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WING LENGTH, WINGSPAN AND BODY LENGTH MEASUREMENTS OF LIVE BIRDS AT BANDING STATIONS

JOHN LIDDY

5 Ben Street, Chermside. Qld. 4032

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Aspects of wing length, wingspan and body length measurements of live birds at banding stations are reviewed, using as examples data from a banding station at Cowiebank, southeastern Queensland. The histogram of the extended length measurement is a useful tool for sexing some morphometric species, and its use at banding stations is recommended: it has good reproduceability, is relatively consistent over periods of years, and is unlikely to result in injury to the bird.

INTRODUCTION

Many species of birds that cannot be sexed by plumage or colours are sexually dimorphic in size, and a range of measurements has been used to find sexual size indicators for live birds. The ideal measurement for sexing should show bimodal distribution without overlap, be easy to take, be reproduceable, and be unlikely to result in injury to the bird. This ideal is rarely encountered.

This paper reviews aspects of wing length, wingspan and body length measurements as applied to live birds at banding stations, and discusses some of the associated problems. This discussion is illustrated with examples from a banding station at Cowiebank (26°58′S, 153°04′E), approximately 11 km east of Beerburrum, south-eastern Queensland, where mist-netting and banding studies were carried out between 1971 and 1987. The study area and operating methods have been described (Liddy 1982, 1989).

WING LENGTH

The wing length of a bird is the distance from the carpal joint to the end of the longest primary feather of the closed wing. However, the wing of a bird is not a simple two-dimensional structure; it is complicated by lateral curvature of the primaries and a camber across and along the wing. There are three main methods of measuring wing length, and the features of each are discussed in The Ringer's Manual (British Trust for Ornithology 1984).

(a) The unflattened wing or minimum chord can give reproduceable measurements for small passerines, but is less satisfactory for larger birds, such as waders, where the primaries have a marked lateral curve. Dampness reduces the natural curvature of the wing: The Ringer's Manual (BTO 1984) cites an experiment in which the wing length of a Dunlin *Calidris alpina* varied by up to 5 mm because of dampness. Confinement in a carrying bag can increase the curvature, particularly if the bird flutters its wings while so confined. This was noted at Cowiebank with some larger species, such as the Bar-shouldered Dove *Geopelia humeralis*. The curvature of the wing can also be affected by entanglement in a mist-net. Carins (1970) described how to take this measurement.

(b) The flattened wing or flattened chord measurement removes some or all of the camber across the wing, but does not correct variations in the lateral curvature. Small differences in the measurement can result from variable pressures applied to hold the wing to the rule, and the method does not correct unavoidable alterations to the lateral curvature. Disney (1963) and Carins (1970) described how to take this measurement.

(c) The flattened, straightened wing gives the maximum measurement by eliminating camber and much of the lateral curvature. Most of the variations in lateral curvature from dampness and handling are eliminated, although small discrepancies can result from differences in degrees of straightness attained. Disney (1974) detailed how to make this measurement. This method is sometimes called the maximum chord measurement, but the term chord, by definition, seems inappropriate for the flattened, straightened wing. The Ringer's Manual (BTO 1984) recommends the use of this measurement for all purposes, except for studies where it is necessary to compare the wing lengths of live birds with those of museum skins. More recently, the length of the 8th primary has been advocated as a measurement of wing length to give reproduceable comparisons between live birds and museum skins (Jenni and Winkler 1989).

Wing lengths obtained by the three methods for the right wing of individuals of various species netted at Cowiebank are shown in Table 1. The measurements of each bird were taken in the sequence: minimum chord, flattened chord and flattened, straightened wing. It may thus be misleading to compare wing lengths recorded by different workers, unless it is certain that the same technique was used. The methods used should therefore always be stated, as was done, for example, by Henderson and Green (1982). It should be noted, however, that different workers using the same technique may record slightly different values for the same birds (Nisbet *et al.* 1970); but these differences will be much less than the variations in wing length of live birds from abrasion between annual moults (Table 2). Hereafter, unless otherwise stated, wing length refers to the flattened, straightened measurement.

