Chapter 3

Chestnut Weaver biometrics and primary moult in Namibia

Chestnut Weaver biometrics and primary moult in Namibia

Abstract

Seasonal variation in body mass and wing length, and the onset and duration of primary moult, were investigated for Chestnut Weavers from northern Namibia. Body mass of adult males was 31.2 g (SD 2.6) and adult females weighed 27.4 g (SD 1.9). Body mass declined from March to April, and started increasing after August (i.e. near the end of moult) in males and females. Wing length in adult males with new primaries (October – February) was 80.7 mm (SD 2.7) and for adult females (October – February) 76.8 mm (SD 2.6). For both sexes wing length declined during and after the breeding season due to extensive feather wear. Adult males started primary moult significantly earlier than females (9 April versus 30 April) and moult lasted longer (206 days versus 189 days). The peak summer rainfall and the start of primary moult were earliest in 2000 and latest in 2004 for males and females. Individual primary feathers took 11 to 18 days to grow.

Introduction

The Chestnut Weaver *Ploceus rubiginosus* is a colonial species of arid regions. It is a local migrant or seasonally nomadic. There are two discrete populations: *P. r. trothae* occurs in northern Namibia, Botswana and southern Angola and the nominate subspecies in eastern Africa in Eritrea, Ethiopia, Somalia, Uganda, Kenya and Tanzania (Craig 2004). In Namibia, this species breeds mostly in the open semi-arid savanna of the Namibian escarpment (Herremans 1997).

In Namibia the Chestnut Weaver has a single breeding season during the wet season, thus breeding can occur anytime from December to May, with a peak in February – March (Herremans 1997). It is not known whether this species makes more than one breeding attempt in any one breeding season (Komen and Buys 1990). Males build the nests, copulate with receptive females and then desert the colony soon afterwards, leaving the females to incubate the eggs and rear the young (Komen and Buys 1990). Nest building takes about four days (Halenke 1971), incubation is 11–14 days and fledging 13–16 days (Craig 2004), giving a breeding cycle of 28–34 days.

Adult wing-moult begins between April and June, and is completed by October (Komen and Buys 1990). Komen and Buys (1990) showed that males initiate moult earlier than females because males can start moult when they have left the colonies, but breeding females must continue caring for their young before they are able to start moult. However, the starting date of moult, the duration of moult and the delay between the starting date of females relative to males, are unknown. The aim of this paper was to provide these data on moult, and on the seasonal variation in body mass and wing length, for Chestnut Weavers in Namibia.

Methods

Ringing data were collected in the standard SAFRING (South African Bird Ringing Unit) electronic format. This includes standard ringing information (such as location and date) and data on bird body mass, wing length and primary moult (de Beer *et al.* 2001). Records were from the degree grid cell 19°S–20°S, 15°E–16°E, mostly on Windpoort Farm (19°20'S 15°28'E), Namibia (Figure 1). Birds were sexed on plumage in the breeding season, and on a combination of features like general size, eye colour, bill length and shape, and leg size during the non-breeding season. Body mass and wing length data were analysed by sex and by month. Monthly rainfall data were recorded on Tandala Ridge on Windpoort Farm.

The Chestnut Weaver has 10 primary feathers, moulted from the innermost primary outwards. The primaries of four wings from two female specimens and two wings of a male specimen were dried in an oven at 60°C for 24 hours to eliminate moisture and weighed (Ohaus GA200D balance, precision 0.0001g), to determine the relative mass of each primary (as described in Underhill and Summers 1993). Underhill and Joubert (1995) showed that small samples are adequate to determine the relative masses of primary feathers because there is little intra-specific variation in this characteristic. The Underhill-Zucchini moult model (Underhill and Zucchini 1988), developed to estimate start and duration of primary moult, was applied to the data sets. The data were considered to be of 'type 2' of Underhill and Zucchini (1988), because full moult scores were recorded for each bird and all birds were considered available for sampling throughout the moult period. The parameters of primary moult were estimated using the transformations recommended by Summers *et*

al. (1980, 1983), designed to reduce the bias introduced by the fact that the individual feathers are of different masses. The moult index used was percentage feather mass grown (PFMG), calculated from the moult score for the individual feathers according to the method of Underhill and Summers (1993). In addition, this analysis was undertaken to estimate the parameters of moult of each primary (Underhill 2003, Underhill *et al.* in press).

