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of my manuscript. However,
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express my gratitude to Mr. G.
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RESUMEN

El comportamiento alimentario del *Brushtail Possum Trichosurus vulpecula* del sudeste de Queensland.

El comportamiento alimentario de los *brushtail possums* fue estudiado en el campo. Se describen los modelos y el tiempo de provisión de forrajes de los *possums* de un bosque esclerófilo abierto, así como el manipuleo de los alimentos. Son discutidas también las influencias de los compentes nutricios y tóxicos del *Eucalyptus* en el comportamiento alimentario del *possum.*

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Plate. A juvenile *Wyulda squamicaudata* on King Leopold Sandstone. The earmarkings denote that it is female 5 first marked on 19.9.81 weighing 280 g. Photo: W. F. Humphreys.

14. THE BIOLOGY OF *Wyulda squamicaudata*, ALEXANDER 1919

*W. F. HUMPHREYS[1], R. A. HOW[1], A. J. BRADLEY[2], CATHERINE M. KEMPER[1,3] and D. J. KITCHENER[1]

The Scaly-tailed Possum, *Wyulda squamicaudata*, is endemic to the Kimberley Region of Western Australia where it is confined to areas of large boulders associated with elements of deciduous vegetation. Nineteen individuals were studied on the King Leopold Sandstones adjacent to the Mitchell Plateau in 1982. It is monotocous giving birth between March and August. Growth of young is relatively slow (head length increases 0.26 mm d^{-1}); they are weaned sometime after eight months. Females are sexually mature around two years old when they weigh about 1.1 kg. There is no sexual dimorphism in size of adults which may weigh up to 2 kg. Sex ratios of adults and pouch young are parity. Adult males have higher haematocrits than adult females but haemoglobin concentrations are similar.

Key Words: Phalangeridae, Marsupialia, Population, Growth, Reproduction, Blood Parameters, Corticosteroids.

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INTRODUCTION

THE Scaly-tailed Possum, *Wyulda squamicaudata*, Alexander 1919, (Plate opposite) was described from a female collected at Violet Valley Station in the eastern Kimberley Region of Western Australia. During the next 45 years a further three specimens were recorded (Finlayson 1942, Calaby 1957) and in the decade after 1965 a further 15 were collected and some observations made on its natural history. It is widely distributed throughout, but endemic to, the Kimberley Region (Fig. 1). It usually lives deep in rock piles and emerges at night to feed on trees (Burbidge 1983, McKenzie *et al.* 1975, 1978). Descriptions of the pelage, external morphology and cranial and dental characteristics have been given elsewhere (Alexander 1919, Finlayson 1942, Calaby 1957). Recent examination using principally electrophoretic criteria (J. A. Kerle, pers. comm.) supports earlier work (Alexander 1919, Finlayson 1942) assigning it generic status with affinities to both *Phalanger* and *Trichosurus*.

This paper results from the study of a small population of *Wyulda* which was found inhabiting an area where we had established a trapping programme for small mammals.

STUDY AREA

The Mitchell Plateau is located in the northwest Kimberley (ca. 14°S, 125°E) about 380 km northeast of Derby. It has a single wet season in summer (November to March) during which 90% of the mean annual rainfall of 1600 mm falls. The general nature of the climate, topography, fauna and flora have been documented from broadscale surveys (Western Australian Museum 1981). The laterite plateau supports open woodlands of *Eucalyptus* spp. and *Livistona eastonii* palms over grassland. The slopes of the scarp, which support deciduous vine thickets and open woodlands, give way to the deeply dissected and jointed King Leopold Sandstones.

The vegetation of the region has been described by Hnatiuk and Kenneally (1981) who recognised 21 alliances and sub-alliances under 14 formations. *Wyulda* was recorded from four locations but in only two alliances, namely vine thickets of low closed forest, and open woodland of the *E. herbertiana* sub-alliance. The main study area was situated in the latter habitat on the King Leopold Sandstones adjacent to Camp Creek, about 14 km west of the airstrip on the plateau. The smoother sandstone regions maintained open eucalypt woodland over spinifex (*Triodia* sp.), while the deeply fractured sandstone supported elements of the deciduous vine thickets.

