

TIME PARTITIONING AND SUBSTRATE USE OF RED-BACKED FAIRY-WRENS *Malurus melanocephalus*

STEPHEN A. MURPHY^{1,2}, JOANNE HEATHCOTE, SILVANNA GARCIA and SARAH M. LEGGE

Australian Wildlife Conservancy, PO Box 1897, West Perth WA 6728.

¹Corresponding author

²Current address: The School for Environmental Research, Charles Darwin University, Darwin NT 0909.

Received: 7 July 2008

Red-backed Fairy-wrens *Malurus melanocephalus* are small insectivorous birds that inhabit Australia's tropical and subtropical savannas. We studied a colour-banded population in the Kimberley, Western Australia, to describe how they partition their time among the main habitat elements within their savanna environment. Eighty-nine focal watches on 29 individuals showed that Red-backed Fairy-wrens spend most of the cooler parts of their day foraging (60%), then preening/loafing (17%), then being vigilant (14%). Behaviours were not randomly undertaken across substrates, with foraging most common in grass, vigilance most common in *Acacia* spp. and preening/loafing most common in the thorny shrub, *Carissa lanceolata*. There was no significant relationship between sex and substrate or activity, suggesting that during the dry season males and females have similar time budgets.

INTRODUCTION

Red-backed Fairy-wrens *Malurus melanocephalus* (RBWs) are among the most widespread of the fairy-wrens, inhabiting the tropical and sub-tropical savannas stretching from mid-north coast of NSW, through coastal Queensland to about Broome in northwestern Western Australia (Higgins *et al.* 2001). Throughout this range, RBWs have been associated with a relatively wide variety of habitats, although almost all are characterised by a dense grassy ground layer (Higgins *et al.* 2001).

Generally, fairy-wrens spend much of their time at ground level, although it seems to be common for individuals to visit much higher substrates in all species that have been studied in detail (reviewed in Rowley and Russell 1997). Where congeners occur in sympatry, there appears to be only weak niche partitioning among substrates for foraging. For example, in a semi-arid shrubland Superb Fairy-wrens (*M. cyaneus*) spent more time on the ground (litter, grass etc) than either White-winged (*M. leucopterus*) or Variegated (*M. lamerti*) Fairy-wrens, which spent most time foraging in the outer- and inner-parts of bushes, respectively (Tidemann 1983 in Rowley and Russell 1997). However, in this and other studies, Superb Fairy-wrens also spent considerable time foraging in shrubs and trees (Wooller and Calver 1988; Cale 1994).

Several studies of avian community and foraging ecology have included RBWs (e.g. Woinarski *et al.* 1988; Brooker *et al.* 1990; Woinarski 1993), although none used individually marked birds. Chan and Augusteyn (2003) did use colour-marked birds, but their study focused on group size, territory size and territory quality, rather than how individuals partition their time among the various substrates in their habitat. Most studies agree that RBWs forage mainly by gleaning, although there is disagreement over the dominant substrate for foraging, with some studies suggesting shrubs and others grasses (reviewed in Higgins *et al.* 2001), the differences likely being related to site and seasonal factors.

There are no studies of total time budgets of colour-marked RBWs that describe how they may use elements in their habitats for behaviours other than foraging. Colour-marking offers advantages over studies involving unmarked individuals, such as being able to confidently follow individuals of known sex during focal watches. In this paper, we used individually colour-marked birds to describe how RBWs partition their time among the main habitat elements and we test for differences between the sexes.

METHODS

The study was conducted at 'Morningson Wildlife Sanctuary' in the Central Kimberley, Western Australia (S17.53°; E126.14°). The dominant vegetation community was open woodland with *Eucalyptus brevifolia*, *Lysiphyllum cunninghamii* and *Corymbia terminalis* in the upper storey; *Carissa lanceolata*, *Acacia lysiphloia* and *A. colei* in the mid-storey; and a diverse grass-layer, dominated by *Dichanthium fecundum*, *Sehima nervosum*, *Triodia bitextura* and *Heteropogon contortus*.

Individual RBWs were caught in mist nets and colour-banded with unique three-colour combinations. Birds displaying monomorphic brown plumage were sexed using the molecular method described in Griffiths *et al.* (1998). DNA for this was extracted using an ammonium acetate protocol from small blood samples of approximately 30µl taken from the brachial vein.

