SEX DETERMINATION OF THE PUKEKO OR PURPLE SWAMPHEN

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The Pukeko or Purple Swamphen *(Porphyrio porphyrio melanotus)* has monomorphic plumage, which makes sexing of the living bird difficult. A method of sexing using body measurements has been proposed (Williams & Miers 1958), but it uses measurements and cut-off values which are not fully reliable. While cut-off values may vary geographically, the reliability of the different measurements should not. This paper uses multivariate techniques to investigate the reliability of combinations of measurements for sexing swamphens and outlines the problems with the existing method.

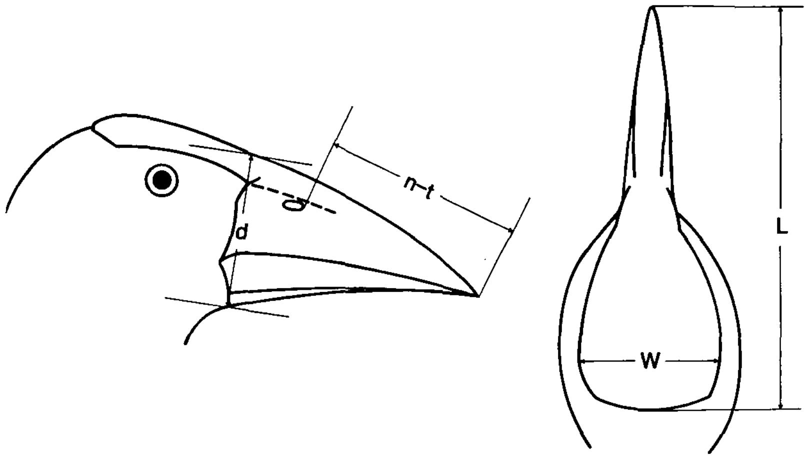
METHODS

During a 3-year study on Pukeko in the Manawatu, New Zealand, by JLC, 133 birds were captured and many subsequently recaptured. Four head measurements (Fig. 1) and weight were taken at all first captures and many of the recaptures. The subsequent behaviour and/or death of these individually tagged birds allowed sex to be assigned for most. The five measurements taken at all captures and in all months of all definitely sexed individuals with adult characteristics (i.e. red culmen, shield and legs) were used in an attempt to determine which measures, or sets of measures, best distinguish the sexes. A 2-group Discriminant Function Analysis was performed using the BMD statistical package (Dixon 1974), and discriminant functions were calculated for every combination of these measures (see Table 1). To determine the sex of an individual, a linear combination of the variables is calculated and compared with a cut-off value — i.e. an individual is classified as a male if

$$\sum_{i=1}^{5} a_i V_i > C$$

where a_i is the coefficient of the discriminate function; V_i is the i^{th} variable and C is the appropriate cut-off value. Otherwise the individual is a female. To rank these sets of measures according to their ability to discriminate between the sexes, the probability of misclassifying an individual was calculated for each set. This ranking is only approximate because the assumptions underlying the statistic are probably not met (Rao 1952).

The same measurements (excluding depth) for a small number of birds sexed by observations of behaviour were available from a similar



(a) (b)

FIGURE 1 — (a) Side view of head measurements. n-t = nares to tip.. d = bill depth.
(b) Top view of head measurements. L = culmen + shield length. w = shield width.

study carried out (by PDW) at Longneck Lagoon in New South Wales. These birds were sexed using the functions produced from the Manawatu sample.

RESULTS AND DISCUSSION

Use of the Discriminant Function Analysis on the Manawatu sample, which included birds of all ages that were indistinguishable from adults and which included measurements taken in all seasons, allowed ranking of the different combinations of these variables as reliable indicators of sex (Table 1). Table 1 also contains the coefficients of the discriminant functions and the suggested cut-off points (assuming equal sex ratio). This analysis showed that use of all characters was the most reliable method of sexing, but this is not easily applied in the field. The single most reliable variable was *nares to tip* (8.8% error). The least reliable was shield width (27.2% error). Williams & Miers (1958), using an unweighted combination of culmen and shield length and weight, found an error rate of 6.6%. Using the same two characters, from our data a weighted combination of culmen plus shield length and weight gives a 7.4% error. Real cut-off measurements for a single character can be obtained by dividing the 'cut-off value' (Table 1) by the coefficient of discriminant function for that character.

When the coefficients and cut-off values obtained with the Manawatu sample are applied to the limited data from New South Wales, nares to tip was the only single character that allowed correct sexing of this rather small sample. Weight or any combination using

TABLE 1 — Combination of variables ranked according to reliability as predictors of sex. (The coefficients of discriminant function and the cut-off values are included for comparison.)

