

Chapter 6

Breeding seasonality and primary moult parameters in *Euplectes* species in South Africa



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Abstract

Bishops and widows are fairly uniform in their ecology, but breed in different microhabitats. The grassland biome in South Africa has a summer rainfall and Long-tailed *Euplectes progne*, White-winged *E. albonotatus*, Red-collared *E. ardens*, and Fan-tailed Widows *E. axillaris* bred from October or November to March. Primary moult started in late March or early April. The widows with long tails (Long-tailed and Red-collared Widows) had moult durations of two months, while the widows with shorter tails (White-winged and Fan-tailed Widows) had moult durations of 1.5–1.7 months. Moult ended in late May or early June. Long-tailed Widows have rounder wings than other weaver species, possibly because their larger size affects flight aerodynamics. Southern Red Bishops *E. orix* and Yellow Bishops *E. capensis* in the Western Cape experience winter rainfall and breed after the rains. In these two species breeding was mainly from August to November and moult started in December. Primary moult duration in the Yellow Bishop was relatively long at 3.4 months. Yellow Bishops grew individual primary feathers at an average rate of 21.3 days per feather, while the other species moulted primaries more quickly: White-winged Widow 8.1 days, Fan-tailed Widow 11.3 days and Red-collared Widow 14.4 days. The number of primaries growing simultaneously was similar in the different species.

Introduction

There are seven breeding species of *Euplectes* bishops and widows in South Africa (Tarboton 2001). The bishops have short tails that are not replaced during the pre-nuptial moult, and the widows grow long black tails in the pre-nuptial moult (Craig 1993). Species in this genus in South Africa have their distributions centred on the grassland and savanna biomes in eastern part of the country; Southern Red Bishop *Euplectes orix* and Yellow Bishop *E. capensis* extend into the fynbos region of the Western Cape (Harrison *et al.* 1997, Figure 1). All seven South African species occur in the two easternmost provinces, KwaZulu-Natal and Mpumalanga; six species occur

in Limpopo Province, Gauteng and the Eastern Cape; five species in North-west and Free State; three in the Western Cape; and one, the Southern Red Bishop, in the Northern Cape.

The species are fairly uniform in their ecology and maintain mutually exclusive territories where they occur in the same area (Emlen 1957, Craig 1980). They are common birds of grassland or marshes, feeding mainly on seeds. They are sexually and seasonally dimorphic; breeding males have black plumage with either red or yellow agonistic signals. The females are dull-coloured through the year. Male widows have elongated black tail feathers which are used in mate selection. Tail length in male widows in breeding plumage varies greatly between species from 65 mm in Fan-tailed Widows *E. axillaris* to 500 mm in Long-tailed Widows *E. progné* (Andersson and Andersson 1994, Pryke 2003). All species feed and roost in large flocks in the non-breeding season, often in mixed-species flocks (Craig 1980).

The Southern Red Bishop and Yellow Bishop breed from September to November in the Western Cape, about three months earlier than the peak from December to March in the summer rainfall region. The other *Euplectes* species breed mainly from October to March (Harrison *et al.* 1997). All *Euplectes* species are polygynous, build a dome-shaped nest with a side entrance, and the female alone incubates eggs and feeds young (Fry and Keith 2004).

Little is known about the moult of bishops and widows. Craig and Manson (1979) found that three *Euplectes* species in KwaZulu-Natal and Zimbabwe moulted soon after breeding; the authors estimated duration of primary moult based on recaptures. Bonnevie *et al.* (2004) found that Southern Red Bishops moulted three months earlier in the Western Cape than in the predominantly summer rainfall regions. Savalli (1993) described the prenuptial moult in Yellow-mantled Widowbird *E. macrourus* in western Kenya.

In this paper, primary moult parameters were estimated for five additional species: Long-tailed Widow, White-winged Widow *E. albonotatus*, Red-collared Widow *E. ardens*, Fan-tailed Widow, and Yellow Bishop. Southern Red Bishop data was analysed in Chapter 5 but is compared to the other *Euplectes* species in this chapter. There was insufficient moult data for Yellow-crowned Bishop *E. afer*. Moult parameters are usually considered to be more fixed than the timing of breeding in a passerine's annual life-cycle (Snow 1976). This paper examines the relationship

between the timing of primary moult and the timing of breeding in the annual cycles of the widows of South Africa.

Methods

Breeding seasonality data were obtained from the BirdLife South Africa Nest Record Card Scheme (NRC) (RP Prÿs-Jones and I Newton unpublished data; Underhill *et al.* 1991). Prÿs-Jones and Newton (unpublished data) estimated the month of laying of the first egg for each record. They then summarised breeding seasonality for all birds in South Africa by presenting monthly totals of clutches laid per species per region. One of the regions they used was the former Transvaal province: this region incorporates the current Gauteng Province, from where most of the records originate anyway. To compare breeding seasonality of weavers, the tabulated data of Prÿs-Jones and Newton were used to estimate the median and the 5th and 95th percentiles for each species and region. The median was calculated by finding the cumulative monthly sums of the percentage of nest records. The median month was the month in which the cumulative sum first exceeded 50%. The values of the sums of the previous and successive months were used to assign a relative distance into the month. For example, if there were 47% of cumulative records by the end of October, and 64% by the end of November, the median clearly is during November. Then using proportions $(50-47)/(64-47)$ gives 17.7%, the relative distance into November. Thus the median lies 17.7% into November (month 11), calculated as 11.177 (and rounded to 11.2 for presentation, i.e. a precision of about three days). The 5th and 95th percentiles were interpolated in a similar fashion. Dates in January were recorded as being in month 1 (not month 0).

