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ESTIMATING SEXES OF NEW HOLLAND AND WHITE-CHEEKED HONEYEATERS FROM HEAD-BILL MEASUREMENTS

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We tested the degree to which New Holland and White-cheeked Honeyeaters could be sexed on the basis of head-bill measurements. Both species showed bimodal distributions of head-bill measurements, with inter-modal troughs at 41.25 mm in New Holland Honeyeaters and at 40.75 mm in White-cheeked Honeyeaters. We proposed that birds with head-bill measurements greater than the inter-modal trough were probably males, and tested this method on birds whose sexes were known from brood patches or observations of nesting behaviour. Of 77 New Holland Honeyeaters (22 male, 55 female) and 47 White-cheeked Honeyeaters (11 males, 36 females), 91 per cent of birds were correctly sexed from their head-bill measurements. We investigated the possibility of using this technique on Yellow-faced Honeyeaters, but found this species to have a unimodal distribution of head-bill lengths.

INTRODUCTION

For New Holland Honeyeaters *Phylidonyris novaehollandiae* and White-cheeked Honeyeaters *P. nigra,* the head-bill measurement (i.e. the distance from the back of the head to the tip of the bill) has been found to show a bimodal frequency distribution with males being larger than females (Rooke 1976; McFarland 1986; Rogers *et al.* 1986; Pyke and Recher 1988; Pyke *et al.* 1989). Based on this there have been two approaches to sexing these two species. In the first approach two thresholds are determined such that 95 per cent of birds with a head-bill measurement that exceeds the larger threshold are males while 95 per cent of birds that measure less than the smaller threshold are females; birds that measure more than the larger threshold are estimated to be males, those that measure less than the smaller threshold are estimated to be female, and birds which measure in between the two thresholds remain unsexed (Rogers *et al.* 1986). Determination of these thresholds is based on the assumption that the head-bill measurements for each sex have a normal frequency distribution and hence that the frequency distribution of measurements for all individuals will be the sum of two normal distributions. This combined distribution is separated analytically into the two separate normal distributions (Day 1969) and the two thresholds calculated from these two distributions (Rogers *et al.* 1986). However, the analytic methods for separating a bimodal distribution into two normal components are not easy to use and require a computer and appropriate software (Rogers *et al.* 1986), and, with this method, many birds remain unsexed and hence their behaviour etc. cannot be considered in relation to sex.

The second approach is based on visual inspection of the bimodal distribution and the midpoint of the measurement interval with the lowest frequency (i.e. of the trough of the distribution) chosen as the threshold for sexing (McFarland 1986; Pyke and Recher 1988; Pyke *et al.* 1989). Birds which measure more than the threshold are estimated to be males while the others are estimated to be females. The length of the measurement intervals for plotting the frequency distribution is made as small as possible such that the distribution remains reasonably smooth with a clear trough.

Using this method, Pyke and Recher (1988) and Pyke *et al.* (1989) obtained thresholds of 41.2 mm and 40.7 mm for estimating sexes of New Holland and White-cheeked Honeyeaters respectively from Brisbane Water National Park near Sydney, New South Wales. For New Holland Honeyeaters in New England National Park in northern New South Wales, McFarland (1986) adopted a sexing threshold of 41.5 mm, after first noting that the frequency distribution of head-bill measurements was bimodal with peaks at 39.5 mm and 43.0 mm.

This second method of sex determination is simple to use, could potentially be applied to a range of banding studies, and provides an estimated sex for all individuals. Its accuracy, however, has not been evaluated.

The principal aims of this paper are (1) to present data showing the bimodal distributions of head-bill measurements on which we based thresholds used for sexing New Holland and White-cheeked Honeyeaters in earlier studies in Brisbane Water National Park (Pyke and Recher 1988; Pyke *et al.* 1989) and (2) to test the accuracy of this method using data from birds whose sexes are known from observations of parental behaviour or from the presence of brood patches. We also consider whether the method may work for the Yellow-faced Honeyeater *Meliphaga chrysops*, another common species at Brisbane Water National Park.

METHODS

Since March 1982 free-flying honeyeaters have been regularly captured and banded in two heathland sites in Brisbane Water National Park, about 35 km north of Sydney (see Pyke and Recher 1988; Pyke *et al.* 1989). For most captures, the distance from the back of the head to the tip of the bill was measured to the nearest 0.1 mm using Vernier calipers (see Rooke 1976 for description of method). When two or more measurements were available for the same bird, we used the average. New Holland and White-cheeked Honeyeaters were classified as adults or immatures using plumage and iris colour (Lane 1974) and checked for the presence of brood patches. Birds with brood patches were assumed to be female (Paton 1985; Rooke 1979).

