

SHORT NOTE

The feeding of New Zealand Kingfisher chicks

I was interested to read the article by Lynley Marie Hayes on *Behaviour of New Zealand Kingfishers feeding chicks* in Vol. 38, Part 1, of *Notornis*.

The author asks and answers several questions relating to the feeding of the chicks and my own observations may be of interest. These were made from hides at 23 nest sites, which ranged in location from forest habitats, open country and swamps, to marine locations. Most of these nest sites were in North Auckland and some in the South Island. I consider the variety of food items depends largely on the location of the nest site. The food taken to chicks in nests in forest habitats consisted mainly of insects, especially cicadas; also freshwater crayfish from forest streams, and skinks. On two occasions the chicks were fed birds. Chicks in nests in open country habitats received insects, caterpillars, tadpoles, earthworms, small fish, skinks and the occasional mouse.

In marine locations chicks were fed small fish, shrimps and mud crabs.

I have photographic evidence to support the feeding of various insects, including German wasps and large dragonflies, tadpoles, earthworms, spiders, fish, freshwater crayfish, skinks, mice and small birds (Silvereyes).

All items were fed whole. Large items were always presented to the chicks head first and whole. Apart from the prey being bashed on a branch to render it supple, no attempt was made to tear the prey apart.

I have noticed a correlation between the age of chicks and the size of food given to them. Very small chicks receive small insects, caterpillars, earthworms and small fish. However, it is surprising to see what a large item a small chick can swallow.

The frequency of feeding appears to vary with time of day. Early in the day chicks are fed at frequent intervals, often every 4 or 5 minutes. During the heat of day in mid-summer periods of over an hour may elapse between feeds.

Newly fledged chicks are fed very frequently during the first few hours after leaving the nest.

In six nests, when I was able to determine the incubation and hatching periods accurately, I found that the first chick left the nest 26 days after hatching, others following over the next 20 hours.

Although New Zealand Kingfishers are considered to be aggressive to other bird species, I have noted three instances where kingfishers have been evicted from nests by Common Mynas (*Acridotheres tristis*).

In one nest under study, 5 eggs were eaten and remains scattered below the tree and mynas were in occupation. In this instance the mynas were eliminated and the kingfishers successfully re-nested. Two other Kingfisher nests, one in a dead tree and another in a roadside clay bank, were taken over by mynas.

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IDENTIFYING THE SEX OF FIORDLAND CRESTED PENGUINS BY MORPHOMETRIC CHARACTERS

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ABSTRACT

We assessed the utility of morphometric characters for identifying the sex of adult Fiordland Crested Penguins (*Eudyptes pachyrhynchus*) on the Open Bay Islands. Penguins that gave ecstatic calls at nest sites during the courtship period were designated as males; their companions at nest sites were designated as females. Measurements of culmen length, foot length and weight showed overlap between sexes, but bill depth and a bill index (culmen length \times bill depth) did not. The bill depth and bill index of penguins of unknown sex fell on either side of the zone of non-overlap between sexes. Although the specific criteria for determining sex vary between populations of Fiordland Crested Penguins, measures of bill size appear to be the best criteria in this and other species of penguin.

INTRODUCTION

Sexual dimorphism in size is common among penguins (Davis & Speirs 1990), males being larger than females. Because males and females are otherwise monomorphic, morphometric characteristics are prime candidates for identifying the sex of live birds captured in the field. Their value is limited, however, because measurements overlap between sexes, although discriminant function analyses provided reasonably accurate separation by sex for Magellanic Penguins (*Spheniscus magellanicus*) (Scolaro *et al.* 1983) and Blue Penguins (*Eudyptula minor*) (Gales 1988).

The sexual dimorphism of crested penguins (*Eudyptes* spp.) is well documented (Warham 1975, Cooper *et al.* 1990) and average differences in size between sexes, particularly for bill dimensions, are among the greatest recorded for penguins. Nevertheless, attempts to distinguish the sexes of live crested penguins from measurements alone are rare. Stonehouse (1971) found for Snares Crested Penguins (*Eudyptes robustus*) that several measures of body and appendage size overlapped considerably between groups of individuals designated as male or female from their behaviour. The best separation was achieved with a culmen index (culmen length \times culmen width) for which only 4.2% of 118 birds showed overlap. Similarly, Warham (1974) used a bill shape index to separate a sample of Fiordland Crested Penguins (*Eudyptes pachyrhynchus*) by sex, but he did not verify the lack of overlap between the sexes by using independent behavioural criteria.

Here we assess the efficacy of several measures of the bill and foot of Fiordland Crested Penguins for discriminating between sexes.