The measurement of wing length of a study skin involves the measurement of a constant feature, and consistent values should be obtained whenever the skin is remeasured using the same technique. Live birds do not yield such consistent measurements when they are retrapped and remeasured. This is due to several reasons:

(a) Abrasion of feathers begins after moult as the tips gradually wear or are broken as a result of the bird's activities. Bell (1970), using minimum chord measurements, showed that the wing lengths of Reed Buntings *Emberiza schoeniclus* were 2–3 mm less than the mean just before the post-nuptial moult. Abrasion had reduced wing lengths of some females by 7 mm, or almost 10 per cent of the normal measurement. As a corollary of this, the wing length will increase during the latter stages of moult as the abraded feathers are replaced. Abrasion tends to be relatively uniform throughout the year (Pienkowski and Minton 1973).

TABLE 1

Wing lengths of individuals of several species, measured in sequence by three different methods. See text for explanation of techniques. Measurements in millimetres.

Species	Minimum Chord	Flattened Chord	Flattened, straightened
Bar-shouldered Dove *Geopelia humeralis*	137	138	143
Collared Kingfisher *Halcyon chloris*	102	104	107
Black-faced Cuckooshrike *Coracina novaehollandiae*	186	189	192
Varied Triller *Lalage leucomela*	97	99	101
Spectacled Monarch *Monarcha trivirgatus*	73	74	75
Eastern Whipbird *Psophodes olivaceus*	86	88	89
Tawny Grassbird *Megalurus timoriensis*	55	56	58
White-browed Scrub-wren *Sericornis frontalis*	54	55	56
Lewin's Honeyeater *Meliphaga lewinii*	92	95	96
Brown Honeyeater *Lichmera indistincta*	70	71	72
Red-browed Finch *Emblema temporalis*	50	51	52

(b) The primary feathers are discarded annually during the post-nuptial moult, and these may also be accidentally lost as a result of the bird's activities. The wing length of most passerines at Cowiebank is determined by the lengths of the 6th and 7th primaries, which are usually slightly longer than the 8th and 5th primaries, although there are exceptions. During moult, the 5th primary of most species at Cowiebank is fully grown, or almost fully grown when the 7th primary drops and is almost always fully grown when the 8th primary is lost. The length of the new 5th primary often equals or exceeds those of the old, abraded 6th, 7th and 8th primaries. For most passerines at Cowiebank, it seems that moult does not reduce the wing length to any significant extent, but if it is so reduced, this seems to occur only between primary moult scores of about 23 and 30, using the primary moult scoring of Snow (1967).

(c) Many passerines have shorter wings during their first year of life, probably because they need increased manoeuverability, while older birds compensate with faster flight and experience (Alatalo *et al.* 1984). These species may show marked increases in wing lengths following the first complete moult. This is illustrated by comparing the 1977 and 1978 wing lengths of a Lewin's Honeyeater *Meliphaga lewinii* (040-28939) in Table 2. The wing lengths of some Palaearctic species show further increases of about 1 per cent following each subsequent moult (Pienkowski and Minton 1983). This is not evident from data for any species at Cowiebank, although measurements of some birds, such as Lewin's Honeyeater (Table 2), do seem to show slight increases over several years.

Table 2 shows measurements of a Lewin's Honeyeater when handled 26 times over a period of seven years. After moult, it had wing measurements of at least 104 mm in five successive years (1 March 1980, 4 April 1981, 24 July 1982, 5 March 1983, 9 June 1984), while abrasion reduced this to 94–95 mm before the pre-nuptial moult in the summer of 1980-81. The wing length of some birds at Cowiebank therefore varied by about 11 per cent in some years and a wing length anywhere between 94 and 105 mm would be attributable to this Lewin's Honeyeater, depending on when it was measured. The same applies if the bird had been collected. Some studies compare wing measurements of study skins from several localities. Collection of birds at different intervals between moults may introduce additional variation that has been generally overlooked and little discussed. It should be noted, however, that not all Lewin's Honeyeaters show significant variation in wing length over a year; one bird had wing lengths of 101–104 mm when measured 13 times over five years.

TABLE 2

Measurements (mm) of flattened, straightened wing length, wingspan and extended length of an individual Lewin's Honeyeater *Meliphaga lewinii* (040-28939) over seven years, 1977–1984. n.a.=not available; PMS=primary moult score, after Snow (1967).

