# SEXING ADULT BLUE PENGUINS BY EXTERNAL MEASUREMENTS

By ROSEMARY GALES

In many species of penguins, the sexes differ in size (Croxall 1985), and in most, the males are about 10% heavier than females. This is apparent in Blue Penguins (*Eudyptula minor*) but the large annual variation in their body weight and the large overlap between sexes make weight unreliable for sexing.

The beak of *E. minor* is its most dimorphic character and the sexes of Blue Penguins of all the six subspecies can be distinguished by comparing the shapes of the beaks (O'Brien 1940, Kinsky 1960, Phillips 1960, Reilly & Balmford 1972, Kinsky & Falla 1976). These workers showed that in general the beak of the male is stouter and has a more acutely hooked tip on the upper mandible than that of the female. The female beak is more slender and tapered. However, this difference, although often described, has not been subjected to statistical analyses. In studying the Australian subspecies, the Fairy Penguin (*E. minor novaehollandiae*), in Tasmania, I have had to sex adults by their beak measurements and so could quantify the reliability of this sexing technique.

In Tasmania in 1984-1986, I sexed 136 adult Fairy Penguins either by dissecting freshly dead birds or by examining the cloaca for signs of swelling and distension at the time of egg laying (Serventy 1956). I measured the beak length (after Baldwin *et al.* 1931) and beak depth (after Warham 1975) of each bird to the nearest 0.1 mm. I analysed these data by Discriminant Function Analysis (DFA, Genstat) and calculated a discriminant score for each bird. DFA weights characters by their powers of discriminating between groups of unknown individuals, using data from individuals of known sex (reference, or known group).

With this technique I classified the sex of 107 Fairy Penguins (wild group), including 23 breeding pairs, which I measured in the field on Albatross Island (40° 24'S, 144° 32'E), Bass Strait, in the 1985/86 breeding season. By comparing the discriminant scores with the known group, I classified each bird as male or female. In addition, to examine the reliability of classifying sex by applying a single DFA, derived from the Australian subspecies, to penguins of a New Zealand subspecies, I calculated discriminant scores from the beak measurements of 40 Southern Blue Penguins (*E. minor minor*) of known sex. I had sexed these birds either by dissection or by cloacal examination (see above) in southern New Zealand between 1982 and 1984. The discriminant scores of these birds were then compared with the scores from the known-sex group of *E. minor novaehollandiae* and classified as male or female. The number which was incorrectly sexed by the DFA method was then used to provide an index of reliability of using a single DFA between subspecies.

## RESULTS AND DISCUSSION

The mean beak measurements of the known groups of the two subspecies of *E. minor* are shown in Table 1. In both subspecies the differences between male and female beak measurements were significant but nonetheless showed considerable overlap. The difference between the beak lengths of the two known-sex groups was not significant for males ($t = 1.50$, $df = 88$, $p > 0.05$) or females ($t = 0.82$, $df = 84$, $p > 0.05$). However, the groups showed highly significant differences in beak depth (males: $t = 4.89$, $df = 88$, $p < 0.05$; females: $t = 3.47$, $df = 84$, $p < 0.05$), with *E. minor minor* having the larger beaks in both sexes.

