KOALA FEEDING AND ROOSTING TREES IN THE CAMPBELLTOWN AREA OF NEW SOUTH WALES

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IN assessing habitat quality for koalas (*Phascolarctos cinereus*), the relative importance of trees used for food and for roosting must be established. Robbins and Russell (1978) and Hindell *et al.* (1985) suggested that trees in which *P. cinereus* roosted by day reliably predicted the trees they browsed. Tun (1993) and Hasegawa (1995), however, using leaf cuticle analysis of *P. cinereus* faecal pellets, questioned that suggestion .

Phillips and Callaghan (2000) investigated preferences of *P. cinereus* in the Campbelltown area, 40 km southwest of Sydney, by recording the presence of faecal pellets beneath trees in survey quadrats. They concluded that *Eucalyptus punctata* (grey gum) and *E. agglomerata* (blue-leaved stringy bark) were preferred species on shale-based soils. However, this method still does not distinguish between trees used for roosting and those used for feeding. Cuticle analysis was therefore used at Campbelltown as a test of dietary preference (Table 1). These data on species use were compared with sightings from a radio-tracking study of the same individuals (Table 2), in a separate study (Ward 2002).

Cuticle analysis depends on the assumptions that species are distinguishable by patterns of epidermal and guard cells and oil glands imprinted in fragments of leaf cuticles that survive the digestive processes and that these fragments occur in the faeces in the same proportions as consumed. Ellis *et al.* (1999) showed that these assumptions were valid for the species they used in their studies on *P. cinereus* in Queensland. Sluiter (2000), using a reference collection of cuticles prepared by B. Ellis (Ellis *et al.* 1997), developed a key to distinguish the species used in the current study.

The faecal samples came from fresh pellets collected opportunistically during a study in which three female *P. cinereus* were radio-tracked in the Campbelltown area over a period of three years (Ward 2002). These three *P. cinereus* have been part of a community-based survey (Ward and Close, 1998, 2002) and have featured in a weekly column run in the *Macarthur Advertiser* since 1996. In this column the *P. cinereus* are identified by the names SHIRLEY, LYN and SARAH. These names will be used here rather than their field numbers (C93006, C96002, and C96011 respectively). SHIRLEY and LYN live in Kentlyn, a suburb of Campbelltown and were adults (≥ 3 years) for all observations documented here. SARAH resides in Wedderburn (6 km south of Kentlyn) and was younger (~2 years) when her pellets were first collected for this study.

The breeding population to which these three *P. cinereus* belong occupies areas around the upper Georges River and its tributaries (Cork *et al.* 1988; Close 1993; Ward and Close 1998). The homerange of SHIRLEY includes a small gully draining into the Georges River (Ward 2002). The vegetation on the upper slopes of the gully is described as Shale/Sandstone Transition Forest (with high sandstone influence and >10 % crown cover) while that on the lower slopes is typical of Hawkesbury sandstone (NPWS 2000). The homerange of LYN, 1 km NE of that of SHIRLEY, includes a shallow gully draining into Peter Meadows Creek, a tributary of the Georges River (S. Ward, unpubl. data). Soils of most of this homerange are derived from Hawkesbury sandstone (NPWS 2000), and the vegetation is typical of those soils. The vegetation on the western edge of the homerange, however, includes Shale-Sandstone Transition Forest (< 10 % crown cover) (NPWS 2000). The third animal, SARAH, inhabits a plateau area at Wedderburn, with a steep slope leading into O'Hares Creek in the east and a shallow gully leading into Pheasants Creek in the west (Ward 2002). The vegetation is typical of Hawkesbury sandstone soils (NPWS 2000).

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Collected pellets from each *P. cinereus* were grouped into three seasons: winter (June to August), summer (December to February) and autumn (March to May). Seasons for analysis for each animal depended on the number of pellets in the opportunistic collection. Three seasons were analysed for SHIRLEY (winter 1997 and 1999, summer 1997-98), and two each for LYN (winter and autumn 1999) and SARAH (winter 1997 and summer 1997-98).

Leaf cuticles were obtained by pooling 2 - 3 mm of the broader ends of each of at least five faecal pellets from each season for each animal. A pinch of acid-washed sand was added to each pooled sample which was then ground for 70 turns of a mortar and pestle. Leaf fragments of various sizes were produced, optimally 200 - 500 µm in diameter and containing several stomata and their surrounding guard cells. Following a modified protocol of Ellis *et al.* (1997), these fragments were then bleached (White King) to digest leaf mesophyll layers, stained using safranine (Bio-scientific), dehydrated in ascending concentrations of ethanol then mounted on slides using Eukitt (Carl Zeiss). Three replicate slides for each pooled sample were examined.

Individual fragments of cuticle were identified to species by using diagnostic patterns of stomata, guard cells, epidermal cells and oil glands (Ellis *et al.* 1997; Sluiter 2000). The number of cuticle fragments of each species was recorded (Table 1). Contingency tests indicated that counts for each set of replicate slides were consistent (SHIRLEY $\chi^2_{[2]} = 1.85$; LYN $\chi^2_{[2]} = 1.95$; SARAH $\chi^2_{[1]} = 0.21$; all $p > 0.05$).