Ringling data were collected by ringers in the standard SAFRING (South African Bird Ringing Unit) electronic format. This includes standard ringling information (such as location and date) and data on bird body mass, wing length and primary moult (de Beer *et al.* 2001). Primary moult records were extracted from SAFRING's database until mid-January 2005 for adult *Euplectes* species. Moult in Southern Red Bishops was analysed in Chapter 5. For each species, a geographic area was chosen so that sufficient records could be obtained for the analysis of moult: generally 200 records spread over a year allow the Underhill-Zucchini model to

converge. In all species moult of the primaries is ascendant, with the feathers renewed from one to nine outwards.

To determine the relative mass of each primary, as described in Underhill and Summers (1993), the primaries of one White-winged Widow and two Long-tailed Widow specimens were used. The White-winged Widow male was a road-kill I found at Skeerpoort, North-west Province. One Long-tailed Widow (non-breeding male) was a road-kill found in Wakkerstroom, Mpumulanga, by Kevin McKann. The other (breeding male) was a road-kill I found in Leandra, Mpumulanga. The primaries were dried in an oven at 60°C for 24 hours to eliminate moisture and weighed (Ohaus GA200D balance, precision 0.0001g). These values were averaged and used for to calculate the relative mass of each primary. 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; they also showed that within the Charadriiformes, the relative masses of the primary feathers were so similar that the average value for the species for which data were available could safely be used for species for which data were unavailable. 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 use of type 2 data assumes that the sample of birds handled on each day is representative of the stages of primary moult in the population on that day. 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). This analysis was then repeated to provide estimates of the parameters of moult of each individual primary (Underhill 2003, Underhill *et al.* in press). The PMFG for White-winged Widows were used for Red-collared Widow, Fan-tailed Widow and Yellow Bishop because wings of these species were unavailable.

For Long-tailed Widows all moult records were pooled (166 records from Mpumulanga, 55 from Free State, 53 from Gauteng, and five records from other provinces). For White-winged Widows, 686 records from Gauteng were used. For

Red-collared Widows, 667 records from Gauteng were used. For Fan-tailed Widows, 1002 records from a one-by-one degree block in KwaZulu-Natal were used. For Yellow Bishops, 777 records from two adjacent one-by-one degree blocks in the Western Cape were used (Figure 2).

Results

Breeding by *Euplectes* species begins earliest in the Western Cape, the median date of egg-laying in this province being September (Table 2). In the grassland biome breeding is in summer: in KwaZulu-Natal median date of egg-laying is in December for all species, and in the former Transvaal it is December or January (Table 2). Median date for onset of egg-laying is variable in the other regions.

Relative feather masses are similar for most Ploceidae weavers (unpublished data; see Chapter 9), as exemplified by Southern Red Bishop and White-winged Widow (Figure 3). The wing shape (by primary feather mass) is different, however, in Long-tailed Widows and in Thick-billed Weavers *Amblyospiza albifrons* which have a more rounded wing with the outer primaries decreasing in size. For the Red-collared Widow, Fan-tailed Widow and Yellow Bishop, wings were not available, so two models were tested using the relative masses of both types of widow wing shapes, i.e. using that of the White-winged Widows and of the Long-tailed Widows. Using the White-winged Widow relative masses gave acceptable results for all three species tested. Using the Long-tailed Widow PFMG did not always give acceptable results, and thus this model was excluded.

Primary moult follows soon after breeding in all species (Tables 2 and 3). Moulting birds were captured throughout the moulting season (Figure 4), sometimes in large numbers; this enabled moult parameters to be estimated reliably. *Euplectes* species breeding in summer rainfall areas (Long-tailed Widow, White-winged Widow, Red-collared Widow and Fan-tailed Widow) had primary moult durations of about two months, starting in late March or early April and ending in late May or early June. The Southern Red Bishop had a moult duration of 2.4 -3.0 months. The Yellow Bishop showed longer duration of 3.4 months, with moult starting in early December (Table 3).

The estimated time for individual feathers to grow varied as follows (Table 4): White-winged Widow, 5–13 days; Red-collared Widow, 9–18 days; Fan-tailed

Widow, 6–18 days; and Yellow Bishop, 14–29 days (Table 3). For Long-tailed Widow, the sample sizes were too small to allow individual feather durations to be estimated. Numbers of primaries growing simultaneously were similar in the five species: Long-tailed Widow 2.2, White-winged Widow 1.9, Red-collared Widow 2.3, Fan-tailed Widow 2.2, and Yellow Bishop 2.0. The start and end dates for individual primaries (Table 4) with that for the whole wing (Table 3) match best for Red-collared Widow (6 April for start of primary 1 versus 5 April for whole wing), and worst for Fan-tailed Widow and Yellow Bishop (7 days difference).