Date	Wing length	Wingspan	Extended length	Primary Moult
1977				
19 June	97	302	225	No
29 Oct.	97	n.a.	224	No
18 Dec.	94	298	224	PMS = 10
31 Dec.	95	302	223	PMS = 13
1978				
7 May	101	315	n.a.	No
1 July	102	317	n.a.	No
6 Aug.	100	314	228	No
17 Sep.	102	313	n.a.	No
16 Dec.	100	314	227	No
29 Dec.	100	313	225	No
1980				
26 Jan.	98	308	228	PMS = 33
1 Mar.	104	323	231	PMS = 48
7 June	103	319	231	No
12 July	103	321	231	No
20 Dec.	95	310	231	PMS = 2
1981				
10 Jan.	94	307	231	PMS = 20
4 Apr.	104	321	232	No
1982				
13 Feb.	103	319	229	PMS = 35
24 July	104	322	231	No
26 Dec.	103	318	231	PMS = 9
1983				
5 Mar.	104	322	231	Recently completed
19 Mar.	105	324	232	No
20 Aug.	103	321	232	No
19 Nov.	105	n.a.	231	No
3 Dec.	n.a.	n.a.	n.a.	No
1984				
9 June	106	n.a.	234	No
Maximum variation 1978–1984				
in mm	12	17	9	
% of longest measurement	11	5	4	

For many passerines, males are larger than females, and adults are larger than immatures of the same sex. This usually results in overlaps in the wing lengths of some immature males and adult females. Data provided by Henderson and Green (1982) for four endemic Tasmanian honeyeaters illustrate these overlaps which limit the value of wing lengths for sexing unaged populations of many species. However, known adults of some species, for example Brown Honeyeaters *Lichmera indistincta* (Liddy 1989), can be sexed reliably by wing length measurements.

Field guides of the British Trust for Ornithology invariably illustrate the wing length measurement being taken on the left wing, and Busse (1984) stated "the left wing is *always* the one measured" (emphasis mine). Disney (1974) and King *et al.* (1975) showed it being taken on the right wing. I initially tried measurements on both wings. I found it much more convenient to hold the bird in the left hand and, in sequence, apply the band with the pliers held in the right hand, record the banding or retrap data, record details of plumage and moult (determined on the left wing but usually checked on the right wing immediately before release), all without having to transfer the bird from hand to hand. With few exceptions, all wing length measurements taken at Cowiebank refer to the right wing.

A stopped ruler is usually recommended for taking the wing measurement (Disney 1974; Busse 1984). Busse (1984), however, described and illustrated a method of taking this using the tip of the second finger as the rule stop. I have not attempted to use this technique in the field, but would not expect the resultant measurement to be as reproduceable as those obtained using a stopped ruler.

Carins (1970) considered that the flattened, straightened wing measurement could result in injury to passerines. He presumably meant damage to the joint between the carpometacarpus and phalanges if excessive pressures were applied to eliminate lateral curvature. No known injury resulted from this measurement of some 6 000 passerines at Cowiebank, where care was taken not to apply excessive pressure when straightening the wing.

WINGSPAN

The wingspan measurement is the distance from tip to tip of the longest primaries of the extended wings; Disney (1974) detailed the method of taking this measurement. At Cowiebank I found it convenient to take this on a measuring board consisting of a hard-surfaced kitchen cutting board with a short aluminium angle bolted to one end as a stop (Fig. 1). A ruler, inscribed in millimetres, butts against the stop and runs the length of the board. The bird is held on its back with the extended wings parallel to the ruler. The tip of the longest primary touches the stop and the wingspan measurement is read directly from the ruler.

There are two basic components to the wingspan measurement:

(i) the actual size of the bird, which is a constant at the time of the measurement, and

(ii) the degree of extension applied to the bird, which can be varied by the person making the measurement.

The maximum wingspan measurement is obtained when the longest feathers of the extended wings, usually the 6th primaries, are held parallel to the ruler; a slight reduction in the measurement will occur if this is not done. Considerable tuition or practice, or both, may be

