

## Chestnut Weaver *Ploceus rubiginosus* biometrics and primary moult in Namibia

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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 31.2g (SD 2.6), and adult females weighed 27.4g (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 (Oct–Feb) was 80.7mm (SD 2.7) and for adult females (Oct–Feb) 76.8mm (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 vs 30 April) and moult lasted longer (206 days vs 189 days). The peak summer rainfall and the start of primary moult was earliest in 2000 and latest in 2004 for males and females. Individual primary feathers took 11–18 days to grow.

### Introduction

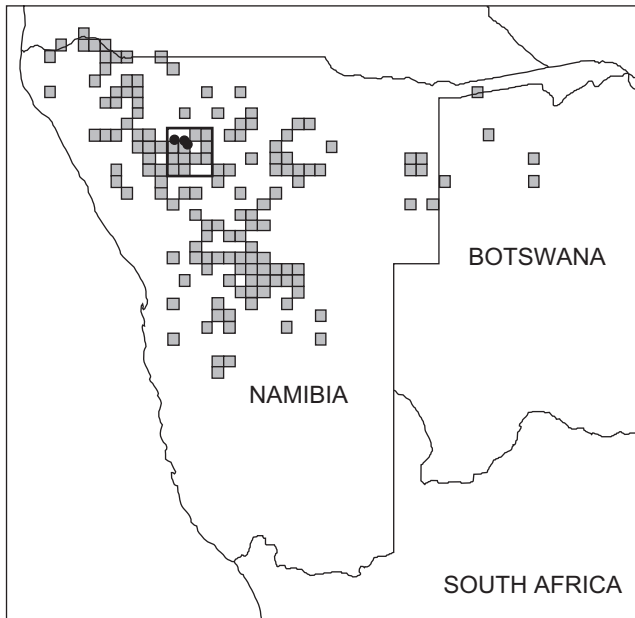
The Chestnut Weaver *Ploceus rubiginosus* is a colonial species of arid regions. It is a local migrant or seasonally nomadic. There are two discrete populations: *P. r. trothae* occurs in northern Namibia, Botswana and southern Angola and the nominate subspecies in eastern Africa in Eritrea, Ethiopia, 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 any time from December–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. The starting date of moult, the moult duration, and the delay between the starting date of females relative to males, are all unknown. The aim of this paper is to provide these data on moult and on the seasonal variation in body mass and wing length for Chestnut Weavers in Namibia.

### Methods

Ringling data were collected by TO 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 by TO 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 24h 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). 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



**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)

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

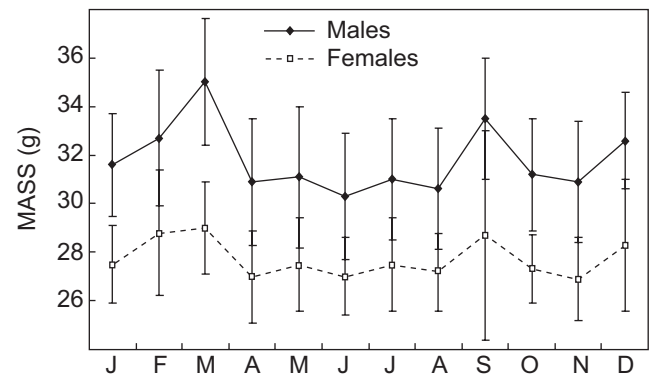
One thousand five hundred and sixty ringing records and six recapture records were obtained for adult Chestnut Weavers of known sex between April 1999 and November 2004.

### Sexual and seasonal variation in body mass and wing length

The mean masses of adult male and female Chestnut Weavers were 31.2g (SD 2.6) and 27.4g (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).

