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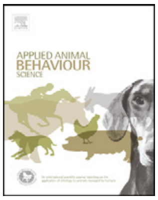

Differential responses of captive southern hairy-nosed wombats (*Lasiorhinus latifrons*) to the presence of faeces from different species and male and female conspecifics

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ABSTRACT

The southern hairy-nosed wombat (*Lasiorhinus latifrons*) appears to use scent marking, including defaecation, for social communication in the wild. This premise assumes that the receiver wombat is able to distinguish between faeces from different sources. To examine this theory, four types of faeces (male wombat, female wombat, dingo and a plastic control) were placed into the enclosures of 12 captive wombats. Behaviour, inter-individual distance and enclosure use were recorded during the period of placement, as well as the period before and the period after. When faeces were present, the wombats used concealed locations more often than other periods (mean%: pre-treatment: 71.3, treatment: 75.6, post-treatment: 72.7; $P < 0.05$). During the same period they also reduced grazing (mean min/period: pre-treatment: 15.8, treatment: 6.9, post-treatment: 13.1; $P = 0.0002$) and walking activity (mean min/period: pre-treatment: 85.2, treatment: 66.9, post-treatment: 78.2; $P = 0.01$), indicating an increased perception of risk. Wombats approached the dingo faeces 5.6 times per treatment period, which was greater than for the control (3.0; $P = 0.004$) or female wombat faeces (3.7; $P = 0.049$). They also avoided other wombats most when male wombat faeces were present (8.3 retreats/period) compared to the control (4.5; $P = 0.02$), or female wombat (4.3; $P = 0.01$). There was a residual effect of increased wombat avoidance the period after presentation of dingo faeces (9.6; $P \leq 0.05$). It is concluded that the southern hairy-nosed wombat can differentiate between faeces from different species and sex of conspecifics, and that predator faeces and those from male conspecifics increase wombat avoidance behaviour either during or after presentation.

1. Introduction

Scent marking is an energetically efficient method of advertising position, territory and reproductive state (Brashares and Arcese, 1999). It is particularly effective when vision is restricted, such as in burrows or at night (Arakawa et al., 2008; Monclús et al., 2009). Animal odours can facilitate communication between conspecifics according to four different functions, scent matching, reproductive signaling, temporal or spatial signaling and resource protection (Begg et al., 2003). Scent matching allows a resident animal to distinguish other residents from intruders by recognizing their scent, thereby reducing the need for territorial encounters (Gosling and McKay,

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1990; Le Roux et al., 2008; Luque-Larena et al., 2001). Male snow voles (*Chionomys nivalis*), for example, show less aggression and more avoidance towards males that have been recognised by scent matching than for those without matched scents (Luque-Larena et al., 2001). This function is particularly relevant to species with overlapping boundaries, or those that operate within a hierarchical social system. Scent marks may also advertise reproductive status and receptivity as they contain gonadal steroid metabolites (Jannett, 1984; Ruibal et al., 2010; Swaisgood et al., 2000). Male captive pandas (*Ailuropoda melanoleuca*), for example, vocalise, lick, investigate and scent mark more when exposed to female faeces compared to male faeces, and they vocalise even more when the marker female is in oestrus (Swaisgood et al., 2000). When scent marks are used for reproductive purposes, behavioural differences should be evident between male and female markers and/or receivers (Begg et al., 2003), and yearly patterns should be apparent for seasonal breeders (Pal, 2003). Scent marks may repel neighbouring individuals allowing temporal and spatial relationships to be established without physical or visual contact (Begg et al., 2003; Clapperton et al., 1989; Gosling and Roberts, 2001). Free-ranging male dogs (*Canis familiaris*) mark close to boundaries shared with neighbours, whilst females mark closer to nesting sites (Pal, 2003), indicating that scent marks are intended to deter intruders. Scent marks around feeding sites may protect resources (Begg et al., 2003; Kruuk, 1992; Miller et al., 2003). Golden lion tamarins (*Leontopithecus rosali*) and otters (*Lutra lutra*) both mark feeding areas to reduce foraging competition. Otters also scent mark more during seasons when food is scarce (Kruuk, 1992; Miller et al., 2003).