Brandao (1998) (see also Underhill *et al.* in press) extended the Underhill-Zucchini (1988) moult model to estimate starting dates for groups of birds (e.g. males and females, or annual groups), holding the other two parameters (duration and standard deviation) constant. She also developed rigorous statistical testing, using the likelihood ratio test, of the null hypothesis that the starting date for each group was the same. This method was applied to analyse inter-annual variation in moult and to estimate starting dates for males and females in different years.

Results

1560 ringing records and six recapture records were obtained for adult Chestnut Weavers of known sex between April 1999 and November 2004.

Sexual and seasonal variation in body mass and wing length

The mean masses of adult male and female Chestnut Weavers were 31.2 g (SD 2.6) and 27.4 g (SD 1.9) respectively (Table 1). Mass declined after the breeding season and started increasing at the end of moult, in both males and females (Figure 2). The peaks in body mass in March, September and December may be due to the small sample sizes ($n<30$ in each of these months for both sexes).

Wing length was analysed for birds with new primaries (October – February), giving 80.7 mm (SD 2.7) and 76.8 mm (SD 2.6) for adult males and females, respectively (Table 1). Wing length declined after the breeding season in both males and females (Figure 3), presumably due to abrasion of feather tips. The extent of feather abrasion is estimated by the difference between the minimum monthly average (in June, Figure 3) and the length of wings with new primaries. The average decreases in wing length were 5.8 mm and 4.6 mm for males and females respectively (Figure 3). Most of this abrasion took place during and immediately after the breeding season.

Timing and duration of primary moult

Relative primary feather masses of males was heavier in males than females for primaries 1-5, equal in primary 6 and heavier in females than males for primaries 7-10 (Table 2).

Records of four males and four females indicated arrested moult because there were new primaries followed by old primaries (one bird in April, one in May, two in July, four in August) and these were excluded from this analysis. Of birds in moult the number of growing primary feathers in an individual was one (92.0%), two (7.8%), and three (0.2%).

Moulting birds were captured throughout the moulting season (Figures 4 and 5); this enables the moult parameters to be estimated reliably. For adult males, duration of moult was estimated to be 206 days (6.9 months) and the mean starting date was 9 April. For adult females, duration of moult was estimated to be 189 days (6.3 months) and the mean starting date was 30 April (Table 3). Males started moulting significantly earlier than females (21 days earlier) (likelihood ratio test, $\chi^2_1=6.63$, $p<0.01$). For three years there were sufficient records to analyse inter-annual variations in the starting date of moult (Table 3), and this is related to rainfall (Figure 6). In 1999/2000 the peak month of rainfall was December (with a smaller peak in March), and males started primary moult on 29 March and females 19 days later. In 2000/01 the peak rainfall month was February, males started moult on 16 April and females 27 days later. In 2003/2004 the peak rainfall months were January – February, males started moult on 25 April and females 13 days later.

The Underhill-Zucchini model was applied to individual primary feathers for adult males in 2000 (Table 4, Figure 7). There were insufficient data in other years or for females for the algorithm to converge. Individual feathers took 11 to 18 days to grow (Table 4). Most apparent overlap in duration of growth of individual primaries was for primaries 1–4 and 9–10. The reduced 10th primary required 11 days to grow, but the SD for this primary was greater than that of the other primaries.

Discussion

Sex differences in body mass and wing length

The biometric data presented in this study are based on a substantially larger sample than hitherto published measurements for *P. r. trothae* (Komen 1990, Table 1), thus

providing a larger range for mass and wing in both sexes. Mean mass for both sexes is within 1 g of Craig's (2004) mean. Mean wing length is greater in Komen's (1990) data by 3.0 mm in males and within 1.0 mm in females.

Seasonal changes in body mass and wing length

Mean mass of both sexes declined after the breeding season and started increasing at the end of moult. This pattern is found in some Ploceidae weavers, but not in others. In Craig's (1978) study of three *Euplectes* species in KwaZulu-Natal, a similar pattern existed; maximum masses were attained at the start of the breeding season by males and at the time of egg-laying by females. Both sexes tended to lose weight during the breeding season, but there was an increase in weight at the time of the post-nuptial moult, before reaching the minimum annual weights during the dry season. This pattern does not apply in Red-headed Weavers *Anaplectes melanotis* where mass does not vary seasonally (Oschadleus 1999). Body mass of Sociable Weavers *Philetairus socius* varied seasonally in different regions without showing clear patterns (Oschadleus 2004).