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

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

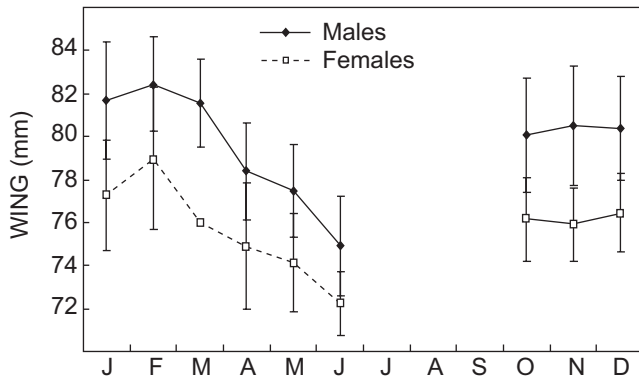


**Figure 2:** Mean (and SD) body mass (g) of adult Chestnut Weavers by month in Namibia, 1999-2004

Wing length was analysed for birds with new primaries (Oct–Feb), giving 80.7mm (SD 2.7) and 76.8mm (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 5.8mm and 4.6mm 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

Individual primary feather masses of two female and one male Chestnut Weaver specimens were weighed (Table 2).



**Figure 3:** Mean (and SD) wing length (mm) of adult Chestnut Weavers by month in Namibia, 1999-2004; wings with primaries 7-9 in moult, are excluded

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, moult duration was estimated to be 206 days (6.9 months) and the mean starting date was 9 April. For adult females, moult duration 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 2000/2001 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 11-18 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 tenth 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 1g of Craig's (2004) mean. Mean wing length is greater in Komen's (1990) data by 3.0mm in males and within 1mm in females.

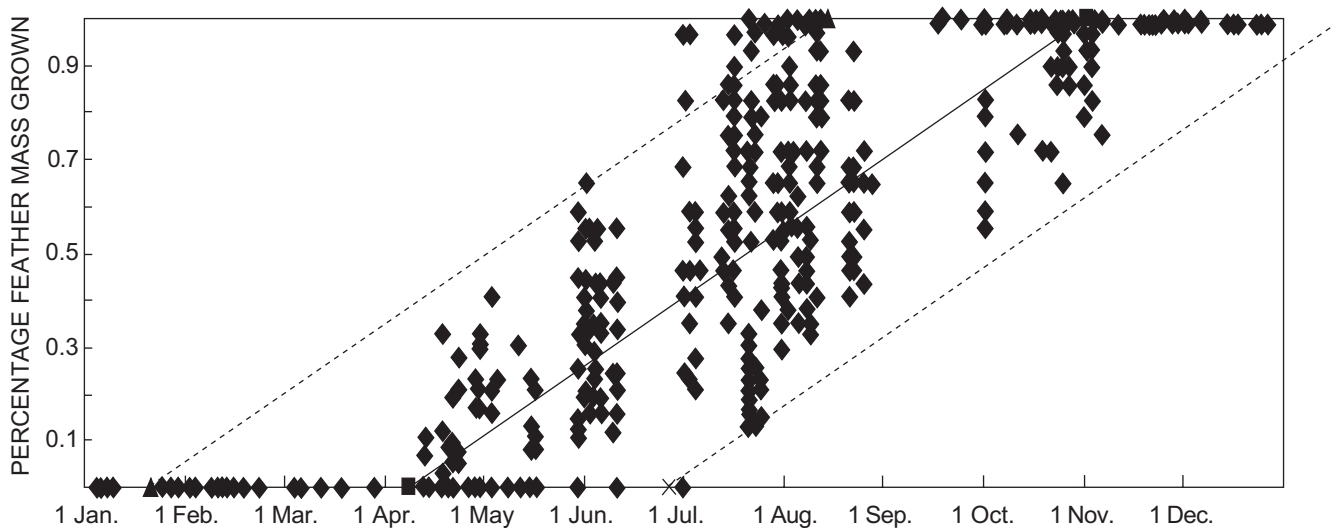
### Seasonal changes in body mass and wing length

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 Redheaded Weavers *Anaplectes rubriceps* 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).

