

**PROCEEDINGS OF THE AUSTRALIAN RANGELAND SOCIETY
BIENNIAL CONFERENCE**

Official publication of The Australian Rangeland Society

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Form of Reference

The reference for this article should be in this general form;
Author family name, initials (year). Title. *In*: Proceedings of the nth Australian Rangeland Society Biennial Conference. Pages. (Australian Rangeland Society: Australia).

For example:

Anderson, L., van Klinken, R. D., and Shepherd, D. (2008). Aerially surveying Mesquite (*Prosopis* spp.) in the Pilbara. *In*: 'A Climate of Change in the Rangelands. Proceedings of the 15th Australian Rangeland Society Biennial Conference'. (Ed. D. Orr) 4 pages. (Australian Rangeland Society: Australia).

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RED KANGAROOS AND EASTERN GREY KANGAROOS IN THE ARID RANGELANDS: FACTORS IMPACTING ON WATER USE.

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ABSTRACT

Red kangaroos (*Macropus rufus*) occur widely in deserts and arid rangelands. Eastern grey kangaroos (*M. giganteus*) are a more mesic species but have spread into the arid rangelands in the past decades. Additional stock watering sites are suggested to have facilitated this movement. We examined the impact of environment, behaviour and diet on field water use by *M. rufus* and *M. giganteus* at Fowlers Gap Arid Zone Research Station in western NSW. The time was late summer and during the study the weather was fine and clear, with mean daily maximum Ta being 31 °C (range, 29-33 °C) and mean daily minimum Ta being 18 °C (range, 14-21 °C).

M. giganteus had marginally higher water turnovers (72 ml/kg.d against 58 ml/kg.d); however, they drank much more frequently than *M. rufus*. Differences between the species were also found in urine concentrations. Patterns of behaviour and diet selection were also noted. Although a specific reason could not be given for the higher water use of eastern grey kangaroos, the provision of additional stock watering sites likely facilitated their spread into the arid rangelands.

INTRODUCTION

The arid rangelands of eastern Australia support four species of kangaroos. Large populations of red kangaroos (*Macropus rufus*) are found in hotter and more arid parts of this region, while densities of the two species of grey kangaroo, the eastern grey kangaroo (*M. giganteus*) and the western grey kangaroo (*M. fuliginosus*) are highest in areas of more reliable rainfall (Caughley *et al.* 1987; Dawson 1995). The euro or inland wallaroo (*M. robustus erbescens*) occurs in the region associated with hill country; it uses microhabitats to moderate some environmental extremes (Dawson and Denny 1969; Dawson 1995).

M. giganteus, from its general distribution, appears to be the most mesic of these species (Dawson 1995). Yet in the past 30-40 years it has markedly extended its range into more arid areas. The putative reason for this has been the provision of extra watering sites for domestic stock in this drier country (Caughley 1964, Caughley *et al.* 1984). However, in an analysis of factors impacting on the distribution and density of *M. giganteus* Caughley *et al.* (1988) suggested a renewable resource, such as food, as a factor determining the inland boundary of the species. What then is the role of water availability in this story?

We have carried out a detailed examination of the comparative water relations of *M. giganteus* and *M. rufus* in the arid rangelands. We also examined the factors which might impact on water use such as thermoregulatory behaviour and diet selection.

METHODS

This study was conducted in late summer at the UNSW Arid Zone Research Station, Fowlers Gap, in the far northwest of NSW. An enclosure of approximately 8 hectares was used. It was naturally vegetated with grass, small shrubs and a few shade trees and contained a water trough. A weather station continuously monitored the air, soil and black bulb temperatures, together with relative humidity, solar radiation, wind speed and rainfall.

For each species of kangaroo 7 adult females without pouch young were used. The majority had been hand raised. They were fitted with identifying reflective collars and were in the enclosure for approximately a month before measurements were made.

Daily water turnovers were measured using tritiated water (Denny and Dawson 1975; Nagy and Costa 1980). After a background blood sample was taken the animals were injected intraperitoneally with 37 MBq of tritiated water in one mL of isotonic saline. An equilibrium blood sample was taken 6-7 hours later. The animals were released after 6-7 days when final samples were taken after the animals had been sacrificed. In addition to the blood samples, urine samples were also taken to determine osmolality via a Knauer osmometer.