TABLE 1 — Beak measurements (mm) of reference and wild specimens of *E. minor*

| SPECIMENS | CHARACTER | SEX | N | MEAN | RANGE | SD | t-statistic |
|---|---|---|---|---|---|---|---|
| E.m. novaehollandiae reference group | length | M | 66 | 39.1 | 36.0 - 42.3 | 1.44 | 9.94* |
| | | F | 70 | 36.8 | 34.0 - 40.1 | 1.17 | |
| | depth | M | 66 | 14.3 | 12.6 - 15.8 | 0.67 | 17.25* |
| | | F | 70 | 12.4 | 11.2 - 13.9 | 0.60 | |
| E.m. novaehollandiae wild group# | length | M | 51 | 38.7 | 36.4 - 42.0 | 1.07 | 9.51* |
| | | F | 56 | 36.5 | 34.2 - 40.1 | 1.32 | |
| | depth | M | 51 | 14.5 | 13.5 - 16.0 | 0.59 | 19.54* |
| | | F | 56 | 12.4 | 11.2 - 13.4 | 0.07 | |
| E.m. minor reference group | length | M | 20 | 38.8 | 36.8 - 41.8 | 1.48 | 2.54* |
| | | F | 20 | 37.4 | 34.2 - 40.9 | 1.95 | |
| | depth | M | 20 | 14.9 | 13.5 - 15.8 | 0.55 | 9.93* |
| | | F | 20 | 13.2 | 12.1 - 14.0 | 0.54 | |

* indicates $P < 0.05$
\# sex classified by DFA

The classification formula which was derived from the *E. minor novaehollandiae* known-sex (reference) group was:

$$D = -83.10 + (10.06 \ln BL) + (17.99 \ln BD)$$

where D is the discriminant score, ln is the natural logarithm, BL is the beak length (mm) and BD is the beak depth (mm).

The sex of a Fairy Penguin can be determined by applying the bird's beak measurements to this formula. When D is positive, the penguin is classified as male, and when negative, female. Using this formula, of the 107 wild-group penguins measured in the field, I classified 56 (52%) as female and 51 (48%) as male (Table 1). As would be expected, there was no significant difference between the *E. minor novaehollandiae* known-sex group and the wild group (DFA classified sexes) in either beak length (males: $t=1.45$, $df=115$, $p>0.05$; females: $t=1.58$, $df=124$, $p>0.05$) or beak depth (males: $t=1.49$, $df=115$, $p>0.05$; females $t=0.004$, $df=124$, $p>0.05$).

The differences between the discriminant scores of males and females within groups were all significant (Table 2) and the distributions of these scores are shown in Figure 1. Of the 136 birds in the *E. minor novaehollandiae* known-sex group, 128 were classified as the correct sex, giving a classification reliability of 94%. The eight penguins which were incorrectly classified by the discriminant formula were four males with relatively small beaks and four females with relatively large beaks.

The numbers of males and females of the 107 wild-group penguins whose sex was classified by the discriminant formula represent a female:male sex ratio of 1:0.91, which compares well with that of 1:0.86 for the same subspecies found by Hodgson (1975). Of the 23 breeding pairs, every pair was classified as a male-female pair.

When I used the formula derived from the *E.minor novaehollandiae* known-sex group to classify the sex of the *E.minor minor* group, the formula classified only 31 of the 40 New Zealand birds as the correct sex. This represents a classification reliability between subspecies of 78%. All nine of the misclassified birds were females, which were classified as males. The relatively low level of reliability is a result of the larger *E.minor minor* beaks, as in Table 1. This is also evident in the differences in the discriminant scores between the two subspecies (males: $t=2.97$, $df=84$, $p<0.05$; females: $t=4.57$, $df=88$, $p<0.05$).

Table 2 — Discriminant scores of *E. minor*

| SPECIMENS | SEX | N | MEAN | RANGE | SD | t-statistic |
|---|---|---|---|---|---|---|
| E.m. novaehollandiae reference group | M | 66 | 1.59 | -1.23 to 3.51 | 1.016 | 17.82* |
| | F | 70 | -1.49 | -3.68 to 0.68 | 0.992 | |
| E.m. novaehollandiae wild group | M | 51 | 1.702 | 0.15 to 3.51 | 0.879 | 18.94* |
| | F | 56 | -1.57 | -4.00 to -0.03 | 0.893 | |
| E.m. minor reference group | M | 20 | 2.317 | 1.13 to 3.88 | 0.738 | 8.83* |
| | F | 20 | -0.316 | -2.57 to 1.23 | 1.111 | |