Wing lengths in male and female Chestnut Weavers decreased extensively as the tips of the outer primaries abraded. Feather wear may be greater in birds living in arid regions than in those in other habitats, due to three environmental factors: thorny vegetation, intense sunlight and exposure to sand (Jenni and Winkler 1994). Herremans (1999) considered that these three factors may explain why Black-chested Prinias *Prinia flavicans* in the Kalahari Desert have a biannual primary moult. Sociable Weavers may have extended duration for primary moult to grow better quality feathers that resist abrasion (Oschadleus 2004). Serra (2001) showed that in Grey Plovers *Pluvialis squatarola* duration of primary moult plays a key role in determining primary quality and hence primary durability, with primary feathers that had been grown fastest showing feather abrasion. In Namibia, Chestnut Weavers build their nests in dense thorny *Acacia* shrubs (Herremans 1997); this may explain why feather abrasion appears to commence during the breeding season.

Timing and duration of primary moult

Komen and Buys (1990) found that adult wing-moult begins after breeding, with males apparently beginning moult earlier than females. The present analysis confirms this. In each of three years, adult males in Namibia started primary moult

two to four weeks earlier than females (Table 3). This is clearly related to the different roles of the sexes in the breeding cycle: males build the nests, copulate with receptive females and then desert the colony soon afterwards, leaving the females to incubate the eggs and rear the young. Thus females postpone the start of moult in order to complete raising the chicks. Primary moult started about a month after the peak rainfall month. This period corresponds with the 28–34 day breeding cycle, thus allowing breeding to fall within the rain period in the study area and primary moult starting as the rains end (Figure 6). Breeding is not restricted to wet years (Komen and Buys 1990), so it would be interesting to compare breeding and moult over more years with greater variation in rainfall.

Ploceidae in semi-arid environments have widely varying primary moult durations, although data have only been analysed rigorously for sedentary Sociable Weavers which have prolonged moult of seven months in the northern Namibian population (*P. s. geminus*) and five to six months in other populations (Oschadleus 2004). Less rigorous moult analyses indicate long moult periods in other arid species weavers. Jones (1978) estimated the duration of primary moult in White-browed Sparrow-weavers *Plocepasser mahali* as six months. Tyler (2001) estimated primary moult duration in Scaly-feathered Finches *Sporopipes squamifrons* as *c*. 7–12 months. The moult durations in Chestnut Weavers in this study (six to seven months) were thus comparable to the moult durations measured in other arid-zone weavers, and longer than those of weavers in the moister eastern and southern parts of southern Africa, where primary moult duration is three to four months (Craig *et al.* 2001).

Acknowledgements – Ringing records, weather data and Chestnut Weaver specimens were provided by Tim Osborne.

References

Brandao A 1998. A comparative study of stochastic models in biology. Unpublished PhD thesis, University of Cape Town, Cape Town

Craig AJFK 1978. Seasonal variations in the weights of Red Bishops, Redcollared Widows and Redshouldered Widows. Ostrich 49: 153-157

Craig AJFK 2004. *Ploceus rubiginosus.* pp 177-179. In: Fry CH and Keith S (eds) Birds of Africa. Vol. 7. Christopher Helm, London

Craig AJFK, Hulley PE, Whittington-Jones CA and Bonnevie BT 2001. Flying times and flight feathers: patterns of moult in sympatric seedeaters. Ostrich Supplement 15: 66-70

de Beer SJ, Lockwood GM, Raijmakers JHFA, Raijmakers JMH, Scott WA, Oschadleus HD and Underhill LG 2001. SAFRING bird ringing manual. Avian Demography Unit Guide 5. Avian Demography Unit, Cape Town

Halenke W 1971. Der Nestbau und das Brutgeschaeft der Kastanienbraunen Weber (*Melanopteryx rubiginosus trothae*, R.796). Mitteilungen Ornithologische Arbeitsgruppe 7(3-4): 6-7

Herremans M 1997. Chestnut Weaver *Ploceus rubiginosus*. In: Harrison JA, Allan DG, Underhill LG, Herremans M, Tree AJ, Parker V and Brown CJ (eds) The atlas of southern African birds. Vol. 2: Passerines. pp 534-535. BirdLife South Africa, Johannesburg

