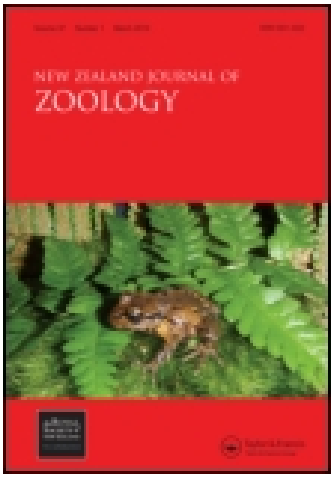

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Den sharing behaviour of captive brushtail possums (Trichosurus vulpecula)

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Den sharing behaviour of captive brushtail possums (*Trichosurus vulpecula*)

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Abstract Den sharing among wild brushtail possums (*Trichosurus vulpecula*) has important implications for disease transmission. This study investigated den sharing in captive possums, and measured interactions between possums sharing dens. Thirty-four sexually mature possums (16 female, 18 male) were housed in single-sex or mixed-sex pairs in large enclosures that contained two dens. Daily patterns of den sharing were recorded for each pair over a 69 day period in the breeding or non-breeding season. Social behaviour within shared dens was sampled using miniature infrared cameras. Male pairs rarely shared dens in the breeding or non-breeding seasons (4% and 1% of days respectively) and usually engaged in 'threats' and 'fights' associated with den defence. Pairs of female possums (in both seasons) and mixed-sex pairs housed together in the breeding season shared dens most frequently (between 84% and 91% of days), and also spent the most time together in dens each night. While sharing dens, affiliative interactions were frequent, including long periods of 'touching', and also 'food sharing' and 'allogrooming'. The preference for den sharing and close contact shown by captive possums highlights the importance of den sharing as a potential route for disease transmission.

Keywords brushtail possum; *Trichosurus vulpecula*; social behaviour; denning; captivity

INTRODUCTION

Brushtail possums (*Trichosurus vulpecula*) seriously threaten New Zealand's environment and livestock industry as they are important vectors in the spread of bovine tuberculosis (*Mycobacterium bovis*; Tb) to cattle and deer (Livingstone 1991). They also cause severe damage to native plants by selective browsing (Nugent 1995) and, through competition, disturbance and predation, adversely affect native fauna (Innes 1995).

Possums are usually solitary animals, although they have widely overlapping home ranges and do not defend a specific territory within this range (Green 1984; Winter 1976). They spend little time engaging in social interaction, except during the breeding season (Winter 1976). Possums regularly use between five and ten dens within their home range, although none are exclusive to one possum and some dens are frequently used by several different animals over time (Cowan 1990). When suitable dens are available (e.g., in large epiphytes), possums tend to den above ground in preference to on or below the ground (Green & Coleman 1987; Cowan 1989). In high density populations or areas with few potential dens, den sharing (two or more possums using the same den at the same time) may occur (Cowan 1990), especially in large sheltered dens (Caley 1996). Several estimates have been made of how frequently wild possums share dens in specific situations, ranging from very rarely (Paterson et al. 1995) to about 25 times per year

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(Caley et al. 1998). Because den sharing involves close contact between possums, and relatively few interactions are observed away from the denning area (Paterson et al. 1995), den sharing behaviour may provide an important mechanism for transmission of diseases (e.g., Tb) between possums (Fairweather et al. 1987; Morris & Pfeiffer 1995). However, the behaviour of possums within dens has not previously been quantified. Therefore, the objective of this study was to determine the incidence of den sharing in single-sex and mixed-sex pairs of possums, and to describe the social behaviour of pairs when sharing dens.

MATERIALS AND METHODS

Thirty-four sexually mature wild possums (mean age 3.7 ± 0.3 years, according to tooth wear (Winter 1980); 16 female, 18 male) were caught in box traps from Kawau Island or the Urewera National Park and transported to the Animal Behaviour and Welfare Research Centre (AgResearch, Ruakura), Hamilton. Possums were initially housed in individual cages for 6 weeks' adaptation to captivity, and were given a small metallic ear tag for identification during a routine veterinary inspection. Seventeen pairs of possums were then housed together in large enclosures for a 69 day period, during the breeding (April to June 1997) or non-breeding season (November 1996 to January 1997). Pairs contained either two females (three pairs in the breeding and one in the non-breeding season), two males (four pairs in the breeding and one in the non-breeding season) or a male and a female (four pairs in the breeding and four pairs in the non-breeding season). Each grassed enclosure (size range 50–130 m^2) contained two identical waterproof dens plus two climbing logs and an *ad libitum* supply of pellet food and water. The dens were made of plywood and measured 300 × 420 × 620 mm high, with an entrance of 110 × 180 mm high. A small wooden camera housing (100 × 100 × 130 mm high), with a clear plastic cover between the camera housing and den, was mounted on the top of each den. As far as possible, possums within each pair were from the same population and were of similar age and body weight.

