MOVEMENTS, MORTALITY AND THE ANNUAL CYCLE OF WHITE-EYES IN SOUTHERN AFRICA

R.P. Prŷs-Jones

The main purpose of this paper is to provide an analysis and feedback of information on *Zosterops* that ringers and other ornithologists have contributed over the years to the SAFRING databank. I have also drawn on other published information, notably from papers in this issue of Safring News, where it helps place the databank results in context.

MOVEMENTS

A total of 38 documented recoveries (excluding retraps) of Cape White-eyes *Zosterops pallidus* is currently available. These comprise 19 from the Transvaal, 14 from the Cape Province, four from Natal and one from South West Africa. Of these 38, only 11 showed any movement at all between places of ringing and recovery, only five moved > 5 km, and maximum recorded movement is only 31 km. No differences are apparent between birds from the Cape and those from Transvaal. On present evidence, Cape White-eyes must be considered essentially sedentary.

What numbers of birds have been ringed to produce these recoveries? Unfortunately, as Macdonald (1984) also found for the Acacia Pied Barbet *Lybius leucomelas*, problems with the computerized files of ringing totals currently preclude a direct answer to this question. However, a reasonable ball-park estimate can be arrived at. Elliott (1974) recorded that up to June 1973 5 839 birds ringed had resulted in a recovery rate of 0,36%. In addition, Bunning (1985) recorded three recoveries from 867 birds ringed in the Transvaal and Whitelaw (1985) obtained no recoveries from 326 birds ringed in the southwest Cape; between them these results imply a recovery rate of 0,25%. 37 recoveries at a recovery rate of 0,36% imply *ca* 10 300 birds ringed; at a recovery rate of 0,25% they imply *ca* 14 800 birds ringed. 15 000 is probably a reasonable upper limit of birds ringed to date.

One's immediate reaction to these figures is that southern African ringers have put in a pretty good ringing effort on a species with a discouragingly low recovery rate. However, the efforts of Australian ringers on the very similar Silvereye *Zosterops lateralis* place our achievements in a rather different perspective. Information contained in a most useful review paper on Silvereye biology by Rooke (1984) shows that over 100 000 were ringed within a ten-year period in eastern Australia for a recovery rate of only 0,075%! At least 36 000 further birds have been ringed in western Australia, with Brown

& Brown (1985) alone having ringed 13 870 in just over eight years for a recovery rate of 0,11%. From these efforts, it has been found that at least a proportion of Silvereyes in southeastern Australia undertake quite extensive migrations through the coastal regions between Tasmania and Queensland; in western Australia, movements are more restricted, but apparently still greater than any that Cape White-eyes aspire to.

Recoveries of Yellow White-eyes *Zosterops senegalensis* are limited to two Zimbabwe birds, only one of which showed any movement (5 km).

MORTALITY

Ringing recovery data can be used to calculate the average rate of mortality in a bird population. A useful summary of ways to proceed, containing a fully worked example (although with the odd mathematical error!), is provided by Haldane (1955). It is first necessary to exclude all birds recovered during their first year of life (the year in southern Africa being taken to run from 1 July - 31 June), because juveniles normally have a disproportionately high mortality relative to older birds. As white-eyes are not normally aged by ringers once they have fledged, we have to play safe by excluding any bird recovered in the year in which it was ringed. This reduces our sample of Cape White-eye recoveries to 31. Secondly, we have to divide the remaining recoveries chronologically according to whether they are 'complete', i.e. all birds ringed in the years in question should by now have died, or 'incomplete', i.e. years from which a significant proportion of birds may still be alive. The greatest elapsed time between ringing and recovery of a Cape White-eye on the SAFRING files is 95 months, so it seems reasonable to proceed on the assumption that the overwhelming majority of birds ringed before 1 July 1976 will by now (June 1985) be dead. Of the 31 recoveries, 27 belong to the 'complete' category; we shall, therefore, concentrate on these, and neglect the others as too few to consider separately.