For prey species, scent marks may provide information about predation risk (Hayes et al., 2006). Rodents (*Melomys cervinipes*, *Rattus fuscipes* and *Uromys caudimaculatus*) and cows (*Bos taurus*) avoid feeding areas where there is evidence of predators (Hayes et al., 2006; Kluever et al., 2009). Prey species may also use scent marks from co-habiting species to assess predation risk. Domestic cows exposed to deer (*Odocoileus hemionus*) scents are less vigilant and eat more, indicating a perceived reduction in predation risk (Kluever et al., 2009).

The southern hairy-nosed wombat (*Lasiorhinus latifrons*) is an Australian terrestrial marsupial that appears to use scent marks for social and reproductive signaling (Gaughwin, 1979; Taylor, 1993). Wombats often defaecate at their burrow entrance and on conspicuous objects such as rocks (Taylor, 1993) and males have been observed to display flehmann (Gaughwin, 1979). Wombats also rub their rumps on prominent objects such as burrow entrances, although this behaviour is not influenced by gender or breeding season and may, therefore, be performed more for grooming purposes rather than for scent marking (Walker et al., 2006). Studies into the function of olfactory communication in wombats may facilitate a better understanding of reproductive and social processes in wild populations, including the critically endangered Northern hairy-nosed wombat (*Lasiorhinus krefftii*). They may also assist in the management of captive populations. To determine if southern hairy-nosed wombats use scents such as faeces for social communication or predator avoidance, it is important to determine firstly whether they can distinguish between scents from different sources and secondly how the scents from different sources affect behaviour (Swaisgood et al., 2000). This study, therefore, aimed to quantify the level of differentiation and behavioural response of southern hairy-nosed wombats to faeces from conspecifics and a predator.

2. Materials and methods

2.1. Study animals

The study was conducted at the Rockhampton Botanic Gardens and Zoo (23° 22′S, 150° 30′ E), Australia, using 12 adult southern hairy-nosed wombats housed in four groups of unrelated individuals each containing one male and two females. Eleven of these animals were wild caught prior to 2005 and the remaining one was born at the zoo in 2003. Accommodation for each wombat group was similar and included a temperature-controlled burrow system, a digging chamber, feeding house, native grass and a log (Hogan et al., 2009). The total area for each enclosure measured between 163 m^2 and 249 m^2 (Fig. 1). All wombats were fed carrots, chaff and macropod pellets (Riverina Australia Pty Ltd., West End, Australia) daily and were weighed weekly. Each wombat wore a distinctive reflective collar for identification on video. Ethics approval was obtained from the University of Queensland Animal Ethics Committee (SAS/806/88).

2.2. Faeces treatments

Four faeces types were used as treatments in this study: natural predator, dingo (D); male wombat (MW); female wombat (FW); and control (C). The predator scats were collected on a single occasion from two adult dingoes (*Canis familiaris dingo*), one male and one female, at the Rockhampton Botanic Gardens and Zoo. After collection they were evenly mixed and distributed into four 12 g doses and frozen at −20 °C until required. Conspecific scats were collected weekly over 6 weeks from two adult *L. latifrons* wombats (one male and one female) residing at a different institution to ensure that the recipient animals were unfamiliar with the donor animals. Collection occurred outside of the breeding season and the female wombat was determined to be anoestrous from faecal progesterone metabolite concentrations (23.1, 24.8, 23.1, 24.8, 18.7, 26.9, 20.3 and 14.8 ng/g in weeks 1–6, analysed by the method of Hogan et al. (2010)). After collection, faeces were immediately frozen at −20 °C. The MW and FW treatments were prepared by combining 2 g from each collection week for a total of 12 g per treatment. Plastic, imitation canine faeces (Dog Dirt, Loftus, Taiwan) were used as a control treatment. To avoid odour contamination, this was washed with the same detergent used to clean the wombat food bowls (Goldie, Morrison C.Q., North Rockhampton, Australia) and rinsed thoroughly with water.

Treatments were randomly assigned to the pre-established wombat groups using an orthogonal Latin square design with four rotations. All groups had access to two dens, one of which was used for sleeping. Each