rasmussen in press *b*). Adult Blue-eyed Shags have up to four concurrent waves of moult in primaries. Secondaries are moulted by bidirectional stepwise moult; waves of PB1 begin at the distal- and proximal-most secondaries and move centrally, and then PB2 begins distally and proximally before completion of PB1. There are up to six concurrent waves in moult of secondaries. Remiges are usually moulted asymmetrically, and subadults have more moulting feathers per wave than do adults (Rasmussen in press *b*). Bernstein & Maxson (1981) found that for the Antarctic Blue-eyed Shag all feather tracts moulted at their heaviest from the end of March to mid-April, and that moult of rectrices was "irregular and often unilateral."

This account provides information on the characteristics of moult of rectrices; seasonality of moult; and degree of correlation of moult among major feather groups for subadult and adult Blue-eyed and King Shags.

METHODS

Specimens which had not yet begun PB1 (the first prebasic moult) were considered juveniles; specimens in PB1 subadults; and specimens which no longer had any juvenile feathers adults. Sample size is given in Table 1. The sample size of King Shags was too small to permit certain of the quantitative analyses which were done for Blue-eyed Shags.

Primaries were numbered P1 (Primary 1) to P10 proximally to distally, secondaries S1 (Secondary 1) to S15 distally to proximally, and rectrices R1 (Rectrix 1) to R6 medially to laterally. I took relative age and moult data from as many flight feathers of each specimen as possible. Age categories 0-10 (1-5 are also growth categories) were assigned to each flight feather: (0) juvenile; (1) missing; (2) new feather just visible; (3) less than ¼ grown; (4) ¼ to ½ grown; (5) greater than ½ to not quite fully grown; (6) full-length, no wear or fading; (7) very slight wear and/or fading; (8)

light but obvious wear and fading; (9) moderate wear and fading; (10) heavy wear and fading. For justification of this method, see Rasmussen (in press *b*).

TABLE 1 — Number and nature of specimens of Blue-eyed and King Shags examined for each season, age, and locality

	Blue-eyed	King
Season		
Winter (Jun-Aug)	4	9
Spring (Sep-Nov)	10	10
Summer (Dec-Feb)	60	39
Autumn (Mar-May)	23	10
Ages		
Juveniles	14	17
Subadults	33	20
Adults	50	31
Locality		
South America	51	48
Falkland Is.	0	15
South Georgia I.	10	0
Shag Rocks (50°33'S, 43°02'W)	1	0
South Shetland Is.	17	0
Antarctica	18	0
Macquarie I.	0	5
Nature of specimens		
Museum skin	70	60
Freshly collected	27	8
Totals	97	68

To determine which (if any) rectrices tended to be replaced first, I tallied frequency of being first-replaced for each rectrix number from R1 to R6 of the left side of the tail (or the right if the left was not usable). For two-way ties between earliest-replaced rectrices within a tail, each was tallied as 0.5; for three-way ties, 0.33; and four-way ties, 0.25. A chi-square analysis was done using equal expected frequencies.

I considered moult of rectrices completely symmetrical if feathers of each bilateral pair (L5, R5) were in the same age category or were moulting simultaneously. Individual rectrix pairs were symmetrical if both feathers of the bilateral pair were in the same age category or were moulting simultaneously.

I examined moult of the following body regions: head (from chin and nape up); neck (from below chin and nape to top of breast and mantle); back (mantle to rump); venter (breast to vent); tertials; and scapulars. Categories describing amount of moult of each body region were: (0) none; (1) very light; (2) light; (3) moderate; (4) heavy. Intensity of moult for body regions was defined as the average of these categories for each region, and for flight feathers, intensity was the average number of moulting feathers per side of each specimen.

To determine predictability of moult among feather groups, Pearson's product-moment correlations were done on the number of moulting feathers on the left wing of each specimen for primaries and secondaries, the left side of each specimen for rectrices, and the presence of body moult.

RESULTS

Moult of rectrices

No regular sequence of replacement could be determined by inspection of rectrix moult data for Blue-eyed and King Shags. In subadult Blue-eyed Shags, R1 is usually the first replaced (X^2=32.12, df=5, $P < 0.001$, Figure 1). In adult Blue-eyed Shags there was no discernible pattern.

Subadult and adult Blue-eyed Shags were very similar in number of non-moulting rectrices occurring between pairs of moulting rectrices (Figure 2). Most pairs of moulting rectrices were separated from each other by one or two non-moulting rectrices in both age classes.

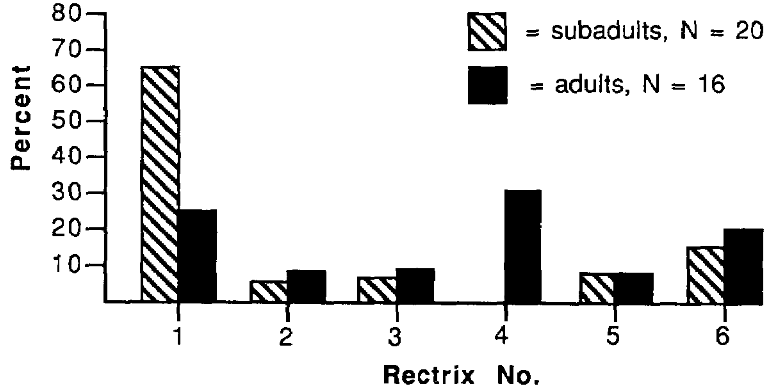

FIGURE 1 — Percentage of cases in which each rectrix was replaced first in subadult and adult Blue-eyed Shags

Adjacent moulting pairs of rectrices in adult Blue-eyed Shags tended to differ by either zero or three growth categories (Figure 3). The earlier-moulted rectrix was more than half-grown before loss of the adjacent rectrix in 50% of the adult Blue-eyed Shags. Of 37 adult King Shags only six had adjacent rectrix pairs that were moulting simultaneously. In most, rectrices were moulted singly (Figure 4); subadults rarely moulted up to four adjacent rectrices simultaneously; adult Blue-eyed Shags up to five; and adult King Shags only up to three adjacent rectrices simultaneously.

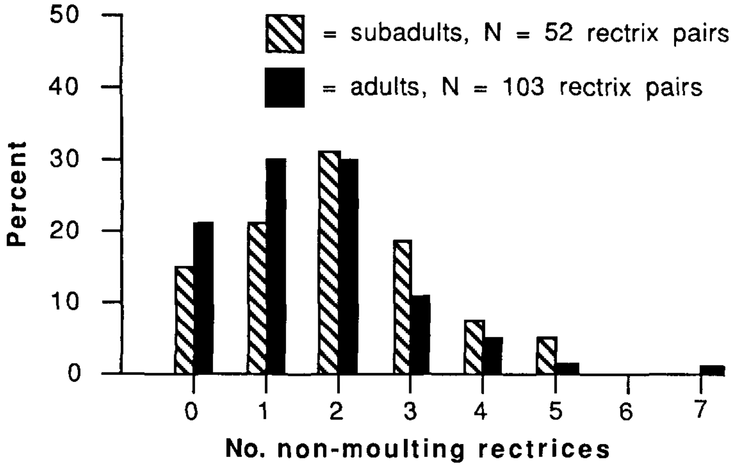

FIGURE 2 — Number of non-moulting rectrices between pairs of moulting rectrices in subadult and adult Blue-eyed Shags

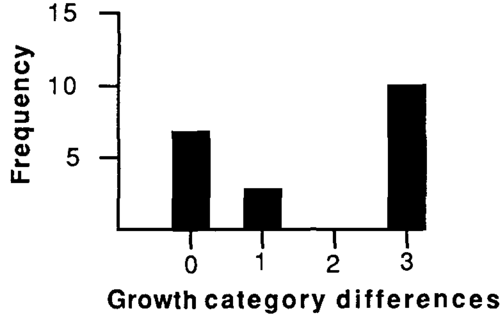

FIGURE 3 — Differences in growth categories between adjacent moulting pairs of rectrices in adult Blue-eyed Shags

In subadult Blue-eyed Shags, the number of moulting rectrices per tail was $\bar{x}$ = 3.70, s.d. = 1.76, range = 0-6, n = 17; in adults, $\bar{x}$ = 3.04, s.d. = 2.3, range = 0-8, n = 44. In subadult King Shags, the number of moulting rectrices per tail was $\bar{x}$ = 2.91, s.d. = 2.34, range = 0-6, n = 11; in adults $\bar{x}$ = 2.5, s.d. = 2.4, range = 0-7, n = 35. Adults more frequently were not moulting rectrices, and sometimes moulted more rectrices simultaneously than subadults (Figure 5).

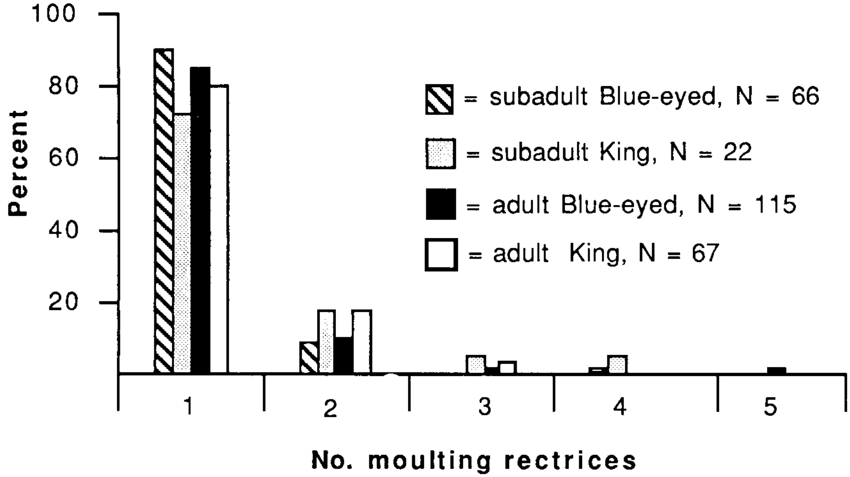

FIGURE 4 — Number of adjacent rectrices moulting in subadult and adult Blue-eyed and King Shags. 1 = rectrices moulting singly

Symmetry of moults

Seven of 21 subadult Blue-eyed Shag specimens had completely symmetrical moult of rectrices, but none of 31 adult Blue-eyed Shags and 17 King Shags had complete symmetry of moult of rectrices. Of 53 bilateral rectrix pairs in subadult Blue-eyed Shags, moult was symmetrical in 23 pairs (43%), and of 113 bilateral rectrix pairs in adult Blue-eyed Shags, moult was symmetrical in 26 pairs (23%). Of 102 bilateral rectrix pairs in adult King Shags, moult was symmetrical in 44 pairs (43%). Differences between subadult and adult Blue-eyed Shags were not statistically significant (complete symmetry: $X^2 = 1.35$, df = 1, $P > 0.05$; bilateral symmetry: $X^2 = 1.30$, df = 1, $P > 0.05$).