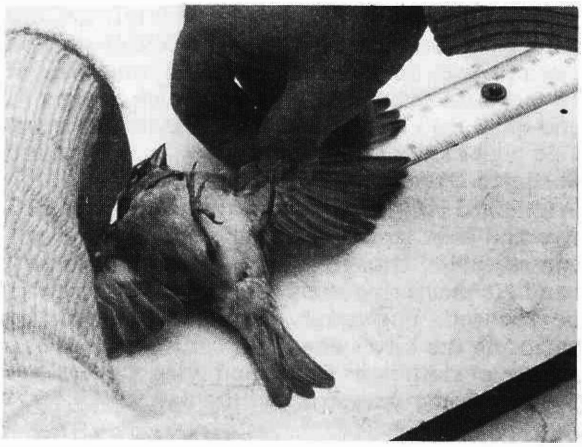

Figure 1. *Wingspan measurement taken on a measuring board.*

necessary before reproduceable measurements of the wingspan can be obtained. Variable measurements are obtained if the wings are not consistently and fully extended, and these have little value as they are not reproduceable. For example, I generally discount my wingspan measurements taken during 1976–77 because it now seems that a few of these birds were not fully extended while being measured (although there is no reason to doubt the 1977 wingspans of the Lewin's Honeyeater given in Table 2). Analyses of wingspan measurements of several species taken after late 1977 indicate that these were consistently taken from fully extended birds; this is confirmed by re-measurements of many birds retrapped shortly after previous measurements.

Wingspans of live birds vary for the same reasons as wing length measurements: abrasion, moult, increases in size with age, and broken or lost feathers.

Disney (1974) noted that the wingspan measurement does not harm the bird if done properly. The converse is, of course, also true: if done incorrectly, or by inexperienced handlers, birds may be injured while the measurement is being taken. The importance of tuition in the technique cannot be overemphasized. Any bird can obviously be injured by overstretching, but some species, of which the White-browed Scrubwren *Sericornis frontalis* was the only example noted at Cowiebank, appear to be susceptible to wing injury without overstretching. Such species should not be measured for wingspan. Birds may also be injured if they are not held firmly and are allowed to flap and struggle. At Cowiebank, no attempt was made to measure the wingspan of species with strong flight muscles, such as pigeons and quail, as I considered there was an unacceptable high risk of injury. Some species, such as the Spangled Drongo *Dicrurus hottentottus* and Little Wattlebird *Anthochaera chrysoptera,* are aggressive and have strong, sharp claws, and can cause considerable damage to the hands of unwary handlers measuring their wingspan. This risk can be reduced, but never entirely eliminated, by enclosing the bird's head in a calico bag, placing a piece of cloth in its claws, and tying the legs and claws with the drawstring of the bag.

The histogram of wingspan measurements is an excellent criterion for sexing some morphometric species such as the Lewin's Honeyeater (Smedley 1977) and Little Wattlebird (Lane 1973). The histogram of wingspans of unaged populations of passerines such as the Brown Honeyeater at Cowiebank shows much less overlap than does that of wing length (Liddy 1989). However, because there is some risk of injury, wingspan measurements should be limited to those species where it is considered to have a definite value, rather than be applied routinely to most birds handled at a banding station.

BODY LENGTH

Disney (1974) detailed a method for determining the total length of live birds. This required that the bird be placed on its back along a ruler, gently stretched and then relaxed slightly, allowing the bird to lie in a natural position. I measured the total length of most birds handled at Cowiebank from August 1975 using this technique. Use of a ruler proved unsatisfactory, and all measurements were made on the measuring board described previously. Many Cowiebank birds did not contract uniformly after stretching and relaxing, and inconsistent measurements were obtained when the birds were remeasured. Disney (1966) presumably referred to this problem when he noted the difficulty of taking this measurement with accuracy; a similar comment was made by King *et al.* (1975). Robertson (1966) quantified the variation in total length measurements of retrapped and remeasured Brown Honeyeaters at Wellington Point, southeastern Queensland. Of 30 birds remeasured, six (20%) showed variations of between 5 and 11 mm. It is tolerably certain that these variations resulted from differences in the degree of contraction exhibited by these birds after stretching and relaxing.

After late 1975 I routinely took an extended length measurement for most birds handled at Cowiebank (Fig. 2). A bird is held on its back, with the body, tail and bill parallel to the ruler of the measuring board. The head is held with the left hand, with the tip of the bill resting against the stop. The bird's thighs and lower legs are held with the thumb and first two fingers of the right hand, and the bird is gently stretched. The little finger of the right hand rests on the tail, applying gentle elongation pressure. The distance from the ruler stop to the end of the longest tail feather is the extended length, with the measurement read directly from the ruler. The extended length is thus defined as the distance from the tip of the bill to the tip of the longest tail feather of a gently extended bird.

The extended length of a bird has two basic components:

(i) the actual size of the bird, which is a constant at the time of measurement, and

(ii) the degree of extension applied to the bird's body and tail feathers, which can be varied by the person taking the measurement.

The variation in the extended length of an individual bird is basically the sum of the variations in the lengths of the bill and longest tail feathers and in the degree of extension applied to the bird. The relative effects of these variables were not determined for any Cowiebank species, although this could have been done by systematically measuring the extended length and the bill and tail lengths of a significant number of retrapped birds.