Between February and October 1987 and between February and September 1988, one of us (DPA) carried out regular observations of reproductive behaviour in New Holland and White-cheeked Honeyeaters (see Armstrong 1990; Armstrong and Pyke 1991 for details). These observations were carried out on one of the sites noted above (Pyke and Recher 1988; Pyke *et al.* 1989) and on another area of heathland about 1 km to the south-west. All breeding birds on the latter site were banded and measured by D.P.A. Birds of both species formed clear breeding pairs, and only one member of each pair was observed sitting on eggs. We assumed these individuals to be females and their mates to be males. Other studies of New Holland Honeyeaters have also found that only one member of each breeding pair sits on eggs (Rooke 1979; Paton 1985; McFarland 1986), and Rooke (1979) confirmed these individuals to be female by performing laparotomies.

RESULTS

(a) Holland Honeyeaters

There were no apparent differences between adults and immatures in terms of head-bill measurements. For both adults and immatures, the frequency distributions were bimodal with peaks around 40.0–40.5 mm and around 42.0–42.5 mm and troughs between about 41.0 mm and 41.5 mm (Fig.1). Data for these different ages, and for birds which were not aged, are therefore combined.

The resulting frequency distribution of all ages (Fig. 1) shows a pronounced trough between 41.0 and 41.5 mm, suggesting a threshold of 41.25 mm for sexing this species. Individuals with head-bill measurements less than 41.25 mm were therefore estimated to be female.

Data for birds of known sex indicated that the threshold predicted sexes fairly accurately. Of 37 females sexed by the existence of brood patches, 33 were estimated to be female using the above

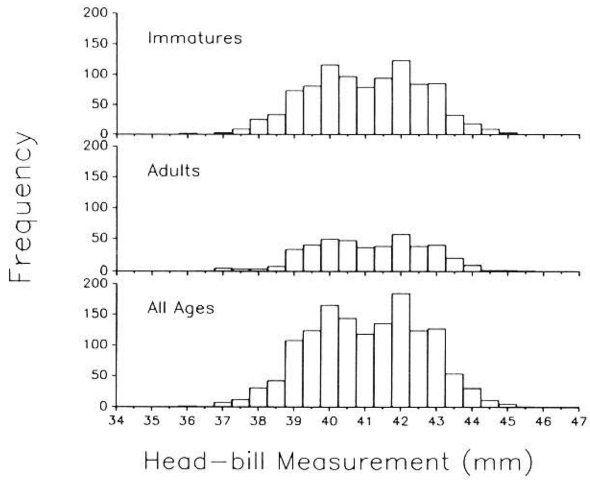

Figure 1. *Frequency distributions of head-bill measurements for New Holland Honeyeaters caught at Brisbane Water National Park.*

head-bill threshold, while the remaining four were estimated to be male. Of 40 birds sexed on the basis of reproductive behaviour, two were incorrectly sexed using the head-bill threshold (1 out of 22 males and 1 out of 18 females). Overall, 92 per cent (n = 77) of the birds that were sexed on the basis of either brood patches or behaviour were estimated to have the same sex using the head-bill threshold.

(b) White-cheeked Honeyeaters

The frequency distributions of head-bill measurements for White-cheeked Honeyeaters also showed the same locations of peaks and troughs for adults and immatures (Fig. 2). When data for both ages and from birds that were not aged are combined, a threshold at 40.75 mm for sex estimation is suggested (Fig. 2).

As for New Holland Honeyeaters, this threshold provided fairly accurate estimates of sexes. Of 28 females sexed by the existence of brood patches, 24 were estimated to be female from their head-bill measurements, while the remaining four were estimated to be male. Of 19 birds sexed on the basis of reproductive behaviour, one was incorrectly sexed using the above head-bill threshold (0 out of 11 males, 1 out of 8 females). Overall, 89 per cent (n = 47) of birds that were sexed on the basis of either brood patches or behaviour were estimated to have the same sex using the head-bill threshold.