Correlation of moults

The number of moulting primaries was not correlated with the number of moulting secondaries, nor was the number of moulting remiges correlated with the number of moulting rectrices in subadults of either form (Table 2). The number of moulting feathers per primary row was significantly correlated with the number of moulting feathers per secondary row in adult Blue-eyed and King Shags. The number of moulting waves in primaries of Blue-eyed Shags and adult King Shags was significantly correlated with the number of moulting waves in secondaries, but was not correlated in 15 subadult King Shags. The number of juvenile primaries remaining was strongly correlated with the number of juvenile secondaries in subadult Blue-eyed and King Shags. The number of juvenile remiges remaining was strongly correlated with the number of juvenile rectrices in subadult Blue-eyed Shags but not in subadult King Shags.

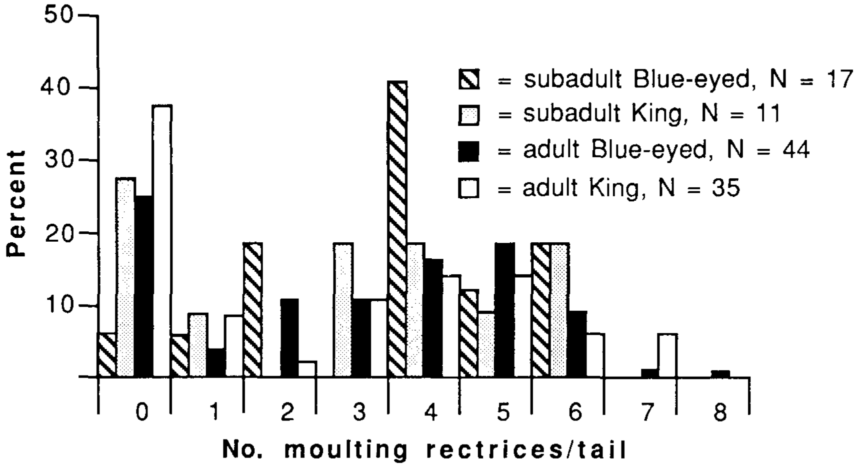

FIGURE 5 — Number of rectrices moulting per tail in subadult and adult Blue-eyed and King Shags

TABLE 2 — Correlations between moult of selected body regions for Blue-eyed and King Shags

	Blue-eyed Shag				King Shag			
	Subadult		Adult		Subadult		Adult	
Correlation	*r*	*n*	*r*	*n*	*r*	*n*	*r*	*n*
No. moulting primaries vs. secondaries	0.29	27	0.50**	40	0.17	15	0.66**	30
No. moulting remiges vs. rectrices	0.09	25	0.78**	36	0.37	15	0.80**	31
No. moulting waves in primaries vs. secondaries	0.56**	26	0.52**	40	0.37	15	0.58**	31
No. remaining juvenile primaries vs. secondaries	0.77**	27	—	—	0.95**	16	—	—
No. retained juvenile remiges vs. rectrices	0.70**	25	—	—	0.24	15	—	—

*=$P<0.05$;**=$P<0.01$.

TABLE 3 — Number of specimens moulting in selected feather groups but not in other specified groups for Blue-eyed and King Shags. Number examined for each category is in parentheses

	Blue-eyed Shag		King Shag	
	Subadult	Adult	Subadult	Adult
No. moulting primaries but not secondaries	12 (28)	6 (37)	4 (15)	6 (30)
No. moulting secondaries but not primaries	1 (28)	5 (37)	4 (15)	0 (30)
No. moulting remiges but not rectrices	2 (25)	5 (36)	4 (15)	3 (30)
No. moulting rectrices but not remiges	0 (25)	0 (36)	0 (15)	1 (30)
No. moulting remiges but not body feathers	3 (27)	5 (29)	4 (17)	5 (19)
No. moulting body feathers but not rectrices	2 (23)	5 (22)	2 (13)	4 (19)
No. moulting rectrices but not body feathers	1 (23)	2 (22)	3 (13)	2 (19)
No. moulting body feathers but not flight feathers	2 (27)	0 (29)	4 (17)	0 (19)
No. commencing PB1 in primaries before secondaries	22 (25)	—	12 (13)	—
No. commencing PB1 in secondaries before primaries	2 (25)	—	0 (13)	—

In both age classes of both species, moult occurred in several cases in primaries when secondaries were not moulting (Table 3). Subadult Blue-eyed Shags and adult King Shags rarely moulted secondaries when not moulting primaries. All classes infrequently moulted remiges when not moulting rectrices and, one exception, did not moult rectrices without also moulting remiges. Most specimens moulted body feathers while moulting remiges and rectrices. Very few subadult specimens and no adults moulted body feathers when not moulting flight feathers.

All feather groups moulted at highest intensity in summer and autumn in subadult and adult Blue-eyed and King Shags (Figure 6). Almost all subadult and adult Blue-eyed Shags were moulting all feather groups (except venter and scapulars) during summer and autumn (Figure 7). In winter a prealternate (pre-breeding) moult of the head and neck occurred in two Blue-eyed Shags and one King Shag. In the two adult Blue-eyed Shags, prealternate moult also occurred in the region of the white back patch, but not elsewhere on the back. No King Shags had prealternate moult on the back.

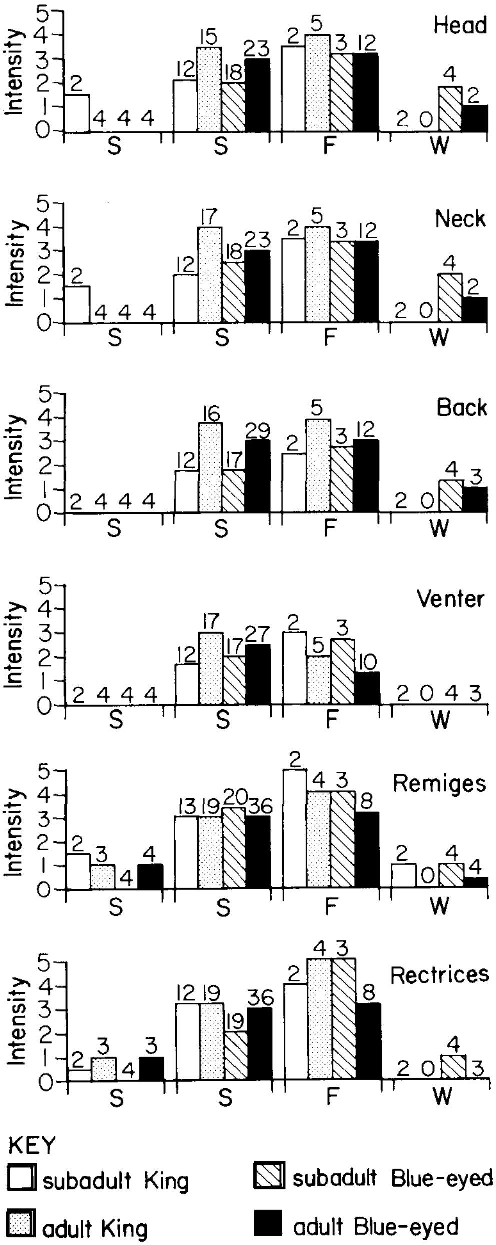

FIGURE 6 — Mean seasonal (austral spring, summer, autumn, winter) moult intensity of various feather groups for subadult and adult Blue-eyed and King Shags. Intensity of moult is defined in the Methods. Number above bar is sample size for that season

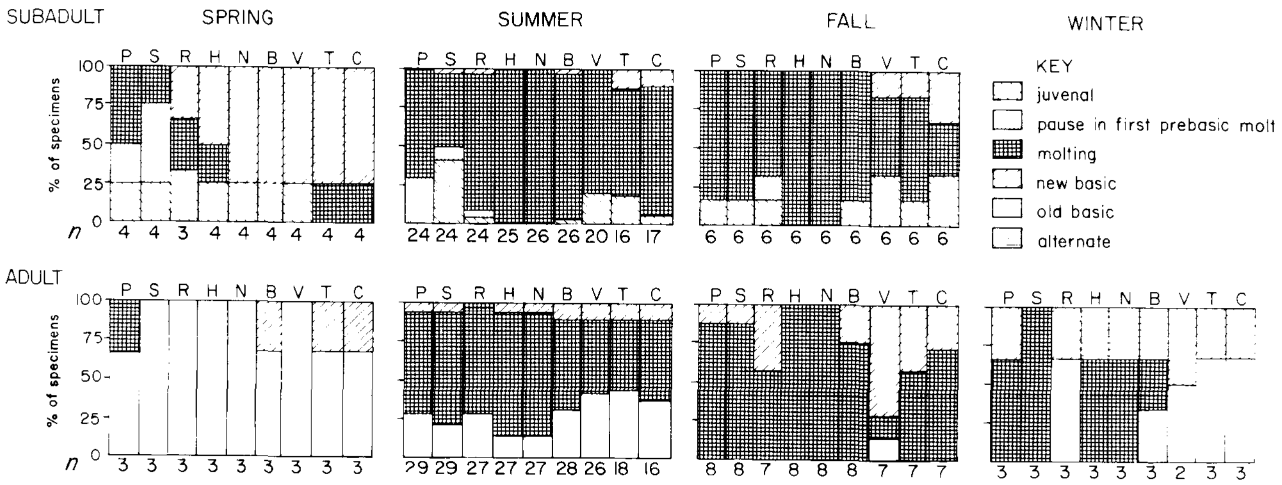

FIGURE 7 — Seasonal percent of adult and subadult Blue-eyed Shag specimens in juvenile, basic, or alternate plumage, or moult of each feather group. No winter specimens of subadult Blue-eyed Shags were available for this study. P. = primaries, S = secondaries, R = rectrices, H = head, N = neck, B = back, V = venter, T = tertials, C = scapulars

Only six adult Blue-eyed Shags were not moulting any feathers when collected (Jan., 2; Aug., 1; Sep., 1; Dec., 2), and only five adult King Shags (Jan., 1; Nov., 1; Dec., 3).