Seasonal variations in the bill length of some species can have small, but measureable, influences on the extended length measurement. For example, the head-bill length of Eastern Spinebills *Acanthorhynchus tenuirostris* varies in some individuals by more than 2 mm, being longer in winter than in summer (Jordan 1987). These changes are more likely due to changes in bill length from seasonal abrasion than to changes in skull dimensions or bill curvature. Similar changes in bill length are to be expected, for example, in the Rainbow Bee-eater *Merops ornatus*, which excavates nesting burrows in the earth.

As with the primaries, the lengths of the longest tail feathers can vary seasonally because of abrasion, moult, breakage or loss. Wear is normally concentrated in the two central feathers, which at the end of the breeding season may consist of broken rachis, almost bare at the top, with broken remnants of the vanes increasing towards the base of the feathers. At the same time the outer feathers are much less worn, and these determine the length of the tail. Many species handled at Cowiebank, such as honeyeaters and whistlers, had squarish tails. Most of the tail feathers of such species have to be abraded to result in significantly shorter tail lengths and consequent shorter extended body-lengths. Other Cowiebank species, of which the fork-tailed Spangled Drongo is the extreme example, have notched tails, and wear of the central feathers does not affect measurements of their tails or extended lengths. The extended lengths of most birds retrapped at Cowiebank showed little variation once the birds had matured. For example, the extended length of the Lewin's Honeyeater in Table 2 was consistently 228–232 mm when measured 14 times between 1980 and 1983, a variation of less than 2 per cent.

Some passerines have shorter tails during their first year; for example, Disney (1974), comparing male Eastern Spinebills, recorded tail lengths of 60-65 mm for adults and 56-61 mm for immatures. Such species show a marked increase in the

Figure 2. *Extended length measurement taken on a measuring board.*

extended length measurement following maturity. This is illustrated by the Lewin's Honeyeater of Table 2, which had extended lengths of 223–225 mm when measured four times during 1977, presumably in its first year, and 228 232 mm when measured 14 times between 1980 and 1983. Another example from Cowiebank is the Black-faced Monarch *Monarcha melanopsis*. Six birds in adult plumage measured between 1977 and 1986 had extended lengths of 192–199 mm (mean 196.0 mm), while five immatured-plumaged birds netted during their northwards autumnal migration had extended lengths of 185–188 mm (mean 186.6 mm). This difference is probably primarily due to differences in the tail lengths.

The central feathers of a few Cowiebank species, such as the fairy-wrens *Malurus*, are elongated, while the Rainbow Bee-eater has streamers to the central feathers. Seasonal abrasion of the tail feathers may result in marked variations in the extended lengths of such species, and analyses of these measurements should be used with caution.

Abraded tail feathers are replaced during the post-nuptial moult, resulting in an increase in the tail length and hence in the extended length measurement. This is illustrated by the measurements of Lewin's Honeyeater 040-08809 during 1980–81. Its length was 308 mm on 12 October 1980, 306 mm on 15 November 1980 and 10 January 1981, and 304 mm on 22 February 1981, when it was undergoing tail moult. After moult, measurements of 310–311 mm were obtained when the bird was retrapped three times during May, June and July 1981. A length of 307 mm was recorded when it was last handled on 12 September 1981. These changes represent a seasonal variation of about 2 per cent.

The extended length measurement is influenced by the degree extension applied to the bird. The technique of measuring it from live birds to obtain reproduceable results is easily learnt. No known injury resulted from taking this measurement from some 6 000 passerines at Cowiebank, although one or two feathers were removed from a few birds when applying the elongation pressure to their tails.

As noted previously, six of 30 (20%) Brown Honeyeaters retrapped and remeasured by Robertson (1966) showed variations in the total length of 5–11 mm. At Cowiebank, extended lengths were taken between 1978 and 1986 for 76 Brown Honeyeaters that were retrapped and remeasured within four months of their previous measurements. Of these, 30 (40%) recorded the same measurement, 31 (41%) varied by 1 mm, 10 (13%) by 2 mm, four (5%) by 3 mm and one (1%) by 4 mm, the maximum variation recorded. The extended length measurement therefore gives results which are much more consistent than those taken by gently stretching a bird and allowing it to relax and contract to an unknown and variable extent.

