TREE USE BY KOALAS (*PHASCOLARCTOS CINEREUS*) ON ST BEES ISLAND, QUEENSLAND – REPORT OF A PILOT STUDY

A. PFEIFFER, A. MELZER, G. TUCKER, D. CLIFTON AND W. ELLIS

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This paper reports on a pilot study of tree use by koalas on a tropical Queensland island. Some koalas on St Bees Island use different tree species and different tree forms by night and by day. Ten female and six male koalas were radio-located for 10 days. Six females and three males were radio-located for nine nights. Known fodder species were used most frequently at night but non-fodder species were used most frequently during the day. Many of these non-fodder tree species appeared to have relatively dense canopies giving greater canopy shade which could provide benefits to koalas using these trees in particular weather conditions. Consequently, the behaviour of three female koalas was observed during the day for three consecutive days. When using trees with relatively dense canopies, the koalas moved less and did not breathe so heavily as when using relatively open canopy trees during the day. Although our data are limited, we hypothesise that (1) koalas select trees at night under a "drive" to feed but select trees used by day under a "drive" to seek shelter; and (2) koalas using closed canopy trees during the day will have a physiological advantage over those koalas that selected trees with canopies that provide relatively little shade. These results have informed the design of an intensive study of koala ecophysiology on St Bees Island. If the findings are substantiated then complex habitat structures may provide better habitat than habitat of simple structure — especially in hot humid environments.

A. Pfeiffer, Colby College, Waterville, ME, USA; A. Melzer (e-mail: a.melzer@cqu.edu.au), G. Tucker & D. Clifton, Koala Research Centre of Central Queensland, Central Queensland University, Rockhampton 4702, Australia; W. Ellis, Koala Study Program, Department of Zoology and Entomology, University of Queensland, St Lucia 4072, Australia; 8 December 2004.

Generally it is expected that the utilisation of habitat by herbivores would be influenced by factors such as local climate, seasonal responses of the plants and the herbivores, social imperatives directing the herbivore as well as the structure and composition of the habitat (Montgomery, 1978). This is the case with koalas and earlier studies suggest habitat utilisation seems to be influenced by rainfall and environmental moisture balance (Hindell, 1984; Gordon et al., 1988; Ellis et al., 1995; Melzer 1995), temperature (Lee & Martin, 1988; Hasegawa, 1995; Melzer, 1995), season (Hindell, 1984; White & Kunst, 1990; U Nyo Tun, 1993; Hasegawa, 1995; Melzer, 1995), habitat structure (Hindell & Lee, 1987; Faulks, 1990; Gordon et al., 1990; Mitchell, 1990; White, 1994; Melzer, 1995; Lunney et al., 1996; Jurskis & Potter, 1997) as well as social imperatives (Hindell & Lee, 1987; Gordon et al., 1990; Mitchell, 1990; Mitchell & Martin, 1990; Melzer, 1995).

Implicit in these expected patterns of habitat utilisation are benefits to the species in terms of overall fitness. Melzer (1995), seeking an explanation for contrasting population densities in adjacent habitats, proposed an energetic advantage to koalas using habitat where the most preferred tree species occurred relatively frequently over koalas using habitat where more preferred tree species occurred less frequently. It has been suggested that utilisation of relatively dense tree canopies in hot weather reflected attempts by koalas to regulate body temperature (Lee & Martin, 1988; Hasegawa, 1995). Melzer (1995) described female koalas apparently modifying their behaviour (increased frequency of apparent sedentary behaviour) in response to apparently adverse environmental conditions.

This pilot study is part of extensive studies on koala ecology on St Bees Island near Mackay. Koalas have persisted on St Bees Island since their introduction from the adjacent mainland in the 1930's (Berck, 1995). The population is of scientific interest as it shows no evidence of overexploiting the island woodland resources — unlike the island populations of southern Australia (Phillips, 1990). Koalas are found throughout the island, in all plant communities

and in a wide range of tree species and tree forms. Our observations suggested that the koalas seemed to use tree species not usually associated with koala ecology and that these trees not traditionally associated with koala fodder seemed to be used more often during the day.