DISCUSSION

Moult of rectrices

In Blue-eyed Shags, moulting rectrices are separated by two or three feathers more often than moulted alternately (Figure 2), although the Cormorant (*P. carbo,* Ginn & Melville 1983) and cormorants as a group tend to moult rectrices alternately (Stresemann & Stresemann 1966). In addition, no Blue-eyed or King Shags showed a pattern of tail moult which conformed to the 1-6-4-2-3-5 sequence that, according to Stresemann & Stresemann (1966), characterises the moult of rectrices in all cormorants.

The pattern of moult of rectrices in Blue-eyed and King Shags, although it at first appears random and unpredictable, actually ensures that few large gaps are present at any one time, even when moult is at its heaviest.

Symmetry of moult of remiges

Moult of rectrices is asymmetrical in Blue-eyed and King Shags as well as in adult Cape Cormorants (*P. neglectus* n = 56, $\bar{x}$ = 17.6% symmetry, raw data from Berry 1976) and Great Frigatebirds (*Fregata minor* n = 16, 31.3% symmetry, raw data from De Korte & De Vries 1978). The minor differences in bilateral symmetry of rectrix moult in adult and subadult Blue-eyed Shags suggest that the pattern is not fixed in an individual throughout life, at least not between the first and succeeding prebasic moults. Moult of remiges also tends to be asymmetrical in Blue-eyed and King Shags (Bernstein & Maxson 1981, Rasmussen in press *b*), as well as in other pelecaniforms.

Intensity and linkage

Body moult of Blue-eyed and King Shags was heaviest in summer and autumn (Figure 6); this agrees with Murphy's (1936) and Watson's (1975) statements that Blue-eyed Shags begin moulting in the breeding season and continue until June: however, this study and Bernstein & Maxson's (1981) study showed that moult occurred at lower intensities at other seasons. In Antarctic Blue-eyed Shags, body moult was heaviest in March and April (Bernstein & Maxson 1981).

The assertion that a post-juvenile (first prebasic) tail moult occurs very soon after fledging in Blue-eyed and King Shags (Murphy 1936) was not supported by this study. The first prebasic moult of rectrices in these species occurs at about the same time as PB1 of remiges and contour feathers (Table 3; Figures 6, 7). Known-age individuals of the King Shag of Macquarie Island (*P. albiventer purpurascens*) attained full adult plumage in their second year of life (Brothers 1985); however, some Antarctic Blue-eyed Shags retained a few juvenile remiges at three years of age (P. Shaw, pers. comm. *in* Bernstein & Maxson 1981).

In addition to the known prealternate moult of the head of Blue-eyed and King Shags and the middle of the back in the Blue-eyed Shag (Watson 1975), a prealternate moult also occurs on the neck (Figure 7). The moults of remiges that occur in winter and spring, because they are continuous (Rasmussen in press *b*), cannot be considered prealternate even though they are concurrent with the prealternate moults of head and neck.

Almost all adult specimens of both forms examined in this study were moulting, several during breeding and winter. Bernstein & Maxson (1981) reported five non-moulting Antarctic Blue-eyed Shags during March, but they apparently included data for juveniles (which do not begin moult until nearly a year old) with those for adults. Nelson (1983) suggested that it should be more advantageous for inshore-feeding pelecaniforms to become stressed in order to produce more young than for pelagic feeders to do so. Although Nelson did not discuss moult as a form of stress, this hypothesis is supported by Stonehouse's (1962) study, in which he found that in pelagic tropicbirds, courtship did not begin until moult was completed (Red-billed, *Phäethon aethereus*), or birds infrequently began breeding with a few moulting feathers (White-tailed, *P. lepturus*). Members of the other pelecaniform families are mostly inshore feeders, and as far as known all moult to some extent during breeding (Gibson-Hill 1950, Rand 1959, Stonehouse 1962, Dorward 1962, Nelson 1964, Bauer & Glutz 1966, De Korte & De Vries 1978, Nelson 1978*a*, *b*).

Although PB1 generally began in primaries before secondaries, and the number of juvenile feathers retained was generally correlated among feather groups in Blue-eyed and King Shags, the number of moulting primaries per specimen was uncorrelated with the number of moulting secondaries; this reflects the variability in number of feathers per wave in subadults.

Adults showed strong correlations in moult among flight feathers, both in number of feathers moulting and in number of moulting waves. In both subadults and adults, when secondaries, rectrices, and/or body feathers were moulting, primaries were usually moulting as well, but primaries frequently moulted when these other feather groups were not moulting. Although data are lacking, it is possible that slower rates of growth of the primaries than of the other flight feathers account for their longer period of moult.

Considerable variability was evident in all aspects of the moult of both Blue-eyed and King Shags, as is the case in other species of cormorants (Potts 1971, Berry 1976, Bernstein & Maxson 1981, Ginn & Melville 1983, and others). This was strikingly shown by two adult female Blue-eyed Shages from Puerto Deseado, Argentina, collected together on the same rock on 22 February 1985; one of these birds had just started moult after a pause while the other had nearly completed body moult and had many new remiges. Some of the variability in moults is related to age, and variability may also be related to breeding success (De Korte & De Vries

1978), sex (Pitts 1971), geographic variation in breeding times (Potts 1967, 1969), individual variation (Dementiev & Gladkov 1951, Nelson 1978), nutritional factors, or lack of selective controls.

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OSNZ BEACH PATROL SCHEME: INFORMATION AND INSTRUCTIONS

By R. G. POWLESLAND and M. J. IMBER

INTRODUCTION

Thousands of kilometres of sea separate New Zealand from the nearest continents, except Australia, which is about 1600 km away. To the east is the Pacific Ocean, to the south are Antarctic waters, and to the west is the Tasman Sea with the Indian and South Atlantic Oceans beyond. Seabirds are well-known long-distance migrants and wanderers. It is not surprising, therefore, that seabirds from all southern oceans of the world have been recorded in the New Zealand region.

Those who have studied birds at sea know that certain identification of the birds seen is often impossible, particularly the penguins and petrels. Therefore, some rarities were first detected by observant beach patrollers. To them we can attribute the only records on the New Zealand mainland of the Adelie Penguin *(Pygoscelis adeliae)*, Bird of Providence *(Pterodroma solandri)*, Stejneger's Petrel *(P. longirostris)*, North Atlantic Shearwater *(Calonectris diomedea)*, Manx Shearwater *(Puffinus puffinus)*, Christmas Island Shearwater *(P. nativitatis)*, Antarctic Skua *(Catharacta maccormicki)* and White-tailed Tropicbird *(Phaethon lepturus)*.

Finding dead seabirds on beaches has revealed not only stragglers to New Zealand but also new species or subspecies. Buller's Shearwater *(Puffinus bulleri)* was first described from a beach specimen. A subspecies of Gould's Petrel *(Pterodroma leucoptera caledonica)* was first recognised in this way, although its breeding place was not discovered until 30 years later. Hutton's Shearwater *(Puffinus huttoni)* was known to many beach patrollers in New Zealand long before its breeding place was discovered in 1965.

New Zealand's geographical position has an important influence on the kinds and numbers of seabirds found on its beaches. It lies nearly at right angles to the prevailing westerly winds. In addition, the side obstructing the westerlies is roughly boomerang-shaped. Thus, it acts as a huge trap for many seabirds which are moving or are being carried eastwards. The winds that seem to cause most casualties on western beaches of the North Island come from west to south-west and are often strong and squally. Perhaps birds swept before these winds are carried north-eastwards, parallel to the South Island's west coast, into the waters off the Wellington and Auckland west coasts (Figure 1). This may explain why, under such conditions, the greatest numbers of dead seabirds are found on these two coasts. Blown towards the land, which they try to avoid, the weaker birds succumb to exhaustion and starvation. Presumably most die by drowning, but sometimes a few are blown inland. The stronger ones survive or perhaps escape through Cook Strait or around North Cape. The numbers cast ashore during and immediately after a storm are undoubtedly related to the numbers

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present offshore and to their condition and health when the stormy weather strikes. However, it is not known how far or for how long dead birds will drift before being cast ashore. Sometimes, a period of exceptionally severe mortality occurs of one or more species, which is called a "wreck".

