

ties (Table 1). Most of the beetles were about 2 cm in length and were nocturnal, foliage-dwelling species. Only *Promethis carbonaria* is a ground-dweller, but it is found on logs and tree trunks. Thus, the Christmas Island Hawk-Owl appears to snatch insect prey mainly from the foliage rather than from the ground.

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# Hybridisation Between *Malurus lamberti rogersi* and *Malurus lamberti assimilis* in North-western Australia

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Now that the Lovely Fairy-wren *Malurus amabilis* of Cape York Peninsula is treated as a separate species of the Red-shouldered Fairy-wren complex (Schodde 1982), four mainland subspecies of the Variegated Fairy-wren *M. lamberti* are currently accepted: *rogersi* in the Kimberley and adjacent Northern Territory; *dulcis* in Arnhem Land; *assimilis* throughout the arid and semi-arid core of the continent; and *lamberti* in coastal eastern New South Wales and south-eastern Queensland. Males of each subspecies are very similar differing only slightly in colour of rectrices (blue in *rogersi* and greenish blue in *assimilis*) and in side of breast (broadly edged violet in *rogersi* and narrowly edged violet in *assimilis*). Females are blue on the dorsum in *rogersi* and *dulcis* and brown in *lamberti* and *assimilis*. Interactions between contiguous subspecies have not been quantitatively assessed, though it has been established that some intergradation occurs between *lamberti* and *assimilis* (Mack 1934, Schodde 1982) and between *rogersi* and *assimilis* (Harrison 1972, Schodde 1982). In this paper we report on the interaction between *rogersi*

and *assimilis* in the Kimberley and adjacent Northern Territory.

