MORPHOLOGY AND HEAD COLOUR IN THE YELLOWHEAD

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Soper (1972) and Falla *et al.* (1966, 1979) have implied that Yellowheads (*Mohoua ochrocephala*) can be sexed by differences in nape colour: canary yellow in adult males and yellow, shaded or tinged with olive-brown, in females and juveniles. Soper also suggested that the olive-brown markings are more extensive in young birds.

While examining study skins of Yellowheads in the Canterbury Museum collection, we noted that some birds labelled as females lacked olive-brown markings on their napes. If they were labelled correctly, nape colour may not be a consistently reliable means of sexing Yellowheads. As is usual for older skins, sex was not noted on many labels; someone had altered the sex on one label, presumably because of nape colour.

Cunningham (1984) showed that male Brown Creepers (*Finschia novaeseelandiae*) are larger than females, and Robertson *et al.* (1983) suggested that the same is true for the Whitehead (*Mohoua albicilla*). As these two species are considered to be closely related to the Yellowhead, male and female Yellowheads may also differ in size.

To determine whether the method of sexing Yellowheads proposed by Falla *et al.* (1966, 1979) can be used with confidence, we studied the relationship between size and nape colour in museum specimens.

METHODS

We examined 45 study skins (22 from the Canterbury Museum, Christchurch; 15 from the Auckland Institute and Museum, Auckland; and 8 from the National Museum of New Zealand, Wellington) and classified each as having a 'yellow' or 'brown' nape. 'Yellow-naped' birds had a yellow crown and some brown edging on the otherwise yellow nape feathers (as shown in the plate in Falla *et al.* 1966, but not in that in Falla *et al.* 1979). 'Brown-naped' birds had brown feathers on the nape and up on to the crown. All specimens we examined were placed in one of the two groups; a few birds (some of which were labelled as juveniles) had brown lines which ran along the feather rachis and joined with the brown tip.

After classifying each specimen by colour, JBC took the following measurements: bill length (chord of exposed culmen), bill depth (at base of exposed culmen), bill width (at base of exposed culmen), length of tarsometatarsus (from tibio-tarsal joint to anterior edge of last complete tarsal scale), and wing length (unstraightened chord of the flattened wing from carpal flexure to tip of longest primary).

We also examined rectrice wear on the 22 Canterbury Museum birds to establish the approximate timing of their moult. RNH examined (binocular microscope, 25X magnification) those specimens with collection dates for pigment distribution and wear on crown and nape feathers.

In this study, we have assumed that the original labels were correct.

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RESULTS AND DISCUSSION

All measurements (means ± 1SD) are given in Table 1. We found no significant differences between yellow-naped and brown-naped birds for any of the characters measured (t-test, $p>0.05$) and the groups had similar variances (F-test, $p>0.05$).

TABLE 1 — Measurements (mm) of 'yellow-naped' and 'brown-naped' Yellowheads. (Mean ± 1SD).

	Bill			Tarsus	Wing
	Length	Depth	Width	Length	Length
Yellow-naped	11.5±0.63	5.1±0.35	5.2±0.28	25.2±0.84	79.2±2.55
Number	20	18	19	22	21
Brown-naped	11.0±0.75	4.9±0.36	5.3±0.38	25.4±0.98	77.7±2.94
Number	22	22	23	21	18

If, as Falla *et al.* suggested, birds with yellow napes are males and those with brown napes are females or juveniles, and if male Yellowheads are larger than females, the two colour 'forms' should differ in size. Our measurements did not support this prediction.

We subjected the data to principal component analysis (PCA) as a more sensitive test to see if there were any size groupings and if such groups were correlated with nape colour. In PCA, the original measurements are transformed into independent linear combinations (principal components) of the variables measured. The first linear combination is so constructed that it describes the greatest possible proportion of the total variability. Each subsequent combination accounts for the largest proportion of the remaining variation.

The loadings of the five variables for the four principal components calculated are shown in Table 2. Most of the variation in principal component 1 was attributable to bill length and depth, tarsus length, and wing length. Most of the variation in principal component 2 was contributed by bill width.

The first two principal components are plotted in Figure 1. The data can be separated into two non-overlapping clusters of points. In one cluster there are large birds with 1st principal component scores greater than -0.75; the other consists of small birds with 1st component scores of less than -1.0. Yellow-naped and brown-naped birds occur in both clusters. If the larger birds were males and the smaller were females, these results would suggest that birds with yellow napes are not necessarily adult males.

