

## SHORT NOTES

### Plumage and bill morphology variations in a population of the Blue Penguin (*Eudyptula minor*)

Kinsky & Falla (1976) offered a geographical breakdown of *Eudyptula minor* into five New Zealand sub-species and one in Australia, using morphological variations of bill and plumage. However, the taxonomy remains enigmatic (Kinsky & Falla 1976, Meredith & Sin 1988, Turbott 1990). The laboratory work cited by Turbott (1990), the field work of Kinsky and Falla (1976) and the present study all undermine the earlier claims for a separate species, *E. albosignata*, for the Canterbury White Flipped Penguin, referred to for example, by Tuck & Heinzel (1978).

The population of Blue Penguins at Oamaru (45°07'S 170°58'E) has achieved prominence as the tourist attraction, "The Oamaru Blue Penguin Colony". As part of the Department of Conservation programme overseeing the welfare of the birds, some 250 to 300 breeding penguins have been banded and closely monitored. Anecdotal observation from the monitoring suggested a variation in bill size, body colour and flipper pattern within the population. Such birds varied from traditional *E. minor* (Harrison, 1983, p.205) in their paler blue body plumage, an increased amount of white on the dorsum of the flipper and a smaller coloured area under the tip of the flipper. This paper presents quantification of those variations and their interrelationships.

The North Otago - South Canterbury coast is a shingle beach that extends for 250 km north to Banks Peninsula before habitat obviously suitable for Blue Penguins occurs again; there is no record of significant Blue Penguin settlement along that coast (Kinsky & Falla 1976). The Oamaru breeding population occupies the foreshore and its immediate hinterland from within the town northern boundary, south to Bushy Beach, a coastline of about 5 km. Dann (1994) estimated the Oamaru population at about 220 breeding pairs, a figure which he considered to be an underestimate and even then representing but 40% of the total population. Monitoring has shown an increase of 35% per annum over each of the last three years (D.M. Houston, pers.comm). These data suggest an informed estimate of not less than 2000 and probably up to 3000 birds for Oamaru. This population is separated from the substantial Otago Peninsula population (Dann 1994) by 85 km of coastline which holds about six scattered colonies averaging no more than 50 birds (D.M. Houston pers.comm).

Over the breeding seasons 1994-95 and 1995-96, 148 birds were photographed. These were birds breeding in the nest boxes in the Oamaru Blue Penguin Colony and its control group on the Oamaru Creek site, approximately 1 km north. The birds that were photographed were, during the second season, selected for the deviation of individuals from the "standard" dorsal flipper pattern of *E. m. minor*, morph 5 (Fig.1). Sufficient sample of morph 5 had been obtained during 1994-95