Behavioural observations were made in the dry season (May and June for 12 days, and October for 5 days), normally between 0600 to 1000 hours and 1630 to 1800 hours. Birds reduced their total activity in the middle of the day due to high temperatures (mean maximum for the months when observations were undertaken was 34°C). Observations were carried out using spotting scopes to minimize observer effects, and data were recorded directly into the computer program ArcPad 7 (Environmental System Research Institute Inc)

loaded on a hand-held portable digital assistant (PDA). We recorded the identity of individuals within each group, and then carried out a focal watch on a particular individual. Focal watches involved recording an individual's substrate and activity at one-minute intervals for as long as possible. Intervals were timed using an audible prompt from the PDA. In practice, the maximum duration of a single observation was about 30 minutes.

Substrate categories were:

- Grass
- *Carissa lanceolata*
- *Acacia* spp.
- *Lysiphillum cunninghamii*
- *Terminalia* spp.
- *Hakea* spp.
- *Eucalyptus* spp. (including *Corymbia* – the bloodwoods)
- Other (dead tree, termite mound, bare ground, forb etc)

Activity categories were:

- Foraging
- Vigilance (alertness from exposed points)
- Preening and loafing
- Social (including singing, chasing, allofeeding, allopreening etc)

Data were analysed in three ways. First, for each focal watch we calculated proportions for substrate and activity to describe substrate use and time partitioning in basic terms. Second, to determine if some activities were associated with particular substrates, we performed a chi-square analysis on data from the first minute of each focal watch. Third, we also did a chi-square analysis to examine whether there was a sex difference between substrate use and activity. Chi-square contingency tables included only the three most common substrates and activities. We analysed just the first observations of focal watches to avoid problems of non-independence. However, individuals could appear in analyses more than once if observations were temporally separated.

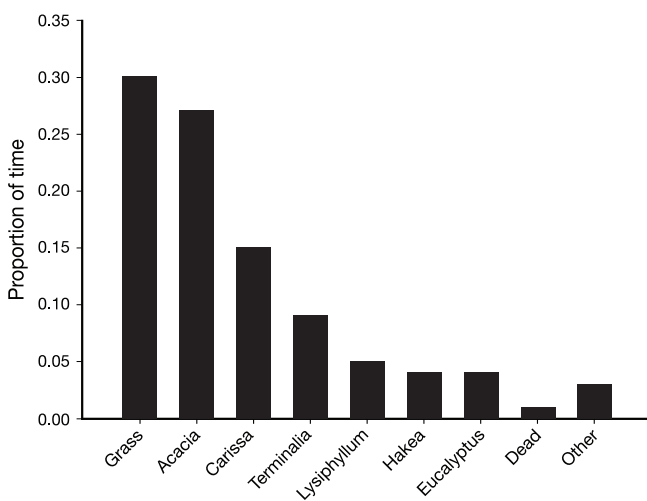


Figure 1. Substrates used by Red-backed Fairy-wrens *Malurus melanocephalus* during the dry season in the Kimberley, Western Australia, based on 454-point observations of 15 males and 14 females.

RESULTS

Twenty-nine individuals (14 females; 15 males) were observed in 89 focal watches for a total of 454-point observations. Of the 454-point observations, individuals spent most time in the grass (30%) with *Acacia* spp (27%) and *Carissa lanceolata* (15%) being the next most common substrates (Fig. 1). Trees (*Eucalyptus* spp. and *L. cunninghamii*) were used infrequently (9% combined). Foraging was the most common activity (60% of time), followed by preening and loafing (17%) and then vigilance (14%) (Fig. 2).

Chi-square analyses of substrate and activity (using the first minute of each focal watch) showed significant departures from random ($\chi^2_4 = 28.7$; $p < 0.0001$). Specifically, vigilance was more commonly performed in *Acacia*, preening/loafing in *Carissa*, and foraging in grass (Table 1). When *Acacia* and *Carissa* were pooled there remained significant differences ($\chi^2_2 = 16.1$; $p = 0.0003$; Table 1). In contrast, chi-square analyses showed that the sexes were equally likely across all substrates and that there was no sex-based bias in observed behaviours ($\chi^2_2 = 3.5$; $p = 0.18$ and $\chi^2_2 = 1.2$; $p = 0.55$, respectively).