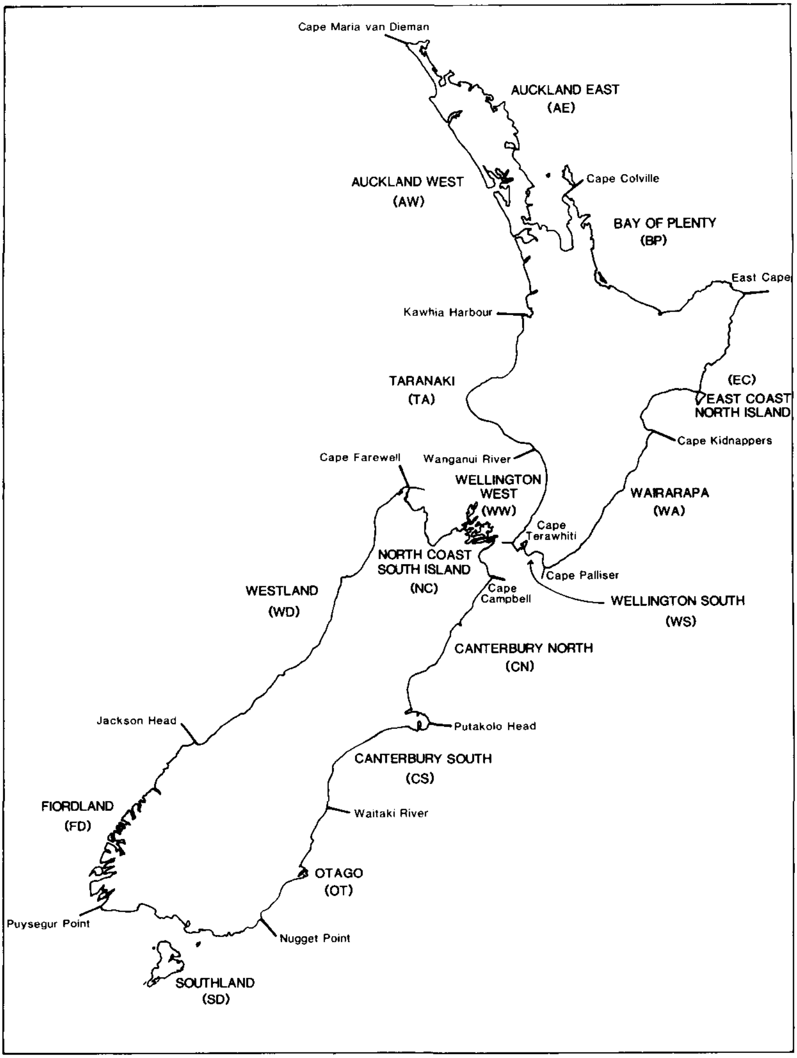

FIGURE 1 — The names, abbreviations and boundaries of the 15 districts of the New Zealand coastline in which beach patrols are grouped

In general, east- and north-facing coasts are not exposed to persistent onshore weather (e.g. Bay of Plenty). Dead seabirds are washed ashore on other than west-facing coasts, of course, although usually in smaller numbers. The number found on other coasts apparently depends mainly on the numbers breeding on nearby islands or migrating along the coast, their condition and whether their movements coincide with severe onshore winds. For example, one of New Zealand's largest wrecks of seabirds was of young Sooty Shearwaters *(Puffinus griseus)* along the east coast of the South Island in May 1961 (Stonehouse 1964), when thousands perished. Emaciated, they were washed ashore or blown inland during a period of rough easterly weather.

Many species of seabirds breed in the New Zealand region and these provide a large proportion of the specimens on beaches in most years. We have three penguins, one albatross, 14 petrels and shearwaters, a storm petrel, two diving petrels, one gannet, seven shags, one skua, three gulls and four terns breeding on the main islands or those close offshore. In addition, almost as many species breed on subtropical and subantarctic islands in the region.

Southern vagrants are occasionally wrecked on our coasts in winter and spring. For example, thousands of Lesser Broad-billed Prions *(Pachyptila salvini)*, Antarctic Prions *(P. desolata)* and Thin-billed Prions *(P. belcheri)*, which breed on several subantarctic islands, were picked up from North Island west coast beaches in June-July 1974 (Veitch 1976). Similarly, hundreds of Antarctic Fulmars *(Fulmarus glacialoides)* were found on the same coastline in September-October 1975 and 1978 (Veitch 1977, 1980).

THE BEACH PATROL SCHEME

Until the Ornithological Society of New Zealand was established in 1939, records of seabirds found dead on our beaches were limited mainly to rarer specimens and large wrecks. Since 1939, the records have steadily increased. The Beach Patrol Scheme was introduced in October 1951. It lapsed a few years later, but was revived in 1960 and has since flourished. Patrollers enter details of their patrols on to standard cards, and the organiser collates these details.

Bull & Boeson (1961) reported the results of patrols between 1939 and 1959. Annual summaries have been published in *Notornis* for cards sent in since 1960. From 1960 to 1967 about 40 patrollers took part in the scheme each year, patrolling about 1200 km of beach. Over the following four years both statistics trebled. Since 1970, the number of patrollers and the distance of beach patrolled gradually increased. The annual averages for 1980-1985 are 235 patrollers and 4347 km. Since the start of the scheme over 200 000 dead seabirds have been found, identified and recorded on cards.

Between 1960 and 1985, nearly 11 500 Beach Patrol Cards were sent in, and they are at present accumulating at the rate of about 700 per year. Each card has records for an average of 4.4 species. Since 1983 the data have been entered into a computer and we hope that, by 1990, the Society's 50th anniversary, all the data will be in a computer file. This will have several advantages for members:

1. The information will be secure. Copies can be readily made and stored at different locations, whereas at present we have only one copy on bulky cards.
2. The information can be analysed quickly for summary reports and to answer members' requests for information.
3. Analyses will be more accurate.
4. Members will have direct access to the information from the patrols.

Objectives

The objectives of the scheme are:

1. To provide information on the species of seabirds washed up on New Zealand's coasts, where they are from and in which months they occur.
2. To record variations in the mortality of seabirds, particularly large wrecks, their extent and the species involved, and associated factors such as meteorological conditions and the condition of the birds.
3. To increase the chance of banded birds being recovered.
4. To increase the collections of seabirds in museums, particularly of species rarely found in New Zealand waters.
5. To provide specimens that can be studied for anatomy, genetics, parasites and moult.
6. To help members to recognise many species of seabirds.

The scheme therefore provides data and study material which are available to anyone interested in seabirds – distribution, migration or dispersal, moult, taxonomy, anatomy, population dynamics, parasites, genetics, food, and the relationships between distribution and food.

Who takes part?

Most patrollers are members of the Ornithological Society of New Zealand. However, records are welcome from anyone who has an interest in seabirds and is prepared to walk the beaches and collect and record their finds. You may submit cards completed by non-members, as long as you have checked that they have identified the birds correctly and put your name on each card. Beach Patrol Cards and Specimen Record Cards are available free from the Beach Patrol Scheme organiser (name and address on the inside cover of *Notornis*).

Method

In beach patrolling, you walk along a section of beach recording several items of information. You can do patrols at any time of the year, but highest mortalities are usually after storms with on-shore winds. Exposed beaches yield more birds than beaches of fairly enclosed harbours. Casual patrols are valuable and the results should be recorded, but regular patrols yield more information. In some regions, groups of members organise monthly patrols. Check with your Regional Representative before you do a patrol in case someone else has gone ahead of you and you could help somewhere else.

If you are patrolling on your own, walk along and search the high-tide line that proves to have most corpses. When patrolling with a team, spread out and walk along different tidelines to cover the whole beach.

Please get permission before crossing private land to reach beaches. Most landowners, once they know why you want access, are pleased to let you through whenever you want to.

To prevent duplication of records, remove all your finds from the beach. Even if you know the beach you are on is seldom patrolled, someone else may patrol the same beach soon after. Collect the birds in a sack or plastic bag. At the finish of the patrol, or along the way if the bag gets too heavy, sort and record your collection. Keep everything you're not absolutely sure about, and bury the rest well above the highest tideline. Better still, take everything home, record the data at leisure, and dispose of unwanted material at a rubbish dump or in the garden.

The scheme is mainly concerned with seabirds, which are defined as penguins, albatrosses, petrels, shearwaters, storm petrels, diving petrels, frigatebirds, gannets, shags, tropicbirds, skuas, gulls and terns. All *dead* specimens of these birds should be recorded on Beach Patrol Cards. However, you often find other species, some of which may be quite rare, and so you should record all dead birds.

The correct identification of all birds found is of the utmost importance. Do not guess. Here are some recommended reference books:

1. *New Zealand Birds* (2nd edition), by Oliver (1955).
2. *The New Guide to the Birds of New Zealand and Outlying Islands*, by Falla, Sibson & Turbott (1979).
3. *The Handbook of Australian Sea-birds*, by Serventy, Serventy & Warham (1971).
4. *Southern Albatrosses and Petrels – an Identification Guide*, by Harper & Kinsky (1978).
5. *Sea-birds – an Identification Guide*, by Harrison (1983).

If in any doubt about the identity of a bird, don't guess. Get the opinion of someone who knows more than you do. Consult your Regional Representative, who should know what to do.

The remains you find on beaches range from complete birds to wings, tails, feet, or just feathers. Although you usually can't identify small bits of skin and adhering feathers, you should record remains that have standard measurements, such as wings, tails and feet. You may not be able to identify the species from such remains, but you should be able to tell the genus. You often find prion remains as wings only; record these as *Pachyptila* spp. or "Prion spp. (wings)".

Unusual finds

You should know the seabird species for which the Rare Birds Committee needs a full description before your identification can be accepted. The descriptions need to be provided on Unusual Bird Report forms.