Discussion

The different wing shapes of the Long-tailed Widow compared to Southern Red Bishop and White-winged Widow are probably due to adaptation rather than phylogeny (Dawson 2005). For a range of European passerines, Dawson (2005) found that the greater relative mass of the outer primaries in some species may reflect a protective function against physical abrasion, or an aerodynamic function in that each of these feathers provides a leading edge to the wing. Scaling relationships (log mass/log length) were related to flight characteristics and habitat, rather than to phylogeny (Dawson 2005). European Starlings *Sturnus vulgaris*, with more rounded wingtips, tended to take off from the ground at a steeper angle of ascent than those with relatively more pointed wingtips (Swaddle and Lockwood 2003). The widows all have a similar ecology but the Long-tailed Widow is considerably larger than other *Euplectes* species, and this may impact on the aerodynamics of its flight, and thus wing-shape. Long-tailed Widow males have tails that are much larger than those of the females and there may be a sexual difference in the relative feather masses – more specimens are needed to determine this.

Breeding seasonality in widows and bishops in summer rainfall areas is well-defined. Start of moult is 2.5–3.5 months after peak egg-laying, and 0.9–1.7 months after 95th percentile of breeding (Table 5). One breeding cycle consisting of the incubation and nestling periods is three to four weeks in all the *Euplectes* species (Table 5); the number of broods per season is less well known.

Euplectes bishops and widows are largely grassland birds, although Yellow Bishop is found more in fynbos and montane habitats, and thus have fairly similar distributions; the core of their ranges, as indicated by the areas of high reporting rates,

are concentrated in the areas where grassland occurs (Figure 1). Duration of primary moult is similar in the grassland species (two months or less), but Yellow Bishops take nearly three and a half months to complete moult. Onset of moult is similar in the summer rainfall species (late March or April). Yellow Bishops start moult earlier in the winter rainfall region, as do Southern Red Bishops, Cape and Southern Masked Weavers (Oschadleus *et al.* 2000, Chapter 5). The Southern Red Bishop has a wider distribution than other *Euplectes* species and has a moult duration of 72 to 89 days (Craig *et al.* 2001, Bonnevie 2004, Chapter 5). In the winter rainfall region of the Western Cape, the primary moult of the Southern Red Bishop started about three months earlier than in the summer rainfall regions, but in all regions the onset of moult commenced at the end of the breeding season (Bonnevie 2004, Chapter 5).

Nuttall (1993) studied the breeding seasonality of four co-occurring species of widow in grassland habitat near Pietermaritzburg, KwaZulu-Natal. Long-tailed Widows developed breeding plumage earliest, and retained it for the longest period of time, followed by Fan-tailed Widow. White-winged and Red-collared Widows exhibited breeding plumage for the shortest periods (Nuttall 1993). Nuttall's (1993) study related to body moult but there is a similarity with wing-moult: in this study Long-tailed and Red-collared Widows had moult durations of two months, while that of White-winged Widows was 1.5 months.

Craig and Manson (1979) made preliminary estimates of the parameters of primary moult from a small sample of recaptures and from the numbers of simultaneously growing primaries in KwaZulu-Natal and Zimbabwe. They estimated duration of moult to be 110 days in Southern Red Bishops, 100 days in male Fan-tailed Widows, and 80 days for Red-collared Widows and female Fan-tailed Widows. These durations are longer than the 47–61 days estimated in the present study for widows in the summer rainfall region.

Adult Yellow Bishops needed 2–4 weeks to grow individual primaries, while the other species moulted individual primaries more quickly. The estimated durations of moult of the individual primaries showed considerable variation; this variation is more likely to be attributable to sampling variation than to biological processes. The number of birds in moult for each primary feather were mostly small. The average of the individual primary durations for a species is however likely to provide a useful characteristic of the species.

The estimated overall duration of primary moult (Table 4) was closely correlated with the interval between the estimated starting date of moult of the first primary to the estimated completion date of moult of the ninth (outermost) primary (Table 3). The estimated starting date of primary moult of Red-collared Widows, for instance, in the overall analysis was 5 April (Table 3) and the estimated starting date for the first primary was 6 April (Table 4b); the overall moult ended on 3 June and the moult of the ninth primary was completed on 4 June. Also the number of primaries growing simultaneously was similar in the different species, indicating relatively uniform growth rates in the different species. Yellow Bishops achieve a long moult duration by growing individual primaries at a slower rate than do other *Euplectes* species, and not by growing fewer primaries simultaneously, as do Sociable Weavers (Chapter 2).

It would be useful to have the relative primary masses of all *Euplectes* species to confirm the results in this study. The South African *Euplectes* species for which primary moult parameters remains unknown is Yellow-crowned Bishop *E. afer*.

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Table 1: Individual primary feather masses (g) of two Long-tailed Widow specimens from Mpumulanga and one White-winged Widow specimen from North-west Province, 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	
	Long-tailed Widow male, left wing	Long-tailed Widow male, right wing	White-winged Widow male, left wing	Long-tailed Widow	White-winged Widow
1	0.0235	0.0356	0.0108	9.4	9.3
2	0.0234	0.0372	0.0112	9.5	9.6
3	0.0250	0.0400	0.0114	10.2	9.8
4	0.0275	0.0440	0.0121	11.3	10.4
5	0.0289	0.0466	0.0135	11.9	11.6
6	0.0305	0.0484	0.0138	12.4	11.8
7	0.0314	0.0468	0.0140	12.4	12.0
8	0.0304	0.0433	0.0146	11.7	12.5
9	0.0295	0.0378	0.0152	10.8	13.0
10	0.0009	0.0014	<0.0001	0.4	0.0
Total	0.2510	0.3811	0.1166	100.0	100.0