Trapping was conducted on the principal study area in September 1981 and , in 1982, during January, April, July, September and over part of the area in November. Numerous other sites were trapped at a similar frequency but *Wyulda* were not found (see How *et al.* 1983).

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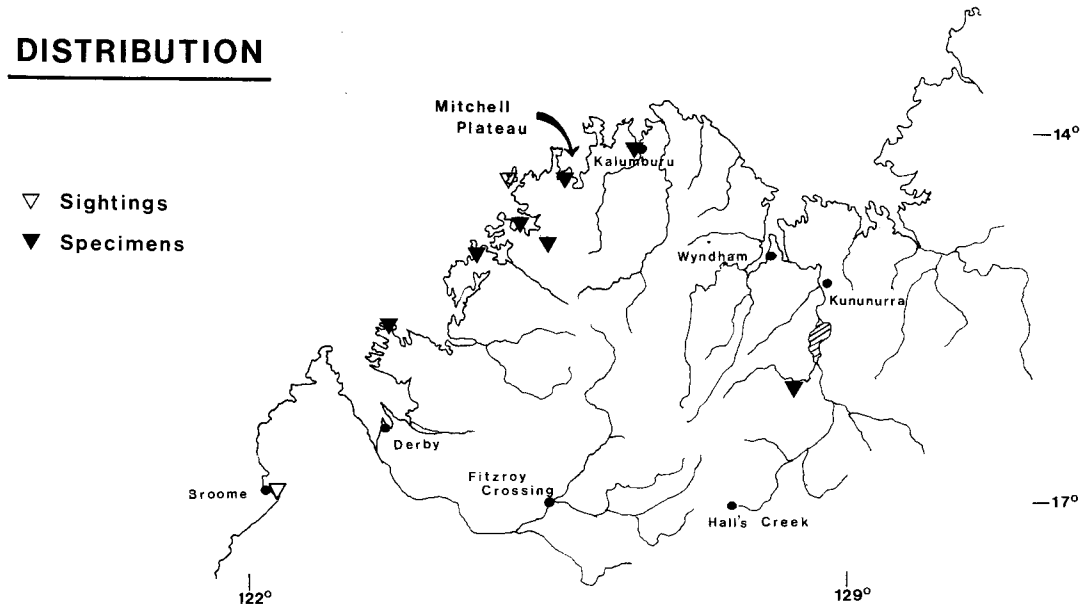

Fig. 1. Map of the north of Western Australia showing the distribution of the Scaly-tailed Possum, *Wyulda squamicaudata.*

METHODS

Wire mesh cage traps (65 × 23 × 23 cm) were placed about 40 m apart on a 150 m square small mammal grid, and extended opportunistically into the surrounding area such that about 18 ha were trapped. The traps were baited with apple and a ball of "universal" bait (peanut paste, oats and bacon). Trapped animals were weighed, measured, had their reproductive and external condition recorded, and if necessary marked by ear clipping, before release. At the first capture of each trip a cloacal swab was taken (How *et al.* 1983) and a blood sample obtained from the orbital sinus. A blood smear was made and 10 μl diluted with Turk's fluid for white cell counts. Blood was kept over ice until returned to the field laboratory. White cells were counted and haematocrit and haemoglobin determined before the remaining blood was centrifuged and the plasma and packed cells returned to Perth in liquid nitrogen.