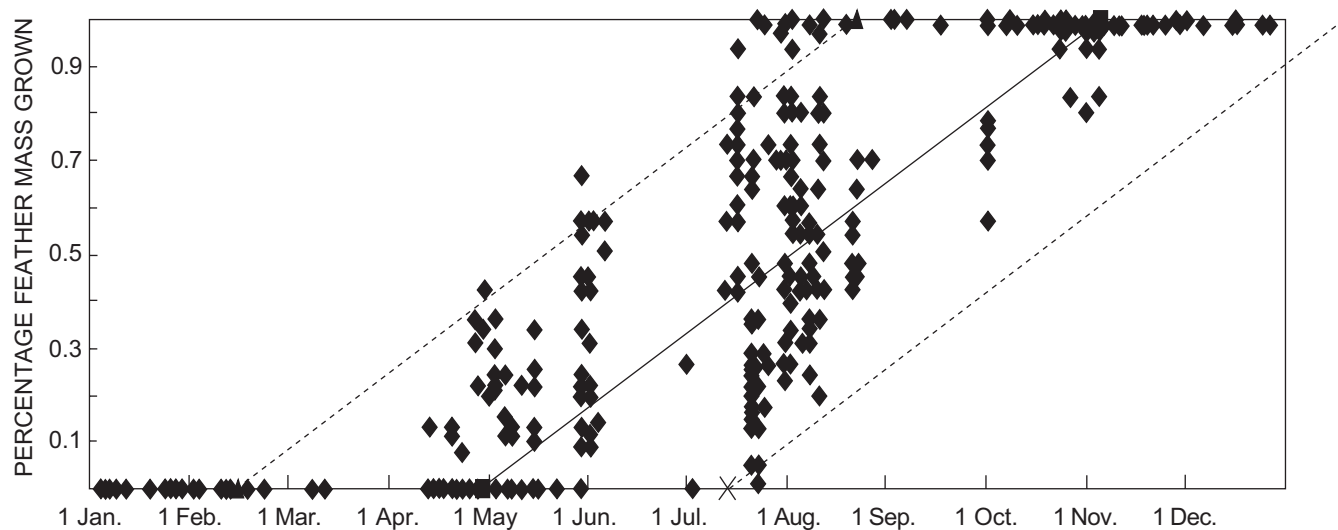
Wing lengths in male and female Chestnut Weavers decreased extensively as the tips of the outer primaries abraded. Feather wear may be greater in birds living in arid re-

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

Primary	Feather mass (g)						Mean PFMG		All
	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	
1	0.0079	0.0078	0.0085	0.0079	0.0086	0.0083	7.98	7.71	7.84
2	0.0083	0.0082	0.0089	0.0083	0.0090	0.0087	8.37	8.08	8.23
3	0.0088	0.0085	0.0092	0.0090	0.0094	0.0094	8.82	8.59	8.70
4	0.0096	0.0099	0.0102	0.0098	0.0105	0.0102	9.82	9.45	9.63
5	0.0112	0.0117	0.0116	0.0115	0.0121	0.0115	11.43	10.78	11.10
6	0.0121	0.0125	0.0128	0.0126	0.0135	0.0136	12.43	12.38	12.40
7	0.0129	0.0130	0.0130	0.0128	0.0144	0.0143	12.85	13.11	12.98
8	0.0133	0.0136	0.0134	0.0135	0.0152	0.0156	13.37	14.07	13.72
9	0.0142	0.0141	0.0131	0.0134	0.0158	0.0159	13.63	14.48	14.05
10	0.0012	0.0011	0.0014	0.0015	0.0016	0.0014	1.29	1.37	1.33
<b>Total</b>	<b>0.0995</b>	<b>0.1004</b>	<b>0.1021</b>	<b>0.1003</b>	<b>0.1101</b>	<b>0.1089</b>	<b>100.00</b>	<b>100.00</b>	<b>100.00</b>



**Figure 4:** Primary moult scores by date for adult male Chestnut Weavers in Namibia, 1999-2004; the solid line joins the mean start and end dates, while the dotted lines show the approximate 95% confidence intervals of moult scores on any given date