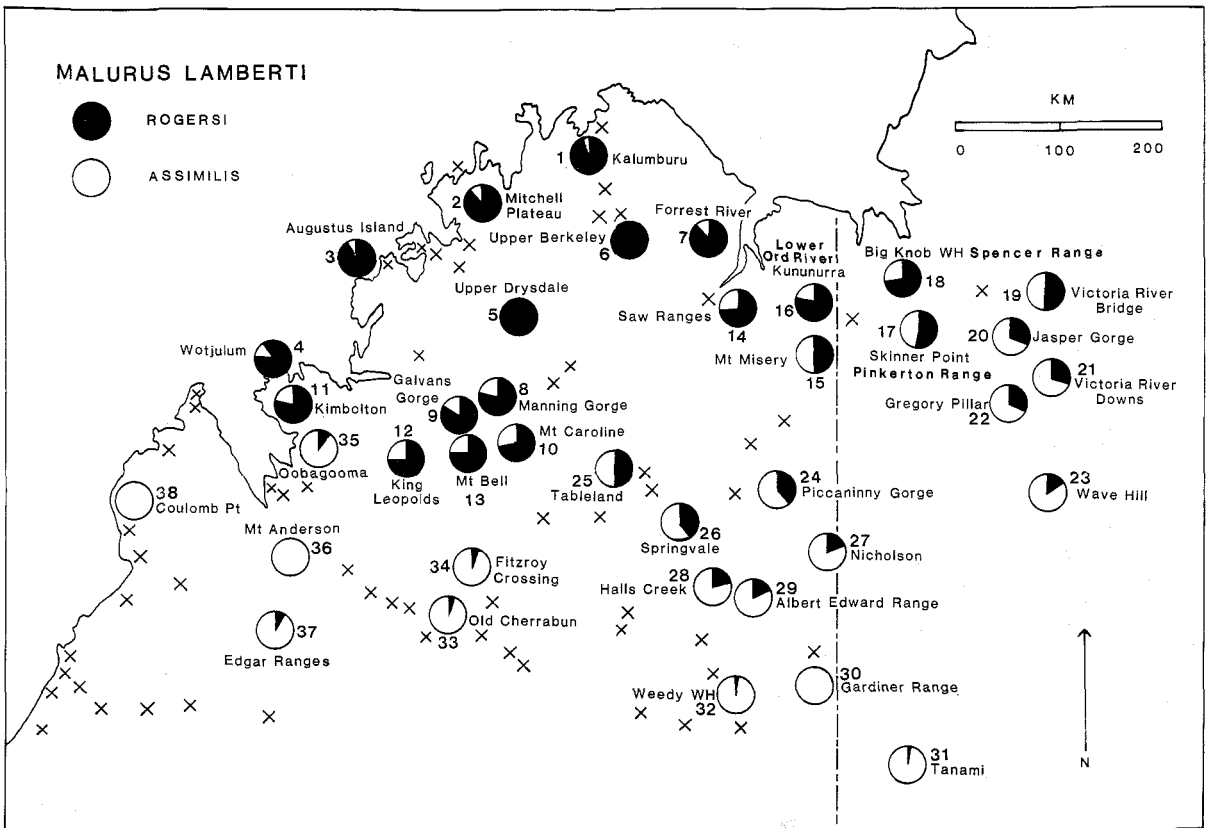
## Methods

We examined 123 male and 124 female specimens of *Malurus lamberti* in American Museum of Natural History (AMNH), British Museum (Natural History) (BMNH), Australian Museum (AM), Museum of Victoria (MV) and Western Australian Museum (WAM).

Because males of *rogersi* and *assimilis* differ only slightly in colour they were not considered further. The striking differences between females were analysed by devising a scale for each character (Table 1). The character index of the crown and back ranged from 0 in *assimilis* to 5 in *rogersi*, for rectrices from 0 to 2, the uppertail coverts from 0 to 3 and belly and flanks from 0 to 2. The total index score (maximum 12) was meaned for each locality and expressed as a percentage of 12 (0 for pure *assimilis*, 100 for pure *rogersi*).

**Table 1** Differences between females of *Malurus l. assimilis* and *M. l. rogersi* in Kimberley and adjacent Northern Territory.

	<i>M. l. assimilis</i>	Character index	<i>M. l. rogersi</i>
Crown and back	grey-brown	0.....5	blue
Rectrices	dull greenish blue	0.....2	bright blue
Uppertail coverts	pale greyish brown	0.....3	dark blue
Belly and flanks	buff	0.....2	cream



**Figure 1** Variation in colour of females of the subspecies *rogersi* and *assimilis* of the Variegated Fairy-wren *Malurus lamberti* in the Kimberley and adjacent Northern Territory. Crosses indicate sight records. The percentage of *rogersi* in a sample is represented by the area of black in the circle.

**Results**

Figure 1 and Table 2 show variation in colour and total index score in the Kimberley and Northern Territory. Specimens from north-west regions south to Kimbolton (Wyndham Range), King Leopold Ranges (localities 8

to 13), Saw Ranges, lower Ord River, Pinkerton Range and Spencer Range have predominantly the characteristics of *rogersi*; and those from south Kimberley and the upper Victoria River drainage, of *assimilis*. Intermediate populations inhabit mid-eastern Kimberley and the middle Victoria River drainage. Intergradation in west Kim-

**Table 2** Character state scores of female specimens of *Malurus lamberti* from the Kimberley and adjacent Northern Territory.