METHODS

We captured 62 Fiordland Crested Penguins on 16-27 July 1990 within a few days of their arrival on shore for breeding at Taumaka, the largest of

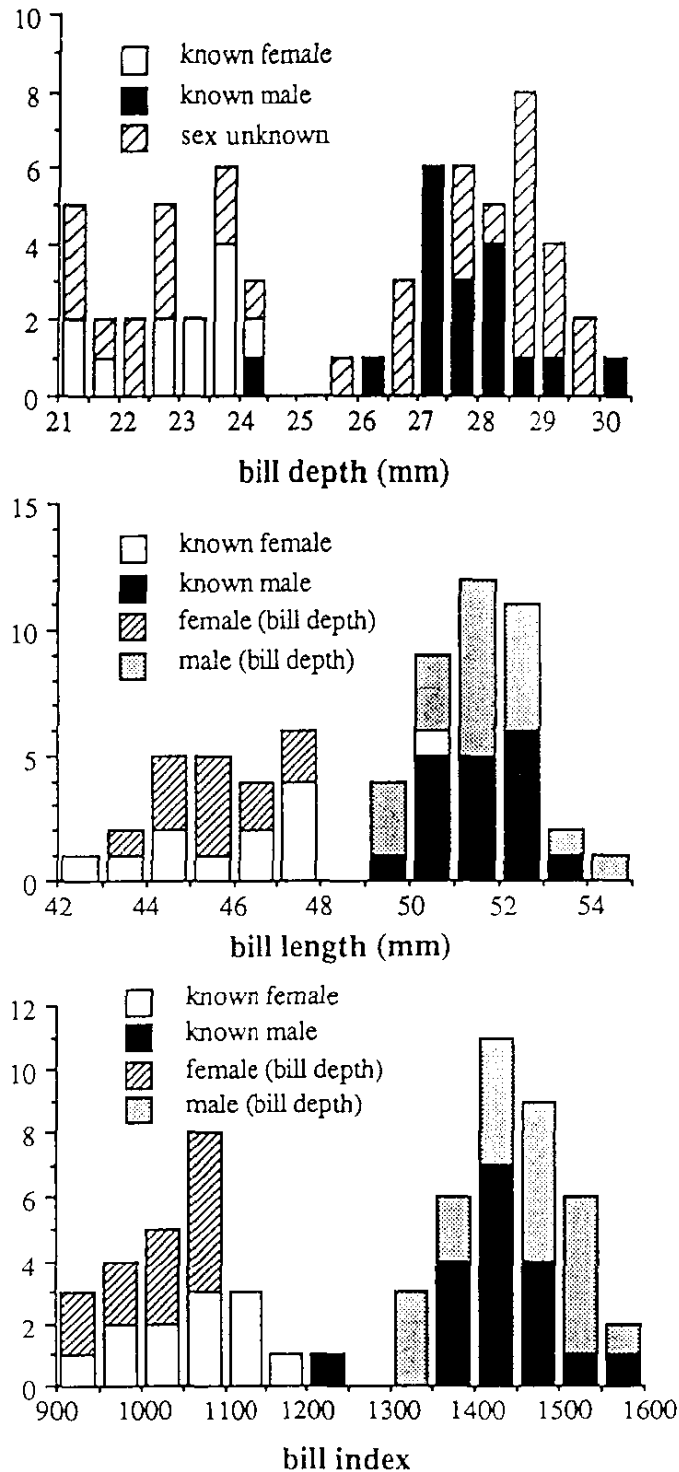


FIGURE 1. (a) Frequency histogram of bill depth for 30 adult Fiordland Crested Penguins whose sex was determined from their behaviour and 32 birds of unknown sex. Each bar represents a 0.5 mm interval. The values for the 3 birds in the 24.0-24.5 range are: 24.3, male; 24.1, female; 24.0, unknown sex.

(b) Frequency histogram of culmen (bill) length for 30 adult Fiordland Crested Penguins whose sex was determined from their behaviour and 32 adults whose sex was determined from bill depth. Each bar represents a 1 mm interval.

(c) Frequency histogram of a bill index (culmen length \times bill depth) for 30 adult Fiordland Crested Penguins whose sex was determined from their behaviour and 32 adults whose sex was determined from bill depth. Each bar represents an interval of 50.

the Open Bay Islands, on the west coast of New Zealand. Birds were noosed on or near nest sites known from studies during the previous 2 years (St. Clair 1990, Phillipson unpubl. data) and weighed to the nearest 0.05 kg with a spring balance. The following measurements were made to the nearest 0.1 mm with metal calipers: culmen length and bill depth (as illustrated by Warham 1972, 1975); and foot length, from the back of the heel to the end of the middle toe pad (Darby & Seddon 1990). All measurements were taken by one person (LSD). Bill width was also taken, but is not considered further owing to the difficulty of measuring at a consistent point along the continuously tapering bill. We attached numbered metal wing bands to the 18 birds not previously banded.