Species of ***national level*** rarity are:

Royal Penguin
Rockhopper Penguin *(moseleyi)**
Black-footed Albatross
Snow Petrel
Juan Fernandez Petrel
Phoenix Petrel
Chatham Is Taiko
Stejneger's Petrel
Cory's Shearwater
Wedge-tailed Shearwater*
Manx Shearwater
Wilson's Storm Petrel
South Georgian Diving Petrel
Long-tailed Skua
Antarctic Tern*
Arctic Tern
White-capped Noddy*
White Tern*
Macaroni Penguin
Magellanic Penguin
Chatham Is Albatross*
Providence Petrel
White-naped Petrel*
New Caledonian Petrel
Chatham Is Petrel
Pycroft's Petrel*
Pink-footed Shearwater
Christmas Is Shearwater
Leach's Storm Petrel
White-bellied Storm Petrel
Antarctic Skua
Whiskered Tern
Fairy Tern*
Common Tern
Common Noddy*

Species of ***local level*** rarity are:

Emperor Penguin
Adelie Penguin
Chinstrap Penguin
Soft-plumaged Petrel
Black-bellied Storm Petrel
Red-tailed Tropic Bird*
Brown Booby
Southern Great Skua*
White-winged Black Tern
Crested Tern
Grey Ternlet
King Penguin
Gentoo Penguin
Yellow-nosed Albatross
Grey-backed Storm Petrel
White-tailed Tropic Bird
Australian Pelican
Masked Booby*
Pomarine Skua
Gull-billed Tern
Sooty Tern*

An asterisk indicates a species for which a description is required only when a bird is found outside its usual known dispersal range. Each of these species is fairly common within a part of the New Zealand region. You should send specimens of species of national level rarity to a museum for confirmation of identity, but those of local level rarity should be confirmed by a Regional Representative.

Permits

We have recommended that all specimens be removed from beaches. All seabirds, except the Southern Black-backed Gull *(Larus dominicanus)*, are protected and it is unlawful to keep protected species, dead or alive, without authority. Rare specimens must be donated without delay to the nearest museum or to the National Museum, Wellington. Some museums even need specimens of less rare species, and you can help by asking your nearest museum what, if any, specimens it needs. If a museum does not want your birds and you want to build up a reference collection, *you must apply to a museum for a permit.* This authorises you to keep specimens, although they are legally the property of the museum.

Filling in Beach Patrol Cards

Use this card to record the results of each patrol. *Record only one patrol on each card.* If you find no birds, fill in a card with a nil result. It is as important to know when and why birds are not dying as it is to know when and why they are dying. Complete the cards as soon as you know the identity of the birds. Please print clearly. Send your completed cards to the organiser before the end of each calendar year.

(1) *Name of Beach* – Give the local name, plus the name of the nearest town or geographical feature (to distinguish beaches with the same name – there are several called Ocean Beach). If you patrol only part of a beach, please give some indication of where you started and finished, e.g. "Baylys Beach, near Dargaville, from Baylys Beach access road to 3 km south".

(2) *Kilometres of Beach* – If you do not have a map to work out the distance patrolled, please provide a full description of where you patrolled under "Name of Beach" so that the organiser can determine the length of the patrol.

(3) *District* – Give the abbreviation for the district where the beach is. The coastline of mainland New Zealand and offshore islands (those less than 50 km from the mainland) is divided into 15 districts. The names of these districts, their abbreviations and their topographical boundaries are shown in Figure 1. The extra district "OI" is for Outlying Islands 50 km or more from the mainland.

(4) *Date of Patrol* – Record as day/month/year, e.g. 11/5/87.

(5) *Observer and Address* – Give the initials and surnames of everyone who took part in the patrol or the name of the beach patrol team. *Please print clearly.* Give also the address of the person sending in the card, to whom any queries can be sent.

(6) *Previous Weather and Remarks* – Give a brief description of wind strength and direction during the past week or fortnight, especially if it was up to gale force (60+ km/h).

(7) *Species Found* – List the species found by giving either their full generic and specific names (e.g. *Puffinus bulleri*) or their common names (e.g. Buller's Shearwater). For the most appropriate names to use, refer to Kinsky (1970, 1980).

(8) *Total Number Found* – Give the total number of each species found.

(9) *Age* – Indicate for each species the number of adults, juveniles (subadult) and unknowns. This section is largely intended for species with distinctive differences of bill or plumage colour between adult and juvenile birds, for example, albatrosses, gannets, shags, gulls and terns. However, if you can learn to tell juvenile (first year) from older petrels and shearwaters, such information is very valuable.

(10) *Freshness* – Decide the freshness category for each bird, and then give totals in each category; do not tick categories. Use the following descriptions of each freshness category only as a guide to how long carcasses have been on the beach. Several factors influence the rate of decomposition

and the end result of this process; for example, if complete birds come ashore in moist, cool conditions decomposition is slow but thorough and often only bones remain. By comparison, in dry, hot conditions decomposition of soft parts is rapid, but sometimes the bill, feet, skin and plumage are left intact although shrunken and stiff.

A. *Fresh* (up to 3 days) – Birds that seem to have been ashore only a day or two. Such birds should have decayed little so that the flesh and internal organs are in good condition, the feathers have not begun to slip, any maggots are small, Mallophaga parasites may still be present, and they do not smell decomposed.

B. *Decaying* (1-14 days) – Birds that are smelly and obviously decomposing. For example, the feathers pull out readily, big maggots are inside and the Mallophaga have gone. Later, after about a week, the carcass begins to pull apart easily (e.g. the wings come away from the body).

C. *Dried* (5 days or more) – All soft tissues have either dried or been eaten, the skin is brittle, and usually most feathers are present and firmly attached. The corpse is so stiff that you cannot spread its wings. Generally, such corpses occur in summer, when high temperatures and hot sand dry the birds within a week or so of their being washed ashore.

D. *Skeleton* (from as few as 3 days if scavenged at sea) – All soft tissues are absent, leaving bones with very few feathers attached. Most plates on the beak have detached and the skin over the legs and feet is falling off after about two weeks. Such material can result from an intact corpse that has gradually decayed over many days. However, invertebrates and fish often eat the soft tissues of birds that die at sea before they are washed ashore. The skeletal remains of such birds often look much the same whether you find them within a day of their being washed ashore or a fortnight later.

(11) *Identified By* – Give the initials of the person who identified the birds. If this person did not take part in the patrol, please give full surname.

(12) *Total Seabirds* – Give the total number of *seabirds* found; do not include other birds.

Filling in Specimen Record Cards

Use this card to record bird measurements, sex, age, moult, weight, size of gonads and details about specimens preserved in a museum or private collection. You can use one card for several specimens provided they are of the same species and collected on the same date. Too few patrollers use the Specimen Record Cards, even when the birds are fresh, and so we lose much valuable information. If birds are not pleasant to handle, fill in the easier parts of the card. You don't have to fill in all sections of the card. Measurements, except of uncommon birds, are best done only on specimens a day or two old. Measure only in millimetres, using calipers or dividers.

1. Complete the sections of this card for *Species, Observer and Address, Where Found, Date, Freshness of Specimen* and *Age* in the same way as on Beach Patrol Cards.

2. For the following measurements, use calipers or dividers and a millimetre ruler.

Sex: Indicate male or female only if you have dissected the bird and seen the gonads. Remember that male birds have paired testes, but females have only one (left) ovary.

Moult: State which feather tracts, if any, are being replaced: primaries, secondaries, tail, head feathers, etc.

Bill length: From tip to beginning of feathers on the forehead (Figure 2a). Do not measure if the upper bill plates are missing or if any forehead feathering has been lost.

Bill width: At the gape (where feathers begin at the lower, inner corner of the upper bill plates, Figure 2b).

Bill depth: At the beginning of the forehead feathers (Figure 2c).

Tarsus: From the notch at the rear of the upper joint to the end of the tarsus with the toes bent hard downwards (Figure 2d).

Mid-toe & claw: From the centre of the mid-toe and tarsal joint to the tip of the claw, with the foot flattened (Figure 2e).

Tail: If not in moult, from between the bases of the central feathers to the tip of the longest feather, which must not be loose (Figure 2f).

Size of gonads: Give the maximum length and width of a testis or the ovary.

3. For the following measurements, use a millimetre ruler or tape-measure.

Wing length: Flatten the wing along a ruler and measure from tip to the carpal flexure (first joint), with the wing in a closed position (Figure 2g). That is, do not straighten the wing or its primaries. Do not measure if the longest primary is missing, broken or in moult. Check that the wing has not become bent by drying out. (Note: In Diomedeidae, Pelecanoididae and Procellariidae, except prions, the outermost primary should be longest – if not, then moult is still in progress; in prions and storm petrels, however, the second primary is always longest).

Total length: Measure from bill tip to tail tip.

Wing span: With the wings straightened, measure from wing tip to wing tip over the top surface.

Weight: Weigh a bird only if it is fresh, intact, dry and free of sand. State the accuracy of your scales, for example, ± 20 g.

Parts preserved and depository: If any part of the bird is preserved, say which part and where it is held.

Depository no. or observer's reference no.: Give the number if the preserved parts have been given one.

Identification confirmed by: Give the initials and surname of the person in authority who has confirmed your identification, or give a description of the bird.

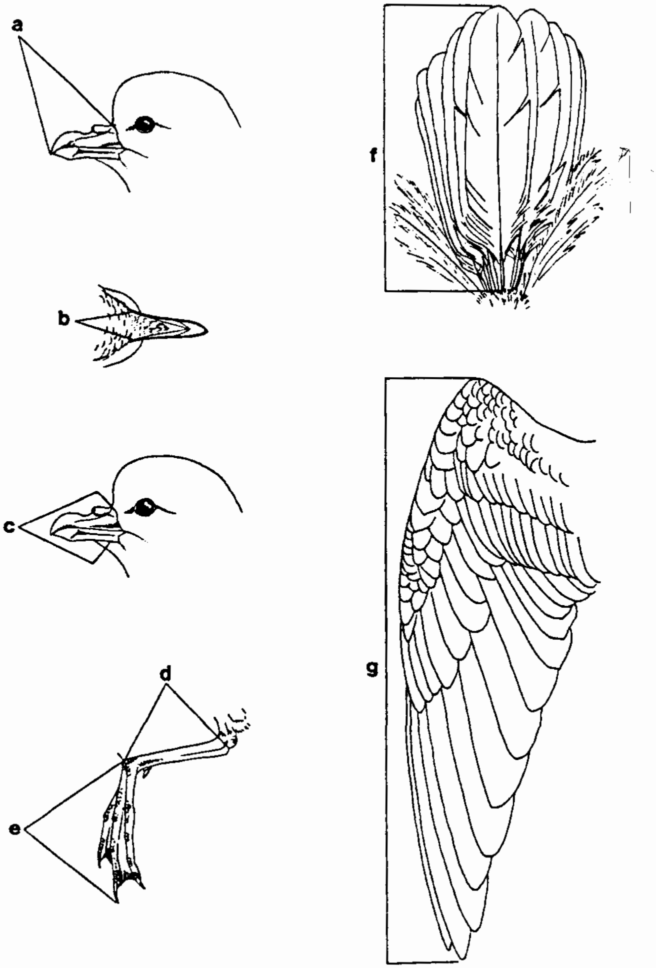

FIGURE 2 — Parts of a Fairy Prion *(Pachyptila turtur)* to show where to take measuements of (a) bill length, (b) bill width, (c) bill depth, (d) tarsus, (e) mid-toe and claw, (f) tail, and (g) wing.

