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## ACQUISITION OF NUPTIAL PLUMAGE IN THE RED-WINGED FAIRY-WREN *Malurus elegans*

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Changes with age and season in the plumage of male Red-winged Fairy-wrens *Malurus elegans* were recorded as part of a study based on more than 600 colour-banded individuals whose age and social history were known. The chestnut lores of juvenile males showed traces of black as early as 39 days after hatching. The earliest record of completely black lores was at 117 days. All young males showed traces of black in the lores by their first April. More than 80 per cent of males did not acquire full nuptial plumage (= Full Plumage, FP) in the breeding season until they were two years old; at one year old, most were half blue or less. Males moulted into their brilliant FP progressively earlier as they became older; a few remained blue all the year. Males in FP in April–July were probably at least four years old. Some juveniles moulted their primaries in the autumn of their first year, but most did not. Information on the timing of changes in plumage suggests criteria for ageing this species at different times of the year.

### INTRODUCTION AND METHODS

Knowledge of changes in plumage with age and of moult cycles is far from complete for Australian passerines. Descriptions based on skins, aviary data or birds of unknown history caught in the wild (even if aged approximately) give an incomplete picture, since variation between years and the social history of individuals are not known. In this paper, we report observations on plumages and moult of Red-winged Fairy-wrens *Malurus elegans* from a study extending over several years in which the age and social status of many individuals was known.

Red-winged Fairy-wrens in Smith's Brook Reserve, a 95.8 ha remnant of Karri *Eucalyptus diversicolor* forest 15 km south-west of Manjimup, Western Australia, were first banded by RB and MB in 1977. In 1980, IR and ER began a field

study of the behavioural ecology of *M. elegans* in the reserve. The groups present were located, their members colour-banded and their territories delineated. All nesting attempts were followed from 1980–1986, and all nestlings banded; their date of hatching was either known or estimated (Rowley *et al.* 1988). From 1987 to the present, an annual census has followed the fate of known individuals. From 1980–1989, more than 600 individuals were involved in this study, most of known age and social affiliation.

Many of these birds have been retrapped repeatedly by RB and MB. Moult of primaries, secondaries and rectrices were recorded. Details of body moult were not taken; however, the general appearance of males and the presence of any blue feathers was noted. Information from retrapping was supplemented by repeated sightings

of individuals in groups monitored throughout each breeding season. By following individuals over several years, the patterns of plumage change with age and season and the timing of moult were determined. Details of changes in the appearance of 26 known age birds followed over several years are given in Appendix 1. When a bird is referred to by band number and no further details given, the reader is referred to this Appendix.

The breeding season extended from late September to early January, but the majority of clutches were initiated in October and November (Rowley *et al.* 1988), and the first nestlings hatched in October. For convenience in assessing age codes and age in years of life, we assumed that all nestlings hatched on 1 October, and that the first year of life extended to 30 September in the year following. The second and subsequent years of life were assessed as 1 October–30 September. However, the age (in days of life) of young birds in their first year was measured from the day of hatching.

Although the plumage of *M. elegans* has been described from skins and aviary data (Pepper 1967; Schodde 1982), field studies of a large number of known individuals show there is a high degree of variability to be found in this long-lived and socially complex species.

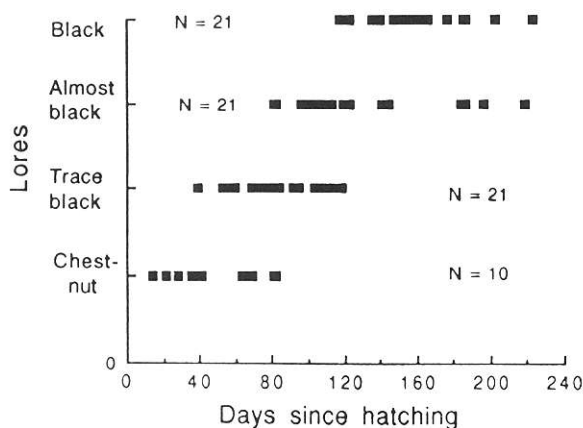


Figure 1. The age (in days since hatching) at which the lores of juvenile male *Malurus elegans* changed from chestnut to black, based on birds banded as nestlings and subsequently recaptured.