As a prelude to an intensive investigation of koala ecophysiology, we sought to confirm that (1) koalas used different tree species by day and by night, and that by day (2) koalas behaved differently when in trees with relatively dense canopies from when they were in trees with relatively open canopies.

THE ISLAND. St Bees Island is a continental island about 20 km north east of Mackay on the Central Queensland coast (20°55'S, 149°26'E). The environment is dominated by highly seasonal rainfall and moderately high temperatures. Most of the annual rainfall (up to 2,000 mm) occurs in the January to March wet season and is strongly influenced by cyclonic rain depressions. The island's volcanic hills and ranges support a mosaic of *Imperata* and *Aristida* dominated grassland, dense *Corymbia*, *Allocasuarina* and *Xanthorrhoea* shrublands, *Eucalyptus tereticornis*, *E. platyphylla*, *Corymbia intermedia* and *Casuarina equisetifolia* woodlands, rainforests and low microphyll vine thickets. A significant structural element in the island's plant communities is the presence of rainforest trees, shrubs and vines as emergents in the grasslands and common mid storey elements in the woodlands. In sheltered bays, mangrove communities occur in shallow lagoons behind sand and rubble banks. Vegetation cover is strongly influenced by historical clearing for grazing (Berck, 1995) and the ongoing influence of browsing by goats (*Capra hircus*) and introduced wallabies (Swamp Wallaby *Wallabia bicolour*, Whiptail Wallaby *Macropus parryi*) (Alistair Melzer, pers. obs.). Despite these influences on vegetation cover, the plant communities are consistent with bioregional ecosystems 8.12.13 (*Xanthorrhoea latifolia* subsp. *latifolia* or *Imperata cylindrica* grassland), 8.12.12 (Variable *Corymbia* spp. ± *Eucalyptus tereticornis* ± *E. platyphylla* ± *E. drepanophylla* ± *E. portuensis* woodland) and 8.12.3 (Notophyll rainforest/microphyll rainforest often with *Argyrodendron polyandrum* and *Paraserianthes toona*, ± *Araucaria cunninghamii*) (Young, 1999).

TABLE 1. Relative frequency of tree and shrub species use over 10 days and 9 nights on St Bees Island in April 2003. Canopy class is a subjective, visual assessment of canopy architecture.

Species	% day-use (n=108)	% night-use (n=70)	Canopy class
Eucalyptus tereticornis	20.4	91.4	Open
Cryptocarya triplinervis	12.0	1.4	Closed
Ficus sp.	11.1		Closed
Paraserianthes toona	7.4		Closed
Mallotus philippensis	6.5		Closed
Cleistanthus cunninghamii	4.6		Closed
Corymbia spp.	4.6	1.4	Open
Pouteria sericea	4.6		Closed
Cupaniopsis anacardioides	2.9		Closed
Diospyros geminata	2.8		Closed
Acacia sp.	1.9		Open
Allocasuarina torulosa	1.9	1.4	Open
Diospyros humilis	1.9		Closed
Elaeocarpus sp.	1.9		Closed
Eucalyptus platyphylla	1.9	1.4	Open
Acronychia laevis	0.9		Closed
Cryptocarya hypospodia	0.9		Closed
Euroschinus falcata	0.9		Closed
Ficus sp. (sandpaper)	0.9		Open
Maytenus disperma	0.9		Closed
Polyscias elegans	0.9		Open
Tabernaemontana orientalis	0.9		Open
Archidendron lucyi		1.4	Closed
Unidentified rainforest spp.	7.4	1.4	Closed

METHODS

Ten female and six male koalas previously fitted with radio transmitters were daily (between 07:00 hrs and 18:00 hrs) radio tracked to their day roost tree for 10 days in April 2003. Of these, six female and three male koalas were tracked to the tree they were using at a randomly determined time (using a random number table) each night (between 20:00 hrs. to 04:00 hrs) for nine nights. Logistical and resource constraints precluded night tracking of the remainder of the study animals.