Herremans M 1999. Biannual complete moult in the Black-chested Prinia *Prinia flavicans*. Ibis 141: 115-124

Jenni L and Winkler R 1994. Moult and ageing of European passerines. Academic Press, London

Jones PJ 1978. Overlap of breeding and moult in the Whitebrowed Sparrowweaver in northwestern Botswana. Ostrich 49: 21-24

Komen J 1990. Size variation in the Chestnut Weaver *Ploceus rubiginosus*. Cimbebasia 12: 69-74

Komen J and Buys PJ 1990. The timing of moult and breeding of the Chestnut Weaver *Ploceus rubiginosus* in Namibia. Cimbebasia 12: 63-67

Oschadleus HD 1999. Redheaded Weaver weights from ringing records. Safring News 28: 17-20

Oschadleus HD 2004. Sociable Weaver biometrics and primary moult. Ostrich 75: 309-316

Serra L 2001. Duration of primary moult affects primary quality in Grey Plovers *Pluvialis squatarola*. Journal of Avian Biology 32: 377-380

Summers RW, Swann RL and Nicoll M 1980. Unbending moult data. Wader Study Group Bulletin 30: 12-13

Summers RW, Swann RL and Nicoll M 1983. The effects of methods on estimates of primary moult duration in the Redshank *Tringa totanus*. Bird Study 30: 149-156

Tyler SJ 2001. Moult in Scalyfeathered Finches *Sporopipes squamifrons* in southeast Botswana. Afring News 30: 56-59

Underhill LG 2003. Within ten feathers: primary moult strategies of migratory waders (Charadrii). In: Berthold P, Gwinner E and Sonnenschein E (eds) Avian Migration. pp 187-197. Springer-Verlag, Berlin

Underhill LG and Joubert A 1995. Relative masses of primary feathers. Ringing and Migration 16: 109-116

Underhill LG, Serra L and Brandao A in press. Progress with the statistical analysis of primary moult. Proceedings of the XXIII International Ornithological Congress, Beijing, China. Acta Zoologica Sinica

Underhill LG and Summers RW 1993. Relative masses of primary feathers in waders. Wader Study Group Bulletin 71: 29-31

Underhill LG and Zucchini W 1988. A model for avian primary moult. Ibis 130: 358-372

Table 1: Mass (g) and wing measurements (mm) by sex of adult Chestnut Weavers in northern Namibia from this study, compared with data from Craig (2004) and Komen (1990). Wing measurements are of birds with new primaries (October – February)

	Males	*Females*
Mass (g)		
Mean	31.2	27.4
Range	23–43	21.1–36
Inter-quartile range (25%)	29.3–33.1	26.3–28.6
Standard deviation	2.6	1.9
n	983	554
Wing (mm)		
Mean	80.7	76.8
Range	70–88.5	69–87
Inter-quartile range (25%)	79–82	75–78
Standard deviation	2.7	2.6
n	528	243
Mass (g), from Craig (2004)		
Mean	32.1	27.8
Range	28–37	25–30
n	39	55
Wing (mm), from Komen (1990)		
Mean	83.7	77.5
Range (from Figure 1)	80–87	74–79
Standard deviation	1.5	1.3
n	42	29

Table 2: Individual primary feather masses (g) of two female and one male Chestnut Weaver specimens from northern Namibia, and the mean relative mass of each primary, used in the calculation of Percentage Feather Mass Grown

Primary	Feather mass (g)						Mean relative feather masses		
	Female 1 right wing	Female 1 left wing	Female 2 right wing	Female 2 left wing	Male 1 right wing	Male 2 left wing	Female	Male	All
1	0.0079	0.0078	0.0085	0.0079	0.0086	0.0083	8.0	7.7	7.8
2	0.0083	0.0082	0.0089	0.0083	0.0090	0.0087	8.4	8.1	8.2
3	0.0088	0.0085	0.0092	0.0090	0.0094	0.0094	8.8	8.6	8.7
4	0.0096	0.0099	0.0102	0.0098	0.0105	0.0102	9.8	9.5	9.6
5	0.0112	0.0117	0.0116	0.0115	0.0121	0.0115	11.4	10.8	11.1
6	0.0121	0.0125	0.0128	0.0126	0.0135	0.0136	12.4	12.4	12.4
7	0.0129	0.0130	0.0130	0.0128	0.0144	0.0143	12.9	13.1	13.0
8	0.0133	0.0136	0.0134	0.0135	0.0152	0.0156	13.4	14.1	13.7
9	0.0142	0.0141	0.0131	0.0134	0.0158	0.0159	13.6	14.5	14.1
10	0.0012	0.0011	0.0014	0.0015	0.0016	0.0014	1.3	1.4	1.3
Total	0.0995	0.1004	0.1021	0.1003	0.1101	0.1089	100.0	100.0	100.0