Figure by P. Morse.

ACKNOWLEDGEMENTS

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SHORT NOTES

First Record of the Australian Little Bittern *(Ixobrychus minutus)* in New Zealand

On 5 February 1987 an apparently exhausted and starving small bittern was caught by a council worker in Westport. The bittern was first seen walking past a supermarket several hundred metres from the saltmarshes of the lower Buller River. It was handed to the Royal Society for the Prevention of Cruelty to Animals and one of its officers, Cindy Cairns, was given care of the bird. The bittern fed readily on tadpoles, bullies, freshwater invertebrates and a supplement of oxheart.

Local Wildlife Officers, Bob Simpson and Nigel Miller, were told about the bird a week later. They in turn asked us to assist with identification by describing, measuring and photographing the bird on 20 February. After rehabilitation the bittern was released into Birchfield swamp north of Westport.

The bird was identified as a Little Bittern *(Ixobrychus minutus)* and the OSNZ Rare Birds Committee later confirmed the identification .

Description

Size: A tiny bittern standing c.200 mm high, usually in a crouched posture.

Head and body: Forehead and crown were dark chestnut with black flecks. A well-defined dark chestnut line ran down the midline of the neck and breast. Otherwise the plumage was pale yellow-buff strongly streaked with black and chestnut lines. The lower breast was plumed and was puffed out during threat displays. Back and mantle were chestnut-brown with large black flecks and pale buff feather edges. Belly and flanks were whitish buff with brown streaks.

Wings: Upper wing-coverts were brown with buff edges. Primaries were black with faint chestnut edges. The under wing-coverts were whitish, and primaries grey.

Tail: Black

Soft parts: Iris and eye ring yellow. Upper mandible brownish grey with yellow on the lower edge. Lower mandible yellow. Legs pale green with yellow footpads and claws grey.

Moult: No sign of moult or immature down.

Measurements: See Table 1.

TABLE 1 Measurements of New Zealand and Australian Little Bitterns

Origin age/date	Westport ? 1987	Australia imm. 1935	Australia male 1922	N.Z. ? ?	N.Z. ? ?	N.Z. ? ?
bill length	42	37	44	54	53	57
bill depth	11	10	11	11	11	12
bill width	8	8	9	10	11	11
tarsus	41	39	41	49	48	c.50
midtoe & claw	44					
tail length	33	34	34	51	49	
wing length	128	117	130	144	151	150
total length		c.350	c.360	c,530	c.530	

Note: measurements taken from study skins held at the National Museum

Discussion

The photographs and measurements were compared with study skins of small bitterns held at the National Museum, Wellington. Skins examined included those of the New Zealand Little Bittern *(I. novaezelandiae)*, Yellow Bittern *(I. sinensis)* from Hong Kong, Least Bittern *(I. cinnamomeus)* from Manilla, and Little Bitterns from Australia, Germany, Belgium, Asia Minor, and Russia.

The plumage pattern of the Westport bird was almost identical to that of a juvenile Little Bittern from Australia and the measurements were similar to those of an adult male, also from Australia (Table 1). Its appearance on the West Coast in a tired and very thin state suggests that the bird may have been windblown from Australia.

All measurements of the New Zealand Little Bitterns were considerably larger than those of the Australian straggler, particularly total length, with the former being about one-third longer than the latter (Table 1). The plumage of the New Zealand and Australian birds was also very different. Compared with the immature *I. minutus*, *novaezelandiae* is much darker overall, being a richer and more even chestnut brown; the underparts are only lightly flecked with buff and the upperparts far less streaked.

This is the first confirmed record of *I. minutus* in New Zealand. While overseas handbooks treat the New Zealand Little Bittern as a subspecies of *I. minutus*, on examination the New Zealand bird is clearly different from all other *Ixobrychus* species. The Little Bittern occurs widely in Australia, Europe, Africa and western Asia.

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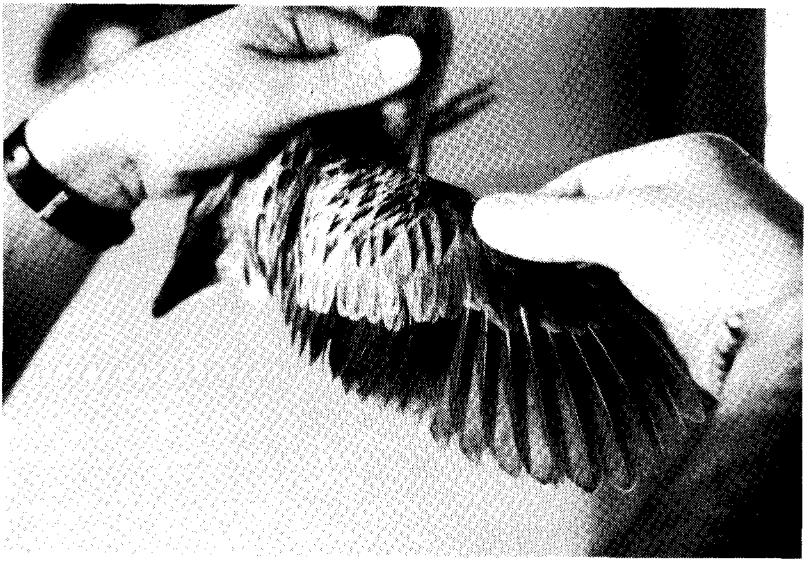

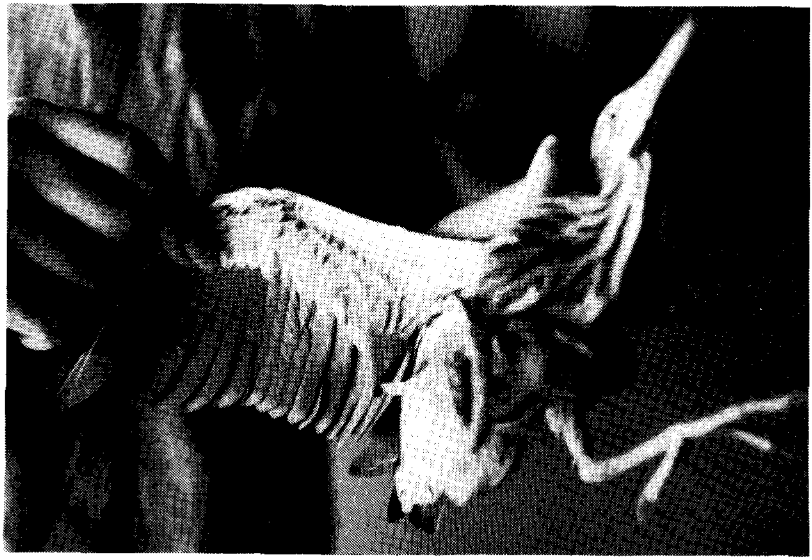

Brooding of a Banded Dotterel Fledgling

In Banded Dotterels *(Charadrius bicinctus)* brooding of the young normally ceases soon after they have their contour feathers, and family members part company within 2 weeks of the young fledging (R. Pierce, pers. comm.). The following account describes unusually late brooding behaviour at the New Zealand Aluminium smelter plant at Tiwai point, near Invercargill, during a cold snap. Dotterels breed in the Tiwai Point area and post-breeding flocks are regular on the extensive mown grass lawns adjacent to the smelter complex.

At 0800 on 25 January 1987, I drove to a sealed car-park west of the administration block. There were no Banded Dotterels on the wide lawns, but on a narrow grass strip between the car-park and the plant's perimeter fence I saw an oddly shaped bundle of feathers. I drove to within 20 m of what proved to be an adult male brooding a full-grown juvenile. The juvenile was tucked under the adult and almost at right-angles to it. It nudged in, in small jerks, bouncing the adult up so that his legs were stiff and straight as he tried to keep balance and in contact with the ground. The morning was cold with a south-westerly wind, into which the adult was facing. There were buildings to the south and east, and the birds were 3 m away from a 3 m high netting fence. I watched from 20 m for 15 minutes.

Both birds wore colour bands, the combinations of which indicated they had been locally banded. The adult was in moult of the head and breast, the back and wing coverts had pale abraded edges, and the tips of some primaries were worn and notched. When I opened the car door the adult moved off the juvenile, which shook itself, ran off, and began to feed. The adult chipped, strutted and made one partial "broken wing" movement. As I walked closer the adult flew low, away from the juvenile, for a metre or two but was obstructed by the fence and building. It veered round and flew towards the juvenile, which then also took to the air. Both landed about 100 m away and fed on the lawn for a minute or two. The juvenile then flew a futher 300 m to feed on another part of lawn. The adult flew high over trees to the west, towards the Awarua Bay coast about 500 m away.