No.	Locality	n	Crown and Back					Rectrices			Uppertail Coverts				Belly and Flanks			Av. Index		
			0	1	2	3	4	5	0	1	2	0	1	2	3	0	1		2	
1	Kalumburu, Pago	3					2	1		3			3				3	94		
2	Mitchell Plateau	1					1			1			1				1	83		
3	Augustus Island	1						1		1				1				92		
4	Wotjulum	3					2	1		3				3			3	86		
5	Upper Drysdale	1						1		1				1			1	100		
6	Upper Berkeley	1						1		1				1			1	100		
7	Forrest River	1					1			1			1				1	83		
8	Manning Gorge	8				4	3	1		2	6		7	1		1	7	78		
9	Galvans Gorge	3					3			1	2		2	1			3	83		
10	Mt Caroline	1				1				1			1				1	66		
11	Kimbolton, Wyndham Range	8				1	7			1	7			4	4		3	5	82	
12	20 km NE Napier Downs	9				4	5			3	6		1	7	1		3	6	75	
13	Mt Bell, Lennard Gorge	4				1	3			1	3			4			1	3	77	
14	Saw Ranges	1					1				1				1				75	
15	Mt Misery	1					1			1			1				1		50	
16	Kununurra, Ord River	3					2	1			3			1	2		2	1	78	
17	Skinner Point, Pinkerton Range	6				2	4			3	3		4	2			5	1	56	
18	Big Knob Water Hole, Spencer Range	4					3	1		1	3			3	1		2	2	73	
19	Victoria River Bridge, Stokes Range	4				3	1			3	1		2	2			4		50	
20	Jasper Gorge	5				3	2			4	1		3	2			1	3	1	33
21	15 km WSW Victoria River Downs	3					2	1		1	2		2		1			3		31
22	Gregory's Remarkable Pillar	5				4	1			4		1	3	1			1	3	1	33
23	Wave Hill Range	6	2	4						4	2		6				3	3		13
24	Piccaninny Gorge	6					6			1	4	1	1	4	1		6			42
25	Bull Hole Bore, Tableland	1					1				1			1			1			50
26	9 km NNW Springvale	1					1				1				1			1		42
27	Nicholson	2				2				1	1		1	1			1	1		21
28	Halls Creek (14-19 km E)	8				8				4	4		6	2			3	5		20
29	Albert Edward Range	5				5				2	3		5				2	3		18
30	East Gardiner Range	1	1							1			1				1			0
31	Tanami	5	5							5			5				4	1		2
32	Weedy Water Hole	2	2							2			2				1	1		4
33	Old Cherrabun	2	2							2			2				1	1		4
34	Fitzroy Crossing-Gogo	2	2							2			2				1	1		4
35	Oobagooma (118 km SSE)	2	1	1							2			2			1	1		8
36	Mt Anderson	4	4							4			4				4			0
37	Edgar Ranges	1	1							1			1					1		4
38	Coulomb Point	1	1							1			1				1			0

berley is abrupt, and in east Kimberley and Northern Territory, gradual.

Geographical contact between *rogersi* and *assimilis* appears to be tenuous in west Kimberley. *Rogersi*-like fairy-wrens are common in shrubbery on the extreme south-western slopes of the Wyndham Range (Kimbolton) where it meets the Robinson River (Oobagooma). South of there the country is flat and covered mainly with savannah woodland and grassland. Although there are a few isolated sandstone hills, south of Oobagooma, no Red-shouldered Fairy-wrens have been recorded on them. The northern-most *assimilis*-like fairy-wrens in this area were collected in coastal pindan scrub 18 km SSE of Oobagooma. *Rogersi*-like fairy-wrens are plentiful in the granite hills of the King Leopold Range, 20 km NE of Napier Downs, but to the south *assimilis*-like birds are not encountered until the the Fitzroy River is approached. A large break in suitable habitat (dense shrubbery with little grass) occurs in the interior of west Kimberley. In east Kimberley and adjacent Northern Territory, suitable habitat is patchily continuous.

## Discussion

The intergradation between *rogersi* and *assimilis* is characteristic of a hybrid zone and supports their treatment as conspecific. The interaction is presumably similar to that between *assimilis* and *lamberti* in eastern Australia (Mack 1934, Schodde 1982), and contrasts with that between *assimilis* and the extremely similar Blue-breasted Fairy-wren *M. pulcherrimus* in south-western Australia (Serventy 1951; Ford 1966), where there is geographical overlap without interbreeding.

Serventy (1951), Ford (1966) and Schodde (1982) have speculated on the sequence of speciation and subspeciation in the Red-shouldered Fairy-wren complex. These authors suggested that *rogersi*, *dulcis* and *lamberti* evolved in their current ranges but three areas of origin have been proposed for *assimilis* namely the

Hammersley Ranges, Central Australian Highlands and inland south-eastern Australia. Range fragmentation in *M. lamberti* was probably greatest during the peak of the last glacio-aridity. By at least 8000 years ago, *assimilis* was present on the western margin of the continent because a population, sometimes referred to as *bernieri*, became isolated on Bernier Island at about that time (Ride 1962; Ford 1966). *M. l. assimilis* also occurs on Dorre and Dirk Hartog Islands off the west coast, but these became separated from the mainland after the isolation of Bernier (Ride 1962). As no other island around the Australian coast has a population of *assimilis*, further aspects of past distribution cannot be deduced.

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