'Complete' recoveries can be analysed by what has come to be known as Lack's method, expressed by the equation:

$$1 - s = \frac{N}{\sum x d_x},$$

where s is the annual survival rate and, hence, 1 - s is the annual mortality rate. N is the total number of recoveries. $\sum x d_x$ is best grasped by referring to Table 1 on page 28; it is the sum of the number of birds recovered in each year multiplied by the number of years the birds in question have survived, i.e. the total at the bottom of column 3.

$$\text{Thus, } 1 - s = \frac{27}{66} = 0,355$$

A standard error (σ) for this estimate is provided by the equation:

$$\sigma = (1 - s)\left(\frac{s}{N}\right)^{\frac{1}{2}},$$

$$\text{i.e. } \sigma = 0,355 \left(\frac{0,645}{27}\right)^{\frac{1}{2}} = 0,055$$

Hence, the average annual mortality of the Cape White-eye is 0,355 ± 0,055, i.e. just over 35% of adults die each year.

This estimate is only valid if the death rate can reasonably be assumed to be independent of age for the data analysed. To check this, we calculate the expected number of recoveries for each year based on a mortality rate of 0,355 (Table 1, column 4), and then the differences between these values and the observed ones (column 5). The sums of the squares of these latter values divided by the expectations provide a test of our assumption (column 6). We find that $\chi^2 = 1,63$ for 3 degrees of freedom, indicating that the probability that death rate is independent of age is > 0,5; thus our assumption is acceptable so far as we can judge.

A knowledge of the mortality rate enables us to answer other questions which may interest ringers. Two examples will perhaps suffice.

1. What is the average expectation of further life of a Cape White-eye after its first year of life? This can be estimated from the formula $-(\log_e s)^{-1}$, where s is the average survival rate (0,645), assumed for the sake of simplicity to be a constant throughout the year. Thus the expectation of further life of an adult Cape White-eye is *ca* 2,3 years.

2. The oldest Cape White-eye on record appears to be one that was retrapped 9,25 years after ringing (Langley 1979). What percentage of post-juvenile birds may be expected to live this long? This can be estimated from the formula s^x, where x is the number of years in question. Thus 1,9% of post-juvenile Cape White-eyes may reasonably be expected to live for nine years.

A final word of caution is perhaps necessary. I have worked through this example in some detail because I hope it may interest ringers to understand the way in which data they provide can be utilized. However, given a sample size of only 27 recoveries, we must in this particular case be considerably circumspect regarding the reliance we place on our annual mortality estimate for use in any broader context.

TABLE 1

STATISTICS FOR THE CALCULATION OF ANNUAL MORTALITY RATE IN THE CAPE WHITE-EYE

YEARS AFTER RINGING, x	NUMBER OF BIRDS RECOVERED, d_x	xd_x	EXPECTED RECOVERY RATE, $\sum(d_x)$	$d_x - \sum(d_x)$	χ^2
1	10	10	9,59	+0,41	0,02
2	7	14	6,18	+0,82	0,11
3	2	6	3,99	-1,99	0,99
4	2	8	2,57	-0,57	0,13
5	2	10	4,67	+1,33	0,38
6	2	12			
7	0	0			
8	2	16			
	27	76	27,00	0,00	1,63

ANNUAL CYCLE

Breeding seasonality

Information on the breeding seasonality of the Cape White-eye, whose range lies almost entirely within South Africa and Namibia (Maclean 1985), is contained in the Southern African Ornithological Society's (S.A.O.S.) Nest Record Card Scheme housed by SAFRING. For the Yellow White-eye, whose range barely encroaches on South Africa, complementary information has fortunately been published for Zimbabwe (Irwin 1981), Zambia (Benson *et al*. 1971), Malaŵi (Benson & Benson 1977) and East Africa, i.e. Kenya, Uganda and Tanzania (Brown & Britton 1980, and subsequent supplements in Scopus). In addition, Dowsett & Dowsett-Lemaire (1984) have recently provided considerable extra information for the Nyika Plateau area, spanning the borders of Zambia and Malaŵi (summarized in Dowsett 1985). This information is tabulated in Table 2 (page 30) for all regions for which > 10 breeding records were available. In all cases, each breeding record is expressed in terms of the month in which the first egg was probably laid.

