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# Growth and Development of the Yellow-bellied Sunbird *Nectarinia jugularis* in North Queensland

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Some passerines in the tropics grow more slowly than do some in the temperate zone which led to the suggestion (Ricklefs 1968) that slow growth was characteristic of tropical passerines. However, Oniki & Ricklefs (1981) found that the growth rate of some neotropical passerines was not distinguishable from the growth rate of temperate zone passerines and Maher (1986) showed that the growth rate of the Brown-backed Honeyeater *Ramsayornis modestus* in tropical Queensland was also indistinguishable from that of temperate zone passerines. There is, however, a shortage of growth studies of tropical passerines, especially in the Australian tropics.

I present data on growth and development of the Yellow-bellied Sunbird *Nectarinia jugularis* obtained near Townsville, Queensland (19°15′S, 146°48′E) from August to November 1984.

## Study area and methods

The study was done in *Eucalyptus-Melaleuca* woodland in the Townsville Town Common Environmental Park. The climate is tropical with contrasting wet and dry seasons with most rain falling from December through March. July, August and September are the driest months. The monthly mean temperature is 19.3°C in July and 27.6°C in January. More detailed climate data are in Maher (1986, 1988). Climate during this study was average.

Nests were usually visited between 0630 and 1000. Individually marked nestlings were weighed on an Ohaus triple beam balance accurate to 0.1 g. The bill was measured from the external nares to the tip and from the corner of the mouth to the tip (gape). The tarsus, manus, seventh primary and one central rectrix were also measured, and development and behaviour were noted. Further details are given in Maher (1986). The weight curves were fitted to the logistic curve (Ricklefs 1967) using a non-linear least squares curve-fitting program.

Adult dimensions were taken, as described above, from ten male and ten female specimens from Queensland in the American Museum of Natural History (AMNH).

Weights of adult sunbirds are from the AMNH, the Australian Museum, the Queensland Museum, and the CSIRO Division of Wildlife & Ecology.

## Results

The adult female Yellow-bellied Sunbird is smaller than the male in all measurements except those of the bill (Table 1). The size difference of manus, tarsus, seventh primary, wing chord and rectrix are highly significant

**Table 1** Measurements (mm) of ten male and ten female specimens of the Yellow-bellied Sunbird from Queensland.

| Measurement | Male mean, *s.d.* | Female mean, *s.d.* | Per cent male | Species mean |
|---|---|---|---|---|
| Bill from: culmen | 19.8, 0.62 | 19.6, 0.69 | 99 | 19.7 |
| external nares | 17.3, 0.54 | 16.9, 0.41 | 98 | 17.1 |
| gape | 21.3, 0.54 | 20.7, 1.11 | 97 | 21.0 |
| Manus | 14.0, 0.99 | 12.9, 1.38 | 92*2 | 13.4 |
| Tarsus[1] | 16.0, 0.60 | 14.9, 0.57 | 94*2 | 15.4 |
| 7th Primary | 44.3, 0.99 | 41.6, 0.97 | 94*2 | 42.9 |
| Wing chord | 56.5, 1.10 | 53.5, 1.60 | 95*2 | 55.0 |
| Rectrix | 39.0, 2.3 | 34.2, 1.20 | 88*2 | 36.6 |

[1] Measured from back of the heel to distal end of tarsus.
[2] Differences significant by *t*-test. $P < 0.01$.

by *t*-test. Males weigh 8.92 ± 1.14 g, (range 7.6-11.0 g, $n$ = 22) and females weigh 91% as much or 8.12 ± 1.11 g, (range 6.0-10.0 g, $n$ = 19). The difference is not statistically significant.

Growth data are from four nestlings. Two are from nests with two young and two from nests in which only one young was raised.

## Plumage development

At hatching (age Day 0), the Yellow-bellied Sunbird has clear orange skin. There is no down and no melanin pigment-spots which mark developing feather follicles are visible in the skin.

Melanin pigment-spots begin to appear late on Day 0 beginning in the primary and secondary feather tracts and later in the anterior spinal tract and the occipital area of the head or capital tract.

By Day 1 pigment-spots are visible in all of the spinal tract, including the pelvic area, and appear on top of the head (coronal area). Melanin pigment also begins to appear in the skin of the head and back. Melanin pigment appears in the two dorsal rows of follicles of the ventral tracts on Day 2. The more ventral follicles will produce yellow feathers which do not contain melanin. The follicles are now discrete nodes in the skin in all tracts except the capital tract. Primary and secondary follicles just pierce the skin.