In Perth further blood constituents were analysed by methods described in Bradley, McDonald and Lee (1980) and McDonald *et al.* (1981). Several of the physiological parameters showed significant regressions with body weight and these were corrected to the mean body weight (X) of 1.338 kg using the equations:

Free corticosteroids (log nmol ml^{-1}) $Y = 1.617 - 2.35 \times 10^{-4}$ ($r = 0.16$, $N = 33$, $P = 0.02$)

Albumin bound corticosteroid (log nmol ml^{-1}) $Y = 2.056 - 2.37X \times 10^{-4}$ ($r = 0.16$, $N = 33$, $P = 0.02$)

Total plasma corticosteroid (nmol ml^{-1}) $Y = 309.8 - 0.098X$ ($r = 0.33$, $N = 33$, $P = 0.0005$).

RESULTS

Distribution and abundance

Wyulda were observed at four locations in the Mitchell Plateau area. On the main study site *Wyulda* were trapped 52 times and involved 19 individuals (Table 1). They were captured throughout the year but were caught more readily with respect to trapping effort in September 1982 ($P < 0.025$).

Table 1. Trapping effort and the number of captures and individuals of *W. squamicaudata* at the Camp Creek study site.

Trip	# Individuals (# captures)	# Trap nights
September 1981	7 (8)	126
January 1982	4 (4)	96
April 1982	5 (6)	120
July 1982	10 (11)	120
September 1982	12 (20)	141
November 1982	2 (3)	38
	19 (52)	641

Single individuals were observed at three other locations. An adult male was trapped in a coastal vine thicket at Walsh Point in April; this was on a grid and part of the regular trapping

programme. A sub-adult male was trapped in an upland vine thicket on the eastern scarp in July and an individual of unknown sex was seen feeding in the outer foliage of a tree at Mertens Falls in September 1981.

Massive boulders and rock piles supporting elements of deciduous vine thicket were common to all four locations. On release *Wyulda* quickly moved into crevices and gulleys of the rock piles. The only individual observed at night was feeding on a tree but rapidly disappeared under large boulders. In this behaviour they resemble the Rock Ringtail Possum, *Pseudocheirus dahli.*

Size

No sexual dimorphism was observed in any of the routine measurements taken or in the adult pelage (Table 2). The measurements are similar to those for a population at Kalumburu in December 1965 and January 1966 (Table 2).

Table 2. Mean body dimensions for adult *W. squamicaudata* from the Mitchell Plateau and Kalumburu areas.

Measurement	Mitchell Plateau Adult ♂	Mitchell Plateau Adult ♀	Kalumburu Adult ♂	Kalumburu Adult ♀
Weight (g.)	1540±263 (7)	1438±200 (8)	1360–1820 (2)	1560±298 (4)
Head Length (mm)	85.8±4.1 (7)	82.8±4.7 (8)	—	—
Pes length (mm)	46.1±2.8 (6)	49.7±1.8 (6)	45– 50 (2)	51.3±4.4 (4)
Ear length (mm)	24 (1)	29.8±0.9 (4)	26– 28 (2)	31.0±2.5 (4)
Head-Body length (cm)	310–370 (2)	290–395 (2)	365– 370 (2)	369± 28 (4)
Tail length (cm)	322± 15 (6)	323± 20 (5)	255– 285 (2)	284± 18 (4)

Growth and Development

The four pouch young measured on successive trips grew in head length by 0.262 mm d^{-1} (S.D. = 0.033). Most studies on phalanger head length growth indicate that they grow linearly with respect to time during pouch life (Tyndale-Biscoe 1955, How 1976, Bell 1981). The smallest pouch young measured in this study had a head length of 8.5 mm but one with a head length of 7.5 mm was collected on Boongaree Island (McKenzie *et al.* 1978). In this study we estimated the age (Y days) assuming a head length (X mm) of 6 mm at birth and constant growth rate during pouch life: Y = (X − 6.0)/0.262.

Calaby (1957) outlined the stage of development of a young aged about 44 days (head length = 17.5 mm) and we can add few additional observations. A female at 115 days had closed eyes and prominent vibrissae, the body was well furred and there was strong demarcation between the furred and scaled parts of the tail. Another young had open eyes at 107 days.