## PLUMAGE DESCRIPTIONS

### Females

The females are deep smoky grey on the crown. The chin is white, grading to a creamy-grey with a rufous tinge on the belly and flanks; the rest of the dorsal surface (including the wings) is light grey-brown, overlaid on the shoulders by faintly rufous scapulars. The tail is grey with a blue-green tinge. Deep chestnut lores extend back to the eye. The bill is shiny black (like that of the male, *contra* Schodde 1982), and the feet and claws dark grey-brown with a pinkish tinge. The ages of females could not be determined on the basis of plumage.

### Juveniles

Young Fairy-wrens leave the nest with tails less than 20 mm long which take another 40–50 days to reach their full length. Once their wings and tails are fully grown, juveniles of both sexes resemble adult females (*contra* Schodde 1982); they have the same dark grey crown, chestnut lores, shiny black bill, dark grey-brown feet with a pinkish tinge, and rufous tinge to the scapulars. The chestnut lores of juvenile males can begin to show traces of black as early as six weeks after hatching, but there is much individual variation.

### Males in their first year

From all nestlings and juveniles banded (N = 491), 63 males whose date of hatching was known were retrapped at least once in their first year. Four stages were scored as their lores changed from chestnut to black: 1. lores chestnut; 2. lores changing (i.e. with a trace of black); 3. lores almost black (i.e. with a trace of chestnut); 4. lores black (Fig. 1). The earliest at which signs of black were seen was 39 days after hatching (62229). Individuals which later proved to be males were retrapped at 81 and 82 days (46454) after hatching with lores still completely chestnut. The earliest at which we recorded completely black lores was 118 days after hatching. Some individuals retained a trace of chestnut for 6–7 months after hatching; one individual hatched on 3 January 1982 was retrapped on 9 August 1982 (212 days) still with a trace of chestnut visible in his lores. The right and left lores were not always identical: one side might be completely black

TABLE 1

Month in which males of known age (less than one year old) were retrapped with lores scored as indicated (N = 109 recaptures).

	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.
Lores chestnut	0	3	6	1	2					
Lores changing (trace black)		4	12	5	7	4				
Lores almost black (trace chestnut)			4	6	5	14	5	5	0	3
Lores black				1	5	13	3	1		

while the other showed a trace of chestnut. Two siblings from the same brood retrapped the same day in April differed in the amount of black in the lores (62227 and 62229 in Appendix 1).

The breeding season is from October to mid-January, and the first nestlings fledge in late October/early November (Rowley *et al.* 1988). This means that young males with both chestnut and black showing in their lores could be seen for approximately six months of the year (Table 1), and during this period juveniles with chestnut lores could not be identified as male or female for about five months (Table 1). In other words, birds with chestnut lores during November–March may be either adult or juvenile females or juvenile males. The presence of a brood patch or feather wear would indicate an adult female, but juveniles with chestnut lores cannot be reliably sexed until April, when all males show at least a trace of black in the lores.

#### *One-year old males*

During the first breeding season after they hatched, most one-year old males (= 1 yo) did not achieve full nuptial plumage (for brevity we refer to this as Full Plumage = FP). To document the extent to which these males progressed into FP, we used information from both sightings and recaptures. For each 1 yo male (N=90), we scored the greatest extent of FP acquired by November, by which time they had progressed as far as they would that season. We recognized five stages:

- (1) No blue visible from a distance; black lores, rufous tinge in the scapulars. In the hand, one or more pale blue feathers were frequently present in the upper back or mantle, but these were found only after careful search (57631, 62168).

- (2) Trace of blue visible from a distance; a few iridescent blue feathers around the eye or in the ear tufts, sometimes a few dark blue feathers in the nape or breast (06424, 06429, 03648, 62172).
- (3) Spotty: ear tufts and crown about half iridescent blue, half grey; nape and breast about half blue; some bright rufous in the scapulars. The overall spotty impression was given by the mixed grey and dark blue in the breast (06423, 06432, 13884, 16538, 16564, 46454).
- (4) Almost complete FP, but with a little grey in the crown and breast visible from a distance (05543, 57666).
- (5) Full Plumage. If seen at a distance, looks to be perfect FP, but in the hand may have some dark grey feathers in the centre of the crown and only a few light blue feathers at its periphery (05583, 13886, 54532, 57672).

About half the males seen at 1 yo were classified as spotty (Stage 3; Table 2). Only 16.7 per cent were classified as FP (Stage 5) or near FP (Stage 4), and 15.6 per cent showed no sign of blue at all (Stage 1). Males that had hatched early in the previous breeding season (October and November) were significantly more likely to progress further towards FP (22.8%; 13 of 57) than males hatched in December or January (6.1%; 2 of 33;  $\chi^2 = 3.1$ ,  $df = 1$ ,  $P < 0.05$ , one-tailed). Siblings from the same brood did not necessarily show the same amount of blue when 1 yo (13884 and 13886, 62171 and 62172).