The trees were identified to genus, at least, and then classified as either open canopy (generally non-rainforest) or closed canopy (generally rainforest) trees by a visual assessment of canopy architecture. Rainforest species were those

species normally occurring in rainforest communities on the island or considered rainforest elements known to "invade" eucalypt communities on the island. Non-rainforest species are those associated with eucalypt woodlands on the island but may also be emergent from some rainforest communities on the island (Young, 1999). The frequency of utilisation of species and open or closed canopy tree by day and by night was compared.

An assessment of the daytime use of open and closed tree canopies was undertaken by detailed observation of three adult female koalas over three consecutive days (9-11 April 2003) with the intent of gaining an indication of koala reaction to different canopy types rather than a detailed activity budget. Each koala was observed for about six minutes (allowing time for the koala to adjust to the arrival of the observer) every two hours between 07:00 hrs and 18:00 hrs providing six records for each animal per day. Each koala was visited sequentially in the same order each time - J1, D1 and then F1. The same observer (A. Pfeiffer) collected all records. Animals were radio-located and approached quietly.

RESULTS

TREE USE. One hundred and seventy eight observations of koala tree use were made over the 10 days and nine nights (Table 1). These observations included 23 trees or shrubs identified to species and a number of rainforest trees not yet identified by us. *Eucalyptus tereticornis* was the most frequently used species by day and by night and was used relatively more frequently at night than at day. The trees and shrubs used occurred in different strata of the woodland community and at various aspects in the landscape.

Of the 108 day-observations of tree use, 32.4 % were in open canopy (eucalypt and other non-rainforest) species and 67.6 % were in closed canopy (rainforest) species. At night 95.7 % of the 70 observations were in eucalypt or non-rainforest species and 4.3 % were in rainforest species. If the observations are assumed to be independent and a chi-square test is applied (Quinn & Keough, 2002) then the utilisation of canopy classes differed significantly between day and night ($X^2 = 183$, $v = 1$, $p = 0.000$). Of these, the frequency of use of *E. tereticornis* (91.4%) dominated the observations of nocturnal tree use but represented only 20.4 % of observations during the day.

When the trees used were classified as open or closed canopy trees, 67.6% of observations of tree use were of closed canopy trees during the day while at night the majority of observations of tree use (95.7%) were in open canopy trees.

KOALA BEHAVIOUR, SHADE AND TREE FORM. An account of observation of behaviour by three female koalas over three days follows.

Day 1.

Koala J1 was located in an open canopy tree (*E. tereticornis*). It was partially protected, curled up with its back to the sun. As the sun rose, the koala received less protection. The koala had changed position at each observation period; initially curled up, sitting, sitting with limbs extended, moving to another branch and curling up, sitting and finally sitting with limbs extended. In the afternoon the koala was fully exposed to the sun and was breathing heavily.

Koala D1 was located in a closed canopy tree (*Pouteria sericia*). The koala was completely shaded throughout the day and did not change position in the canopy or body stance.

Koala F1 was located in a closed canopy tree (*Ficus* sp.) The koala was completely shaded throughout the day and did not change position in the canopy or body stance.

Day 2.

Koala J1 was located in an open canopy tree (*E. tereticornis*) in a shaded location. As the sun rose, the koala was exposed to nearly full sun. At this stage it was breathing heavily and appeared unable to settle. By the third observation period the koala had moved to a small closed canopy tree (*Diospyros geminata*). The koala was curled up in total shade. It did not change stance or position in the canopy for the remainder of the day.

Koala D1 was found in an open canopy tree (*Corymbia intermedia*) in the densest portion of the canopy. By midday the koala was only partially shaded or, at times, fully exposed to the sun. During the day the koala moved down the trunk and around to the shaded quadrant. As the day progressed the koala continued to move into the shaded quadrant of the trunk. Body stance was leaning against the tree with limbs extended.

Koala F1 was found in a closed canopy tree (*Diospyros geminata*) in total shade. At one observation period the koala was partially exposed to the sun. At this time the koala's limbs were extended. Otherwise the koala remained in the same position in the canopy and exhibited no other changes in stance.

Day 3.