**Figure 5:** Primary moult scores by date for adult female Chestnut Weavers in Namibia, 1999-2004; the solid line joins the mean start and end dates, while the dotted lines show the approximate 95% confidence intervals of moult scores on any given date

gions 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 the duration for primary moult to grow better quality feathers that resist abrasion (Oschadleus 2004). Serra (2001) showed that in Grey Plovers *Pluvialis squatarola* primary moult duration 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);

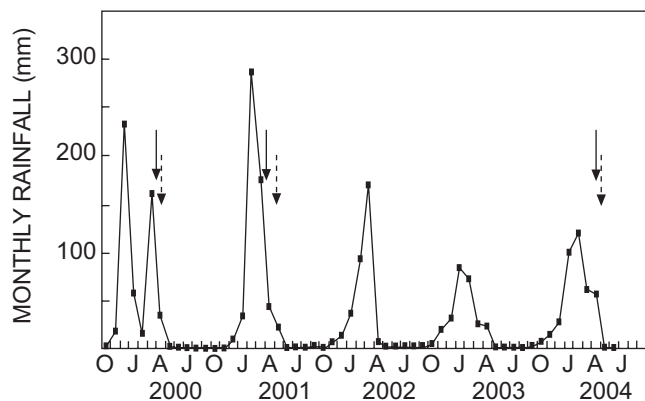
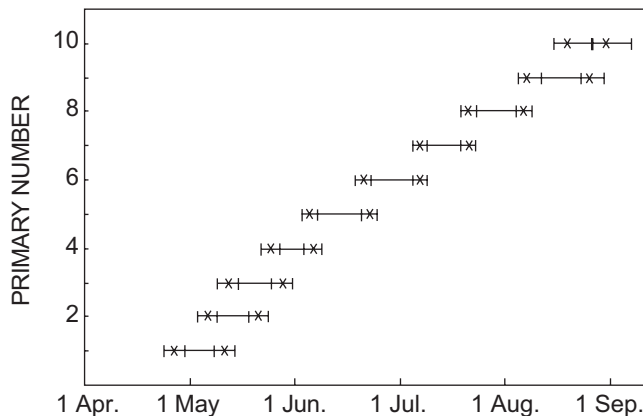
this may explain why feather abrasion appears to commence during the breeding season.

#### 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 2–4 weeks earlier than females (Table 3). 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

**Table 3:** Estimates of the primary moult parameters for adult Chestnut Weavers in Namibia, 1999–2004

Sex	Year	Mean starting date	Standard Error	Standard Deviation (days)	Standard error	Duration (days)	Duration (months)	Standard error	Mean completion date	Standard error	n
Male	All	9 Apr	2.9	39.5	1.2	205.8	6.9	3.8	1 Nov	1.8	97
Female	All	30 Apr	3.2	37.5	1.5	189.4	6.3	4.8	5 Nov	2.9	552
Male	2000	29 Mar	3.3	37.2	1.2	203	6.8	4.1	18 Oct	2.4	386
Male	2001	16 Apr	4.3	37.2	1.2	203	6.8	4.1	5 Nov	2.9	227
Male	2004	25 Apr	3.8	37.2	1.2	203	6.8	4.1	14 Nov	5.8	244
Female	2000	16 Apr	3.9	35.4	1.5	190.3	6.3	5.3	24 Oct	3.1	223
Female	2001	13 May	4.6	35.4	1.5	190.3	6.3	5.3	19 Nov	3.8	133
Female	2004	8 May	4.2	35.4	1.5	190.3	6.3	5.3	14 Nov	7.2	101

**Figure 6:** Monthly rainfall at Tandala Ridge, Windpoort Farm, 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 2000; crosses indicate the dates of the start and end of moult for each primary feather, and vertical lines indicate standard deviations for ten primaries; data in Table 4**Table 4:** Estimates of the primary moult parameters of individual primary feathers for adult male Chestnut Weavers in Namibia in 2000 (n = 386)

Primary	Mean starting date	Standard error	Standard Deviation (days)	Standard error	Duration (days)	Standard error	Mean completion date	Standard error
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

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 5–6 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 (6–7 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 3–4 months (Craig *et al.* 2001).

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