Every morning, approximately 2 h after sunrise, the location of each possum was recorded. The delay before first sharing a den (in days) and the percentage of mornings spent sharing, were recorded for each pair. Social behaviour within the dens at night was sampled for 11 of the pairs (mean age 4.2 ± 0.3 years; 10 female, 12 male), using miniature infra-red video cameras (60 × 80 × 25 mm high; Laser Innovations NZ Ltd., Napier) in each available den. Time-lapse video recorders (Panasonic, model AG–6720a) were used to record the behaviour of each pair inside the den from sunset until sunrise. Preliminary recordings showed that den sharing possums seldom interacted during the daylight hours while they slept (Day unpubl. data), so observations were conducted during the night time only. Each pair was observed for four nights, with at least seven days between observations. A total of 528 hours of den recordings were made. The total time that each pair spent in a shared den was determined and each social interaction was recorded. A social interaction was defined as a 'bout', a discrete sequence of behaviours, separated by at least 1 min from any other bout. Three interaction types were defined: (1) '*threats*' involving 'raised-paw threat' and 'swipe' behaviours (see Table 1 for behaviour definitions); (2) '*fights*' involving 'box' and 'fight' behaviours; and (3) '*affiliative*' interactions involving 'touch', 'food share' and 'allogroom' behaviours. For example, a sequence of five 'raised-paw threats' and eight 'swipes' were classed as a single threat interaction.

The percentage of mornings on which given possums were found sharing a den was analysed using the log-linear model in the Genstat 5 statistical analysis package (Release 3.1; Lawes Agricultural Trust, Rothamsted Experimental Station). Log transformation was performed on the latency to first sharing data to stabilise variances, and the differences between pair types and seasons were tested using accumulated analysis of variance. The total time spent den sharing and the frequencies of interactions were analysed with a generalised linear analysis of variance and t-tests in the Minitab statistical package (release 11.11; Minitab Inc., USA). All values reported in the results are mean ± standard errors.

RESULTS

All of the female and mixed-sex pairs of possums shared a den at some time during the 69 day housing period, but two of the five male pairs of possums never did. Female pairs shared dens very frequently throughout both the breeding and non-breeding seasons (84 ± 9% and 91 ± 9% of days respectively; Fig 1). Den sharing was also frequently observed in mixed-sex pairs of possums in the breeding season (87 ± 7% of days), but was significantly less frequent

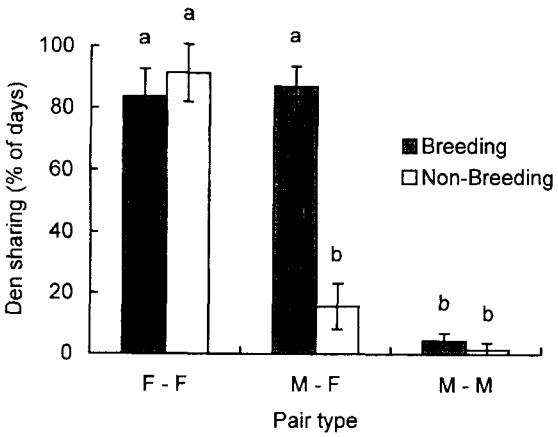

Fig. 1 Mean percentage (± SE) of mornings on which possum pairs were found to be sharing a den, over a 69 day period during the breeding or non-breeding season. F-F = female-female pair (N = 4); M-F = male-female pair (N = 8); M-M = male-male pair (N = 5). Significantly different bars indicated by different letters ($P < 0.001$).

in the non-breeding season (16 ± 8% of days; $P < 0.001$). Male pairs shared dens only rarely in the breeding (4 ± 3% of days) or non-breeding seasons (1 ± 2% of days), and shared them significantly less often than either female pairs or mixed-sex pairs in the breeding season ($P < 0.001$). The latency to first sharing was similar for female pairs and mixed-sex pairs in the breeding season (0.3 ± 0.3 days and 1.0 ± 0.4 days; n.s.). However, mixed-sex pairs in the non-breeding season (34.5 ± 5 days) and male pairs (42.5 ± 16 days) were slower to begin den sharing ($P < 0.05$).