TABLE 2

The extent to which one year old males had progressed towards full nuptial plumage (FP) by November, in relation to the month in which they hatched (N = 90).

Month of hatching	Plumage scored as				
	No Blue	Trace Blue	Spotty	$\frac{3}{4}$ FP	FP
October	4	4	12	4	3
November	2	5	17	2	4
December	6	3	15	1	
January	2	1	4		1
N	14	13	48	7	8
Per cent	15.6	14.4	53.3	7.8	8.9

#### *Males more than one-year old*

All males seen or recaptured during their second winter were in non-breeding plumage. By the second summer after hatching, at about 2 yo, almost all males seen had FP. Of 64 known 2 yo males seen or recaptured, only two were recorded in November as almost FP, with breast slightly spotty (16564, 36478); the rest were FP.

Most 2 yo males were not the senior male in their group — in most cases there was at least one, sometimes two, older and perhaps dominant males in the group. Therefore whether a male was full plumage or not did not depend on his being the sole, senior or dominant male in the group.

#### MOULT

Most males appeared to moult twice a year, with the exception of a few old males in some years. In late summer and autumn, flight and tail feathers were replaced and the nuptial plumage of the body was replaced by a female-like 'eclipse' plumage, except that the lores remained black. Later, at some time before the next breeding season, there was a second body moult in which the eclipse plumage was replaced by the bright nuptial plumage.

When captured, all birds were examined for signs of moult in the remiges and rectrices. Most were simply recorded as, for example, 'moulting primaries', but for 74 adults (38 males, 36 females) and 18 juveniles (12 males, 6 females), moult was scored for primaries, secondaries and rectrices on moult cards of the Australian Bird

and Bat Banding Scheme. A primary moult score was estimated for all these individuals by summing the numerical value for each feather (Snow 1967). Figure 2 indicates that moult normally started some time in January, and was completed by the end of April. Juveniles moulted later than most adults and some did not appear to moult in their first year. Moult of primaries started with P1 and progressed regularly (descendant) outwards to P10. Moult of secondaries followed the pattern described by Svensson (1984): S1–6 moulted ascendant, starting with S1; the innermost three secondaries (tertials) moulted more or less together, starting at the same time as or before S1. Tail moult appeared to progress from the central rectrices towards the outer ones, but was often irregular.

Four females appeared to moult later than usual, (Fig. 2). In two cases, we knew that the females had reared late broods, one hatching on 17 December and the other on 6 January. Late broods were probably the reason for the late moult recorded for the other two late females, but they lived in peripheral groups that were not followed in detail.

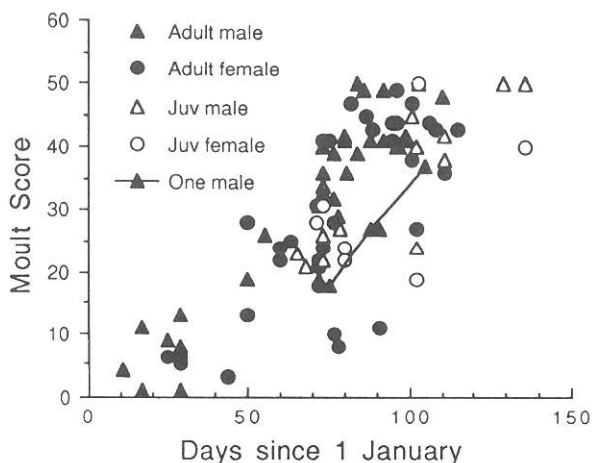


Figure 2. Moult of primaries of adult and juvenile *Malurus elegans* (male and female). Primary moult score is plotted during the period December to May. Adults are individuals known from plumage (males) or previous records to be at least one year old; juveniles include only individuals from known nests or males caught with chestnut in the lores. The line joins three records for one male caught three times in one year.

Body and primary moult appeared to start at about the same time. In some males, P1 and P2 were moulting while the body was still FP; in other cases, when only P1 had been lost, the body had progressed from FP to spotty breast, usually the first area to show signs of body moult. The last traces of the nuptial plumage to disappear (and first to appear) were traces of blue around the eye and on the mantle.

