

A behavioural study of wild brushtail possums (*Trichosurus vulpecula*) infected with *Mycobacterium bovis* in New Zealand.

Norton S¹, Corner LAL², Morris RS^{1*}. ¹ EpiCentre, Institute of Veterinary, Animal and Biomedical Sciences, Massey University, New Zealand. ² Department Large Animal Clinical Studies, University College Dublin, Belfield, Ireland.

Summary

Brushtail possums infected with bovine tuberculosis are the primary reservoir of infection for cattle and deer in New Zealand. As part of a larger study we monitored 22 tuberculous possums and 8 non-diseased possums by weekly radio-location and two-monthly trapping over a two year period on a 36 ha study site in the Wairarapa region of New Zealand, during a period of repopulation following intensive removal of the local possum population. Infection re-established in limited foci within the site (hot spots), representing approximately the same denning areas as previously infected, but with different strains of *M. bovis*. Tuberculous possums survived a median of 11 weeks (range 1-100 weeks) after showing clinical evidence of disease, and died mainly in or near their home ranges. In conjunction with other related studies, it was concluded that long-term persistence of tuberculosis occurs through direct interaction between infected and susceptible possums in persistent foci of infection associated with den sites favourable to transmission, with only short-term survival of the organism in the external environment.

Introduction

In New Zealand the introduced brushtail possum (*Trichosurus vulpecula*) is a wildlife reservoir of bovine tuberculosis (*Mycobacterium bovis*). This reservoir complicates efforts to control the disease in domestic cattle and deer, although intensive control of possum populations over the last decade has reduced the number of infected herds very substantially. As part of a long-term study of the epidemiology of tuberculosis on an endemically infected site, intensive control of possums was undertaken throughout the site, then the re-emergence of infection was investigated¹ as the possum population re-established, to understand the behavioural and environmental influences which cause persistence of infection.

Tuberculosis is transmitted among possums and from infected possums to cattle and deer by aerosol transmission². Excretion of *M. bovis* increases as the disease progresses³. Terminally-ill tuberculous possums change their behaviour - becoming weak, uncoordinated, active in daylight, and not showing normal avoidance reactions to other animals². Both cattle and deer have been shown to actively investigate possums behaving in this way⁴.

The epidemiological factors leading to transmission of disease among possums and from possums to cattle and deer are not completely understood. The objective of this study was to identify aspects of behavior of tuberculous possums that may influence transmission of disease to other possums and to cattle and deer.

Materials and Methods

The study was carried out between March 1998 and February 2000 on a 36 ha site in the Wairarapa region of the North Island of New Zealand and has been described previously⁵. Vegetation was 70% dense regenerating native vegetation (scrub), 15% open woodland and 15% pasture. Live trapping was conducted bimonthly throughout the study for 3 consecutive nights to examine and individually identify possums on the site. Naturally tuberculous possums were fitted with radio collars after palpation revealed enlarged superficial lymph nodes. Lymph node aspirates were collected for culture. At the start of the study eight randomly-selected captured possums were experimentally infected with a strain of *M. bovis* not present in the region, radio collared and re-released. Non-diseased possums were radio collared for control data and were matched with naturally tuberculous possums on geographic location, and age and sex where possible.

A total of 22 tuberculous possums and 8 non-diseased possums were monitored throughout the study period. Study possums were located weekly by radio telemetry. Den and trap locations were plotted with a Geographic Information System. Activity ranges (den sites and trap locations) and den ranges (den sites only) were calculated using kernel density surfaces.

Results

The carcasses of 17 (10 naturally infected and 7 experimentally infected) tuberculous possums were recovered. Twelve carcasses were recovered from dense scrub, 3 from long grass in areas of sparse scrub and 2 from pasture. Ten of the 17 recovered carcasses were found at the lowest elevation recorded for that possum, which in general was close to cattle grazing areas. No possum carcasses were recovered from dens.