Meteorological records published in the *Southland Times* on 26/1/87 and 4/2/87 show that the mean temperature for January 1987 was 15.5°, 1.9° warmer than average, and was the third highest on record. The extreme minimum of 6.1° recorded on January 24 equalled the record low set in 1940. Official readings for the 24 hours up to 9 a.m. on 24/1/87 were: max. temp. 16 C, min. temp. 6 C, grass min. temp. 5 C, rainfall 2.3 mm. For the 24 hours up to 9 a.m. on 25/1/87 readings were: max. temp. 13 C, min temp. 9 C, grass min. temp. 9 C, rainfall 16.0 mm.

This unusual brooding behaviour therefore occurred after a cold night (24th/25th), and the previous night (23rd/24th) had been exceptionally cold. This cold snap occurred in a unusually warm month. December's mean maximum temperature was 18.2 °C and mean minimum 9.3 °C *(Southland Times* 5/1/87). The juvenile would have had little experience of, and perhaps low tolerance to, the low temperatures. Both birds appeared healthy. After they had started feeding for the day the adult did not remain to "supervise" the juvenile.

I am grateful to Ray Pierce for his comments on a draft of this note.

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Bird Counts on the Chatham Islands

While working on the Chatham Islands in November-December 1983, I undertook some bird counts on South East Island and in an area of forest on Chatham Island which was soon to be gazetted as a Nature Reserve and partly fenced. This tract of rolling bush-covered hills and gullies totalling 1028.7 ha was donated to the Crown as a Nature Reserve by the late Manuel Tuanui and Evelyn Tuanui of Awatotara, Chatham Islands, in early 1983. It is located in Blocks IX, X, XIII and XIV of Orepuke (Oropuke) Survey District on the southwest coast of the main island and known as the Tuku Nature Reserve. I also made general observations of species occurrences while working in other parts of the islands. These Tuku counts and those from the smaller South East Island, which has been a reserve for about 30 years, will provide information for future comparisons.

The forest types in both locations have been described by Dennison *et al.* (1984). The introduced mammals on Chatham Island are rats (*Rattus rattus* and *R. norvegicus*), mice, cats, possums, cattle, sheep and pigs. Eastern Buff Wekas were introduced from mainland New Zealand in about 1905 to the large islands, but South East Island has no introduced mammals or wekas.

Methods: For the counts, I used the method suggested by Dawson & Bull (1975) and on Chatham Island I set up seven stations in the proposed reserve about 200 m apart along a track between the Taiko study base camp and a high bush-covered knoll known as Taiko Hill. I counted at each station 14 or 15 times over 10 days in December 1983. On South East Island I set up five stations 200 m apart in the Woolshed Bush and counted at them 10 times each in November-December 1983.

All counts were done in dry weather with little or no wind, differing amounts of sunshine and temperatures of 10-20 °C. Counts were recorded between 0930 and 1600, except for seven Tuku counts between 1600 and 1745 on a clear, windless day of 20 °C when sunset was at 2145. Starting times were varied so that most times of the day were covered.

As the vegatation in both areas is fairly uniform, I assumed the sampling stations to be similar. Totals of 100 counts in the Tuku and 50 on South East Island were combined for each species and a mean calculated for each count.

Results: Two species (Chaffinch and weka) were present only in the Tuku counts; and five species were on South East Island that did not show up in the Tuku counts. Black Robin and snipe are confined to South East Island and Mangere Island, I have seen both Tuis and Starlings elsewhere on the main island, and the Chatham Island Tomtit occurs only on South East Island.

The Silvereye and the Chaffinch, in that order, were the most conspicuous species in the Tuku. Although few were seen (13% and 2% respectively), Chaffinches were singing loudly at that time of the season (81.9% of those counted). Silvereyes were identified by their calls as only 2.8% were in song.

TABLE 1 — Birds recorded during 5-minute counts at two locations on the Chatham Islands

	Mean per count		% Seen	
SPECIES	SE n=50	Tuku n=100	SE	Tuku
Harrier *Circus approximans*	0.04	0.01	100	100
Red-crowned Parakeet *Cyanoramphus chathamensis*	3.52	0.67	45	3
Shining Cuckoo *Chrysococcus lucidus*	0.08	0.03	0	0
Skylark *Alauda arvensis*	0.02	0.03	0	0
Hedgesparrow *Prunella modularis*	0.32	0.25	13	0
Chatham Island Warbler *Gerygone albofrontata*	1.50	0.11	45	27
Chatham Island Fantail *Rhipidura fuliginosa penitus*	0.68	0.22	65	27
Thrush *Turdus philomelos*	0.06	0.60	0	5
Blackbird *Turdus merula*	1.02	0.64	12	2
Silvereye *Zosterops lateralis*	1.20	2.16	8	13
Redpoll *Acanthis flammea*	1.08	0.53	33	0
Eastern Buff Weka *Gallirallus australis hectori*	AB	0.07	AB	0
Chaffinch *Fringilla coelebs*	NR	1.77	NR	2
Chatham Island Snipe *Coenocorypha aucklandica pusilla*	0.18	AB	22	AB
Chatham Island Tomtit *Petroica macrocephala chathamensis*	1.84	AB	32	AB
Black Robin *Petroica traversi*	0.02	AB	0	AB
Tui *Prosthemadera novaezelandiae*	1.94	NR	32	NR
Starling *Sturnus vulgaris*	0.92	NR	35	NR

AB Absent
NR Not recorded

The Tui and the Chatham Island Pigeon were not recorded at all in the Tuku counts but were observed by me in that locality on other occasions. No Chaffinches were seen or heard by me on South East Island, although they seemed quite common on Pitt Island only a few kilometres away.

On South East Island, the four most conspicuous species were Red-crowned Parakeet, Tui, Chatham Island Tit and Chatham Island Warbler, in that order. Parakeets and warblers were seen on 45% of the times counted, and Tuis and Tits were seen 32% of the times.

Most birds in the Tuku were difficult to see and were seldom near the ground. On South East Island, the forest birds were not afraid of humans and were frequently observed on or near the ground. Results of the counts are detailed in Table 1.

Discussion: Although this study was quantitative and Fleming's (1939) study was qualitative, some comparisons can be made. His prediction that Chatham Island Pigeons were declining (1937-38) and would continue to do so has been correct. Pigeons are few in isolated pockets of forest in the south of the main island (pers. obs.); Morris (1979) saw 10 pigeons in 12 days in 1977. There are none on Pitt Island, where they were described as abundant in 1939. Recent attempts by the former Wildlife Service to establish a few pairs on South East Island have been unsuccessful (pers. obs.).

Fleming reported Tuis as plentiful in the Tuku area in 1937-38, but I recorded none during my counts; I have however observed solitary Tuis in the southern tableland and coastal area from time to time. In my counts Chatham Island Warblers were 13.6 times more frequent on South East Island than in the Tuku, a difference not as great as that shown by Dennison *et al,* who estimated the density to be 0.3 pairs per hectare in the Tuku and 10.4 or 8.2 pairs per hectare on South East Island.

In 1937-38 parakeets were described as "the most abundant land bird" on South East Island; these counts confirm this for 1983. Tits were still to be found in the southern tableland block before 1940 but no sightings have been made recently.

In the 45 years since Fleming's account, numbers of Tuis, pigeons and parakeets have been reduced on the main island, Long-tailed Cuckoos probably no longer visit the group, and the Chatham Island Tit has become extinct on Chatham Island.

I thank Mike Imber for commenting on the manuscript.

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REVIEWS

A Field Guide to Australian Bird Song: Cassette 3. 1987.

This cassette, the third in a series, should be of particular interest to New Zealand ornithologists as it contains recordings of many wader species that are regular visitors to our shores.

The cassette covers 68 species, starting with crakes and ending among the terns. The localities in which the recordings were made range through Lord Howe Island, Chatham Islands, Tasmania, New Zealand, Papua New Guinea and Australia, the oldest recording dates being 1961 and the most recent July 1986.

Waders are among the most difficult species to capture on tape, many existing recordings having been obtained in under less than ideal conditions. The compilers of the guide go to considerable lengths to point this out in the written introduction. Given the variety of recording equipment in use and the extreme difficulty in recording waders in general, the result is quite acceptable, although not equal in quality to the first two tapes in the series. As on the earlier tapes the spoken identifications are by Len Grice. The folio that comes with the tape continues the high standard set by the earlier volumes and is a model of its kind. At least 47 of the species on this third tape are on the New Zealand list, some such as the Painted Snipe being very recent additions.

Most of the 68 species are first releases and should create considerable interest on both sides of the Tasman. All of the waders on this tape were captured in the Australasian region, which is unique in a publication of this type.

Available from The Bird Observers Club, Box 185, P.O. Nunawading, Victoria 3131, Australia for $A10.50 post paid. For reviews of cassettes 1 and 2 see *Notornis* 31: 355 (1984) and 34: 87 (1987).

L. B. McPherson

The Unknown Music of Birds: Hungatron LPX19347.

This unusual bird disc, which won the record of the year award for 1987, is by well-known Hungarian researcher Dr Peter Szoke, a senior research fellow of the Hungarian Academy of Sciences in Budapest.

This disc explores the hidden structures and melodies in the songs of birds from a wide range of families from many parts of the world by slowing down (stretching) such song to as much as 1/64th of its true speed. Many birds sing as fast as 150 notes per second and three different notes simultaneously, which is far too fast for the human ear to follow. When these recordings are slowed down to as much as 1/64th, one can hear the structure, often of great beauty and melody, of complex songs of species such as the Grey Warbler, Kea, Blue Duck, Yellow-breasted Tit, all of which are on this disc. The 16 tracks deal with different types of sounds, the first with birds as we normally hear them, the second with gradual slow-down to emphasise the hidden melodic structure of the sounds, the third with species presenting a steady unchanging pitch. Track 4 deals with simple pitch intervals, track 5 more complex calls, and track 6 even more complex songs. Track 7 deals with the ability of birds to learn songs other than those of their species.