The histogram of the extended length measurement is almost as useful as that of the wingspan for sexing some morphometric species such as the Brown Honeyeater (Liddy 1989), but it has been little used in banding studies. This measurement is reproduceable, shows consistency over years once the bird has reached maturity, is easy to take, and is unlikely to result in injury to the bird. Its use as a routine measurement at banding stations is recommended.

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BOOK REVIEW

Behavioural Ecology of the Galah *Eolophus roseicapillus* in the Wheatbelt of Western Australia. Ian Rowley. 1990. Surrey Beatty & Sons, Chipping Norton, Australia. 188 pp. rrp $39.60.

The publication of this book is of considerable importance. Not only does it represent the long awaited results of one of this country's major long-term bird studies, but it is also the first of the modern scientific monographs on Australian birds. We have to go back to Frith's 'The Mallee Fowl' (1962) for something of its magnitude. Like that book, 'The Galah' stands to draw international interest to this subject. It should also be of great interest to both the legions of Psittaciphyles, as well as to behavioural ecologists. Because of its scope and orientation, this book should be able to proudly share the bookshelves with some of the recent important monographs such as Woolfenden and Fitzpatrick's 'The Florida Scrub Jay' and Koenig and Mummes 'The Acorn Woodpecker' (And it really whets the appetite for something synthesising those other great continuing studies such as Rowley's own fairy-wrens and the Heron Island silvereyes).

For such a familiar, common and widespread species, it is quite astonishing just how little was known of the galah before this study began. Again, it has been the modern attention to individuals and their specific activities that has revealed so much. This book reports on the behavioural ecology of the species in the grainlands of southern Western Australia. Although the initial motivation for the research stemmed from the pest status of the species, this has not limited the scope of the work to aspects associated with management. Indeed, while much of the immense array of data and discussion is used to provide a sound basis for control and conservation issues, the body of the work is an extremely comprehensive picture of behaviour, breeding, ecology and life history. Nonetheless, the conservation 'moral' of this story runs throughout: in particular, the steady loss of nest hollows may be catastrophic for this and many other cockatoos throughout Australia's rural lands.

Although the small print and seemingly endless items listed in the Contents section caused initial alarm (there are 31 sub-headings in Chapter 4 alone), I need not have worried. This is not an unreadable academic thesis-style book of colourless writing. Ian Rowley seems to be almost single-handedly swimming against the rising tide of scientific jargonism and indigestible writing in biology. This is a reader-friendly book, full of real English and first-person familiarity. However, it is also not a 'I couldn't put it down' read. Inevitably, the sheer volume of aspects covered and the detail given to even minor behaviours makes for a comprehensive but somewhat tedious account. Such a minor point is however of little consequence when compared to the value of the information given.

One of the freedoms inherent in producing a book versus a paper is the virtually unrestricted space the author is given: at last, all of those bits of detail and supporting data can be included, and figures and tables proliferate. 'The Galah' contains 54 illustrations (including 18 black and white and 16 colour photos) and 33 tables. The quality of the 34 figures is excellent throughout. Needless to say some photographs by Graeme Chapman (who also undertook a large slab of the field work) are superb: the 468 galahs perched on the aerial is one of those photos you can almost hear. (I was a bit disappointed with the colour mix though; darker and duller than the originals I would bet). I did think that the amount of tabulated data was excessive and tended to not always be well supported by textual interpretation. There is a lot of information that could have been analysed by multivariate techniques and the result discussed in the text.

Nonetheless, these data will be of real use to aviculturists, biologists, and biostatisticians who have yearned for some real information to work on. I can see plenty of scope for using the book in teaching numerous ecological concepts such as the history, survivorship, and reproductive strategy. It will also be of real interest to people with a more general appreciation of one of the archetypal Aussie Creatures.

Overall, the quality of the publication is excellent, and the content has obviously benefited from careful scrutiny. The individualistic Rowley writing style will be too casual and 'chatty' to some, refreshingly accessible to others. The publishers do need to consider the value of careful 'production — phase' editing, a problem evident in their other important bird book of late (Ford's 'Ecology of Birds'). Only a few glitches caught my eye in 'The Galah' (e.g., no capital in Fig. 8; a lack of scale in Fig. 47, which is in Rowley (1983) Fig. 51?) but some editorial direction as to the suitability or acceptability of all tables and figures should be given.

This is an important book of an important bird. I recommend it warmly.

Darryl Jones
Nathan, QLD