We identified 18 penguins as males by observing them give ecstatic calls from nest sites during the courtship period. In other species of penguin only males routinely emit ecstatic calls from nest sites before egg-laying (Sladen 1958, Jouventin 1982). Three of these birds were also seen to mount a mate. By 27 July, 11 of the penguins designated as males were joined on a nest site by a second bird, including one male whose initial partner was replaced by another; these 12 mates comprise our sample of known females.

RESULTS

All measurements of males and females overlapped except bill depth (Table 1). Among the other measures, overlap was least for culmen length, intermediate for foot length, and greatest for weight. Average values for males were significantly greater than for females in all cases (Table 1).

Measures of bill depth for the remaining 32 birds lay on either side of the non-overlap zone (Figure 1a), indicating that bill depth was probably sufficient to distinguish males from females in this sample. For all other measures the number of birds falling into the zone of overlap between sexes increased with the addition of birds of unknown sex.

Although we found no overlap in bill depth between sexes, the zone of non-overlap is so narrow that bill depth may not be reliable for discriminating between sexes in a larger sample. To achieve greater separation, we derived a bill index by multiplying bill depth by culmen length. We used culmen length because, like bill depth, we could measure it consistently on all birds and we found a reasonable gap between the measures of males and females (Figure 1b), except for one female with an unusually long bill. The bill index provides a larger gap between birds of known sex (7% of the range of values recorded) than does bill depth alone (2% of the range of values recorded) (Table 1). The 32 birds of unknown sex fall well outside the zone of non-overlap (Figure 1c). The 11 calling males that acquired mates were all larger than their respective mates in both bill index and bill depth.

DISCUSSION

Our results indicate that bill depth, or the product of bill depth and length, can be used to distinguish male and female Fiordland Crested Penguins on the Open Bay Islands. The analysis confirms Warham's implication (1974, Fig. 7) that bill size can be used to identify sex in this species. We cannot

TABLE 1. — Measurements of live adult Fiordland Crested Penguins whose sex was determined from their behaviour. The sample size is 18 males (M) and 12 females (F). Student's *t* tests were used for comparisons between sexes.

		Mean \pm SD	Range	<i>t</i> value	
Bill depth (mm)	M	27.6 \pm 1.2	24.3-30.0	10.82	P<0.001
	F	22.9 \pm 1.0	21.1-24.1		
Bill length (mm)	M	51.7 \pm 1.2	49.6-53.8	8.79	P<0.001
	F	46.0 \pm 2.2	42.8-50.6		
Foot length (mm)	M	116.9 \pm 4.5	109.3-126.8	4.74	P<0.001
	F	109.7 \pm 2.9	104.4-113.6		
Body weight (kg)	M	4.16 \pm 0.36	3.50-5.10	3.31	P<0.01
	F	3.68 \pm 0.40	2.80-4.20		
Bill index (depth x length)	M	1429 \pm 76	1232-1569	2.42	P<0.05
	F	1055 \pm 85	907-1184		

compare our bill index directly with the index used by Warham (1974), because he incorporated culmen width in the final product. However, the products of mean depth and mean length for males and females, based on data from Table 5 in Warham (1974), lie well below the mean values for our entire sample (males, 1333 v. 1441; females, 981 v. 1041). The differences result primarily from significant differences in bill depth between samples from Warham's study at Jackson Bay and this study (Table 2). Bill lengths did not differ significantly (Table 2). Somewhat surprisingly, the weights of both males and females in Warham's population (Warham 1974: Table 5, line 1) were significantly greater than the weights we recorded (Table 2). Although weights of penguins decrease through the reproductive period, both samples were obtained soon after birds arrived at breeding areas in July. Yearly variation might account for the differences in weight between studies.

This comparison between areas indicates that sex criteria based on size may not apply to all populations of Fiordland Crested Penguins, even if they are nearby (Jackson Bay is on the mainland about 30 km from Open Bay Islands). Similarly, Gales (1988) found that her discriminant function formula derived from bill measurements of Blue Penguins in Australia was much less effective in distinguishing the sex of birds in a different subspecies of Blue Penguin in New Zealand.