More than 75% of Cape White-eye nests in the southwest Cape contained eggs laid between September and November, whereas elsewhere in South Africa the peak tends to be roughly one month later, i.e. October to December. Earlé (1981a) also found October to early December to be the peak breeding period for white-eyes in Natal. The breeding season of the Yellow White-eye in Zimbabwe, Zambia and Malaŵi resembles that of the Cape White-eye in the southwest Cape, peaking between August/September and November, but in East Africa, spanning the equator, it breeds throughout the year. However, it should be noted that East Africa is a vast region with few records, and year-round breeding need not necessarily occur in all years or all areas.

Numbers

Working in the southwest Cape, Whitelaw (1985) caught peak numbers of Cape White-eyes in December, February and March. In the Transvaal, Bunning (1985) recorded a more pronounced peak between February and April. The timing of these peaks, following directly after the main breeding seasons in the respective areas, points to their major cause being flocks of newly-independent juveniles, many of which probably die before the end of their first year of life.

Moult

In the absence of a national moult scheme (soon to be remedied!), our main sources of information on moult of the Cape White-eye are those provided by Whitelaw (1985) for the

TABLE 2

BREEDING SEASONALITY OF WHITE-EYES

	PERCENTAGE OF BREEDING RECORDS												SAMPLE SIZE
	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	
<u>Cape White-eye</u>													
Southwestern Cape	1	7	23	26	27	11	4		<1	<1			281
Karoo			13	19	44	13	6	6					16
Eastern Cape			4	24	31	30	9	1					67
Natal		1	7	26	33	25	6	2					142
Transvaal		2	4	47	22	18	4	2					45
<u>Yellow White-eye</u>													
Zimbabwe		6	42	32	11	6	3						244
Zambia		31	17	17	7	17	7	3					99
Malawi			41	35	12		6		6				17
East Africa	12	2	6	2	12	6	8	14	10	14	6	8	50
Nyika Plateau			9	61	25	4							75

TABLE 3

SEASONALITY OF PRIMARY MOULT IN WHITE-EYES

	PERCENTAGE OF WHITE-EYES CAUGHT PER MONTH EXHIBITING ACTIVE PRIMARY MOULT											
	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN
Cape White-eye:												
Southwestern Cape	0	0	0	4	6	10	43	67	78	40	0	0
Eastern Cape	(0)	0	0	0	0	(0)	(22)	(75)	(100)	-	(33)	-
Yellow White-eye:												
Nyika Plateau	-	(0)	0	0	2	17	70	73	(22)	(0)	-	5

N.B. : - = no birds caught; ( ) = total sample < 10 southwest Cape, Dowsett (1985) for the Sedgefield area (just within the eastern Cape region according to the boundaries used for the nest record card analysis), and Earlé (1981b) for Natal. For the Yellow White-eye, Dowsett (1985) provides information from the Nyika Plateau. A synopsis of the data of Dowsett (1985) and Whitelaw (1985) is provided in Table 3; that of Earlé (1981b) cannot be summarized in a precisely comparable fashion.

The timing of moult appears to vary between the different areas in a fashion correlated with the breeding season variations. Moult in the southwest Cape is concentrated between January and April, but has begun even before this. In the eastern Cape and Natal, the main period of moult is delayed by up to a month, being concentrated between February and May. On the Nyika Plateau, however, moult is well under way by January, and may be largely complete by April.

Weight

Bunning (1985), Earlé (1981b) and Whitelaw (1985) present mean monthly weights for Cape White-eyes in the Transvaal, Natal and southwest Cape respectively, but comparison of their data reveals little in the way of common seasonal trends (Figure 1 on page 33). It seems probable that at least part of the reason for this revolves around differences both in the precise timing of breeding and moult and in the proportions of juveniles caught. As Dowsett & Dowsett-Lemaire (1984) stress, seasonal change in weight of individual retrapped birds provides much better comparative material than does mean population weight.