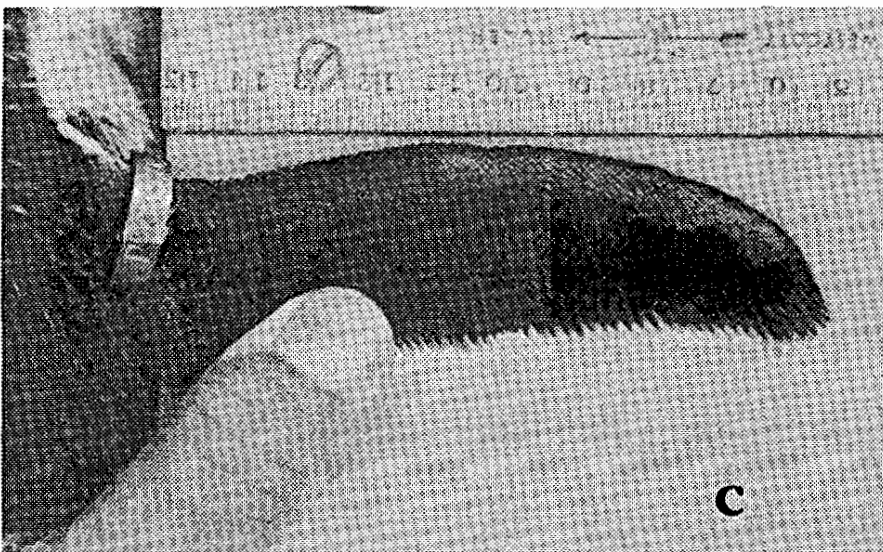
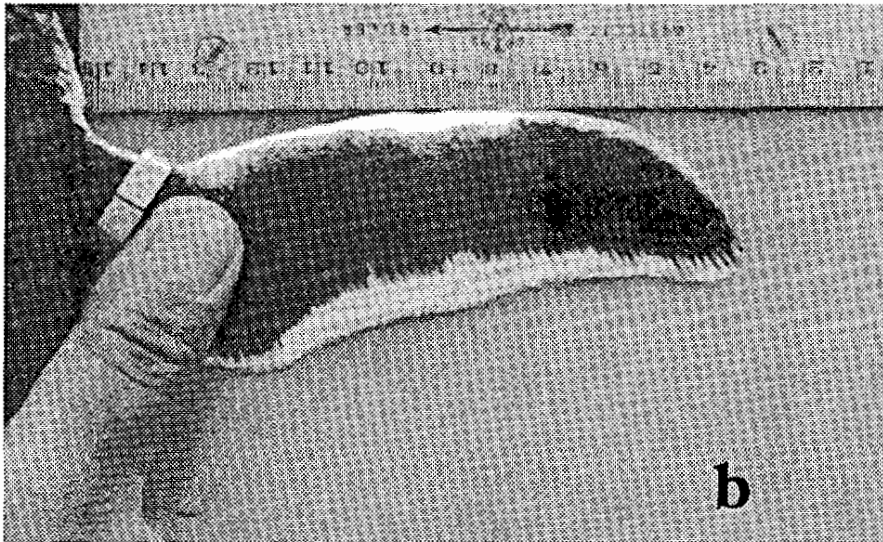
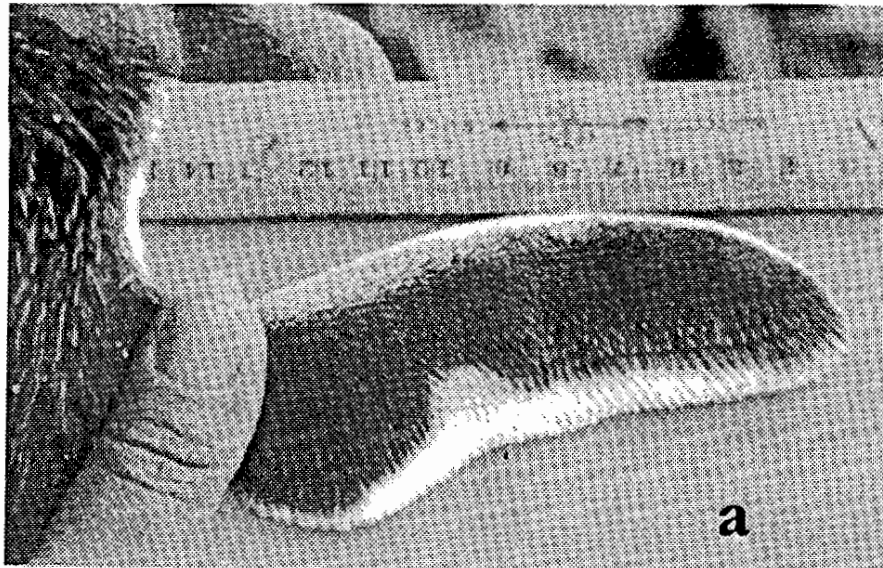


FIGURE 1 - Illustration of dorsal flipper pattern of Blue Penguins used in morph definition. a) morph 1; b) morph 3; c) morph 5.

TABLE 1 - Definition of morphs 1 to 5 and their prevalence in banding records (N = 557).

Morph	Description	Prevalence, %
1	White of leading edge, $\geq 3.0$ mm wide, thumb print	3
2	Leading edge, $> 1.1$ mm, thumb print	4
3	Leading edge, $\geq 3.0$ mm, no thumb print	6
4	Leading edge, 1.1 to 3.0 mm, no thumb print	14
5	Leading edge $\leq 1.0$ mm, no thumb print	72

and it was necessary to expand the sample of morphs 1 to 4. A compact 35 mm camera was used, equipped with 90 mm zoom lens, automatic focus and flash. Both surfaces of the right flipper were photographed on a small board against a millimetre scale. The bill length and depth at the nostril were measured with Vernier callipers, following the method of Kinsky & Falla (1976).

Using the photographic prints of the dorsal flipper plumage (Fig.1.), five morphological grades were derived (Table 1). The white of the trailing edge may extend anteriorly in either or both of two adjacent sites. Those sites are not distinguished and any such extension is referred to as the "thumb print". Irregularity of the colour/white border was not uncommon, so a thumb print was counted only if it dented the colour by  $\geq 5$  mm.