Crown-feather pigmentation pattern

The rachis and barbs of all crown feathers are usually yellow; pigment intensity varies and some shafts may be almost white, particularly near their base. Most barbules along the length of each barb are also yellow, but near the barb tip the barbules are olive-brown. These are seen in the whole feather as an olive-brown (here 'brown') tip. Examination of the few dated specimens indicates that the progressive yellowing of the crown and nape in adults may be caused by both the loss of the brown barbules and by the breaking of the barbs at a point proximal to the change in barbule colour. Feathers further down the nape have longer sequences of brown barbules, and the intensity of coloring therefore increases from the forehead to the nape. Wear may be more rapid and extensive immediately above the bill and on the crown as the bird forages and preens; this would give the effect of a progressively reaward change in head hue through autumn, winter and spring.

TABLE 2 — Loading of the five characters measured, for the four principal components calculated.

	Principal component			
Character	1	2	3	4
Bill length	0.824	0.231	0.331	-0.346
depth	0.891	-0.013	0.353	0.067
width	0.546	-0.831	-0.069	-0.033
Tarsus	0.718	0.170	-0.624	-0.242
Wing	0.821	0.187	-0.124	0.508

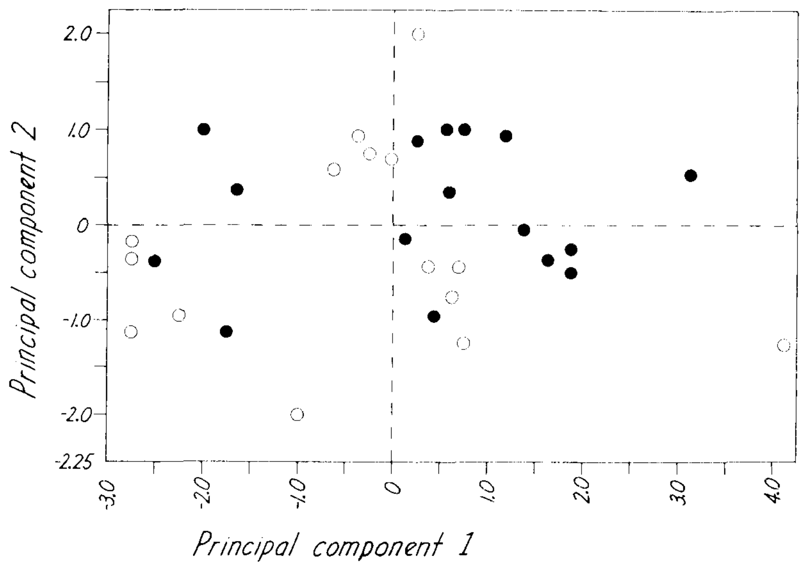

FIGURE 1 — Distribution of ordinate values for principal components 1 and 2. Open circles, brown-naped birds; closed circles, yellow-naped birds. Note broad segregation into two clusters.

Some skins, including those marked 'juvenile' in the Canterbury Museum, have another, very narrow, band of brown barbules right against the rachis (on each side), which appears as a central band joining the brown tip. These feathers occur up on to the crown and produce the most marked 'brown-naped' condition. They probably indicate a first-year bird, as one (CM AV. 1001) was taken on 24 July and another (CM AV. 1005) is dated 8 October, probably too early for a bird of the year.

Moult

If we assume that juveniles have brown napes, it appears that the 'brown-naped' plumage lasts at least until the breeding season after fledging, which agrees with Soper's observations. Yellowheads probably undergo a sequence of moults as follows (nomenclature from Humphrey & Parkes 1959): natal down (October-November-December), prejuvenal moult, juvenal plumage, first prebasic moult (January-February-March), first basic (immature) plumage, second prebasic moult (January-February-March), second basic (adult) plumage, and so on. The single moult is supported by the pattern of progressive wear, including shaft breakage, seen on dated skins.

More work is obviously necessary, preferably on live known-age birds in which the course of moult and changes in head colour can be followed through the year. The results presented here do, however, indicate that care is necessary in sexing Yellowheads (and other 'well-known' birds) by sight and in drawing behavioural and ecological conclusions from such decisions. For example, the "polygamy" noted by Soper (1972) may have been an instance of a juvenile (of either sex) helping at the nest, rather than another female mated to the male as Soper suggested.

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