TABLE 2. — Bill measures and body weights of live adult Fiordland Crested Penguins at Jackson Bay (Warham 1974) and the Open Bay Islands (this study). Student's *t* tests were used for comparisons between areas.

	<u>Jackson Bay</u>		<u>Open Bay Island</u>		<i>t</i>	
	n	Mean ± SD	n	Mean ± SD		
Bill depth (mm)						
Males	94	26.1 ± 1.7	38	28.0 ± 1.1	6.33	P<0.001
Females	61	21.8 ± 1.3	24	22.7 ± 1.0	3.02	P<0.01
Bill length (mm)						
Males	94	51.1 ± 2.0	38	51.5 ± 1.2	1.14	P>0.10
Females	61	45.0 ± 1.7	24	45.8 ± 1.8	1.90	P>0.50
Weight (kg)						
Males	20	4.53 ± 0.37	38	4.11 ± 0.39	3.93	P<0.001
Females	17	4.03 ± 0.40	24	3.71 ± 0.40	2.46	P<0.05

Our finding that bill measurements provided the least overlap between sexes, and hence the greatest discriminatory power for identifying sex, reflects the general situation in penguins. The bill is the most dimorphic character in Blue Penguins (Gales 1988), and bill depth and width of Magellanic Penguins had the greatest discriminating power of the 10 variables used by Sclaro *et al.* (1983) for determining sex. A sex dimorphism index (male value/female value) is greater for one or more bill measures than for foot or flipper length in Adélie Penguins (*Pygoscelis adeliae*) (Ainley & Emison 1972) and all of the crested penguins (Stonehouse 1971, Warham 1974, 1975, Cooper *et al.* 1990). Although dimorphism indices for body weight can be as large as for bill measures, changes in body weight over time and considerable overlap between sexes make weight a poor indicator of sex. Thus, bill morphometrics are likely to be of greatest use in deriving sex criteria for other species of penguin and in refining sex criteria for Fiordland Crested Penguins.

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SHORT NOTES

Bellbirds feeding on sap of black beech

The Bellbird (*Anthornis melanura*), like other meliphagids, specialises in nectar feeding (e.g. Turbott 1947, Falla *et al.* Moon 1982, Soper 1984). The structure of its tongue seems particularly adapted for this purpose (McCann 1964), and the list of flowering plants on which it feeds is impressive (see esp. Merton 1966, Gravatt 1970, Falla *et al.* 1978:203, Baker 1986). Bellbirds are also known to eat fruits and berries (Turbott 1947, McCann 1964, St. Paul 1975, Falla *et al.* 1978, Norton 1980, Moon 1982, Soper 1984), insects (Turbott 1947, McCann 1964, Merton 1966, Gravatt 1970, St. Paul 1975, Falla *et al.* 1978, Gaze & Fitzgerald 1982, Moon 1982, Soper 1984), spiders (Turbott 1947), pollen (Gaze & Fitzgerald 1982, Soper 1984), and artificial foods such as sugar water and honey (Falla *et al.* 1978, Moon 1982). Bellbirds

are also one of the species known to eat honeydew extruded by mealybugs on tree trunks (Falla *et al.* 1978:203). Insofar as we have found, however, there is only one mention of Bellbirds feeding on sap (Merton 1966), and so we report a confirming observation.

On 18 December 1990, when we were recording vocalisations near the bridge over the Buller River in Nelson Lakes National Park, we observed Bellbirds clinging to and sometimes pecking gently on tree trunks. At first we thought the birds were searching for insects or feeding on honeydew, but at 0830 h we saw a female Bellbird extruding her tongue at what appeared to be a wound in the trunk of a black beech (*Nothofagus solandri*). Upon close inspection of this place about 1 m above the ground, we found viscous sap, on which a bee was feeding.

Tree sap being nutritionally related to nectar and honeydew, it is not surprising that Bellbirds utilise this food source when it is available. Merton (1966: 181) drew special attention to his two observations of Bellbirds feeding on sap: once on a whau (*Entelea arborescens*) about 1 m above ground and once on a karaka (*Corynocarpus laevigatus*) about 3 m above ground. The bird thus takes sap from trees of at least three families. Several authors report Bellbirds inspecting tree trunks and often assume the birds are searching for insects, but it seems possible they are also inspecting trees for sap oozes at ruptures caused by such factors as freezing, wind damage, and animal-inflicted wounds. Whether the Bellbird can actually pierce the bark by pecking on it, thereby causing sap to flow – as does the Yellow-bellied Sapsucker (*Sphyrapicus varius*), a North American woodpecker – is not known.

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