The oldest young seen in the pouch were 147 days (67 g) and 151 days, while the youngest young seen out of the pouch was aged about 210 days and was caught in a trap that had held a lactating female the previous day. Two other females were still lactating at an estimated 191 and 247 days following the birth of their young.

A juvenile female, first caught at an age of about 210 days, did not appear to mature in her second year. Although caught in each trip, by November 1982, at an estimated age of 20 months and weighing 1150 g, its pouch was still small and dry and its teats small (<2 mm). Two other females were trapped in July and September weighing 1110 and 1050 g, both with small teats, undeveloped pouches and no indication of having bred. The lightest female with a pouch young weighed 1100g in late September when the young was about 33 days old.

Three males with weights of 640, 1050, and 1100 g had scrotal measurements distinctly smaller than those of adults.

Reproduction

The estimated ages of nine pouch young from this study and of two others (WA Museum; from Wotjulum and Boongaree I.) are consistent with births occurring between March and August (Fig. 2). Only in January and April were there any females without pouch young or not lactating (Fig. 3). The sex ratio of pouch young was five males, five females and one unsexed.

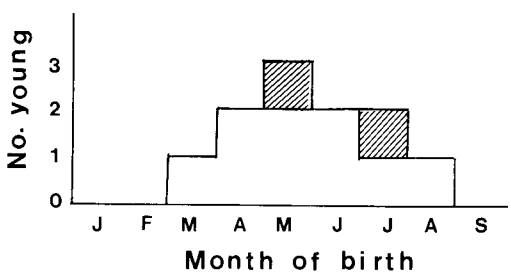

Fig. 2. Distribution of estimated dates of birth of nine *Wyulda* from the Mitchell Plateau area and two (shaded) from elsewhere in the Kimberley Region.

The two adult females with adequate trap histories had a single pouch young in both years.

The ovary of a lactating female showed no indication of persistent corpora lutea (=albicans) as found in *Trichosurus caninus* (Smith and How 1973).

An adult female collected at Kalumburu on January 22, 1966, had a 'joey' weighing 2 oz (57 g) (WA Museum, unpublished data) suggesting that breeding may extend beyond August.

Population Biology

In the main study area there were eight males (two sub-adults) and 11 females (three sub-adults). An adult and a sub-adult male were trapped at other locations.

One adult male and one adult female were removed for further study and a sub-adult male died accidentally. The overall density was roughly 1 ha^{-1}. Between successive recaptures males and females respectively moved 146 m (SD 11.3, n=13) and 76 m (SD 82.8, n=20). For those individuals trapped three or more times, the maximum range length for males was 272 m (SD=89, n=3) and for females was 221 m (SD=135, n=3).

None of the nine pouch young seen were known to be lost before the end of pouch life.

Condition

We have no indication of seasonal weight change in *Wyulda* (Tables 2 and 3); the maximum weight was 2050 g in the adult male caught in the Walsh Point vine thicket.

Various measurements of blood and its constituents are given in Table 4. Adult males had higher PCV's ($P<.05$) than females but haemoglobins were similar. Leucocyte counts were not different in any age or sex class and plasma testosterone concentrations were the same in sub-adult and adult males. Weight corrected values of protein ($F_{4,31}$ =2.83 P = 0.042), albumin ($F_{4,26}$ = 5.87 P = 0.0017), free corticosteroid ($F_{4,26}$ =4.13 P = 0.01), and total corticosteroid ($F_{4,26}$ = 3.02 P = 0.036) showed significant seasonal variation (Fig. 4), but only for albumins between September and January were follow up tests significant (*a posteriori* SNK procedure: Sokal and Rohlf 1981).