Koala J1 was found in an open canopy tree (*E. tereticornis*). Initially, the koala was shaded by an

adjacent tree canopy. Protection was reduced during the morning and by the third observation period the koala had moved to the quadrant of the canopy facing away from the sun. Here the koala was only partially protected. Its body stance was sitting with limbs extended. It was breathing heavily.

Koala D1 was found in partial shade in the canopy of a closed canopy tree (unidentified rainforest tree). During the day the animal became fully shaded. It adjusted its position in the canopy once in the early afternoon. Otherwise it remained sitting and did not move.

Koala F1 was found in a closed canopy tree (*Ficus* sp.) in the shaded quadrant of the canopy. It remained in full shade throughout the day and did not change stance or position in the canopy.

Koala J1 was repeatedly located in the same open canopy *E. tereticornis* over the three days. Koala F1 revisited a closed canopy *Ficus* sp. and used the same point in the canopy over the three days. This raises some uncertainty regarding the assumed independence of koala tree use records justifying the use of chi-sq. test earlier. Despite this, the differences in the day and night data are of sufficient magnitude to suggest that there is a real difference between day and night tree use by some koalas on St Bees Island.

DISCUSSION

In this pilot study, some St Bees Island koalas appear to have used habitat in a different way by day and night over 10 days in April 2003. At night, open canopied trees were used much more frequently than during the day. During the day closed canopy trees were used much more frequently than at night. So these koalas appear to be changing tree types on a diurnal basis.

The open canopy tree used most frequently at night was *E. tereticornis*, a prominent Queensland koala food source. The most frequently used and predominantly closed canopy day use trees are not currently known to form part of the diet of koalas. The only study of total daily activity in tropical koalas (Melzer, 1995) indicated a predominantly nocturnal feeding regime – about 88% of feeding activity occurring between 18:00 and 06:00 hrs. Preliminary unpublished data from faecal pellet analysis of St Bees koalas suggest that over 90% of the koalas diet is composed of *E. tereticornis* (Gail Tucker, unpublished data). Further, since the day and night trees used by the koalas occur together, we hypothesise that St Bees Island koalas are selecting each assemblage under different influences – a drive to feed (night) and a drive to seek rest and shelter (day).

The detailed observations of three koalas in their day use trees suggest that these koalas using trees that provide little shade are more active and, apparently, occasionally stressed (laboured breathing), and when using trees that provide relatively dense shade throughout the day the koalas exhibit little movement and show no signs of stress. These few observations are consistent with expectations raised in the literature discussed earlier. They encourage us to hypothesise that St Bees Island koalas using trees with canopies that provide good shade may have a physiological advantage over those animals that use trees that provide little shade. If supported then woodlands with a complex structure incorporating trees, shrubs and lianes with dense canopies may be "better" koala habitat than woodlands of simple structure – assuming random selection of trees under the drive to select "day shelter".

In this pilot study, however, one of the koalas (koala J1) was repeatedly located in an open canopy *E. tereticornis* while another koala (koala F1) revisited a closed canopy *Ficus* sp. and used the same point in the canopy. So, random utilisation of habitat cannot be assumed and must be demonstrated in future while also having implications for the analytical approach adopted.

This study has supported our perception that at least some St Bees koalas are using habitat in a complex manner. Differences in tree use and animal behaviour on the island are observable and can be measured. Future work will replicate these observations with more individuals of both genders, over different seasons and in contrasting aspects and habitat structures around the island. The relationship between canopy architecture, microclimate and state of the koala will be pursued.

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AUTHOR PROFILE

Aubris Pfeiffer was a visiting USA undergraduate student at the Koala Research Centre of Central Queensland (KRC). Dr Alistair Melzer is principal researcher in the KRC and Senior Research Fellow at Central Queensland University's Centre for Environmental Management (CEM). Gail Tucker is an MSc candidate and a research worker at CEM. Delma Clifton is a PhD candidate and an Associate Lecturer in CQU's School of Biological and Environmental Sciences. Dr William Ellis is Senior Research Officer at University of Queensland's Koala Study Program and a CQU Adjunct Fellow.