Other follicles pierce the skin on Day 3 beginning on the spinal tract and the primary and secondary coverts. Hair-like processes on the tips of developing rectrices also just pierce the skin. Follicles are generally visible on Day 4, including on the head, which now appears wrinkled, and on the anal circlet. By Day 6 follicles emerge on all parts of the capital tract and the anal circlet follicles finally emerge beginning on Day 7.

Emergence of feathers from the ends of the follicle sheaths begins on Day 6 in all tracts except the capital and scapular tracts and the primary and secondary coverts. The feathers of the scapular tract and primary and secondary coverts begin to emerge on the following day, but emergence of feathers on the head does not begin until Day 10.

Feather emergence proceeds slowly. It is not until Day 11 that the feathers spread although the frontal area and sides of the head are still 'quilly' and the flight feathers have only emerged about 1 cm from their sheaths.

At Day 12 the primary and secondary feather sheaths break down, the remiges spread and the wing looks functional. The rectrices have also emerged from their follicles and only the feathers on the front of the head are still enclosed in sheaths. The nestling appears ready to fledge and normally does so on Day 13.

## Physical development

Newly hatched nestlings squirm when handled and can right themselves. Their eyes are closed and they void faeces in a mucous faecal sac. Gaping for food was first noted on Day 1. The eyes begin to open on Day 3, most nestlings' eyes were partly open the next day and by Day 6 all were completely open.

Nestlings begin to grasp with their feet on Day 5 and grasped the nest lining when being removed on Day 6. The next day they struggled when being handled and on Day 11 when the wing feathers were beginning to expand they were very active and alert. The first flight was on Day 13 when one flew 15-20 m from my hand.

Yellow-bellied Sunbird nestlings never vocalised while being handled. This contrasted with the nestling Brown-backed Honeyeaters that began calling on Day 4 (Maher 1986).

## Weight gain

Four newly hatched nestlings weighed 0.92 ± 0.26 g (range 0.8-1.1 g) or 10.8% of the mean adult weight of 8.52 g (Table 2). At fledging, 13 days later, two nestlings weighed 7.4 and 8.0 g (mean 7.7 g), an 8.4-fold increase in weight and 90% of mean adult weight. The

**Table 2** Mean daily weights and weight gains (g) of Yellow-bellied Sunbirds.

| Age (days) | *n* | Mean weight | *s.d.* | Mean weight change |
|---|---|---|---|---|
| 0 | 4 | 0.92 | 0.13 | — |
| 1 | 5 | 1.54 | 0.23 | 0.62 |
| 2 | 6 | 2.10 | 0.33 | 0.56 |
| 3 | 6 | 2.77 | 0.53 | 0.67 |
| 4 | 5 | 3.66 | 0.44 | 0.89 |
| 5 | 3 | 4.1 | 0.6 | 0.44 |
| 6 | 4 | 5.28 | 2.14 | 1.18 |
| 7 | 4 | 5.9 | 0.90 | 0.62 |
| 8 | 3 | 6.13 | 0.95 | 0.23 |
| 9 | 3 | 6.77 | 1.08 | 0.64 |
| 10 | 4 | 7.28 | 1.08 | 0.51 |
| 11 | 3 | 7.17 | 0.85 | -0.11 |
| 12 | 3 | 7.13 | 0.84 | -0.04 |
| 13 | 2 | 7.7 | — | 0.67 |

mean daily weight increment was 0.62 g from Day 0 to Day 1 and increased to 1.18 g on Day 6 and then declined. The trend is irregular presumably because of the small sample.

Weight gain of the Yellow-bellied Sunbird conforms to the logistic curve like most passerines (Ricklefs 1968). The growth constant (Ricklefs 1967) was K = 0.370 ± 0.031 (range 0.326-0.398, $n$ = 4) with a calculated asymptote of 8.6 ± 1.3 g (range 7.0-9.7, $n$ = 4). Days to the inflection of the growth curve ($t_i$) were 5.80 ± 0.87 (range 5.1-7.1, $n$ = 4) and the days to grow from 10 to 90 per cent of the asymptote ($t^{10-90}$) were 11.9. These data indicate a relatively slow rate of development.

The data can be described by the logistic equation $W = A/[1 + e^{-k(t-ti)}]$ or $W = 8.6/[1 + e^{-0.370(t-5.8)}]$, where W is weight in grams, e is the base of natural logarithms and t is age in days with Day 0 as the day of hatch, A is the asymptote of the growth curve, K the growth rate constant and $t_i$ the age of inflection of the growth curve.