From the photograph of the ventral surface, the extent of the coloured patch under the tip was quantified as a percentage of that area of the underwing that lay distal to the carpal joint. A transparent grid was placed parallel to the radio-ulna and a vertical line passed through the carpal joint. Any square that was 50% or more occupied by flipper image was counted. All squares with any colour in them were also counted. The number of coloured squares was expressed as a percentage of that counted for the whole distal flipper.

Banding records indicate that 27 % of Oamaru birds exhibit some degree of white flipper variation (Table 1) but the photographed birds were not randomly selected and do not represent morph prevalence. Statistical analyses were made of the bill depths and flipper pattern between morphs 1 and 5; analysis was made of these extreme morphs in order to establish the significance of the association (Table 2). Both bill depth and ventral flipper tip colour differed significantly between morphs 1 and 5 (Student's  $t_{107} = 2.59$  for bill depth,  $t_{52} = 4.80$  for tip colour, both  $P < 0.01$ ). It is clear that "white flipperedness" is associated with a deeper bill and a smaller dark area under the tip, with no account taken of gender.

The Canterbury population of Blue Penguins has a discernibly paler shade of blue in the dorsal plumage and on the face (Kinsky & Falla 1976) and a narrower band of colour in the axilla, between the white of the trunk and the ventral flipper (C.N. Challies, pers. comm). Such variations, although recognisable in the Oamaru birds, could not be quantified. However, the presented morphological variations have provided a positive association between bill depth and pallor of the plumage (leucism).

TABLE 2 - Biometric data of bill depth and flipper tip of Blue Penguins at Oamaru, morphs 1 and 5.

	Mean	S.D.	Range	N
<i>Morph 1</i>				
Bill depth, mm	15.59*	1.8	11.3 - 18.6*	22
Tip area, %	2.44	2.43	0.0 - 9.0	18
<i>Morph 5</i>				
Bill depth, mm	14.65	1.42	12.0 - 17.8	87
Tip area, %	5.74	3.67	0.0 - 16.0	78

\* Without a single outlier, (11.3 mm), the mean is 15.9 mm.

TABLE 3 - Comparison of bill depths of Blue Penguin subspecies, Kinsky &amp; Falla (1976) and Oamaru birds.

Taxon	Range	Mean		Sample size	
		female	male	female	male
<i>E. m. albosignata</i>	11.8 - 19.8	15.4	17.0	21	25
<i>E. m. variabilis</i>	11.2 - 18.8	13.6	16.0	69	75
<i>E. m. minor</i> (Otago)	12.3 - 17.4	13.3	15.2	9	11
Oamaru, morph 1	11.3 - 18.6	15.6*		22*	
Oamaru, morph 5	12.0 - 17.8	14.65*		87*	

\* The genders cannot be separated within the Oamaru population.

Whilst no bird has been recorded from the Oamaru population that showed the patterns of *E. m. albosignata* (Kinsky & Falla 1976), one was picked up dead at Waihao River mouth, 45 km north of Oamaru, November 1966. The plumage characters of the Oamaru birds are probably indistinguishable from those given by Kinsky & Falla (1976) as *E. m. variabilis*, their Cook Strait population. Table 3 compares the range of bill depths for morphs 1 and 5 of the Oamaru population with the three relevant groups distinguished by Kinsky & Falla (1976) and indicates that, of the Oamaru birds, morph 1 (leucistic) falls within the range of *E. m. albosignata*, whilst morph 5 is compatible with both *E. m. minor* and *E. m. variabilis*. As a field study, gender of the Oamaru birds is not available, which is unfortunate, for morph 1 may be expected to affect the discriminatory score of Gales (1988).

Kinsky & Falla (1976) made the sub-specific distinction between *E. minor minor*, (south east coast, South Island) and *E. m. variabilis*. Their Fig. 1 indicated a northward extension of the Banks Peninsula population, contacting the southern boundary of *E. m. variabilis* at Cook Strait. However, an absence of Blue Penguin population is indicated between Banks Peninsula and North Otago. In the material for description of *E. m. albosignata*, they included "stragglers from Otago". The present results provide evidence of the movement of Canterbury birds to the south, a dispersal noted by Turbott (1990). A large bill size is not inevitably associated with leucism, as seen in the Chatham Island population (Kinsky & Falla 1976). The lack of geographically sharp population demarcations was noted by Meredith & Sin (1988). Unfortunately, those authors were unable to quantify the variations of flipper pattern discussed.

This work indicates that phenotypic variation can be defined by the dorsal flipper pattern. Further work will study the offspring of birds of defined morphology in order to assess phenotypic inheritance.

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