Table 2: Months of egg-laying (percentages) for *Euplectes* species in South Africa (from Prÿs-Jones and Newton unpublished data); see Chapter 5 for Southern Red Bishop data. The percentages are summarized as 5th percentile (represents start of moult), 95th percentiles (end of moult), range (90% range of egg-laying) and median egg-laying month; numbers represent parts of months, e.g. 12.4 = 40% through December (see text) Localities are abbreviations for South African provinces: WC=Western Cape, EC=Eastern Cape, NC=Northern Cape, KZN=KwaZulu-Natal, FS=Free State, Tvl=former Transvaal (includes Gauteng)

Species	Locality	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	n	5 th	95 th	Range	Median	
Southern Red Bishop																			
	EC			1	3	15	58	14	8	2				160	11.1	2.6	3.5	12.6	
	FS					3	36	56	4	<1	<1			240	12.1	2.0	1.9	1.2	
	Karoo		2	6	34	4		1	6	43	3			96	9.5	4.0	6.5	2.3	
	KZN				6	12	67	13	1	1				1276	10.8	1.8	2.9	12.5	
	NC				5	86	9							22	11.0	12.5	1.4	11.5	
	Tvl				2	20	34	30	10	4				1043	11.2	2.9	3.8	12.8	
	WC	<1	18	47	25	10	<1							1109	8.3	11.5	3.3	9.7	
Yellow-crowned Bishop																			
	EC						13	27	7	47	7			15	12.4	4.3	3.9	3.1	
	FS					6	53	12	24	6				17	11.9	3.2	3.3	12.8	
	Tvl					1	19	54	13	11	2			104	12.2	3.7	3.5	1.6	
Yellow Bishop																			
	EC			9	18		45	18	9					11	9.6	2.5	4.9	12.5	
	KZN					10	80	10						10	11.5	1.5	2.0	12.5	
	WC	<1	23	44	26	5	1							239	8.2	11.2	3.0	9.6	
Fan-tailed Widow																			
	EC					25	50		25					16	11.2	2.8	3.6	12.5	
	KZN			4	5	24	40	18	7	1				148	10.2	2.5	4.3	12.4	
White-winged Widow																			
	KZN					13	41	38	6		3			32	11.4	2.7	3.3	12.9	
	Tvl				1	4	37	26	29	3				70	11.8	2.9	3.1	1.3	
Red-collared Widow																			
	EC			14	25	32	7	4	18					28	9.4	2.7	5.4	11.3	
	KZN				17	31	36	13	2	2				64	10.3	1.9	3.6	12.0	
	Tvl				4	18	46	25	4	4				28	11.1	2.6	3.5	12.6	
Long-tailed Widow																			
	EC			20	45	25		10						20	9.3	1.5	4.3	10.7	
	FS				9	45	26	6	13	1				152	10.5	2.7	4.2	11.9	
	KZN			3		38	25	22	13					32	11.1	2.6	3.6	12.4	
	Tvl				7	17	30	31	13	2				87	10.7	2.8	4.1	12.9	

Table 3: Estimates of the primary moult parameters of adults of five species of widowbirds (Long-tailed Widow, White-winged Widow, Red-collared Widow, Fan-tailed Widow, and Yellow Bishop) in South Africa; Southern Red Bishop data is from Chapter 5
Localities are abbreviations for South African provinces: WC=Western Cape, EC=Eastern Cape, GP=Gauteng, KZN=KwaZulu-Natal; and area in which the data were collected; Gauteng is included in the Transvaal region of Table 2

PFMG model = * indicates that the PFMG data of White-winged Widows was used as wings of the species concerned were not available; Model = blank means that wings of the species concerned were used

Area	PFMG model	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
Long-tailed Widow											
all		26 Mar	4.8	20.6	2.9	60.7	2.0	8.7	25 May	7.1	279
White-winged Widow											
GP		18 Apr	2.5	26.3	1.6	46.5	1.5	3.3	3 Jun	2.6	685
Red-collared Widow											
GP	*	5 Apr	2.5	30.8	1.6	59.9	2.0	3.5	3 Jun	2.6	667
Fan-tailed Widow											
KZN grid 2930	*	2 Apr	1.9	18.1	0.9	50.5	1.7	2.8	23 May	2.0	1002
Southern Red Bishop											
WC grids 3318 & 3418		13 Dec	1.1	25.3	0.6	88.6	3.0	1.7	12 Mar	1.2	3154
GP, 1998-2003		23 Mar	1.5	35.1	1.1	71.9	2.4	2.5	3 Jun	2.3	4808
EC		28 Apr	4.0	47.3	2.9	89.0	3.0	7.0	26 Jul	6.1	622
Yellow Bishop											
WC grids 3318 & 3418	*	4 Dec	2.0	23.3	1.0	103.4	3.4	3.0	17 Mar	1.8	777

Table 4: Estimates of the primary moult parameters of individual primary feathers for adult widowbirds in South Africa