### Growth of body parts

The manus reached adult size on Day 7 and the tarsus on Day 9 (Fig. 1). At fledging on Day 13, the bill was 51% of adult size (from nares) and 73% of adult size from the corner of the mouth, the primary feathers and rectrices were 68% and 33% grown respectively.

On semi-log scale paper these data show that the tarsus and manus and bill from gape grow at similar rates; all elongate rapidly for the first three to four days and then the daily growth rate gradually declines until adult size is reached or until fledging.

Because of the decurved bill of the bird, the bill from nares is a better measure of bill length than is the measure bill-from-gape. This measurement plotted on semi-log paper also shows rapid growth for the first three days, then a slower relatively constant rate which is maintained until fledging. At fledging the bill is still only 51% of adult size.

## Discussion

The Yellow-bellied Sunbird grows 15% slower than the Brown-backed Honeyeater and the difference is highly significant by $t$-test ($t$ = 3.214, $P < 0.01$, $d.f.$ = 16).

In my previous paper (Maher 1986), the honeyeater data were analysed by a graphical method (Ricklefs 1967). For comparison with the Yellow-bellied Sunbird these data were re-analysed (see Methods) and gave a growth constant of K = 0.424 ± 0.029 (range 0.359-0.485, $n$ = 14) with a calculated asymptote of 12.1 ± 0.91 g (range 10.9-13.6, $n$ = 14). This reduction of 6.6%

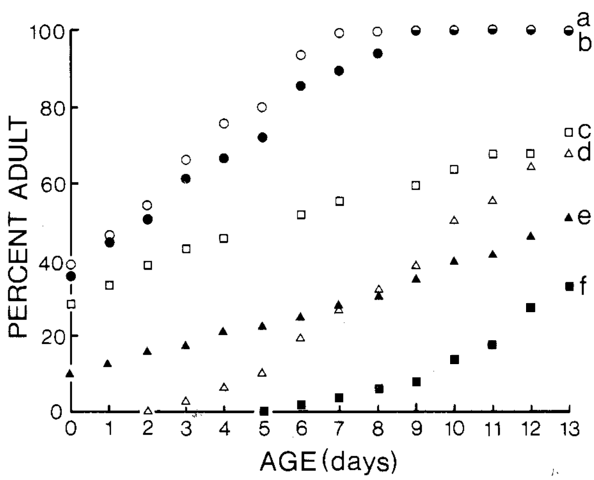


**Figure 1** Differential growth. Data are mean lengths as percent of adult measurements of: a. manus, b. tarsus, c. bill from gape, d. seventh primary, e. bill from nares, f. central rectrix.

in the growth rate and increase of 4% in the asymptote approximates the differences cited by Oniki & Ricklefs (1981) when they compared growth data analysed by the two methods.

The growth rate of the sunbird is 5% slower than the average of 30 small (< 100 g) tropical passerines, K = 0.387 ± 0.079 (Ricklefs 1976) and is within one standard deviation of the mean of that sample. Its growth rate is 25% slower than the average of nine tropical passerines, K = 0.461 ± 0.060, from Manaus, Brazil (Oniki & Ricklefs 1981) and the difference is significant by *t*-test ($t = 2.822$, $P < 0.05$, *d.f.* = 11). While it is also well below average (K = 0.502 ± 0.071) of 51 temperate passerines (Ricklefs 1976) it is not significantly different ($t = 1.82$, $P > 0.05$) from that sample by *t*-test (Sokal & Rohlf 1969, p. 223), thus the Yellow-bellied Sunbird does not appear to grow significantly more slowly than temperate zone passerines.

Its growth and development, although slower, is very similar to that of the Brown-backed Honeyeater and resembles that of arctic and temperate passerines that have been studied in detail (see Maher 1986). The problem of clarifying the adaptations of growth and development of tropical passerine birds compared with temperate and arctic zone passerines requires more study of differential growth in addition to studies of weight gain.

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# Phatic Communication in Bird Song

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Complexity and diversity in bird song have provoked many hypotheses from the Anti-monotony Principle (Hartshorne 1956) to the Beau Geste Hypothesis (Krebs 1977). Studies of the vocal displays of the lyrebirds (Menuridae) (Robinson 1974, 1975, 1977) led to an examination of vocal mimicry in the sub-song of the Australian Magpie *Gymnorhina tibicen*. These studies suggested that vocal mimicry could be a means of expressing sociability rather than communicating a specific meaning. The term phatic is used to describe this function in speech (Sykes 1985) and was used to explain the function of vocal mimicry in the song of the Superb Lyrebird *Menura novaehollandiae* (Robinson 1977). It is now proposed that it could have wider application.