Of the 11 pairs of possums that were observed with video cameras in dens, six pairs (three female-female, two mixed-sex and one male-male) shared dens during the nights recorded. All six sets of recordings were made in the breeding season. The female and mixed-sex pairs spent more of each observation night sharing dens (422 ± 33 min and 430 ± 21 min per night, respectively) than the male pair (59 ± 40 min per night). The behaviours observed between den-sharing possums are described in Table 1. When the pairs shared dens, affiliative interactions (126 ± 34 interactions per pair) were more frequent than threats (7 ± 2 interactions per pair) or fights (8 ± 5 interactions per pair), except that no affiliative interactions were observed in the male pair. Threat and fight interactions usually resulted in one animal leaving the den. In the mixed-sex and female pairs, either possum in the pair might groom each other, generally on the dorsal part of the other possum (e.g., the head, neck, back or tail). No allogrooming was observed on the underbelly, mouth or anal area of the other possum, although the ears were groomed. It was not clear whether one possum, grooming another, ever removed or consumed anything from the fur or skin of the other animal. Food sharing was observed only in the dens of mixed-sex and female pairs (1.0 ± 0.3 times per pair per night). Normally, one of the possums carried food from the enclosure into a den occupied by the other animal, and both animals then ate from the same food item at the same time.

Table 1 Social behaviours observed between pairs of den sharing possums.

Behaviour	Definition
Raised paw threat	Possum raises one front paw off the ground towards another possum from a quadrapedal stance, with its body lowered and head extended forward.
Swipe	Possum rapidly swings one front paw towards another possum, without making contact with any part of the other possum.
Box	Possum rapidly swings both front paws (alternately left and right paws) toward another possum, making contact with other possum's body or head.
Fight	Possum maintains physical contact with another possum, and may 'box', kick (with its hind paws) or bite the other animal. Usually involves vocalisation.
Touch	Possum contacts some part of another possum (for >2 s) with part of its body, face or paws, without displaying 'swipe', 'box' or 'fight' behaviours. Includes sleeping, sitting and lying in contact.
Food share	Both possums in a pair consume the same food item at the same time. Possums' mouths are < 10 cm apart.
Allogroom	One possum uses its front paws and teeth to manipulate the fur or skin of another possum, without performing any 'box' or 'fight' behaviour.

DISCUSSION

This study has shown that sexually mature female-female and mixed-sex pairs of possums commonly share dens in captivity. Although we provided two dens per pair, some pairs preferred to den together. Other observations of captive possums sharing dens (e.g., Duckworth & Miekle 1995; McLeod et al. 1997) did not describe the gender of the sharing possums or the nature of their behaviour within the dens.

In this study, mixed-sex den sharing occurred most frequently during the breeding season. In the wild, Cowan (1989) found that the majority of possums choosing to share a den do so in the autumn and winter (the main possum breeding season). This behaviour suggests that 'consort' relationships are being established between mixed-sex pairs in the breeding season, which may extend for a 30–40 day period before mating (Winter 1976). In consort pairs, the female possum is usually dominant, and her tolerance of the male possum determines whether he will be allowed to share the den (Winter 1976). Females usually become more tolerant of males as the breeding period progresses (Jolly 1981). Consort relationships are not developed during the non-breeding season, which may reduce the amount of den sharing that occurs in mixed-sex pairs at that time.

Female-female pairs in this study also readily shared dens in both seasons. Efford (1991) suggested that some degree of tolerance between wild females from the same matriline might be expected, although we did not know whether our captive females were related or not. Female possums have previously been shown readily to associate outside the den in our captive colony (Day et al. 1998). However, in the mixed-sex pairs during the non-breeding season, and in the male pairs, most interactions at dens concerned defence or take-overs, and resulted in one animal leaving the den. These pair types were never observed to share dens for more than a few minutes at one time. Likewise, Cowan (1989) found that 75% of all recorded den sharing in wild possums involved mixed-sex pairs, 22% involved female-female pairs and only 3% involved two males.

The frequency of den sharing observed in this study (up to 90% of days in some pairs) was much higher than has been recorded in wild possums. Den sharing in the wild is relatively infrequent (less than 7% of days), unless den sites are limited and possum density is high (Cowan 1990). However, collection of den sharing data from the wild is difficult, as most den sites are not easily viewed (Fairweather et al. 1987). Furthermore, den sharing estimates usually rely on tracking radio-collared animals, which may not correctly represent the population if they are not tracked to dens every day. Our data suggest that some pairs of possums prefer to den together rather than apart when living in captivity, perhaps because they have repeated close contacts that allow greater opportunity for social bonds to form than is normal for wild possums (Winter 1976). Also, the probability of den sharing in wild possums may be reduced, simply because high quality dens are usually not a limiting resource in New Zealand forests (Green & Coleman 1987).