(a) White-winged Widow, Gauteng, n=685

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	21 Apr	2.7	29.0	2.4	5.0	1.5	26 Apr	2.7	
2	20 Apr	2.6	28.2	2.2	8.8	1.9	29 Apr	2.7	
3	24 Apr	2.5	25.7	2.1	8.1	1.8	2 May	2.5	
4	27 Apr	2.5	25.0	2.1	7.3	1.8	4 May	2.5	
5	30 Apr	2.3	22.4	1.8	11.6	2.1	12 May	2.4	
6	8 May	2.2	19.9	1.7	7.7	1.8	16 May	2.2	
7	16 May	2.2	17.6	1.8	5.2	1.5	21 May	2.1	
8	20 May	2.1	17.6	1.9	5.7	1.5	26 May	2.0	
9	23 May	2.5	23.2	2.0	13.0	2.3	5 Jun	2.5	
mean					8.1				

(b) Red-collared Widow, Gauteng, n=667

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	6 Apr	3.1	39.9	2.9	16.0	2.4	22 Apr	2.9	
2	6 Apr	3.0	38.6	2.7	17.9	2.5	24 Apr	2.9	
3	10 Apr	2.9	37.0	2.6	17.5	2.5	27 Apr	2.9	
4	19 Apr	2.7	34.0	2.4	14.4	2.2	3 May	2.7	
5	28 Apr	2.6	31.4	2.3	9.4	1.8	7 May	2.6	
6	2 May	2.4	27.3	2.0	12.9	2.1	15 May	2.4	
7	10 May	2.2	24.9	2.0	10.7	1.9	21 May	2.3	
8	15 May	2.1	21.8	1.8	13.6	2.1	28 May	2.2	
9	18 May	1.9	19.4	1.6	17.1	2.2	4 Jun	2.1	
mean					14.4				

(c) Fan-tailed Widow, KwaZulu-Natal grid 2930, n=1002

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	9 Apr	2.5	24.4	1.7	6.8	1.7	16 Apr	2.6	
2	7 Apr	2.4	21.5	1.7	6.4	1.6	14 Apr	2.7	
3	11 Apr	2.4	20.8	1.6	8.5	1.9	19 Apr	2.6	
4	11 Apr	2.3	19.4	1.4	11.7	2.3	23 Apr	2.7	
5	13 Apr	2.2	17.4	1.3	17.2	2.7	30 Apr	2.6	
6	24 Apr	2.5	18.2	1.5	9.6	2.4	3 May	2.6	
7	29 Apr	2.6	15.1	1.5	11.0	2.5	10 May	2.4	
8	3 May	2.5	14.9	1.3	17.8	2.8	21 May	2.2	
9	17 May	2.2	10.4	1.2	13.0	2.3	30 May	1.6	
mean					11.3				

(d) Yellow Bishop, Western Cape grids 3318 and 3418, n=777

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	11 Dec	2.2	19.7	1.4	14.4	2.1	25 Dec	1.9	
2	12 Dec	2.1	19.5	1.3	17.3	2.2	29 Dec	1.9	
3	18 Dec	2.1	19.4	1.3	18.7	2.2	6 Jan	1.8	
4	24 Dec	2.4	25.2	1.5	24.3	2.5	17 Jan	2.0	
5	4 Jan	1.9	19.0	1.3	21.4	2.1	25 Jan	1.7	
6	19 Jan	1.9	21.2	1.4	20.9	2.1	8 Feb	1.8	
7	30 Jan	1.9	22.2	1.4	21.7	2.2	21 Feb	1.9	
8	11 Feb	2.1	25.3	1.5	28.5	2.5	11 Mar	2.2	
9	25 Feb	2.2	26.1	1.6	24.5	2.5	22 Mar	2.4	
mean					21.3				

Table 5: Breeding and moult in *Euplectes* species in South Africa. Average incubation and nestling periods are in days (from Tarboton 2001). Median breeding month and start and end of moult are calculated from data in Tables 2 and 3
Localities are abbreviations for South African provinces: WC=Western Cape, KZN=KwaZulu-Natal, Tvl=former Transvaal

Species	Incubation	Nestling	Sum	Locality	Median breed (month)	Moult start (month)	Moult start – median breeding (month)	Breed end (month)	Moult start – end of breeding (month)
Red Bishop	13	14.5	27.5						
Yellow-crowned Bishop	12	11	23						
Yellow Bishop	13.5	14.5	28	SWC	9.6	12.1	2.5	11.2	0.9
Fan-tailed Bishop	12.5	15.5	28	KZN	12.4	4.1	3.7	2.5	1.6
White-winged Widow	12	12	24	Tvl	1.3	4.6	3.3	2.9	1.7
Red-collared Widow	14	16	30	Tvl	12.6	4.2	3.6	2.6	1.6
Long-tailed Widow	14	15	29	KZN	12.4	3.9	3.5	2.6	1.3
Long-tailed Widow				Tvl	12.9	3.9	3.0	2.8	1.1

Figure 1: Distributions, in southern Africa, of five *Euplectes* species which occur in South Africa, where darker shading indicates higher reporting rates (from Harrison *et al.* 1997); the final graphic shows the Grassland biome (from Allan *et al.* 1997)