Figure 1 does, however, highlight the generally higher weights of birds in the southwest Cape relative to those in Transvaal. Taking all months combined, the average southwest Cape bird weighs 0,87 g, or 7,9%, more than the average Transvaal bird (mean wt. 10,97 g). Cape White-eyes from Natal, and also from the eastern Cape (Dowsett 1985), have mean weights between these two extremes, being on average 4,1% and 3,0% heavier respectively than Transvaal birds. Yellow White-eyes caught by Dowsett (1985) on the Nyika Plateau weighed essentially the same as Cape White-eyes in the Transvaal.

CONCLUSIONS

Having embarked on this paper, I was pleasantly surprised at the scope of the conclusions possible from the data available. Nevertheless, it must be clear how much more information ringers could profitably obtain. Given their relative abundance, but low recovery rates and limited movements, white-eyes provide excellent examples of species from which comprehensive data should be obtained on initial handling (Prŷs-Jones 1984). Two

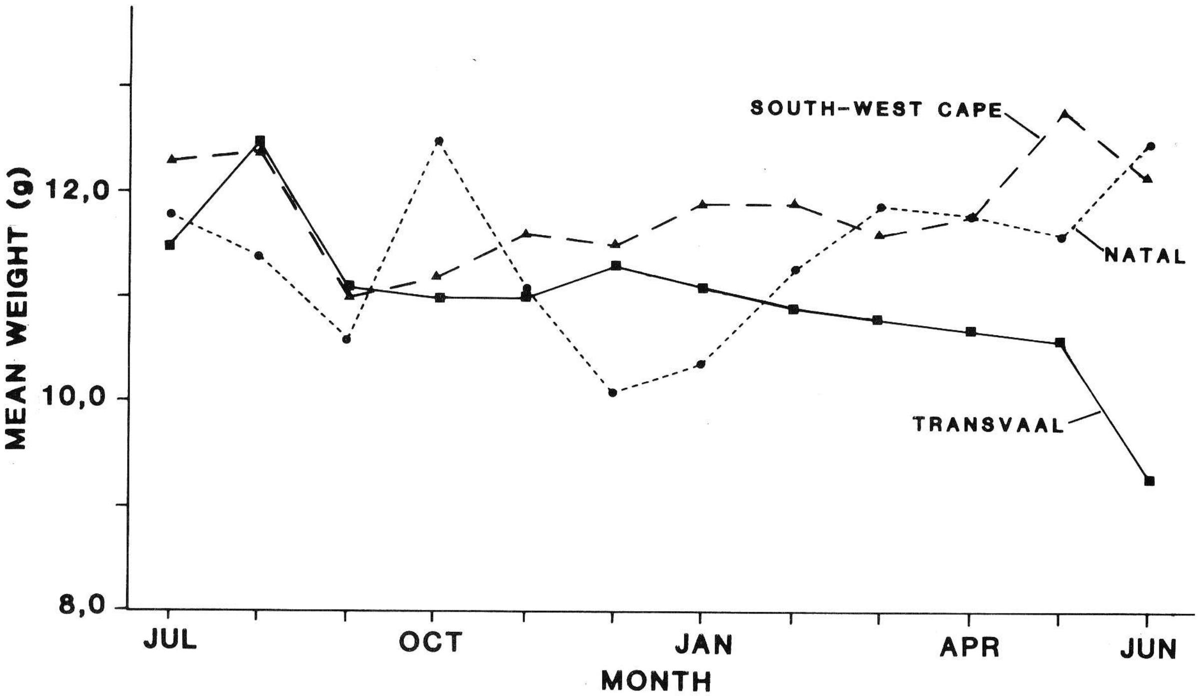

FIGURE 1

MEAN MONTHLY WEIGHTS OF CAPE WHITE-EYES IN THREE REGIONS OF SOUTH AFRICA examples may be mentioned. First, almost no birds are presently aged or sexed, but these are clearly not impossible tasks. Regarding sexing, Dowsett (1985) has highlighted the possibilities of cloacal examination, and presence of a brood patch is almost certainly useful during the breeding season. Regarding ageing, I know from examination of other *Zosterops* species that skull ossification enables one to identify many free-flying juveniles if carried out correctly on birds not in heavy head moult. Secondly, the accounts of both Dowsett (1985) and Whitelaw (1985) reveal that it is still unclear if either of our white-eye species has a complete post-juvenile moult. The answer to this may be considerably more complex than a simple yes/no if the results for Silvereyes summarized by Rooke (1984) are anything to go by. Armed with a general background of white-eye biology (Skead 1967), a knowledge of ageing and sexing methodology (Svensson 1984) and an appreciation of the technique of moult recording (Ginn & Melville 1983), any ringer can make a useful and enjoyable contribution.

ACKNOWLEDGEMENTS

I am grateful to Ian Newton for the extraction of much breeding seasonality information from nest record cards, and the S.A.O.S. and SAFRING for use of nest record card and ringing data.