Whereas the pattern of moult in the remiges appeared regular and similar in all individuals, and to vary little with age, the pattern of body moult varied both with age and seasonal conditions. Figure 3 illustrates this for each month by plotting the percentage of all males that were captured or retrapped and assigned to one of three categories — Full Plumage, Part-blue and No Blue (juveniles were not included until April, when all should have been identifiable as males). In January, most males were FP; about 20 per cent were Part-blue or No Blue and these were mostly 1 yo males. In February and March, most adult males were Part-blue, as they lost their nuptial plumage and moulted into eclipse (No Blue). In April, the high proportion of males with no blue reflects the inclusion of juveniles for the first time. The proportion of FP males was lowest in March and increased in April and May because some males remained in an eclipse plumage for a very short time. The proportion of Part-blue and No Blue males remained at about 40 per cent for most of the winter when moult was suspended. Many males (including some less than 1 yo) acquired a few light blue feathers in the mantle before moult was suspended (juveniles 05583, 06423, 13884, 16538, 62217; adults 16564, 36478, 54532). In July, more birds began (or resumed) the moult into nuptial plumage, and by October, most males that were going to reach FP that year had done so. This moult to FP can occur quite quickly — in four individuals it was complete in less than one month — so that the increase in the percentage of FP males from June to December shows the variability in the onset of moult between different individuals.

Males which moulted into FP in autumn or winter (April–July) or from FP to FP were older males. Moult directly from FP to FP was recorded on only three occasions, once in a known age male (54532) on 25 April 1986, when he was 5 yo. Ten males of known age were recorded in FP during the winter; of these, nine were over 4 yo.

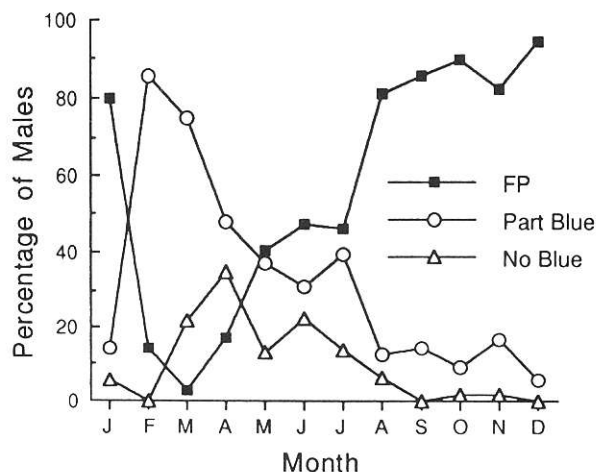


Figure 3. Percentage of males captured or retrapped in each month that were in Full Plumage, Part Blue or with no blue visible at all. Juveniles captured are not included until after April.

One (13886) was only 2 yo but had acquired a territory of his own in his third winter, a rare event at that age. For a few known age males, their recapture record shows that they attained FP progressively earlier as they grew older (36478, 06433, 54532, 57672). Because survival of adults is high in *M. elegans* (Brown *et al.* 1990), many males were of unknown age at the start of the study, and survived for several years more. However, we can assign a minimum age for many males that were recorded as FP in winter. Of 53 males in FP retrapped from April to July, 35 were 4 yo or more. For these older birds, the timing of moult into FP during winter may vary from year to year in the same individual. For example, Male 54515 was FP in June 1984, showed no blue at all on 12 July 1986, and was FP on 16 May 1987. Male 05580, caught as a breeding male in October 1981, was FP on 15 May 1987, but on 19 May 1988, had only two blue feathers in the mantle. Male 57666, in his sixth year, was FP on 30 May 1987, and had only four blue feathers in the mantle on 11 May 1988. This variation may be related to inter-seasonal differences, for example in temperature, rainfall or food availability.

During their first year of life (hatching to 30 September), 97 known males were recaptured at least once (136 recaptures; Table 3). Of these only 13 were recorded as moulting primaries,



TABLE 3

Moult recorded during their first year in juvenile males with known date of hatching.

		Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.
Recaptures	(N)	22	14	22	34	14	15	4	8	3
Moulted Primaries	(N)	0	0	4	7	2	0	0	0	0
	(%)	0	0	18	21	14	0	0	0	0
Presence of blue feathers	(N)	0	0	0	0	8	4	1	5	3
	(%)	0	0	0	0	57	27	25	63	100