Plant biomass and diet composition were estimated using the techniques of Dawson and Ellis (1994). Plants were grouped into six categories; grass, flat chenopods, round chenopods, forbs, malvaceous subshrubs and trees. The height of each plant along transects was recorded. The biomass of each plant category was determined from equations based on percent cover and plant height. Forestomach samples were taken at the termination of the experiment to determine diet in terms of the categories above. The microscopic technique used to analyse diets was based on the methods used by Dawson and Ellis (1994).

Behavioural observations were made in 6h blocks to give 4 days of data on all kangaroos. Observations were made from a tower, with scans being made every 10 min during daylight and 20 min at night. Night observations used a red spotlight and marine binoculars. Behaviour was noted as foraging, resting, locomotion and other, eg grooming, drinking. Between dawn and dusk the positioning of the animals, in shade or sun, was noted.

Data analysis mostly used single factor ANOVA. Diets were analysed using the techniques outlined in Dawson and Ellis (1994). Behavioural observations were compared using Wilcoxon signed-ranks tests. The drinking frequencies were compared using a Chi-squared test.

RESULTS

Weather during the study was stable with clear skies, light winds and no rain; the mean daily max. temperature was 31 °C (range 29-33 °C), and the mean daily min. temperature was 18 °C (range 14-21 °C). Black globe temperatures, which give an integrated estimate of environmental heat load, had daily maxima which exceeded 45 °C.

Water use is shown in Table 1 together with plasma and urine osmolality and the days between drinks of the two species. *M. giganteus* turned over significantly more water and drank more frequently. *M. rufus* concentrated urine more than the *M. giganteus*.

Table 1. Field Water Metabolism of *M. giganteus* and *M. rufus* in Summer at Fowlers Gap Research Station,

	E. Grey Kangaroos	Red Kangaroos
Mass, kg	24.3±1.3	22.6±1.4
H ₂ O Turnover, ml/kg.d	72±3 *	58±8
H ₂ O Turnover, ml/d	1750±80 *	1310±190
Plasma osmol. mosmol/kg	287±1	294±2
Urine osmol. mosmol/kg	1422±36 *	1843±28
Days between drinks	2-3 *	9

Values are means ± SE; number of *M. giganteus* and *M. rufus* were 7 and 6 respectively.

* associated with *M. giganteus* values shows significant difference from *M. rufus*, P= 0.05.

Behavioural patterns of the two species were not markedly different. At night and during cooler daylight hours the kangaroos foraged. They spent most of the daylight resting, moving into the shade as temperatures and solar radiation rose. A majority of *M. giganteus* were resting by 07:00h, over an hour prior to *M. rufus*. Generally, *M. giganteus* spent more time in shade (and deeper shade) than *M. rufus* (figure 1). Both species began feeding by 17:00-18:00h in the evening, with *M. rufus* commencing marginally before *M. giganteus*. A significant proportion of *M. rufus* appeared to rest between 23:00h and 02:00h.