REFERENCES:

Benson, C.W. & Benson, F.M. 1977. 'The Birds of Malawi'. Limbe: Montfort Press.

Benson, C.W., Brooke, R.K., Dowsett, R.J. & Irwin, M.P.S. 1971. 'The Birds of Zambia'. London: Collins.

Brown, L.H. & Britton, P.L. 1980. 'The Breeding Seasons of East African Birds'. Nairobi: East Africa Nat. Hist. Soc.

Brown, R.J. & Brown, M.N. 1985. Banding Silvereyes in Western Australia. Safring News 14: 3-6.

Bunning, L.J. 1985. Some notes on the Cape White-eye in the Transvaal. Safring News 14: 7-12.

Dowsett, R.J. 1985. Notes on white-eyes in the Cape Province and south-central Africa. Safring News 14: 13-18.

Dowsett, R.J. & Dowsett-Lemaire, F. 1984. Breeding and moult cycles of some montane forest birds in south-central Africa. Rev. Ecol. (Terre et Vie) 39: 89-111.

Earlé, R.A. 1981a. Factors governing avian breeding in *Acacia* savanna, Pietermaritzburg, part 1: extrinsic factors. Ostrich 52: 65-73.

Earlé, R.A. 1981b. Factors governing avian breeding in *Acacia* savanna, Pietermaritzburg, part 2: intrinsic factors. Ostrich 52: 74-83.

Elliott, C.C.H. 1974. Sixteenth ringing report for southern Africa. Ostrich 45: 161-166.

Ginn, H.B. & Melville, D.S. 1983. 'Moult in birds'. Tring: B.T.O. Guide 19.

Haldane, J.B.S. 1955. The calculation of mortality rates from ringing data. Acta Congr. Int. Orn. 11: 454-458.

Irwin, M.P.S. 1981. 'The Birds of Zimbabwe'. Harare: Quest Publishing.

Langley, C.H. 1979. Some longevity records for Cape White eyes from the Rondevlei Bird Sanctuary. Safring News 8: 26.

Macdonald, I.A.W. 1984. What can be learnt from the Safring databank - The case of the Acacia Pied Barbet. Safring News 13: 25-34.

Prŷs-Jones, R. 1984. Guest editorial. Safring News 13: 1-2.

Rooke, I.J. 1984. The Silvereye (*Zosterops lateralis*: Aves: Zosteropidae): a review. J. Roy. Soc. West. Aust. 66: 163-169.

Skead, C.J. 1967. 'The Sunbirds of Southern Africa also Sugarbirds, White-eyes and the Spotted Creeper'. Cape Town: A.A. Balkema.

Svensson, L. 1984. 'Identification Guide to European Passerines'. 3rd ed. Stockholm.

Whitelaw, D.A. 1985. Musings on the Cape White-eye in the southwestern Cape. Safring News 14: 19-24.

R.P. Prŷs-Jones, Percy FitzPatrick Institute of African Ornithology, University of Cape Town, RONDEBOSCH, 7700.

- o O o -