Variables Incorporated	Estimated % error	Coefficients of Discriminant Function for Variables					Cut-off Value
		1	2	3	4	5	
1 2 3 4 5	2.5	.0083	-.00816	.015	.0094	.00017	1.258
1 2 3 5	3.0	.011	-.01	.016		.0002	1.156
1 2 3 4	3.4	.0081	-.0056	.014	.012		1.195
1 3 4 5	3.5	.0029		.011	.014	.00012	1.053
2 3 4 5	3.7		-.0019	.015	.015	.00017	1.019
1 2 4 5	3.9	.0084	-.0053		.011	.00016	.940
3 4 5	3.9			.013	.016	.00014	.996
1 3 4	4.1	.004		.011	.015		1.052
1 4 5	4.6	.0045			.014	.00012	.852
1 2 3	4.7	.011	-.0078	.016			1.05
3 4	5.0			.015	.018		.966
2 3 4	5.0		.00039	.014	.018		.962
1 2 5	5.1	.011	-.0076			.00019	.788
1 2 4	5.1	.0082	-.0032		.013		.897
1 4	5.4	.0057			.015		.846
1 3 5	5.6	.0047		.011		.00014	.770
2 4 5	5.8		.0096		.017	.00016	.695
4 5	5.9				.017	.00017	.684
1 3	7.0	.0062		.012			.771
1 5	7.4	.0064				.00014	.581
3 5	7.5			.015		.00019	.627
2 4	7.6		.0029		.019		.657
1 2	7.6	.012	-.0055				.696
4	8.8				.020		.603
1	9.6	.0079					.554
2 3	12.6		.0064	.017			.573
3	12.7			.018			.518
2 5	14.0		.00092			.00021	.227
5	14.2					.00023	.217
2	27.2		.0037				.096

Variable 1 = Culmen + shield length; 2 = Culmen width; 3 = Depth, 4 = Nares to Tip; 5 = Weight.

this character were of little or no use, as none of the males or females at Longneck Lagoon reached Williams & Miers' cut-off weight of 950 g.

The published method devised by Williams & Miers (1958) relies on the combined measurements of culmen plus shield length (Fig. 1) and body weight. Adult males were considered to exceed 950 g with a culmen and shield length exceeding 70 mm. Owing to limitations imposed by sampling during the non-breeding season, and from two localities only, Williams & Miers were unable to account for seasonal, age or geographical variations. They suspected that such differences may introduce complications, and this study attempts to determine which variables are the most stable with season and age.

Weight is the least reliable measurement for sexing pukeko. Seasonal variations in weight were common, especially for breeding females (cf. Anderson 1975). More serious was the geographic variability. At Longneck Lagoon few males reached the 950 g cut-off weight determined by Williams & Miers from their New Zealand samples. This is also known to occur in other areas in New South Wales (B. Gilligan, pers. comm.). The extent to which geographical variation affects the other variables is unknown but could be significant.

Culmen plus shield length is also subject to seasonal variation. The shield characteristically swells with the onset of breeding and regresses later in the year. Such changes are well documented for other gallinules (see Gullion 1951, Anderson 1975). This measurement also correlates with social status (Craig 1974). Furthermore, young of the year from 4-5 months can have a fully red shield and legs, thus being indistinguishable from adults, but still have a small culmen plus shield length and hence appear to be female. Even yearlings (up to 18 months old) retained in their natal territory and socially prevented from breeding have a juvenile-sized shield and hence fall within the female range.

Three other measurements were used in our studies. Shield width suffered from all the limitations mentioned above. The remaining two measurements, nares to tip of the beak (N-T) and depth, had a number of advantages: (i) both have hard end-points which ensure minimal operator error; (ii) neither varies seasonally; and (iii) both reach adult size by the time the shield has become red and so juveniles need not be separated out by eye colour or other characteristics. It is not surprising, then, that these latter two measurements (nares to tip, and depth) had the lowest error when two measurements were used.

CONCLUSIONS

We recommend the use of the measurements *nares to tip* and *bill depth* for sexing *Porphyrio p. melanotus*. These measurements have fixed end-points allowing accurate reproduction. They also allow sex determination at the earliest age and do not vary seasonally. However, in any study, the more independent measurements used, the greater the accuracy that can be obtained. It should be stressed that homosexual and reverse copulations do occur, making short-term observations insufficient for accurate sexing.

Though the variables *nares to tip* and *bill depth* are remarkably stable over age and seasons, it seems unlikely that they will have the same absolute values for all populations. It is also doubtful that any simple set of cut-off points could be generally applicable, and we recommend that other workers derive their own cut-off values for the reliable measurements.

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SHORT NOTES

SOME RED-CAPPED DOTTEREL RECORDS

The Red-capped Dotterel *(Charadrius alexandrinus ruficapillus)* has a curiously inconclusive history in New Zealand. Apart from an isolated record of an adult male collected near Waikanae in December 1878, its history is limited to that of, apparently, a single female that bred with a Banded Dotterel *(C. bicinctus)* in 1947 and 1950, successfully raising at least one hybrid young (Oliver 1955, *New Zealand birds)*. It presumably bred also in the intervening years. This occurred on the Ashley River bed in northern Canterbury. On the ocean beach near the mouth of the Ashley River and, on one occasion at the mouth of the nearby Waipara River, an adult female was seen repeatedly in October-December 1955 but not in February-May 1956 (W. C. Clark & B. D. Heather 1957 *in* Class. Summ. Notes, *Notornis* 7 (3): 80).

More recent reports, as yet unpublished, of dotterels seen in the Ashley River area that were Red-capped, hybrids, or both suggest that a small population may still persist. I therefore wish to put on record several recent sightings of my own in case they will contribute to a better understanding of the species' status in New Zealand, once the situation in Canterbury is better known.