secondaries or tail in March, April or May (6423, 6432, 13873, 16538, 62181). It appears that only some birds moult their primaries in their first year, and of those that do, not all moult all ten. Siblings from the same brood did not necessarily moult at the same time. Two male siblings (62171 and 62182), hatched on 12 November 1986, were retrapped on 21 April 1987; one was moulting primaries, secondaries and tail, and the other was not moulting at all. Most males in their first year underwent at least one body moult, from non-breeding to the part-nuptial plumage that they had at one year old. Some also moulted body feathers earlier in the year when primaries were moulted; a few young males recaptured in May, June or July had blue feathers in the mantle (Table 3; 05583, 06423, 13884, 16538, 62217). In these males moult was not active but suspended, as for older males: Male 06423, hatched on 24 October 1983, was recaptured on 2 July 1984 with two blue feathers in the mantle, and again on 18 August 1984 still with two blue feathers in the mantle. He had been caught on 9 March 1984 moulting primaries, and was seen as a spotty male from October to December 1984.

The date of hatching was not known exactly for only one of the 13 juvenile males found moulting primaries when retrapped in autumn. The other 12 were from nests early in the breeding season, all of which hatched before 23 November. Similarly, for juvenile females retrapped in autumn, nine were moulting primaries and all of these had hatched before the end of November. Of the 13 juvenile males known to have moulted primaries in autumn, nine were seen or retrapped in the summer after they hatched; of these, only two were FP or nearly so. One male FP at one year old was not moulting when retrapped in the

previous April. Therefore, not all early hatched males which moulted their primaries in autumn acquired FP when 1 yo.

## DISCUSSION

*Malurus elegans* differs from the Suber Fairy-wren *M. cyaneus* (Rowley 1965) in that only about 20 per cent of males acquire full nuptial plumage in the first breeding season after they hatch. In the Splendid Fairy-wren *M. splendens* (Schodde 1982; Rowley unpublished), 1 yo males are almost completely blue, although the belly frequently remains buff and is not fully blue until the birds are 2 yo. At 2 yo, all *M. splendens* and *M. elegans* males are FP in the breeding season, differing from White-winged Fairy-wrens *M. leucopterus* (Tidemann 1989) in which males only moult into nuptial blue plumage when they become the dominant male in a group. Male *M. leucopterus* that are subordinate to a blue male remain brown, or at most part-blue, so that there is only one FP male in a group. If a blue male disappears in the course of the breeding season, one of his brown or part-blue subordinates may become blue.

In *M. elegans*, there may be more than one FP male in a group: we have seen groups (N=9) with four FP males of different ages, all more than two years old. Since we have no measures of dominance, we can say nothing about the influence of dominance status on plumage. The younger males moult into FP in the breeding season at two years old or more, but they generally do so later in the year than the older males in the group, which may become blue as early as April. Thus whether a *M. elegans* male attains FP in the breeding season does not depend solely on his breeding status in the group. A helper male may be FP in April, May or June if he is old enough. The senior

breeding male in a group may not moult into FP until August if he is less than 4 yo. In at least two cases, the sole male in a group was a 1 yo male who was not completely FP. *M. cyaneus* (Rowley 1965), *M. splendens* (Rowley 1981a; unpublished), Blue-breasted Fairy-wren *M. pulcherrimus* (Rowley 1981b) and Purple-crowned Fairy-wren *M. coronatus* (Rowley 1988; unpublished) are similar to *M. elegans* in the occurrence of more than one FP male in a group.

A test of whether age alone influences the time of acquisition of FP, or whether breeding status is also significant, would be to compare the times at which helper and senior males of the same age become FP. Since survival of breeding males in *M. elegans* was so high (Brown et al. 1990), most senior males in groups were of unknown age. Such cases were rare; during the study, few birds of known age became senior male while a brother of similar age remained a helper. In at least one case, the individual variation appeared to be independent of social status or age. Two sibs (13884 and 13886) were retrapped as 1 yo helpers in November 1985. Male 13886 was FP, with a large cloacal protruberance, while 13884 was spotty, with a smaller cloacal protruberance. Both were FP in November 1986, 13884 as sole male in his natal territory and 13886 as sole male in an

adjacent territory. Male 13884 was retrapped on 3 June 1987, in eclipse plumage with four blue feathers in the mantle, while 13886 was retrapped in FP on 12 May 1987. An interesting area for further investigation would be the size of cloacal protruberances in males of different plumages at different times. The cloacal protruberance, a sperm storage organ, has been shown to vary in size with season and reproductive status in several species (Wolfson 1954; Tidemann 1989; Nakamura 1990).