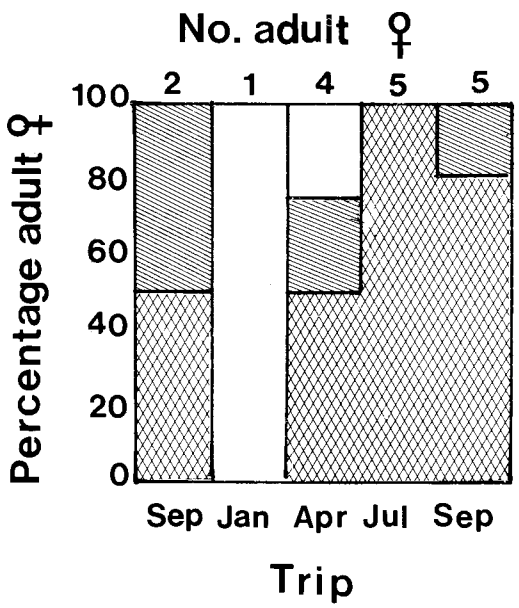

Fig. 3. The proportion of adult female *Wyulda* which were lactating but without pouch young (hatched), and those with pouch young (cross hatched) in different seasons in the Mitchell Plateau area.

Table 3. The weight of *Wyulda* adults in different seasons at the Camp Creek study site.

	Adult ♂	Adult ♀
September	1437 ± 214 (6)	1500 ± 236 (7)
January	1250 – 1420 (2)	1660 (1)
April	1500 (1)	1513 ± 185 (5)
July	1570 ± 82 (3)	1520 ± 195 (5)

Parasites

Prior to this study only the cestode *Bertiella trichosuri* had been recorded from the small intestine of *Wyulda* (Beveridge; pers. comm.); a parasite which is found also in the genus *Trichosurus* (Presidente *et al.* 1982). Examination of material from this study yielded the trematodes *Adelenema trichosuri* from the caecum and *Austrostrongylus* sp. from the small intestine. The latter genus has been considered characteristic of wallabies, and the genus *Paraustrostrongylus*, which was recorded from *T. arnhemensis* in the Mitchell Plateau area, characteristic of possums (P. J. A. Presidente, pers. comm.).

DISCUSSION

Wyulda squamicaudata occurs in the same geographic areas as the more widespread phalanger *Trichosurus arnhemensis*. In the Mitchell Plateau area these species do not overlap in range: *Wyulda* is restricted to boulders and rockpiles with elements of vine thicket vegetation, while *T. arnhemensis* is found in open woodlands on the laterite plateau and the closed mangrove forest.

Comparison of *Wyulda* with other phalangers shows considerable differences (Table 5). The two tropical phalangers, *T. arnhemensis* and *Wyulda*, have similar sizes, sex ratios and densities but *Wyulda* appears to breed in its third year while *T. arnhemensis* breeds in the second year, like *T. vulpecula* in southern Australia. *Wyulda* has a restricted breeding season while *T. arnhemensis* may breed all year round with peak breeding in July and August (J. A. Kerle, 1984). *Wyulda* grows much more slowly than *T. arnhemensis*, respectively 0.26 and 0.33 mm d^{-1}, and emergence from the pouch and weaning occur later in *Wyulda* (Table 5).

