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**Honey possums and their association with *Banksia* woodlands**

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***Biology of the honey possum (Tarsipes rostratus)***

The honey possum is a small marsupial endemic to the South West of WA (Figure 1). This tiny marsupial (which usually weighs between 7-16g) has adapted to feed exclusively on nectar and pollen, a diet which requires flowering plants to be available all year round (Wooller *et al*., 1981; Wooller *et al*., 1984). The honey possum is the only non-flying mammal that feeds solely on nectar and pollen (Turner, 1984). The honey possum has adapted a bristled tongue which has many papillae at the tip enabling feeding on floral pollen (Richardson *et al*., 1986).

**Figure 1**: The honey possum (*Tarsipes rostratus*) (Photo credit: Pat Dundas)

***Adaptations to feed on nectar and pollen***

The long snout and long bristled tongue of the honey possum are adapted to allow these animals to bury their head into inflorescences to feed on nectar (Russell *et al*., 1989) much like the long beak and tongue of birds such as honeyeaters which feed on similar plant species. Pollen is brushed or licked off flowers (Russell *et al*., 1989). In addition to feeding specialisations, honey possums are also adapted generally to an arboreal lifestyle. Honey possums have a semi prehensile tail which provides support and balance (Renfree *et al*., 1984). The toes on both the front and back feet have wide pads with extra traction allowing honey possums to move easily over branches and flowers. Honey possums are crepuscular feeders and tend to feed actively at night (Arrese *et al*., 2003) as well as early morning and late afternoon (Hopper *et al*., 1982).

### *Food plants & feeding*

The high biodiversity of native WA flora in the southwest can cater to the dietary needs of the honey possum, since different plant species have staggered flowering periods. The sandplain heathlands (which includes *Banksia* woodlands) of the western and southern coastlines of WA support a diverse range of flowering plants dominated by Proteaceae species and consequently, this is where the greatest number of honey possums have been captured (Wooller *et al.,*1984). Honey possums are a locally common species and have been noted as the most common mammal in the Fitzgerald River National Park (Chapman 1995). Honey possums feed on species primarily from Proteaceae and to a lesser extent Myrtaceae species which are rich in nectar (Wooller *et al*., 1984). *Banksia* species are especially favoured foodplants of honey possums (Richardson *et al*., 1986).

Honey possums are generally opportunistic in their selection of foodplants which relates to flowering species present in a particular area, however some animals sampled over a number of days showed specific foodplant preferences (Dundas, 2008). To determine food plant species being utilised by honey possums, pollen samples are collected by wiping a sticky gel with a stain over the head of captured animals (Wooller *et al*., 1983). Honey possums will inadvertently pick up pollen on their heads as they feed on nectar and pollen so this is an effective technique to determine which plant species they are utilising. Pollen grains in flowering plants are unique and honey possum foodplants can be determined by comparing samples collected from animals with reference slides collected from flowering plants in the study area (Figure 9).

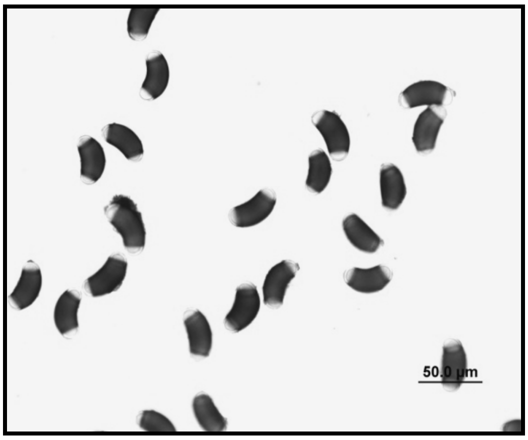



**Figure 2:** *Banksia plumosa* (left) and *Adenanthos cuneatus* pollen reference slides (Photo credit: Shannon Dundas)

A total of 20 different pollen species were sampled from honey possums collected at Cape Riche, with nine species identified as important honey possum foodplants as they were found more frequently on animals (Dundas, 2008). Based on pollen, *Banksia plumosa* subsp. *plumosa* (Figure 3) was identified as the preferred foodplant at the Cape Riche study site followed by *Adenanthos cuneatus (*Figure 5). Despite the common image of the honey possum on showy *Banksia* species such as *Banksia coccinea*, less conspicuous species which have flowers close to the ground are more frequently visited foodplants at Cape Riche (Dundas, 2008) and Fitzgerald River National Park (Saffer, 1998) Figures 3-6).