An interesting aspect of moult in male *M. elegans* is that in autumn many adults which had moulted from FP into eclipse plumage nevertheless had a few blue feathers in the mantle. These were not seen unless the bird was examined carefully in the hand, and would not have been detected unless significant numbers of known individuals were retrapped in each month. Some juveniles also acquired a few blue feathers. Moult then appeared to be suspended throughout midwinter until at some stage in late winter or spring, further body moult occurred, and there was a steady progression to FP. The period of eclipse ranged from 7–8 months in males in their second year to 1–2 months in older males, with no eclipse at all in some old males. The significance of this variation was difficult to interpret. Further understanding of the relationship among age, breeding status

TABLE 4

Ageing and sexing Red-winged Fairy-wrens by plumage.

Lores	Time of Year	Plumage	Sex	Age code
Chestnut	Nov.–Jan.	Tail not fully grown	U	J
Chestnut	Nov.–Mar.	Little or no feather wear	U	J/1
Chestnut	Feb.–Mar.	Some wear; no primary moult	U	1
Chestnut	Feb.–Mar.	Primary moult	U	1+
Chestnut	Apr.–Sep.	Little or no feather wear	F	1+
Chestnut	Oct.–Jan.	Worn feathers*	F	2+
Chestnut and black	Dec.–Aug.	With or without primary moult	M	1
Black	Feb.–Apr.	No primary moult; full eclipse	M	1
Black	Feb.–Apr.	Moult in primaries; full eclipse	M	1+
Black	Apr.–Aug.	No blue; full eclipse	M	1+
Black	Feb.–Apr.	Some blue; part eclipse; probably moulting	M	2+
Black	Sep.–Dec.	Some blue; part-eclipse: 'spotty'	M	2
Black	Apr.–Jul.	Full blue	M	3+**
Black	Aug.–Mar	Full blue	M	2+†

\*Female helpers are quite common in *M. elegans*. Not all females 1 yo or more will have a brood patch during the breeding season. Breeding females will have a brood patch and very worn, probably bent tails. Female helpers (also 2+) will have worn straight tails and no brood patch.

\*\*Most males in FP through the winter are 5+, but exceptions do occur.

†An occasional two year old male may be not quite FP in hand.

and plumage changes will not come until hormonal changes are measured in birds of known age and social situation, a costly and very specialized approach (Beletsky *et al.* 1990).

We can use the information presented to suggest some criteria for estimating the age and sex of birds seen or captured at different times (Table 4). Even if caught as a recognizable juvenile in November–March, a bird with chestnut lores cannot be reliably sexed; this is not possible until April. Females are particularly difficult to age; those which are not juveniles can only be aged as in their second year or older (age code = 2+). Some males can be aged with more exactness; males that are only part-blue in the period mid-October to the end of December are almost certainly one year old or nearly so (= 2). Full Plumage males in the breeding season (October–January) cannot be aged with any certainty (= 2+); males in FP in April–June are certainly more than two years old (= 3+) and probably more than four years old (= 5+). However, we must emphasize that the times at which changes occur may vary in different parts of the range of *M. elegans*, since, for example, rainfall and temperature regimes at Manjimup are very different from those of habitats closer to Perth.

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#### APPENDIX 1

We present the plumage and moult history of a number of males, from recaptures and sightings, selected to illustrate points made in this paper. This appendix deals only with birds whose ages are known, and we use the actual age of individuals: a bird is 1 yo when it has completed one year of life and is in its second year.

Abbreviations: S = description based on sighting; if no specific date is given, the bird was seen on several occasions during the month or months indicated; R = recaptured; M = moult; p = primary; PMS = Primary Molt Score; H = hatched; CP = Cloacal protruberance, with measurement in millimetres, length × breadth × height. Blue in mantle refers to the number of blue feathers in the mantle of a bird otherwise in eclipse plumage. No blue describes a male in eclipse plumage, with black lores and no traces of blue at all.

05543: H 1982; caught as juvenile 30 Mar. 1983 with trace of chestnut in lores, no M; R 10 May 1983, no blue, no M; R 23 June 1983 no blue; S 30 Dec. 1983 Almost FP, breast spotty; R 23 Nov. 1984 FP; S Feb. 1985, M: head and breast patchy.

05583: H 27 Oct. 1983; R 7 June 1984, 1 blue in mantle; R 6 Sept. 1984, 6 blue mantle, blue round eye and face; R 20 Sept. 1984, mantle complete; S Oct.–Dec. 1984, looks to be FP; S 20 Feb. 1985, M: breast and head spotty; S Oct.–Dec. 1985 FP.