DISCUSSION

In this study, RBWs spent a similar amount of time in grass and *Acacia* shrubs. However, our analysis has shown that different substrates were used for different activities, with foraging more common in the grass than any other substrate, even when all shrub species in our analyses were pooled. This is in contrast to Brooker *et al.* (1990) who recorded shrubs as the most common foraging substrate for RBWs in the dry season. This may be best explained by a higher relative abundance of shrubs at Brooker *et al.*'s (1990) more mesic study site in northern Kakadu National Park. Mean annual rainfall at nearby Oenpelli is approximately 1,400 millimetres (Australian Bureau of Meteorology 2008), whereas the mean annual rainfall at our study site is approximately 800 millimetres (unpublished data).

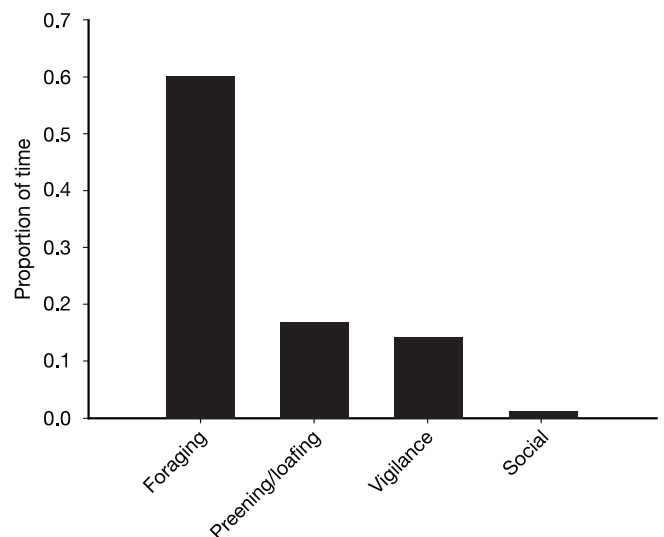


Figure 2. Red-backed Fairy-wren *Malurus melanocephalus* behaviour (expressed as proportion of time) during the dry season in the Kimberley, Western Australia, based on 454-point observations of 15 males and 14 females.

TABLE 1

Contingency table for the relationship between substrate and behaviour in Red-backed Fairy-wrens *Malurus melanocephalus* during the dry season in the Kimberley, Western Australia. Data are from the first-minute of 89 focal watches on 15 males and 14 females.

		Behaviour			
		Foraging	Loafing/Preening	Vigilance	
Substrate	<i>Acacia</i>	Observed count	13	3	16
		Expected count	21.2	2.5	8.3
		Deviation	-8.2	0.5	7.7
	<i>Carissa</i>	Observed count	10	4	0
		Expected count	9.2	1.1	3.6
		Deviation	0.8	2.9	-3.6
	Grass	Observed count	36	0	7
		Expected count	28.5	3.4	11.1
		Deviation	7.5	-3.4	-4.1
	Shrubs*	Observed count	23	7	16
		Expected count	30.5	3.6	11.9
		Deviation	-7.5	3.4	4.1

* data for *Acacia* and *Carissa* pooled.

Red-backed Fairy-wrens foraged much less on all other substrates within the study area, although some of these substrates were important for other activities. For example, *Carissa* was the preferred substrate for preening and loafing, presumably partly because of dense shade and partly due to the predator-deterrent function of the long, sharp thorns that adorn these shrubs. Much less time was spent preening or loafing in the grass layer where there is likely to be less protection from predators (also suggested by Rowley and Russell (1997) for Superb, Splendid *M. splendens* and Red-winged *M. elegans* Fairy-wrens). We do not think it likely that we overlooked birds preening or loafing in the grass because, in practice, it was relatively easy to keep track of individuals in the grass as they went about foraging in a hop-and-search mode.

Acacia spp. were the second most common substrate used after grass, where vigilance was the most common activity. Compared to *Carissa*, both *Acacia* species in the study area have a somewhat more open growth form that may allow good vantage from points that are not actually exposed, which presumably is an ideal attribute for a vigilance substrate. That males were less vigilant than females was a surprise to us, given the high rates of cuckoldry in this species (Karubian 2002) and other fairy-wrens (Rowley and Russell 1997). We expect that males might become more vigilant towards the end of the dry season as the breeding season approaches.