Possums sharing dens performed mainly affiliative behaviours such as allogrooming and food sharing, which provide excellent mechanisms for the transmission of disease. The close physical contact between possums while sharing dens allows the ingestion of infectious material, direct transmission of organisms from one animal's body to the other, and aerosol transmission over very short distances. Den sharing has previously been suggested to be one of several routes for the spread of Tb between possums (Fairweather et al. 1987; Cowan 1989; Morris & Pfeiffer 1995), since Tb infection is often concentrated around denning areas (Paterson et al. 1995). Den sharing behaviour may prove to be important for the spread of other diseases, or for the development of biological control strategies for possums.

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REFERENCES

Caley, P. 1996: Is the spatial distribution of tuberculous possums influenced by den "quality"? *New Zealand Veterinary Journal 44*: 175–178.

Caley, P.; Spencer, N. J.; Cole, R. A.; Efford, M. G. 1998: The effects of manipulating population density on the probability of den-sharing among common brushtail possums, and the implications for transmission of bovine tuberculosis. *Wildlife Research 25*: 383–392.

Cowan, P. E. 1989: Denning habits of common brushtail possums, *Trichosurus vulpecula*, in New Zealand lowland forest. *Australian Wildlife Research 16*: 63–78.

Cowan, P. E. 1990: Brushtail possum (*Trichosurus vulpecula*). *In*: King, C. M. *ed.* The handbook of New Zealand mammals. Auckland, Oxford University Press. Pp. 68–98.

Day, T. D.; O'Connor, C. E.; Waas, J. R.; Pearson, A. J.; Matthews, L. R. 1998: Social behaviour and leptospirosis transmission in possums. *Royal Society of New Zealand Miscellaneous Series 45*: 115–121.

Duckworth, J. A.; Meikle, L. M. 1995: The common brushtail possum. *Australian and New Zealand Council for the Care of Animals in Research and Teaching News 8*: 4–8.

Efford, M. G. 1991: The ecology of an uninfected forest population *In*: Jackson, R. *ed. Symposium on Tuberculosis. Veterinary Continuing Education Publication 132.* Massey University, Palmerston North. Pp. 41–51.

Fairweather, A. A. C.; Brockie, R. E.; Ward, G. E. 1987: Possums (*Trichosurus vulpecula*) sharing dens: a potential infection route for bovine tuberculosis. *New Zealand Veterinary Journal 35*: 15–16.

Green, W. Q. 1984: A review of ecological studies relevant to management of the common brushtail possum. *In*: Smith, A. P.; Hume, I. D. *ed.* Possums and gliders. Sydney. Surrey Beatty and Sons, Chipping Norton. Pp. 483–499.

Green, W. Q.; Coleman, J. D. 1987: Den sites of possums, *Trichosurus vulpecula*, and frequency of use in mixed hardwood forest in Westland, New Zealand. *Australian Wildlife Research 14*: 285–292.

Innes, J. 1995: The impacts of possums on native fauna. *In*: O'Donnell, C. F. J. *ed.* Possums as conservation pests. Wellington, Department of Conservation. Pp. 11–15.

Jolly, J. N. 1981: Aspects of the social behaviour of the possum *Trichosurus vulpecula*. *In*: Bell, B. D. *ed.* Proceedings of the First Symposium on Marsupials in New Zealand. *Zoological Publication No. 74.* Victoria University, Wellington. Pp. 141–142.

Livingstone, P. G. 1991: Tuberculosis in New Zealand – current status and control policies. *Surveillance 19*: 14–18.

McLeod, B. J.; Thompson, E. G.; Crawford, J. L.; Shackell, G. H. 1997: Successful group housing of wild-caught brushtail possums (*Trichosurus vulpecula*). *Animal Welfare 6*: 67–76.

Morris, R. S.; Pfeiffer, D. U. 1995: Directions and issues in bovine tuberculosis epidemiology and control in New Zealand. *New Zealand Veterinary Journal 43*: 256–265.

Nugent, G. 1995: Effects of possums on the native flora. *In*: O'Donnell, C. F. J. *ed.* Possums as conservation pests. Wellington, Department of Conservation. Pp. 5–10.

Paterson, B. M.; Morris, R. S.; Weston, J.; Cowan, P. E. 1995: Foraging and denning patterns of brushtail possums, and their possible relationship to contact with cattle and the transmission of bovine tuberculosis. *New Zealand Veterinary Journal 43*: 281–288.

Winter, J. W. 1976: The behaviour and social organisation of the brush-tailed possum (*Trichosurus vulpecula* Kerr). Unpublished Ph.D. thesis, University of Queensland, Brisbane.

Winter, J. W. 1980: Tooth wear as an age index in a population of the brush-tailed possum, *Trichosurus vulpecula* (Kerr). *Australian Wildlife Research 7*: 359–363.