06423: H 24 Oct. 1983; R 9 Mar. 1984, 136 d old, lores black, M tail and primaries: PMS = 21, p1–4 = 5, p5 = 1, p6–10 = 0; R 2 July 1984, 2 blue in mantle; R 18 Aug. 1984, 2 blue in mantle; S Oct.–Dec. 1984, head blue at front and rear, rufous scapulars, breast spotty; S Feb. 1985, M: blue on head gone; S Oct.–Dec. 1985, FP; R 29 Jan. 1986, M primaries, PMS = 8, p1=4, p2=3, p3=1, p4–10 = 0, throat and breast now blotchy; S Nov. 1986 FP.



06424: H 24 Oct. 1983; S Oct.–Dec. 1984, black lores, some blue in face, not half blue; R 9 Sept. 1985, mantle, rump, ear coverts, throat half blue; nape and crown with trace blue; scapulars, half rufous; R 20 Oct. 1985, FP; R 12 July 1986, no blue; S Nov. 1986, FP.

06432: H 6 Nov. 1983; R 27 Feb. 1984, lores almost black; R 6 Mar. 1984, PMS 23, p1–4 = 5, p5 = 3, p6–10 = 0; R 31 Aug. 1984, blue round eye, 4 blue in mantle; Oct.–Nov. 1984, spotty; about half blue, with breast blotchy; Nov.–Dec. 1985, FP.

06433: H 6 Nov. 1983; R 5 Mar. 1984, 119 d old, lores almost black, no M; R 31 Aug. 1984, blue round eye, 4 blue in mantle; S Oct.–Nov. 1984, breast spotty, less than half blue; R 17 May. 1985, blue round eye, 4 blue in mantle; S Oct.–Nov. 1985, FP; R 17 July 1986, blue round eye, 8 blue in mantle; R 27 July 1988, mantle half blue; R 19 June 1989, FP (5 y old).

06479: H 17–24 Nov. 1983; 14 Mar. 1984, lores black, no M; R 20 Dec. 1984, 3 blue saddle, black lores, blue round eye; S Oct.–Dec. 1985, FP; S Oct.–Dec. 1986, FP; R 3 Aug. 1988 (4 y old), spotty, blue round eye, 7 blue mantle, more in pin; S 6 Nov. 1988, FP.

13873: H 23 Oct. 1984; S 19 Feb. 1985, black in lores; R 13 Mar. 1985, lores almost black, PMS = 22, p1–4 = 5, p5 = 2, p6–10 = 0.

13884: H 31 Oct. 1984; R 9 May 1985 black lores, one blue in mantle, M secondaries and tail, PMS = 50; R 22 Nov. 1985, spotty; rufous scapulars, breast spotty, mantle blue, a few blue feathers on face, CP  $3 \times 2 \times 2$  mm; R 9 July 1986, M tail, 1 blue in mantle; S Nov. 1986, FP (sole male in natal territory); R 3 June 1987, 4 blue in mantle (sib of 13886, from same brood).

13886: H 31 Oct. 1984 (sib of 13884); R 22 Nov. 1985, FP, crown not quite perfect, CP  $6 \times 5 \times 3$  mm (both 13884 and 13886 1 yo helpers); S Nov. 1986 FP (dispersed to adjacent territory as sole male); R 12 May 1987, FP.

16538: H 21 Nov. 1984; R 19 Dec. 1984, lores chestnut; R 16 May 1985, lores black, 3 blue in mantle, PMS = 50, p1–10 = 5, M secondaries and tail; S Nov.–Dec. 1985, spotty; S Nov.–Dec. 1986, FP.

16564: H 1 Jan. 1985; R 20 Apr. 1985, black in lores, no M; S Oct.–Dec. 1985, spotty; few blue in face, black smudges on grey breast; R 29 Jan. 1986, M, PMS = 13; p1 = 5, p2 = 4, p3 = 3, p4 = 1, p5–10 = 0; S Nov. 1986, almost FP, crown imperfect, breast spotty; R 21 Apr. 1987, trace blue round eye, 6 blue mantle; S Oct.–Dec. 1987, FP.

36478: H 1979; first caught 6 Mar. 1980, some black in lores; 27 Apr. 1980, lores black, no M; R 13 Nov. 1980, blue on face and side of head, mantle complete; R 24 Nov. 1981, almost FP; S Oct.–Dec. 1982, FP; R 13 Apr. 1983, blue round eye, 2 blue mantle; S 18 Aug. 1983, half blue; S 12 Oct. 1983, FP; R 31 Aug. 1984, FP (almost 5 y old); S Oct.–Dec. 1985, 1986, FP; R 13 Apr. 1987, FP, M almost finished, still one secondary nearly full grown (7 y old, in eighth year); senior male since 1985, still alive Nov. 1989.