A median of 27 observations (range 21 – 52) were used to calculate activity ranges. The median activity range was 2.0 ha (range 1.0 ha – 4.2 ha). Few (35%) activity ranges had a pasture component and this comprised a relatively small component (10% - 25%) of the entire activity range. Of the 17 tuberculous possums that died naturally, 8 died within the boundaries of their activity range and 6 died within 200 m of their activity range boundary. The remaining 3 possums had made extended forays in the 2 weeks before dying. A median of 12 observations (range 5 – 21) were used to calculate den ranges. The denning range of individual possums varied from 0.3 ha to 2ha (median 1.0 ha). Denning ranges frequently overlapped, both between- and within-sexes and between non-diseased and tuberculous possums. The denning range was equal to approximately 25% of the activity range. Simultaneous den sharing was not observed in this study.

Possums made infrequent extended forays from their established activity areas, usually between 200 m and 350 m. Half the recorded forays were made by tuberculous possums. Two tuberculous possums each made unusually large forays of 500 m and 620 m. Seven male possums and 2 females made a total of 12 extended forays. Forays were mostly during February, August, September and October and showed no consistent direction.

After palpable lesions became detectable the median survival time of naturally tuberculous possums was 11 weeks (range 1 – 100 weeks). During most of the

disease process, the behaviour of diseased possums was indistinguishable from that of non-diseased possums. However, during the terminal one to three weeks of life possums became weak, lethargic, and showed poor coordination and balance.

Discussion

Eradication of tuberculosis from cattle populations in New Zealand is dependent on three elements, which, for practical reasons, have variable effectiveness: (1) reduce exposure of livestock to diseased vectors, (2) reduce the number of vectors, and (3) reverse the trend of disease spread within the vector population.

This study has addressed the first of these elements, suggesting scrub as the environment where transmission of tuberculosis occurs among possums, and where transmission from possums to livestock is most likely. To reduce exposure of livestock to tuberculous possums, grazing should be confined to areas free of scrub. Terminally ill possums are both debilitated and highly infectious³. Debilitation induces abnormal behaviour which is attractive to stock while severely reducing the possum's ability to avoid investigation². It may also cause possums to wander during daylight, when livestock are most active, increasing the risk of an encounter.

Ranging behaviour of tuberculous and non-diseased possums was similar and frequently overlapped. This supports the hypothesis of Pfeiffer⁶ that transmission of disease between possums would be most frequent in areas of favoured denning, due to competition for dens and mating activity. Extended forays may contribute to the localised geographic spread of tuberculosis due to interactions between a travelling and resident possum where either is infectious. However the maintenance and dissemination of tuberculosis is centred on small hot spots in scrub where infected possums den, and transmit infection to nearby possums and to cattle which explore these areas. Farm-level efforts to control tuberculosis in New Zealand should limit livestock access to these areas. Localized control of tuberculous possums would be most effective when areas of favoured denning are identified and targeted.

References

1. Corner, LAL, Stevenson, MA, Collins, DM and Morris, RS. The re-emergence of *Mycobacterium bovis* infection in brushtail possums (*Trichosurus vulpecula*) after localised possum eradication. *New Zealand Veterinary Journal*. 2003; 51 (2): 73-80.
2. Paterson, BM and Morris, RS. Interactions between beef cattle and simulated tuberculous possums on pasture. *New Zealand Veterinary Journal*. 1995; 43(7):289-293.
3. Jackson, R; Cooke, MM; Coleman, JD; Morris, RS; de Lisle, GW, and Yates, GF. Naturally occurring tuberculosis caused by *Mycobacterium bovis* in brushtail possums (*Trichosurus vulpecula*): III. Routes of infection and excretion. *New Zealand Veterinary Journal*. 1995; 43(7):322-328.
4. Sauter, CM and Morris, RS. Behavioural studies on the potential for direct transmission of tuberculosis from feral ferrets (*Mustela furo*) and possums (*Trichosurus vulpecula*) to farmed livestock. *New Zealand Veterinary Journal*. 1995; 43(7):294-301.
5. Corner, LAL; Norton, S; Buddle, BM and Morris, RS. The efficacy of bacille Calmette-Guérin vaccine in wild brushtail possums (*Trichosurus vulpecula*). *Research in Veterinary Science*. 2002; 73 (2):145-152
6. Pfeiffer, DU. The role of a wildlife reservoir in the epidemiology of bovine tuberculosis (thesis). Massey University; 1994.