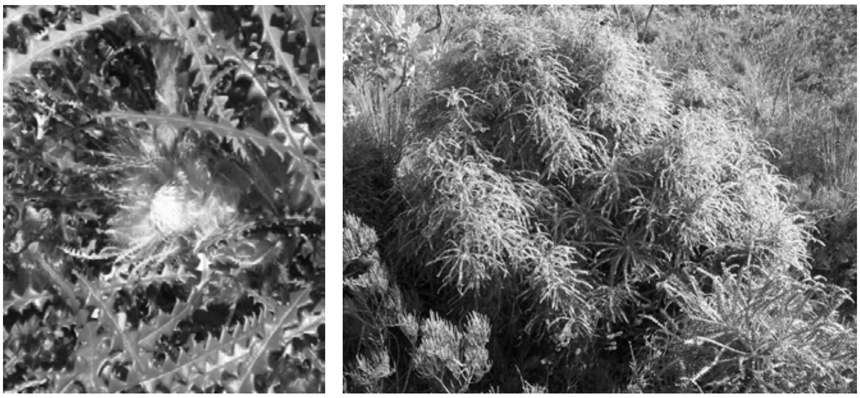

**Figure 3:** *Banksia plumosa* subsp. *plumosa* flower (3cm across) left and shrub right (Photo credit: Shannon Dundas)

**Figure 4:** *Banksia nutans* flower (4-7cm long) left and shrub right (Photo credit: Bill Dunstan)


**Figure 5:** *Adenanthos cuneatus* flower (top) and shrub (bottom left) (Photo credits: FloraBase 2011 online database florabase.calm.wa.gov.au).


**Figure 6:** *Calothamnus gracilis* flower (left) and shrub (right top) (Photo credits: FloraBase 2011 online database florabase.calm.wa.gov.au).

***Honey possum lifecycle and reproduction***

Honey possums have marked sexual dimorphism with females tending to be larger than males (Renfree *et al*., 1984). Honey possums are aseasonal breeders and females can be found with pouch young throughout the year (Garavanta, 1997; Wooller *et al*., 1981). Although they do not have a specific breeding season, more female honey possums carrying pouch young can be found when preferred food plants are in flower which varies with location (Garavanta, 1997; Wooller *et al*., 1981). Honey possums are the smallest newborn mammals with average birth weight between 21µg-5mg (Renfree, 1980). Female honey possums exhibit embryonic diapause (where the growth of fertilised embryos can be delayed within the uterus) which is thought to be under environmental control such as the flowering periods of foodplants (Russell *et al*., 1989).  Female honey possums have one to two litters of 2-3 young a year (Russell *et al*., 1989). They carry young in their pouch for around 56-63 days until they reach about 2-2.5g (Renfree *et al*., 1984). Once they have left the pouch, young will be carried on the mothers back and she will suckle them until they are approximately 91 days old before they disperse on their own (Russell *et al*., 1989).

The mating system of honey possums is promiscuous with females in oestrus mating with many males and as a result, male honey possums have large scrotums which are approximately 4.2% of their total body weight (Renfree *et al*., 1984). Interestingly, male honey possums have the longest sperm of any living mammal, which indicates competitive gamete selection (Renfree *et al*., 1984). Both male and female honey possums reach sexual maturity at around six months of age (Russell *et al*., 1989).

From trapping records, the average lifespan of the honey possum is estimated to be one year (Wooller *et al*., 1981). Long term studies of honey possum populations in the Fitzgerald River National Park estimate the annual mortality rate (determined by capture rates) to be greater than 80% (Garavanta, 1997). The surviving population of honey possums have a high reproductive potential and are sufficient to increase the population to previous numbers within a year (Wooller *et al*., 1981). The lifecycle of the honey possum is correlated to nectar availability (Garavanta, 1997; Wooller *et al*., 1981) and it is thought that the annual mortality of majority of the population is due to starvation when flowering foodplants are scarce (Wooller *et al*., 1993).

***Torpor in the honey possum***

Since honey possums are so small and live within a seemingly narrow range of limits, they need a mechanism to conserve energy when food is scarce. Torpor is a state in which the body temperature is allowed to fall (on a daily basis) such that metabolic rate can be reduced by up to 90% (Figure 7) (Collins *et al*., 1987). It is thought that torpor is initiated when critical energy levels are reached at which time honey possums enter torpor to conserve energy (Collins *et al*., 1987). Torpid honey possums have been captured in pit traps in the Fitzgerald Range National Park during March, April, June and September and with the exception of June (mid-winter), these months had the lowest daily nectar production by plants, indicating food was relatively scarce (Collins *et al*., 1987). Laboratory research demonstrates that honey possums can go into torpor for several hours at a time, usually when subjected to periods of environmental stress such as food scarcity and low temperature (Collins *et al*., 1987; Withers *et al*., 1990). Smaller honey possums enter torpor more readily when deprived of food especially when ambient air temperatures are low (Collins *et al*., 1987; Withers *et al*., 1990).