Table 3: Estimates of the primary moult parameters for adult Chestnut Weavers in northern Namibia, 1999–2004
m=male, f=female

Sex	Year	Mean starting date	Standard error (days)	Standard deviation (days)	Standard error (days)	Duration (days)	Duration (months)	Standard error (days)	Mean completion date	Standard error (days)	n
m	1999–2004	9 Apr	2.9	39.5	1.2	205.8	6.9	3.8	1 Nov	1.8	975
f	1999–2004	30 Apr	3.2	37.5	1.5	189.4	6.3	4.8	5 Nov	2.9	552
m	2000	29 Mar	3.3	37.2	1.2	203	6.8	4.1	18 Oct	2.4	386
m	2001	16 Apr	4.3	37.2	1.2	203	6.8	4.1	5 Nov	2.9	227
m	2004	25 Apr	3.8	37.2	1.2	203	6.8	4.1	14 Nov	5.8	244
f	2000	16 Apr	3.9	35.4	1.5	190.3	6.3	5.3	24 Oct	3.1	223
f	2001	13 May	4.6	35.4	1.5	190.3	6.3	5.3	19 Nov	3.8	133
f	2004	8 May	4.2	35.4	1.5	190.3	6.3	5.3	14 Nov	7.2	101

Table 4: Estimates of the primary moult parameters of individual primary feathers for adult male Chestnut Weavers in northern Namibia in 2000 (n=386)

Primary	Mean starting date	Standard Error (days)	Standard deviation (days)	Standard Error (days)	Duration (days)	Standard Error (days)	Mean completing date	Standard Error (days)
1	28 Apr	3.0	32.1	1.1	14.5	1.2	13 May	2.9
2	8 May	2.8	32.1	1.1	14.5	1.2	22 May	2.9
3	14 May	3.3	23.6	2.5	15.5	2.9	29 May	2.8
4	26 May	2.8	22.2	2.2	12.1	2.4	7 Jun	2.5
5	6 Jun	2.3	18.6	1.6	17.2	2.5	23 Jun	2.2
6	21 Jun	2.2	18.1	1.5	16.3	2.4	7 Jul	2.1
7	7 Jul	2.1	17.5	1.6	13.8	2.2	21 Jul	2.0
8	21 Jul	2.0	17.2	2.1	15.9	2.6	6 Aug	2.3
9	7 Aug	2.5	19.1	2.4	17.9	3.3	25 Aug	3.9
10	18 Aug	3.9	11.4	3.4	11.1	4.2	29 Aug	7.0

Figure 1: Capture sites of adult Chestnut Weavers in the one degree grid cell 19°S 15°E, Namibia, 1999–2004. Solid circles show sites from which biometric and primary moult data were obtained. All the quarter-degree grid cells in Namibia and Botswana in which Chestnut Weavers were recorded during the Southern African Bird Atlas Project are shaded (Herremans 1997)