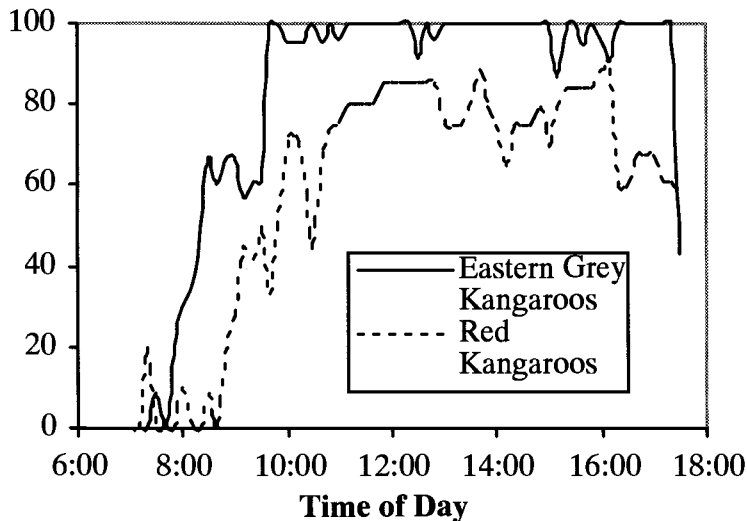


Figure 1. Proportion of the day kangaroos spend in the shade

The characteristics of the vegetation in the enclosure and the dietary pattern of the two kangaroo species is shown in Table 2. Total ground cover was only 26%, with the biomass being 240 g/m². In terms of biomass the dominant type of vegetation was flat chenopods, mainly bladder saltbush, *Atriplex vesicaria*. Green grass predominated over dry material. Grass was the principal dietary category in both species of kangaroo. Although dietary overlap between the species was large (77±4%), the diets were significantly different (Mantel test). *M. giganteus* ate more grass and less malvaceous sub-shrubs and forbs than *M. rufus*. The dietary niche breaths, or similarity of diets to available resources indicate marked selection; overlaps between diets and biomass were only about 25% for both species. This is highlighted by the pattern of preferences. Both the kangaroos had a positive preference for grass but that of *M. giganteus* was significantly higher. The water content of the vegetation varied. Grass with green material was 30-60% water, with dry grass being less than 10% water. Other non tree vegetation was 60-80% water.

Table 2. Vegetation Characteristics of Study Area and Diet Intakes and Preferences of *M. giganteus* and *M. rufus* at Fowlers Gap Station.

	grass	Fl Chen.	Ro Chen.	Malv.	Forbs	Trees
Vegetation						
Cover %	11.1±2.0	9.4±1.2	3.5±0.6	0.4±0.2	1.3±0.4	0.7±0.5
Biomass g/m ²	57±12	135±16	34±7	2±1	3±1	8±6
Diet						
<i>M. giganteus</i>	80±3	5±1	1±1	3±1	3±1	4±1
<i>M. rufus</i>	75±3	4±1	2±1	6±2	5±1	7±1
Preference						
<i>M. giganteus</i>	+0.41*	-0.91*	-0.93	-0.22*	+0.11	-0.11
<i>M. rufus</i>	+0.14	-0.96	-0.92	+0.24	+0.17	-0.03

Values are means \pm SE. Preference values (Electivities) lie between +1 and -1; large positive values indicate strong preference while large negative values indicate avoidance. Preference values for *M. giganteus* marked * are significantly different from those of *M. rufus*, $P < 0.05$.

DISCUSSION

The notion that *M. giganteus* are spreading into the arid rangelands because of more water sources is well established (Caughley *et al.* 1984). Our data indicate a higher water turnover by *M. giganteus* and more frequent drinking. Caughley (1964) also suggested that *M. giganteus* visited water more frequently than *M. rufus* in summer. However, why should *M. giganteus* need more water than *M. rufus*? Possible options are: 1) a higher thermoregulatory requirement; 2) a poorer water conserving ability; 3) a high intake of dry food; 4) different activity patterns.

Recent studies have shown only small differences between *M. giganteus* and *M. rufus* in metabolic and thermoregulatory characteristics and, notably, evaporative water requirements did not differ markedly at high temperatures (Dawson *et al.* 2000a, b). Since these studies were conducted in climate chambers, the impact of solar radiation loads is uncertain.

Excretory water losses by *M. rufus* appear lower than in *M. giganteus*. Urine osmolarities point to this (Table 1). Overall, the urine concentrating abilities of *M. giganteus* are not comparable with those of *M. rufus*. Blaney *et al.* (2000) report the max. urine osmolarity of *M. giganteus* to be 2752 mosmol/kg as compared with 4054 mosmol/kg for *M. rufus*. However, from the urine flow rates reported by Blaney *et al.* (2000) it is unlikely that concentration differences could be fully responsible for the water turnover differences of 440 ml/d. Unfortunately, we have no measurements of relative faecal water losses.

It is difficult to see how differences in either diet or behavioural patterns would have resulted in the differing water turnovers and drinking frequencies of the two species. Water content of feed can directly influence water turnover in these kangaroos (Blaney *et al.* 2000); both kangaroos selected grass but grasses varied markedly in water content with growth stage and we do not know the water content of the plants or plant parts being eaten. In regard to behavioural patterns, *M. giganteus* spent less time in the sun than *M. rufus* and foraged less during daylight. The implication would be that this was done to avoid thermoregulatory water use.

In summary, our results show that in arid rangelands *M. giganteus* uses more water and drinks more frequently than *M. rufus* during late summer. While many factors were examined a specific single cause for these results was not obvious. However, the pattern of water use of the eastern grey kangaroos is not inconsistent with the idea that their spread into the arid rangelands during the past half century is related to the provision of more water sites for domestic stock.

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