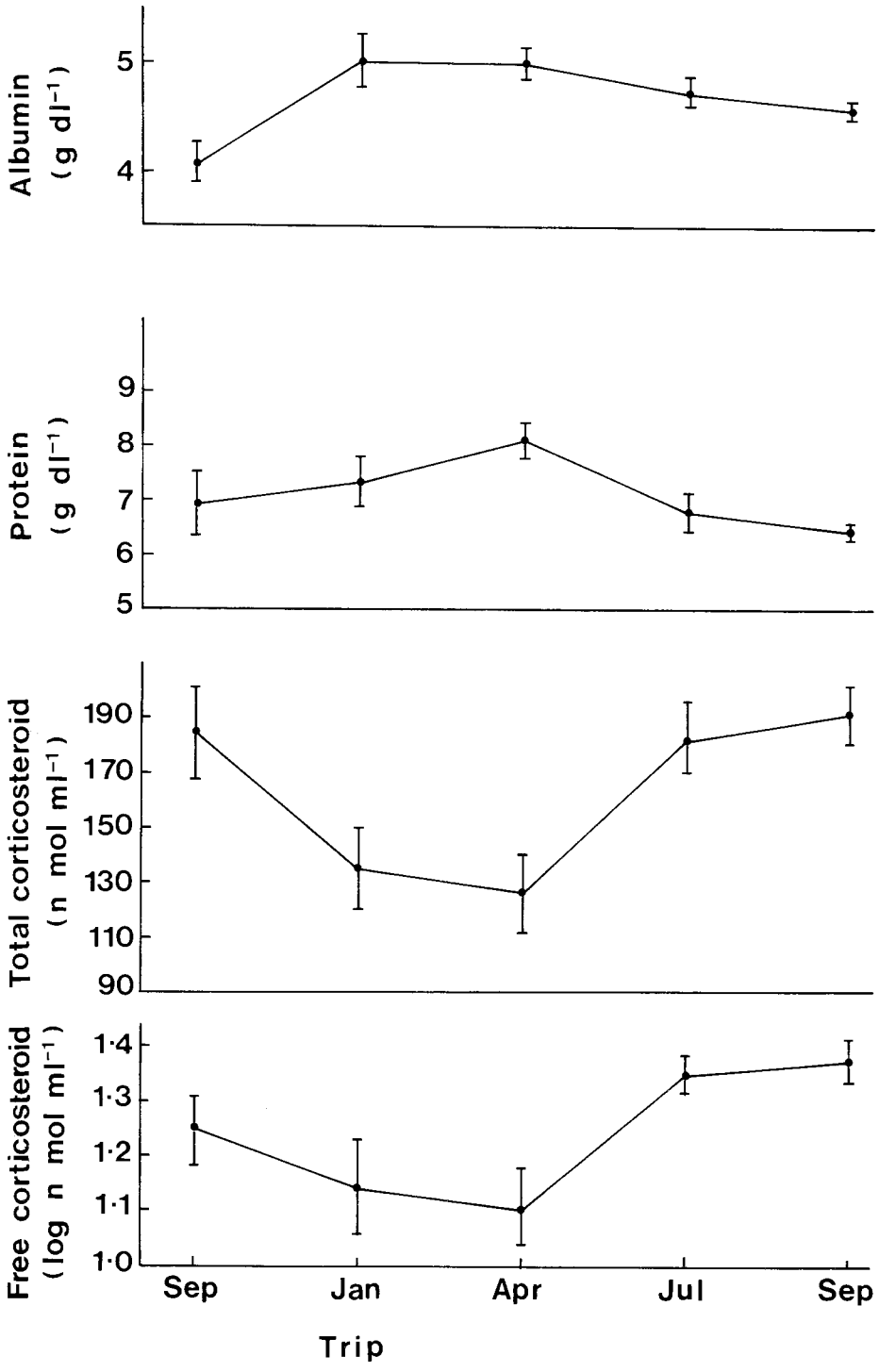

Fig. 4. Seasonal variation in the plasma concentrations of albumin, protein, total corticosteroid and free corticosteroid from *Wyulda* in the Mitchell Plateau area.

Table 4. Haematological measures and constituents from *Wyulda* at Mitchell Plateau.

Class	Haematocrit (%)	Haemoglobin ($g\,dl^{-1}$)	Leucocytes (10^9L^{-1})	Testosterone ($nmol\,ml^{-1}$)
Adult ♂	44.9±10.0 (11)	14.8±4.2 (11)	4.60±1.92 (12)	7.05±0.50 (15)
Sub-adult ♂	44.7± 9.9 (3)	15.2±0.4 (2)	6.22±1.10 (2)	
Adult ♀	41.0± 7.1 (15)	13.3±2.3 (13)	4.24±3.44 (15)	
Sub-adult ♀	40.3±10.5 (4)	11.5±2.1 (5)	3.71±2.31 (4)	