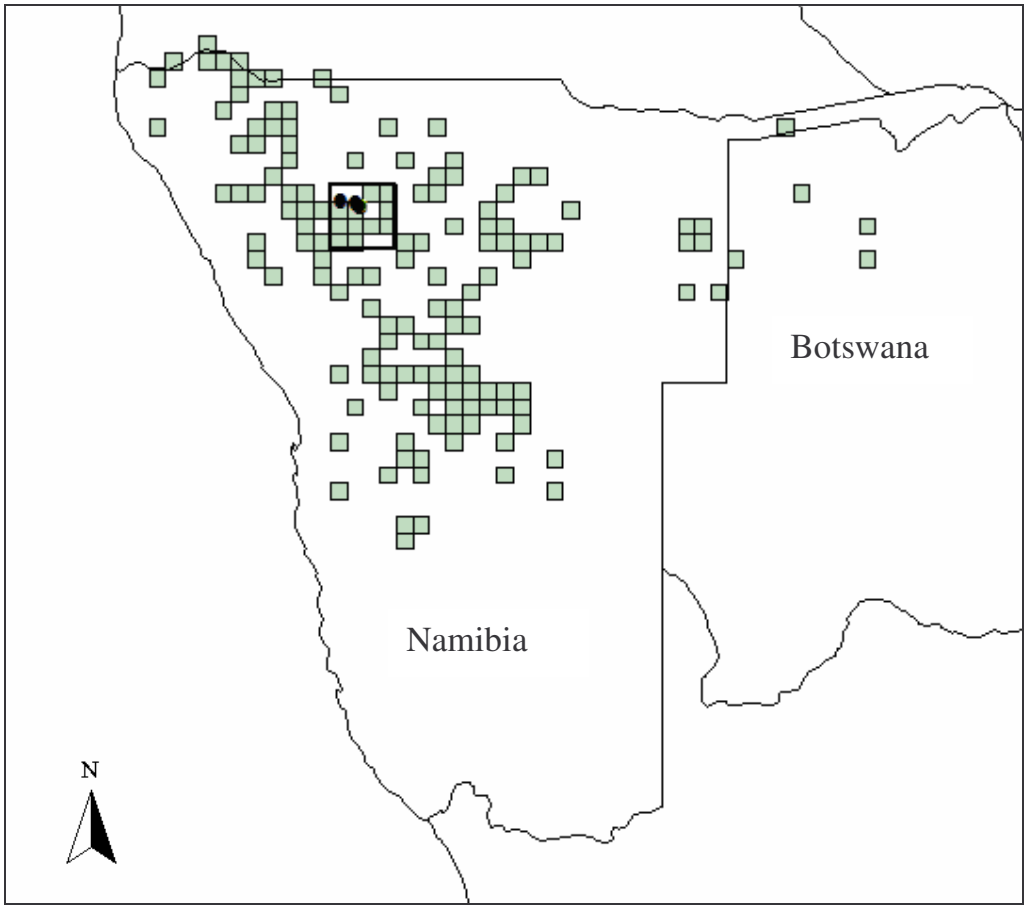

Figure 2: Mean (and SD) body mass (g) of adult Chestnut Weavers by month in northern Namibia, 1999–2004
Sample sizes for males and females respectively are listed under the Month
males, open squares; females, closed squares

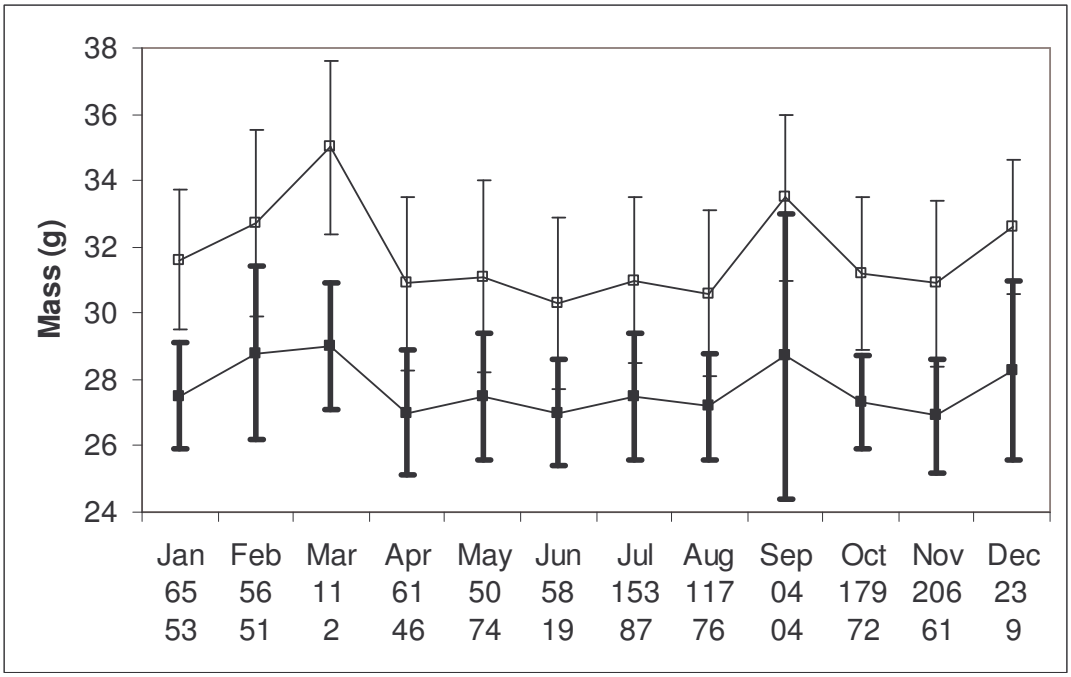

Figure 3: Mean (and SD) wing length (mm) of adult Chestnut Weavers by month in northern Namibia, 1999–2004; wings with primaries 7–9 in moult, are excluded
Sample sizes for males and females respectively are listed under the Month
males, open squares; females, closed squares