**Figure 7:** Honey possum in torpor (Photo credit: Pat Dundas)

***Researching honey possums***

Honey possums are captured in pit traps which constitute a length of PVC pipe which is buried into the ground up to the rim (Figure 8). Drift fences which are lengths of fly wire are placed either side of the pit trap so as honey possums intersect the drift fence, they follow it along to the pit trap which they fall into. Pit traps are opened at dusk and checked at first light. Given the period of fasting honey possums experience by spending the night in a pit trap, once removed from the trap, they are fed a honey or sugar water solution for energy.

**Figure 8:** Honey possum in pit trap (Photo credit: Shannon Dundas)

To determine habitat use and movement patterns, honey possums were fitted with tiny radio transmitters. These weigh 0.36g and are glued to the back of the honey possum (Figure 9). This temporary attachment of the transmitters means they will fall off the honey possum within a week before the battery is exhausted. Honey possums were tracked primarily between dusk and dawn when they are most active but some animals were also active during the day (Dundas, 2008). Tracking involves two people each with a handheld antenna and receiver to allow for triangulation of tracked honey possum locations. Each transmitter has a unique frequency which can be programmed into the receiver. Detection of the transmitter is established by an ongoing beep and the location of the animal is determined by the strength of the signal as the closer you get to the animal, the louder the beep becomes.

**Figure 9:** Honey possum with attached radio transmitter (Photo credit: Pat Dundas)

***Phytophthora cinnamomi in Banksia woodlands***

*Phytophthora cinnamomi* is a soil borne water mould which causes *Phytophthora* dieback disease in susceptible plants (Hardham, 2005). The penetration of the roots by the pathogen results in necrotic lesions on the roots and trunk which hinder the infected plants' ability to obtain water and nutrients, eventually causing the plant to die (Shearer, 1994).

*Phytophthora cinnamomi* is spread within the environment by movement of water and via root to root contact of infected plants (Shearer, 1994). The movement of infected soil primarily carried on vehicles and shoes is a significant means by which the disease is spread (CALM, 2003).

Since *Phytophthora cinnamomi* is an introduced pathogen, many native species have limited natural resistance and are therefore severely threatened with infection by the pathogen (Shearer *et al.,* 2004). Plant species within Proteaceae, Papilionaceae, Epacridaceae and to a lesser extent Myrtaceae families tend to be the most susceptible to dieback in the Banksia woodlands and jarrah forest of southwest Australia (Shearer *et al*., 2004). In *Banksia* woodlands, an estimated 32% of plant species classified are classified as susceptible to *P. cinnamomi*, with 15% of plant species classified as highly susceptible (Shearer *et al.,* 2004).

***Secondary impact of dieback on honey possums***

There is a concern for the future of honey possum populations in the presence of the plant pathogen *Phytophthora cinnamomi*, particularly since this pathogen has an impact on susceptible Proteaceous species which the honey possum relies on for food. The spread of this pathogen is likely to have an effect on the abundance and movements of honey possums, as the availability of food sources becomes seriously depleted.

In 2007, I conducted a study in a proposed conservation park close to Cape Riche located on the south coast of Western Australia, 119km east of Albany in Western Australia (34.00S 118.43 E) (Dundas, 2008). The site was selected based on a known honey possum population and the patchy mosaic of *P. cinnamomi* affected and unaffected habitat. The loss of primary *Banksia* species (*Banksia baxteri* and *Banksia attenuata*) as a result of *P. cinnamomi* infestation resulted in the change from a tall, dense *Banksia* thicket into a low open sedge at a study site (Dundas, 2008).

Radio tracking of honey possums revealed some interesting results. Honey possums were recorded moving long distances (i.e a 10.7g male travelling 1.4km (cumulative between 28 fix locations over 9 days) and a 16g female travelling over 720m in one night) to forage for foodplants in healthy vegetation (Dundas, 2008). Previous studies have indicated that honey possums are sedentary and only moved on average 20-30m between traps (the longest recorded movement between traps being 125m) (Garavanta 2000). More recent tracking of honey possums have also shown honey possums are capable of moving longer distances (Bradshaw *et al*., 2007; Bradshaw *et al*., 2002).

In terms of foodplant preferences in dieback affected areas, seven of the nine foodplants species identified from pollen collected from honey possums are recognised as being susceptible to *Phytophthora cinnamomi (* **susceptibile:** *Banksia plumosa, Adenanthos cuneatus, Beaufortia anisandra, Banksia brunnea, Banksia nutans, Banksia tenuis,* ***resistant:*** *Eucalyptus angulosa, unknown susceptibility: Calothamnus gracilis)* (Dundas, 2008). Honey possums also utilised plants which were still managing to survive in affected areas such as *Adenanthos cuneatus* and *Calothamnus gracilis* but they were also seeking out favoured *Banksia plumosa* in healthy areas.

Future preservation of the honey possum relies on conservation of *Banksia* woodlands which are so important for providing this species with food and refuge.

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