In many ways, RBWs are an ideal model species for examining vertebrate ecology in tropical and sub-tropical savannas. We found them to be very easy to catch, highly sedentary within a small home range (unpublished data) and their habit of perching for extended periods on exposed positions makes colour-band recording relatively

straightforward. The present study has shown that RBWs spend about 90 per cent of their time in the grass and shrubs for different activities. Given that these habitat elements are heavily impacted by fire, and RBWs decline after fire (Crawford 1979; Woinarski 1990; Woinarski *et al.* 1999; Valentine *et al.* 2007), RBWs are well suited for investigating this most pressing conservation issue.

ACKNOWLEDGEMENTS

We thank Colin and Pam Brown, Atticus Fleming and David Drynan for their help and support. Michelle Hall, Sonia Tidemann and an anonymous referee provided helpful comments to earlier versions of the manuscript. This work was carried out under *Licence to Take Fauna for Scientific Purposes Number: SF5637, DEC AEC Ethics approval 45/2006 and ABBBS Licence Number 2289.*

REFERENCES

- Australian Bureau of Meteorology (2008). Monthly climate statistics for Oenpelli. http://www.bom.gov.au/climate/averages/tables/cw_014042.shtml. Accessed 20 November 2008.
- Brooker, M. G., Braithwaite, R.W. and Estbergs, J.A. (1990). Foraging ecology of some insectivorous and nectivorous birds in forests and woodlands of the wet-dry tropics of Australia. *Emu* **90**: 215-230.
- Cale, P. (1994). Temporal changes in the foraging behaviour of insectivorous birds in a sclerophyll forest in Tasmania. *Emu* **94**: 116-126.
- Chan, K. and Augusteyn, J. D. (2003). Relationship between bird-unit size and territory quality in three species of fairy-wrens (*Malurus* spp.) with overlapping territories. *Ecological Research* **18**: 73-80.
- Crawford, D. N. (1979). Effects of grass and fires on birds in the Darwin area, Northern Territory. *Emu* **79**: 150-152.
- Griffiths, R., Double, M. C., Orr, K. and Dawson, R. J. G. (1998). A DNA test to sex most birds. *Molecular Ecology* **7**: 1071-1075.

- Higgins, P. J., Peter, J. M. and Steele, W. K. (2001). 'Handbook of Australian, New Zealand and Antarctic birds. Volume 5: Tyrant-flycatchers to Chats'. (Oxford University Press: Melbourne.)
- Karubian, J. (2002). Costs and benefits of variable breeding plumage in the red-backed fairy-wren. *Evolution* **56**: 1673-1682.
- Rowley, I. and Russell, E. (1997). 'Fairy-wrens and Grasswrens'. (Oxford University Press: Oxford.)
- Valentine, L. E., Schwarzkopf, L., Johnson, C. N. and Grice, A. C. (2007). Burning season influences the responses of bird assemblages to fire in tropical savannas. *Biological Conservation* **137**: 90-101.
- Woinarski, J. C. Z. (1990). Effects of fire on the bird communities of tropical woodlands and open forests in northern Australia. *Australian Journal of Ecology* **15**: 1-22.
- Woinarski, J. C. Z. (1993). A cut-and-paste community: birds of the monsoon rainforests in Kakadu National Park. *Emu* **93**: 100-120.
- Woinarski, J. C. Z., Brock, C., Fisher, A., Milne, D. and Oliver, B. (1999). Response of birds and reptiles to fire regimes on pastoral land in the Victoria River District, Northern Territory. *Rangeland Journal* **21**: 24-38.
- Woinarski, J. C. Z., Tidemann, S. C. and Kerin, S. (1988). Birds in a tropical mosaic: the distribution of bird species in relation to vegetation patterns. *Australian Wildlife Research* **15**: 171-196.
- Wooller, R. D. and Calver, M. C. (1988). Birds in the understorey of dry sclerophyll forest in south-western Australia after fire. *Wildlife Research* **1988**: 331-338.



Male Red-backed Fairy-wren *Malurus melanocephalus* within the grass layer at Mornington Wildlife Sanctuary.
Photo: D. Adams