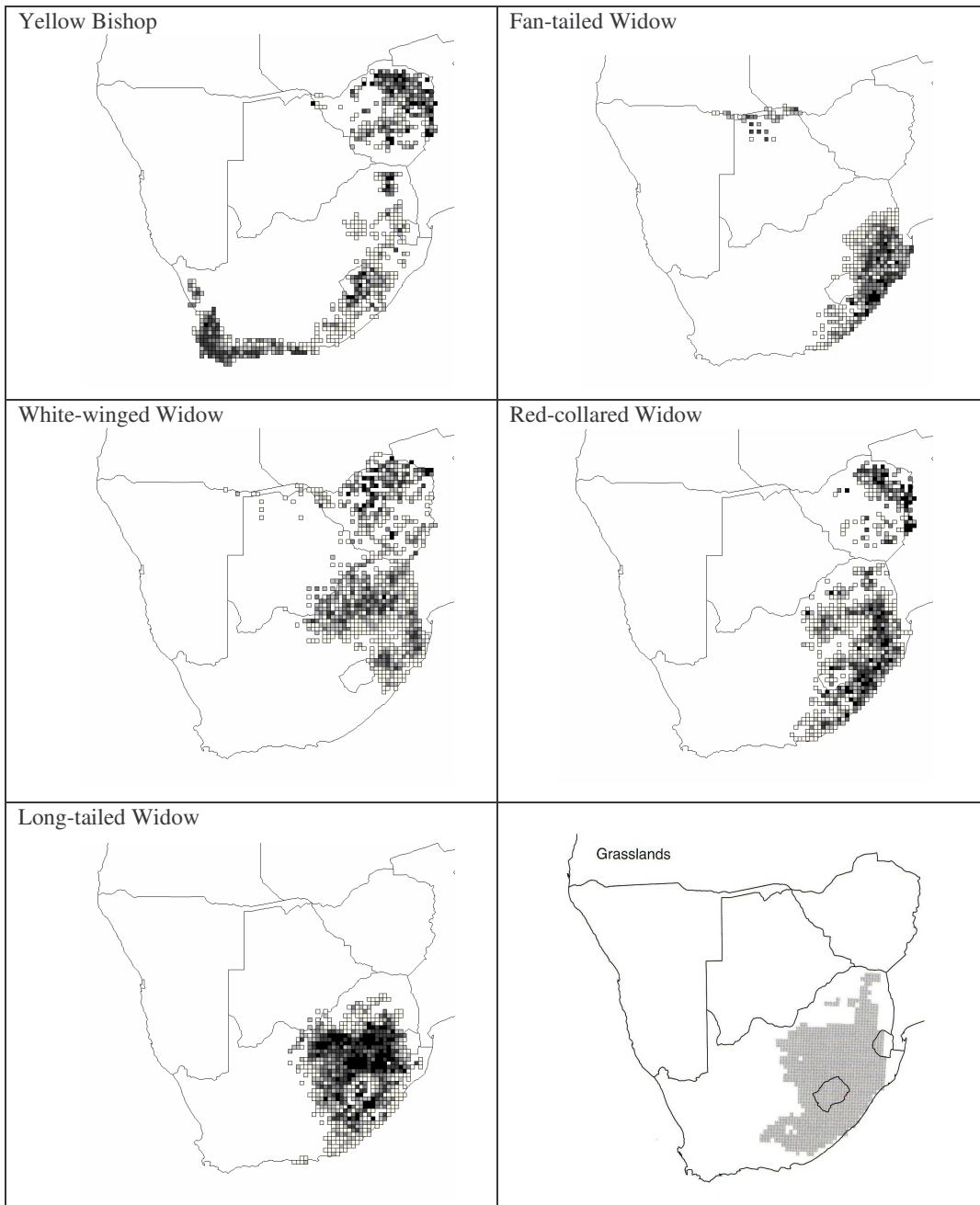


Figure 2: Capture sites for adult widowbirds in South Africa, showing sites from which primary moult data were obtained. Open circles in the Western Cape represent Yellow Bishop records; open circles in KwaZulu-Natal are for Fan-tailed Widow records; open circles in Gauteng are for White-winged Widow and Red-collared Widow records; closed squares are Long-tailed Widow records. For Southern Red Bishop capture sites, see Chapter 5