* indicates $P<0.05$

The differences in the beak dimensions between the sexes and between the six subspecies of *E.minor* were illustrated by Kinsky & Falla (1976). From their data and my results, the conclusion is that a discriminant formula derived from one subspecies cannot be used reliably to sex other subspecies. Juvenile birds may make the difference worse. The beaks of *E. minor* fledglings are on average only 91% of the adult length and 81% of the adult depth (Gales, 1987) and the age at which they reach adult dimensions is not known. However, the formula presented here for adult Fairy Penguins in Australia gives a high reliability of classifying the correct sex from beak measurements. In practice, one can rapidly sex the adults of *E. minor novaehollandiae* in the field, at any time of the year, with 94% accuracy simply by taking the two beak measurements and calculating the discriminant score.

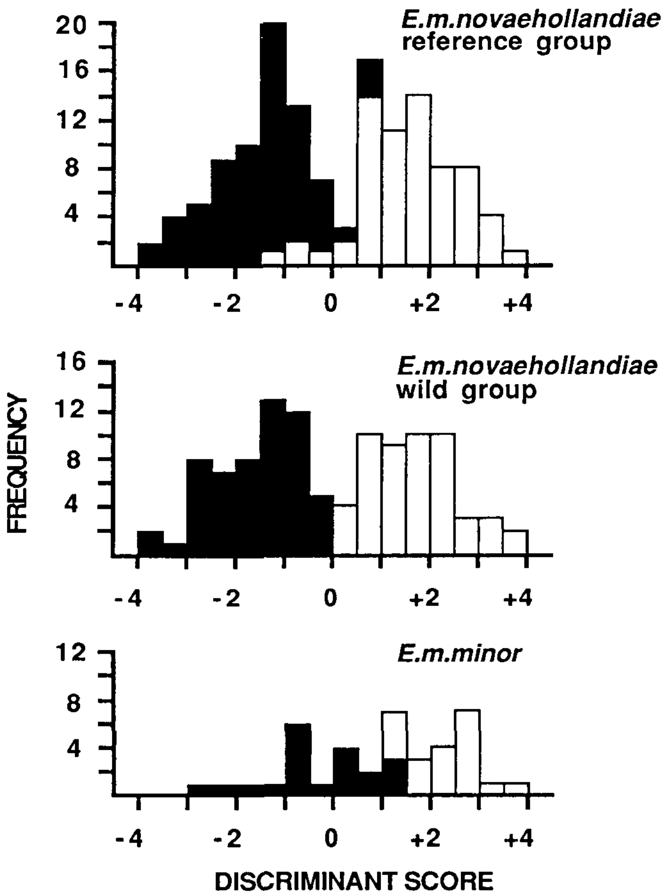


FIGURE 1 — Discriminant scores of female (solid) and male (open) reference specimens of *E.m. novaehollandiae* and of live specimens of *E.m. novaehollandiae* and reference *E.m. minor* classified as female or male

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# SHORT NOTE

## Southern Crested Grebes on a lowland coastal lake in winter

During the week of 18-24 July 1987, 52 lakes, ponds and lagoons throughout Canterbury were surveyed as part of the annual census of Southern Crested Grebes *(Podiceps cristatus australis)* and New Zealand Scaup *(Aythya novaezealandiae)*. One hundred and seventy-six Crested Grebes were found, the highest number recorded in Canterbury since our counts began in 1981 (unpubl. data) and only 17 short of the total count from a South Island-wide survey in 1980 (Sagar 1981). The most notable feature of the 1987 count was the discovery of 20 Crested Grebes on Lake Forsyth, a lowland coastal lake near Christchurch. An additional grebe was seen on nearby Lake Ellesmere at Kaituna Lagoon on the same day. Only Lake Alexandrina had more grebes (59 birds).

Lake Forsyth (680 ha) is a coastal lagoon adjacent to Lake Ellsesmere. It is long and narrow and surrounded by steep hills which are part of Banks Peninsula. The waters are highly eutrophic, often being discoloured with high concentrations of algae.