46454: H 16 Oct. 1985; R 6 Jan. 1986, 82 d old, lores chestnut; R 23 June 1986, no blue; S Nov.–Dec. 1986, breast with a few dark spots, blue eyebrows and cheek; R 18 Jan. 1987, M, PMS = 9, p1 = 5 p2 = 3, p3 = 1, p4–10 = 0; R 21 Apr. 1987, no M, no blue; S Dec. 1987 FP; S Dec. 1988, FP.

54532: H Nov. 1980; first caught 28 Nov. 1980, lores chestnut; R 14 Feb. 1981, trace of chestnut in lores; R 5 Mar. 1981, trace of chestnut in lores, no M; S Oct.–Dec. 1981, FP; R 18 Mar. 1982, M, PMS = 39, p1–6 = 5, p7 = 4, p8 = 3, p9–10 = 1; S Oct. 1982, FP; R 5 May 1983, 4 blue in mantle; S Oct.–Dec. 1983, 1984, 1985, FP; R 25 Apr. 1986, M FP to FP (5 y old); Oct. 1986, 1987, 1988, FP.

57631: H 29 Oct. 1981; R 6 Jan. 1982, 69 d old, lores chestnut; R 18 Mar. 1982, 140 d old, lores black, no M; S Oct.–Dec. 1982, brown bird, black lores, no blue; R 13 Apr. 1983, no blue; S Oct.–Dec. 1983, FP; R 14 Mar. 1984, M, PMS = 40, p1–6 = 5, p7 = 4, p8 = 3, p9 = 2, p10 = 1, M secondaries, tail, full eclipse except some blue in ear coverts; R 17 June 1984, no blue; S Oct.–Dec. 1984, FP.

57666: H 17 Dec. 1981; R 19 Mar. 1982, trace of black in lores; R 20 Apr. 1982, lores black, no M, no blue; S Nov.–Dec. 1982, almost FP; R 5 Mar. 1983, no blue; R 13 Oct. 1983, FP; R 31 Aug. 1984, FP; S Oct.–Dec. 1985, 1986, FP; R 7 Apr. 1986, M primaries and secondaries, PMS = 40, 1 blue in mantle, trace blue in breast, trace rufous in scapulars; R 30 May 1987, FP in sixth year; R 11 May 1988, eclipse, 4 blue in mantle.

57672: H 2 Dec. 1981; R 10 Dec. 1982, spotty; R 4 Apr. 1983, no blue; S Nov.–Dec. 1983, FP; R 25 Mar. 1984, M secondaries and tail, PMS = 50, 3 blue in mantle; S Nov.–Dec. 1985, FP; R 2 May 1987 (5 y old), FP.

62168: H 26 Oct. 1986; R 13 Jan. 1987, lores almost black; S Nov. 1987, brown bird, lores black, no blue visible; S Nov. 1988, FP; S Nov. 1989, FP.

62171: H 31 Oct. 1986 (sib of 62172); R 17 Jan. 1987, 78 d old, lores changing; S Oct.–Nov. 1987, spotty.

62172: H 31 Oct. 1986 (sib of 62171); R 17 Jan. 1987, 78 d old, lores changing; S Oct.–Nov. 1987, eclipse male, black lores, less blue than 62171.

62181: H 12 Nov. 1986 (sib of 62182); R 21 Apr. 1987, 160 d old, lores black, M primaries, secondaries, tail, PMS = 38, p1–7 new, p8 = 3, p9–10 old; S Nov.–Dec. 1987, spotty; S Nov. 1988 and 1989, FP.

62182: H 12 Nov. 1986 (sib of 62181); R 21 Apr. 1987, lores black, no M; S Nov.–Dec. 1987, spotty; S Nov. 1988, FP.

62217: H 28 Nov. 1986; R 30 May 1987 no M, 4 blue in mantle; R 25 Nov. 1987, spotty, half blue, no CP visible; S Nov. 1988, FP.

62227: H 17 Dec. 1986 (sib of 62229); R 19 Apr. 1987, lores almost black, not M; S Nov.–Dec. 1987, brown bird, black lores, no blue visible.

62229: H 17 Dec. 1986 (sib of 62227); R 25 Jan. 1987, 39 d old, faint black in lores; R 19 Apr. 1987, 123 d old, lores black, not M; S Nov.–Dec. 1987, spotty.