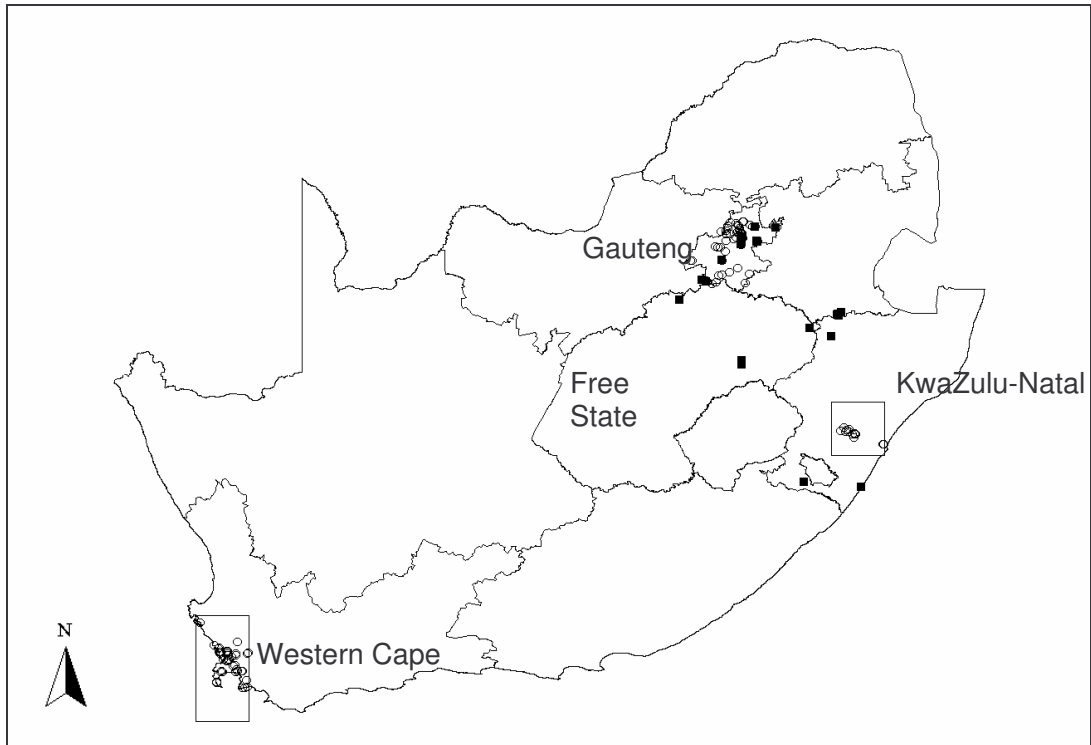


Figure 3: Relative feather masses for three adult *Euplectes* species in South Africa
Southern Red Bishop, open triangles; White-winged Widow, crosses; Long-tailed
Widow, solid squares

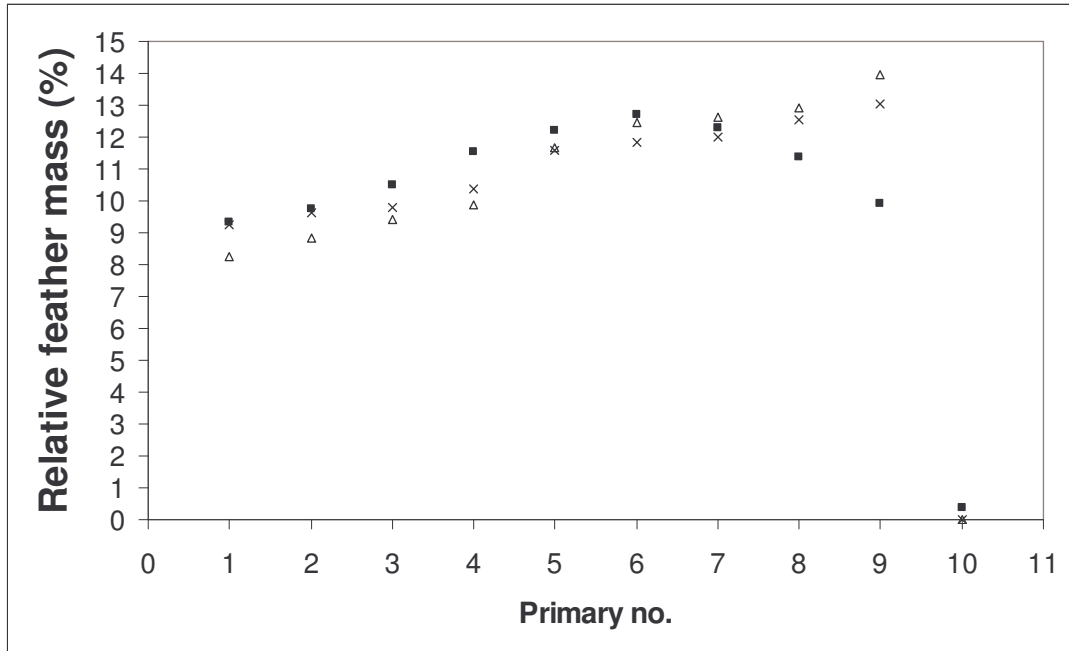
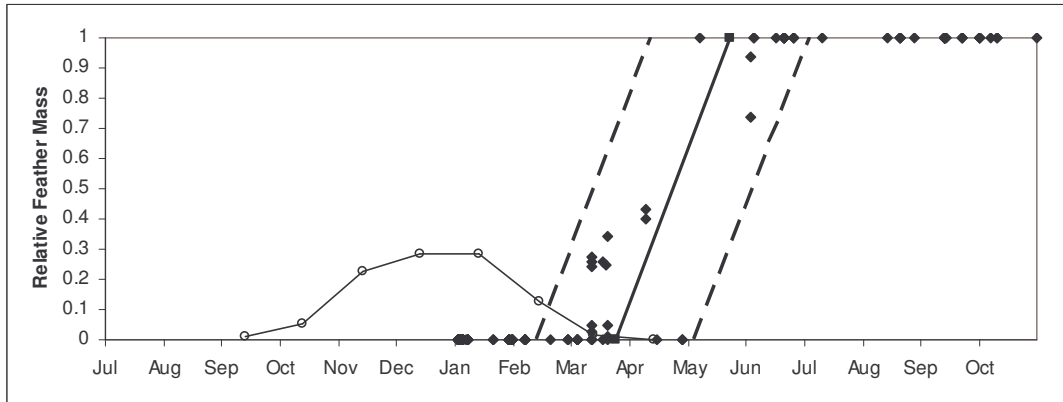
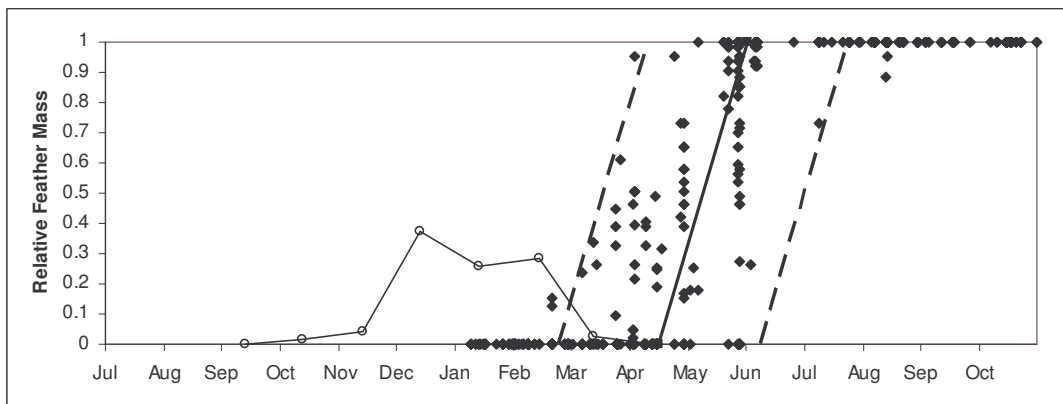