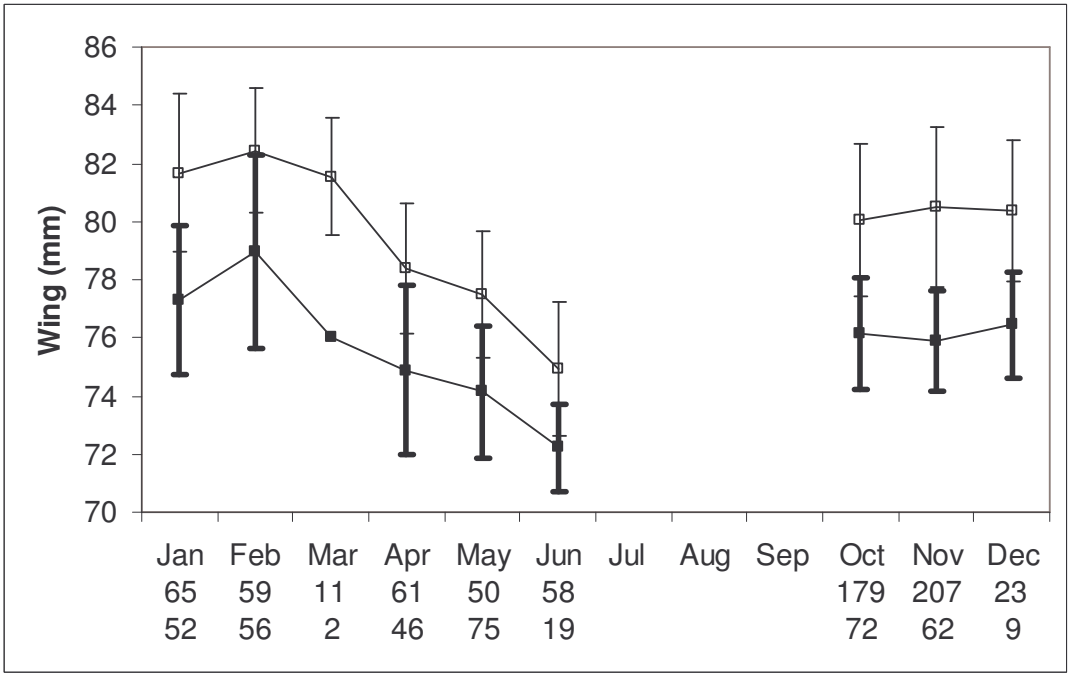

Figure 4: Timing of primary moult for adult male Chestnut Weavers in northern Namibia, 1999–2004; the solid diamonds represent relative feather mass values by date; the solid diagonal line joins the estimated mean start and end dates of moult, while the diagonal dotted lines show the approximate 95% confidence intervals of moult scores on any given date