Side 2 presents musical rhythms (who knew that the White Heron calls in 2/4 time?). Track 2 gives examples of different types of buzzing rhythms (Locustella warblers). Track 3 demonstrates the ability of some species to transpose musical motifs up or down the scale. Track 4 demonstrates a more restricted song type such as the Yellow-breasted Tit has, and track 5 a more complicated version of this type of song; examples given include Grey Warbler. Track 6 is of non-musical song, and track 7 gives a folk music structure of great beauty. Tracks 8 and 9 slow down Hermit Thrush song and compare it with a human voice singing the same notes, which are then speeded up to that of the bird song. The opera singer Janos Toth reaches a new high and is hard to distinguish from the thrush by this method.

If you are interested in the structure of bird song, this is a useful disc to have. The New Zealand agent is Ode Record Co. Ltd, P.O. Box 1535, Auckland, or 199 Karangahape Road. The technical quality of this disc is very good, even excellent, and is superior to the authors' earlier recordings. Price not known, probably about $NZ15.00.

L. B. McPherson

OBITUARY

CHARLES ALEXANDER FLEMING

KBE, DSc, FRS, FRSNZ

1916-1987

Photo: Ken George

New Zealand lost one of its most distinguished scientists with the sudden death of Sir Charles Fleming at his home in Wellington on 11 September 1987 at the age of 71.

Sir Charles was born in Auckland and educated at Kings College and Auckland University where, after majoring in both geology and zoology, he gained his masterate with a thesis on prions. He joined the New Zealand Geological Survey in 1940 as an assistant geologist and remained in that organisation for the rest of his working life, except for a period of war service as a coastwatcher at the Auckland Islands. He returned to the Survey after the war and eventually became Chief Palaeontologist, a post that conveniently linked his geological and zoological interests. Declining further promotion, he concentrated his energies on research, the affairs of the Royal Society, and his varied cultural interests (music, art, languages and history).

His many outstanding research contributions in geology were matched by others in zoology – notably in ornithology, but also in biogeography, conservation, and the taxonomy and songs of cicadas. At the time of his death he had some 500 publications to his credit, including books, major research papers and numerous shorter articles. Apart from research, he took a very active part in the affairs of the Royal Society of New Zealand and was its president from 1962 to 1966. He also served a term (1968-69) as president of the Australian and New Zealand Association for the Advancement of Science.

The quality of his work earned him many honours, both at home and abroad. He was a Fellow of the Royal Society (one of the few New Zealanders to hold this distinction), a Foreign Member of the American Philosophical Society (the only New Zealand resident to be so honoured), a Corresponding Fellow of the American Ornithologists' Union, a Fellow of the Royal Australasian Ornithologists' Union, and a Fellow of the Royal Society of New Zealand. In 1977 he was made a Knight Commander of the Most Excellent Order of the British Empire (KBE) for services to science.

His ornithological contributions began with his classic study of the birds of the Chatham Islands (1939), closely followed by other major studies on the prions (1941) and New Zealand flycatchers (1950).In studying the life history of the Silvereye (1943), he was one of the first New Zealanders to use coloured leg bands (home-made in those days) to identify individual birds in the field. Another pioneering effort, undertaken jointly with the late Dr K. Wodzicki, was a census of the Gannet population of New Zealand (1952) by counting nests shown on aerial photographs and checking the results by ground visits to some of the gannetries. This resulted in the first full census of any New Zealand seabird. Sir Charles had less opportunity for sustained ornithological research in later life, but he nevertheless kept up with current advances by extensive reading, and he watched and photographed birds whenever opportunity offered. He enjoyed such activities immensely and his observations and experiences were often the subject of articles and lectures. Thus, in addition to his main ornithological papers, he has published several shorter ones plus many articles and short notes which together record a lifetime's observations and thoughts on a wide range of ornithological topics.

The Ornithological Society of New Zealand has particular reason to be grateful to Sir Charles. He was one of its founders, a very active regional organiser in its early days, its president in 1948-49, and a faithful attender and contributor at meetings of the Wellington Branch over a period of some 40 years.

As a palaeontologist, Sir Charles was naturally interested in the geographical affinities of elements of the New Zealand fauna and flora and in their appearances and disappearances throughout geological time, and he published extensively on these topics. He was particularly interested in the array of ancient forms (including several kinds of birds) preserved from extinction by New Zealand's long isolation, and he became very critical of the human mismanagement that had caused the recent extinction of some of these species and threatened the survival of others. Indeed, the proper conservation of New Zealand's native plants and animals, based on sound scientific principles, became a major concern for Sir Charles during the latter years of his life, and he fought long and hard to improve matters. Future generations will have much for which to thank him in this regard.

Those of us who were privileged to know Charles as a friend will remember him for his ready wit and agile mind, for his infectious enthusiasm in his appreciation and understanding of beautiful things both natural and man-made, and for his helpfulness and unobtrusive generosity. No less characteristic was his determination to use his intellectual abilities, possessions and reputation in the service of others, particularly in the promotion of good science and the conservation of natural resources for the physical and aesthetic enjoyment of future generations. The contributions of Sir Charles to the scientific and cultural life of New Zealand were indeed exceptional, but they were not his alone. Lady Fleming, a naturalist and historian in her own right, made these achievements possible through her dedication as Charles's adviser, secretary, field companion and competent manager of home and family. We extend our sympathy to Lady Fleming and her family, and also our grateful thanks for all she and Sir Charles have given us.

P. C. Bull

CHARLES FLEMING – The Mentor

People interested in natural history have always fallen back on older generations for their knowledge and encouragement. This has been particularly so in New Zealand where, until recently, the study of birds and of nature in general has found little place in our education system.

So, whether they have liked it or not, our older naturalists have become the mentors for ascending generations of naturalists.

This was one of Sir Charles Fleming's roles in New Zealand ornithology, but for those who benefited from his knowledge and encouragement it was probably his most important role. Indeed, much of the mail that arrived at the Fleming house after his death expressed gratitude for help given over the years.

Those who knew him but were not associated with natural history probably did not see this side of him. They probably saw him as a unique and different personality inclined to serious conversation tempered with a ready wit. With his usual bow tie and often bordering on the dramatic, he may have seemed endearingly eccentric.

But his group of disciples saw him differently. He was a source of strength whose approach was subtle in that he respected the limited knowledge of others. This respect showed, for example, in the constant use Charles made, in his many and varied papers, of the limited knowledge of others, acknowledging it meticulously.

As a result, Charles and his helpers grew together, both sides seeming to benefit from the association. How flattering to get an acknowledgement or, as a school child, to receive a mention for catching a cicada or providing a valuable sighting of some new Australian immigrant.

The mentor-disciple relationship often started with an approach from Charles. A hurried scribbled note would arrive, either on his best deckled-edged 'Balivean'-addressed paper or just on a page from his field notebook. After a few moments' struggle with his handwriting, you would make out a request. Flattered by receiving word from the eminent Charles, you would soon be out trying to establish whether the Little Egret had found the Miranda coastline of whether *Amphipsalta cingulata* did in fact clap its wings when it sang. And a Charles Fleming request required an exact scientific reply. There was no use saying "I think so". This just resulted in a further scribbled letter asking you to look again.

In return for detailed replies, though, Charles was prepared to lead his band of helpers on. Large numbers of birds, trees and insects were added to amateur lists, along with knowledge of habitat, habits, and insect and bird song. Charles could reproduce the calls of bush birds and cicadas well enough to prepare the novice for what to listen for in the wild.

Charles led me to my first encounters with all the rarer bush birds, several seabirds and several shorebirds. He also introduced me to some 40 varieties of New Zealand cicadas, a tally which kept growing through the 1960s and 70s as new varieties were discovered and papers came from the tireless Fleming pen.

Charles was one of the first to become aware that New Zealand's old culture, tied to Europe, was disappearing and that a new culture, based on New Zealand's natural history, was emerging. He made us realise that we have around us much that is unique and memorable and not shared with anywhere else in the world. 'Podocarp Gothic', for example, his term for our wooden ecclesiastical architecture, gave a new meaning and importance to our English Gothic in rimu rather than stone. The same could be said for 'classical kauri', his term for the simple architecture of early Northland farmhouses.

It is not surprising, then, that this man who revelled in the emergence of the New Zealand culture also enjoyed the work of New Zealand writers – Mason, Glover, Fairburn, Baxter, Holcroft. He used their lines in papers and often quoted them to reinforce a point. He could quote too the unpublished haiku poems of his old friend A. H. Hooper, and I can well remember him at a summer wedding in late January, when the jollity was over but the heat and the cicada noise remained, saying for no apparent reason:

Cicadas crackling –
No longer does the blackbird
Sing at my window.

Few have the depth of feeling for nature and the moment to realise that cicadas crackle only after the blackbirds have ceased to sing, in association with season.

Those to whom Charles gave interest and encouragement over the years saw him, I believe, as one does the clematis. The clematis climbs through the rank dark undergrowth of anonymity, eventually to flower gloriously at the top, where everyone can see it. Then, when its petals fall away and it blends back into the forest, one can still 'see' the flowers at the top just by glancing at the vine at the bottom. The Charles Flemings of this world are never lost; they go on recurring, chiding and helping, often coming to mind at unexpected moments: but this Charles Fleming seems to bring a smile to your face at the same time.

Stuart Chambers

No longer will he walk the salty sand
Or cast an eager and discerning eye
Upon the birds that haunt the tidal strand
Of that loved rivermouth at Waikanae.

No longer will he brave the wind and wet
When vernal whitebait run in Waimeha,
Plying with practised skill his treasured net
Keen, as a carefree boy, to fill his jar.

No longer will he watch on sand-dune pool
Teal, shovelers, dabchicks and the passing tern,
Or use his tape recorder to befool
The shy rails in the raupo and the fern.

No need to grieve. His questing spirit soars
To realms where nought of lasting value dies.
His mind and pen threw open unknown doors
Illuminating Earth's old mysteries.

R. B. Sibson