Figure 4: Timing of egg-laying and primary moult for adult *Euplectes* species in different parts of South Africa; the open circles with thin solid line shows the proportion of eggs laid per month (from the Nest Record Cards summary by Prÿs-Jones and Newton unpublished data); the solid diamonds represent 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. For Southern Red Bishop graphs, see Chapter 5

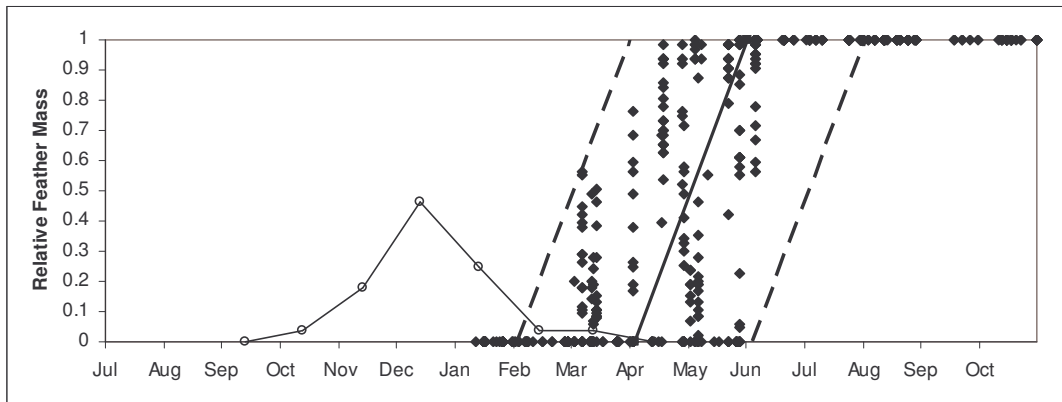
(a) Timing of breeding and primary moult in Long-tailed Widows, all records



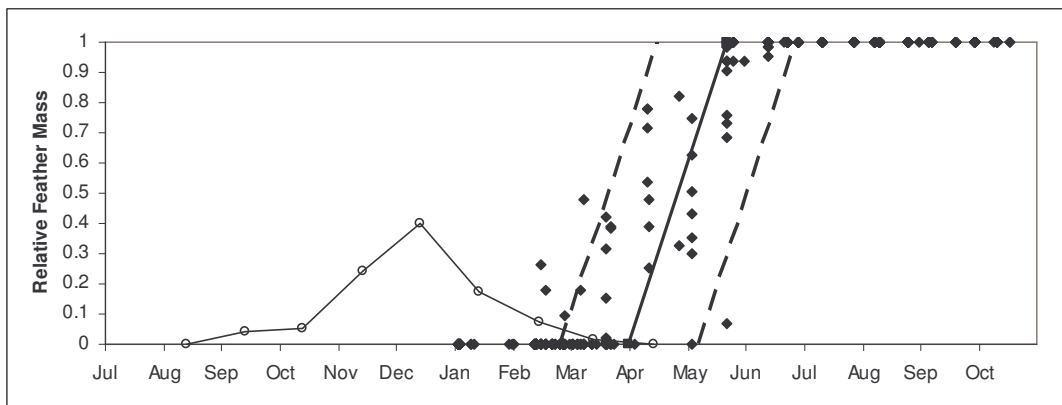
(b) Timing of breeding and primary moult in White-winged Widows, Gauteng (grids 2527, 2528, 2627, 2628)



(c) Timing of breeding and primary moult in Red-collared Widows, Gauteng (grids 2527, 2528, 2627, 2628), using relative feather masses of White-winged Widow



(d) Timing of breeding and primary moult in Fan-tailed Widows, grid 2930 (KwaZulu-Natal), using relative feather masses of White-winged Widow



(e) Timing of breeding and primary moult in Yellow Bishops, Western Cape (grids 3318–3418), using relative feather masses of White-winged Widow