No significant associations were found between pellet counts and seasons for any animal (SHIRLEY $\chi^2_{[4]} = 7.57$; LYN $\chi^2_{[4]} = 1.96$; SARAH, $\chi^2_{[1]} = 0.22$; all $p > 0.05$). Cuticle fragment results were then pooled for each animal (Table 1).

Animal	Ep	Ea	Cg	Unknown	Total
SHIRLEY	96	19	30	0	145
LYN	61	1	0	4	66
SARAH	73	25	0	0	98

Table 1. Counts of cuticle fragments found in each koala's faecal pellets by species. **Ep** = *Eucalyptus punctata* ; **Ea** = *E. agglomerata* ; **Cg** = *Corymbia gummifera* .

There were insufficient data to compare observations of tree use (from radio-tracking studies) for the actual seasons in which pellets were collected. However, there were no significant differences between pooled observations (SHIRLEY 37 observations, LYN 22, and SARAH 13) from the periods used for faecal pellet analysis and between observations made outside those periods (SHIRLEY $\chi^2_{[2]} = 0.24$; LYN $\chi^2_{[2]} = 2.35$; SARAH $\chi^2_{[1]} = 0.20$; all $p > 0.05$).

Grey gum, *E. punctata*, was the principal component of the pellets, comprising 66 – 92 % of the cuticle fragments for all three animals (Table 1). This species has long been regarded as important to *P. cinereus* (Robbins and Russell 1978; Cork and Warner 1983; Cork *et al.* 1988). However, despite the dominance of *E. punctata* cuticle fragments, there were significant differences among the three animals ($\chi^2_{[6]} = 68.84$, $p < 0.005$). LYN's pellets were almost exclusively *E. punctata*, whilst both SARAH's and SHIRLEY's pellets had significant amounts of blue-leafed stringy bark, *E. agglomerata*, and SHIRLEY's pellets also had many red bloodwood, *Corymbia gummifera*, fragments (Table 1).

There were also significant differences among the three animals in their tree choice as determined by radio-tracking observations ($\chi^2_{[6]} = 36.67$, $p < 0.005$). The percentage of observations in *E punctata* (17 – 25 %) was consistent for all three *P. cinereus* but 15 % of SARAH's observations were in stringybarks, whilst only 0.5 % of SHIRLEY's observations were in this group (Table 2). Although all three *P. cinereus* were observed most often in trees in the 'Other' category, most of these observations for the two Kentlyn animals were in the densely foliated turpentine, *Syncarpia glomulifera*. This species does not occur commonly at Wedderburn.

Animal	Ep	Str	Cg	Other	Total
SHIRLEY	33	1	5	158 (81)	197
LYN	23	7	8	53 (32)	91
SARAH	15	11	5	41 (0)	72

Table 2. The number of diurnal radio-tracking observations for each koala in different tree species. **Ep** = *Eucalyptus punctata;* **Str** = Stringybarks* = *E. agglomerata, E. capitellata, E. eugenioides, E. globoidea,* and *E.oblonga*. **Cg** = *Corymbia gummifera;* **Other** = *Syncarpia glomulifera, Acacia spp., Angophora costata, A. bakeri, Banksia serrata, Casuarina spp., Ceratopetalum apetalum, C. gummiferum, E. crebra, E. haemastoma, E. pilularis, E. piperita, E. sieberi, E. tereticornis, Glochidion ferdinandi, Ligustrum lucidum, Melaleuca spp., Pittosporum undulatum*. (From Ward 2002). * Stringybark species were grouped together due to difficulties in distinguishing these species in the field.

The frequency of sightings in *E. punctata* was clearly lower than the 66 – 92 % of *E. punctata* cuticle fragments detected in each animal's pellets. This difference, and the number of *P. cinereus* sightings in trees such as *S. glomulifera*, a species which was not detected in the faecal pellets, indicates that all three animals selected trees for non-dietary reasons, presumably because of the shelter they provide. *S. glomulifera* has dense, leafy foliage, and may be chosen because the dense foliage protects *P. cinereus* from sun and predators.

Our results are consistent with the hypothesis that *E. punctata* and stringybarks (principally *E. agglomerata*) are the preferred dietary species of Campbelltown *P. cinereus*, and with the findings of Phillips and Callaghan (2000) that *E. punctata* and *E. agglomerata* were significantly preferred. In New South Wales the State Environmental Planning Policy 44 (SEPP 44) provides legislative controls over development of potential *P. cinereus* habitat. Whilst *E. punctata* is listed in the SEPP 44 as a recognised food tree, *E. agglomerata* is not. We believe that there is now strong evidence, from two separate studies, that *E. agglomerata* is a significant browse species, and therefore should be listed under Schedule 2 of SEPP 44 legislation. Other stringybark species may also prove to be important food sources in the Sydney region.

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