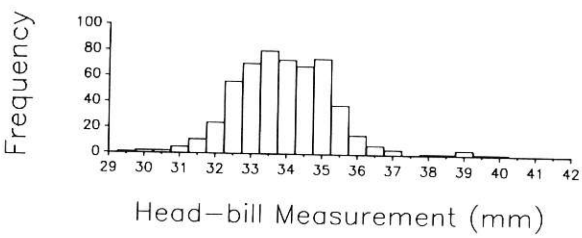

Figure 3. *Frequency distribution of head-bill measurements for Yellow-faced Honeyeaters caught at Brisbane Water National Park.*

(c) Other honeyeater species

The frequency distribution of head-bill measurements for Yellow-faced Honeyeaters is apparently unimodal rather than bimodal (Fig. 3). Therefore, there is no obvious threshold value that could be used to sex this species, and estimation of sex on the basis of head-bill measurement is unlikely to be very accurate.

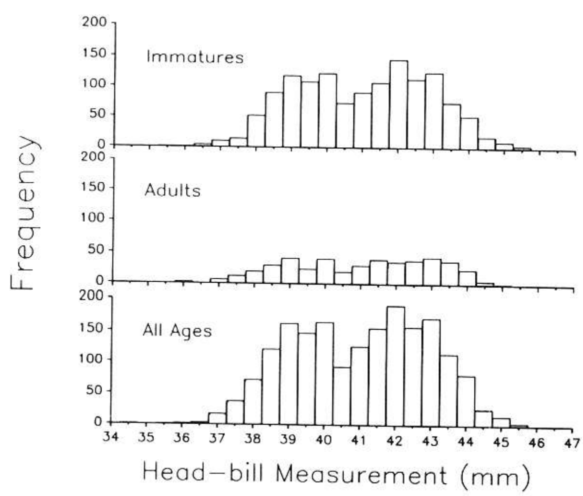

Figure 2. *Frequency distributions of head-bill measurements for White-cheeked Honeyeaters caught at Brisbane Water National Park.*

DISCUSSION

Our results indicate that New Holland Honeyeaters and White-cheeked Honeyeaters can be sexed fairly accurately on the basis of their head-bill measurements. We caution that head-bill measurements may vary between regions, and that it may be inappropriate to use the threshold values we obtained to sex New Holland Honeyeaters or White-cheeked Honeyeaters in other populations. For example, Rooke's (1976) data suggest that New Holland Honeyeaters in Western Australia tend to have greater head-bill measurements than those at our sites, so that use of our thresholds in Western Australia would result in many females being incorrectly sexed as males. Rooke (1976), using data for birds of known sex (from laparotomy), found that 23 of 24 males had head-bill measurements of at least 42.7 mm, and all 21 females had measurements of at most 41.9 mm.

No differences were apparent between adults and immatures for both New Holland and White-cheeked Honeyeaters (Figs. 1 and 2). However, Rogers *et al.* (1986) reported mean head-bill measurements for male and female White-cheeked Honeyeaters that increased with bird age from juvenile to immature to adult. For these Victorian birds, the differences between the age groups were small, amounting to only 1.2 mm between the means for juvenile and adult males and only 0.8 mm for females. Consequently, similar differences may become apparent for the present study area with greater sample sizes.

We suggest that the method of sexing tested in this paper could be applied to region-specific studies of a variety of species. Banders needing a sexing technique could plot the morphological variables they routinely collect to determine if any show bimodality in distribution. If such bimodality is detected, the usefulness of that bimodality for sexing birds can be evaluated using a subsample of birds of known sex. In some cases, however, accurate sexing may not be possible on the basis of a single morphological trait but may require analysis of a combination of these variables using multivariate techniques such as discriminant analysis (e.g. Craig *et al.* 1980; Nugent 1982).

For our birds, the head-bill measurement appeared to be the most useful measurement for estimating sex. We examined data on some other morphological measurements (culmen, tarsus, tibia, wing chord, wing length) but none of these showed clearly bimodal distributions. For other species, one or more of these other measurements might provide a better estimate of sex. However, head-bill measurements are fairly simple to take and can probably be obtained with greater precision than the other measurements.

One factor affecting the precision of head-bill measurements is the number of observers taking the measurements. In our study most measurements were made by four observers, each of whom may have differed in measurement technique. Such variation amongst observers would increase the variance in measurements, thereby increasing any overlap between the sexes and hence errors in estimating sex using a head-bill threshold. Accuracy might therefore be greater if a single observer took all measurements.

There was no apparent headbill threshold suitable for sexing Yellow-faced Honeyeaters (Fig. 3). Males are, however, larger on average and have larger headbill measurements than females (Rogers *et al.* 1986). Rogers *et al.* (1986) determined sexing thresholds in terms of adult wing length and found that 43 per cent of birds were correctly sexed, 0.4 per cent were incorrectly sexed, and 56.5 per cent remained unsexed. We did not take sufficient measurements of wing length for this species to attempt our sexing method using this trait.

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