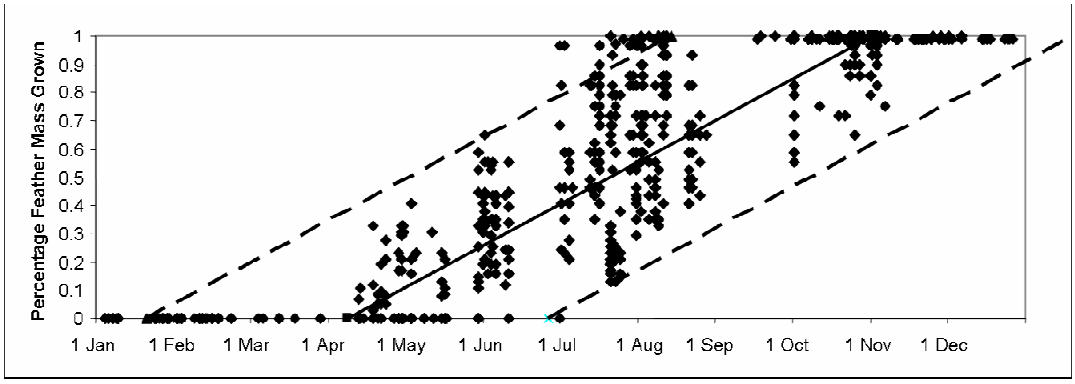

Figure 5: Timing of primary moult for adult female Chestnut Weavers in northern Namibia, 1999–2004; the solid diamonds represent relative feather mass values by date; the solid diagonal line joins the estimated mean start and end dates of moult, while the diagonal dotted lines show the approximate 95% confidence intervals of moult scores on any given date

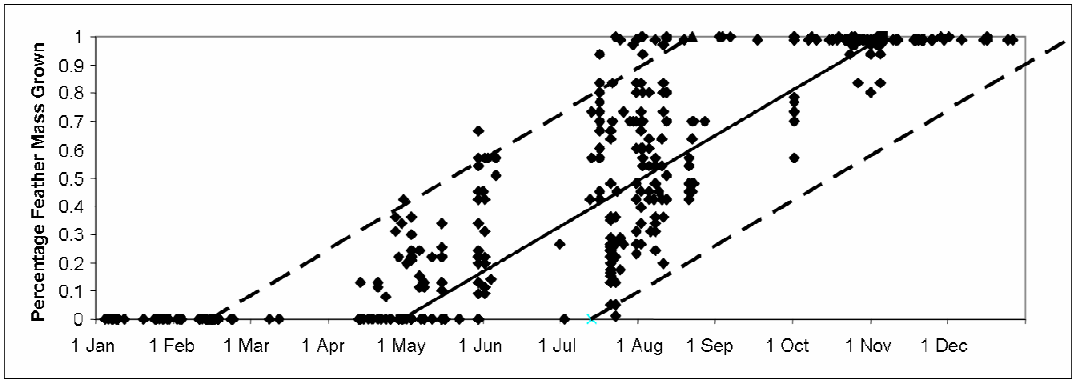

Figure 6: Monthly rainfall at Tandala Ridge, Windpoort Farm, northern Namibia, October 1999 to June 2004. Arrows indicate the mean start of primary moult, with solid arrows for males and dashed arrows for females

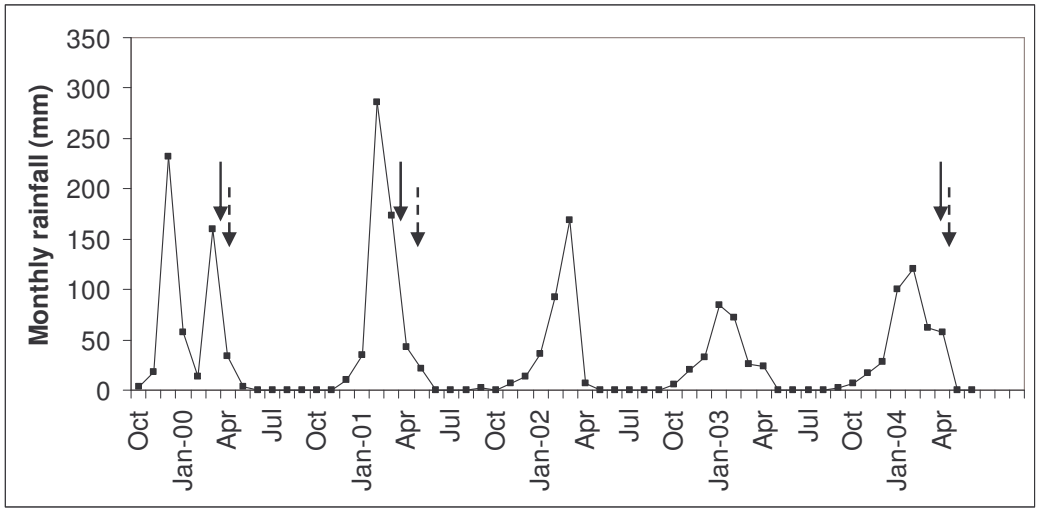

Figure 7: Individual primary growth of adult male Chestnut Weavers in northern Namibia in 2000; crosses indicate the dates of the start and end of moult for each primary feather, and vertical lines indicate standard deviations for 10 primaries; data in Table 4