Table 5. Comparison of parameters from four species of Phalangeridae

Distribution	*Wyulda squamicaudata* Kimberley, WA	*Trichosurus arnhemensis* Northern WA and NT	*Trichosurus vulpecula* Australia and Tasmania	*Trichosurus caninus* Southeast Australia
Adult size (kg)	1.4-2.0	♂ 1.6 ♀ 1.4 (5)	♂ 2.0-4.0 ♀ 1.5-3.5	2.5-4.5
Adult sex-ratio (p ♂)	0.47	0.48-0.67 (5)	0.38 (2)	0.50 (4)
Density (ha^{-1})	1.0	0.5-6.0 (5)	0.4-2.1 (4)	0.35-1.8 (4)
Max Range Length (m)	♂ 272 ♀ 221	?	♂ 458 ♀ 350 (4)	♂ 516 ♀ 505 (4)
Age at Maturity (mths)	♂ >18 ♀ 24	♂ 15-18 ♀ 12-14 (5)	♂ <18 ♀ 9-12 (6)	♂ 30-36 ♀ 24-36 (3)
Breeding season	Mar-Aug	All year (5)	Mar-May and Sep-Nov (7)	Mar-May (3)
Adult breeding (%)	c. 100	?	90 (2)	80 (3)
Pouch-Young sex-ratio (p ♂)	0.5	0.5 (5)	0.5 (4)	0.5 (3)
Pouch-Young growth, head length ($mm\,d^{-1}$)	0.262	0.328 (5)	0.383 (8)	0.338 (3)
Pouch-Young mortality (%)	?	16.7 (5)	< 18 (7)	56 (4)
Age at Weaning (mths)	>8	5.5-6.5 (5)	6-7 (4)	8-9 (3)
Haematocrit	♂ > ♀	?	♂ > ♀ (1)	♂ > ♀ (1)
Haemaglobin	♂ = ♀	?	♂ > ♀ (1)	♂ > ♀ (1)

(1) Barnett *et al.* 1979; (2) Dunnet 1964; (3) How 1976; (4) How 1981; (5) Kerle 1984; (6) Pilton and Sharman 1962; (7) Smith *et al.* 1969; (8) Tyndale-Biscoe 1955.

The sparcity of information available from this study results from its opportunistic origin. The available demographic data permit comparison with the adjacent and confamilial *Trichosurus arnhemensis* and show that *Wyulda* has the attributes of a *K*-selected species. This suggests that *Wyulda* perceives its environment to be relatively predictable, a situation similar to the demographic response of *T. caninus* relative to *T. vulpecula* occupying dissimilar but adjacent habitats in southeastern Australia (How 1981). Table 5 contains comparative data for the basic demographic parameters of four species of the family Phalangeridae and shows that the species which occupy the same geographic region but separate habitats have different demographic characteristics consistent with separation along the *r-K* selection continuum of Pianka (1970). Nevertheless individual species may show widely disparate demographic characteristics. For example *T. vulpecula* in Tasmania shows demographic changes which correlate with the age of a habitat since burning (Hocking 1981). Comparison of individual species from different habitats in the Mitchell Plateau area would give a measure of their demographic plasticity. Such differences do occur in the area between the plateau and the mangroves in a mosaic-tailed rat, *Melomys* sp. cf. *burtoni*. Coastal populations are denser, differ in demography, size at sexual maturity, sex ratio, levels and seasonal variation in free corticosteroid levels and in the albumin polymorphism (L. Schmitt and our unpublished data).

Haematological values are given for comparative purpose and do not differ in levels or pattern from other Phalangeridae. Free corticosteroid levels, which are indicative of stress, are highest in the late dry season, a period which coincides with breeding and probably when food resources are less abundant. Plasma proteins and albumins are highest during and immediately after the wet season and decline through the dry season (Fig. 3); this may be indicative of a decline in the quality of the diet during the dry season.

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