The Spatio-Temporal Distribution of *Mycobacterium bovis* (Bovine Tuberculosis) Infection in a Badger Population

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Background

The European badger (*Meles meles*) is implicated as a reservoir of *Mycobacterium bovis* (bovine TB) infection for cattle in Britain and Ireland. Understanding the underlying causes of the distribution of bovine TB in badgers is therefore important in the context of effective management of the disease in cattle.

The spatio-temporal distribution of *M. bovis* infection was investigated using data from a long term epidemiological and ecological study of the dynamics of bovine TB in a wild population of badgers in Woodchester Park, South West England. In this high-density population, badgers are aggregated into social groups, each of which occupies a mutually exclusive territory. Since the capture mark recapture study began in 1976, 10,697 trapping and *post mortem* records have been obtained from 2258 individual badgers to date (April, 2001). Epidemiological analyses were carried out on an intensively studied sub-sample of 21-25 badger social groups.

Methods

Badgers were captured in cage traps, anaesthetised, examined and after a period of recovery were released at the point of capture. The infection status of badgers was determined on the basis of a serological test (ELISA) for antibodies and microbiological culture of clinical samples (faeces, urine, sputum, pus from abscesses, and bite wound swabs) as follows,

Negative = negative to both tests.
Exposed = positive on the serological test only.
Excretors = positive on the culture of at least one clinical sample.
Super-excretors = at least two consecutive positive culture results, or two positive culture results from different samples (e.g. faeces and urine).

The infection status of badger social groups was described using a group index based on the mean infection status of the residents (where negative=0, exposed=1, excretor=2, super-excretor=3).

Results

From 1982 to 1999 the annual prevalence of test positive badgers (i.e. positive on serological or microbiological tests) was 4.2% - 18.9% of the population, although only 1.4% - 8.8% were confirmed to be infectious (i.e. excretors and super-excretors) (Figure 1).

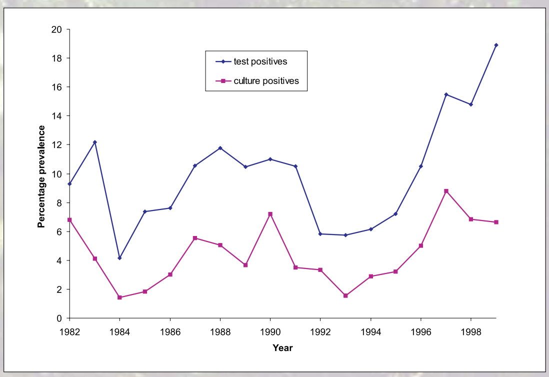

Figure 1. The prevalence of *M. bovis* infected badgers in the Woodchester Park population (test positives = exposed, excretors and super-excretors, culture positives = excretors and super-excretors).

Infection was aggregated in social groups in the west of the study area (Figure 2). Mantel tests were used in a randomisation approach, to assess associations between social groups by comparing two matrices. Social groups that were similar in respect to infection status were also close to each other in space (Pearson's r=0.283, n=22, P<0.01) and had more movement of badgers between them (Spearman's r=0.146, n=22, P=0.05). However, temporal trends in disease were not similar amongst neighbouring groups (Figure 3), suggesting that the spread of infection between them was insufficient to synchronise disease trends.

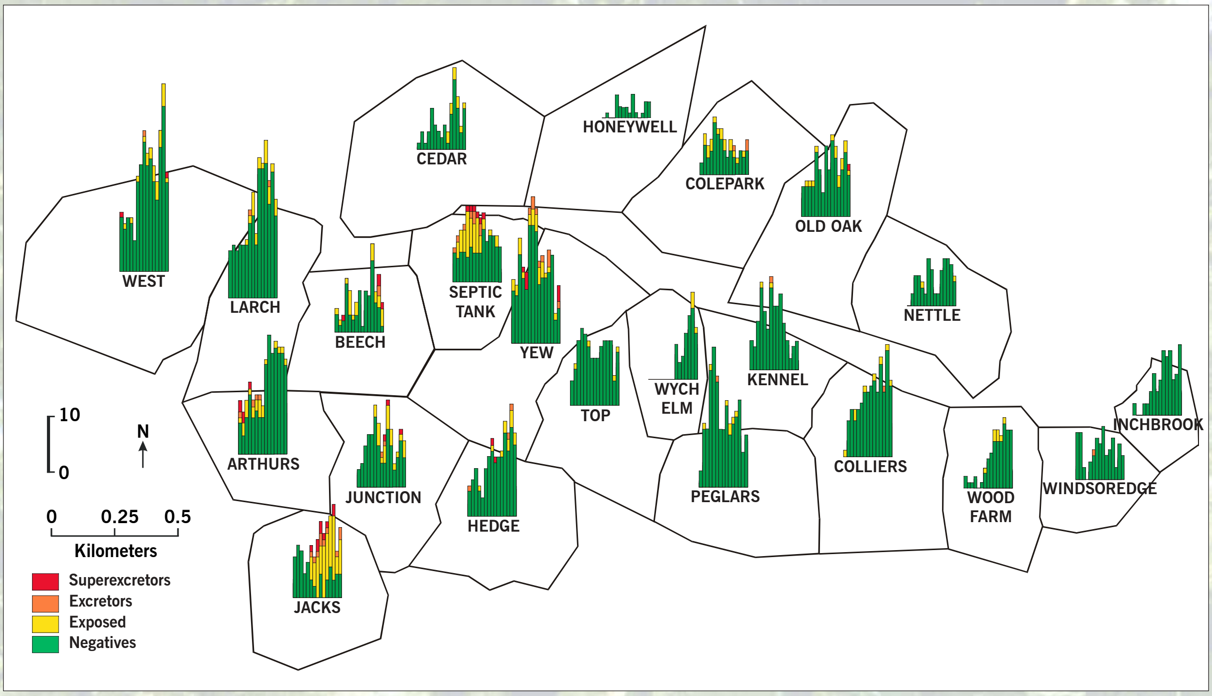

Figure 2. Schematic map showing the spatio-temporal distribution of infection in badger social groups at Woodchester Park. Bars represent the frequency of individuals in each infection class per year (1981-1996).

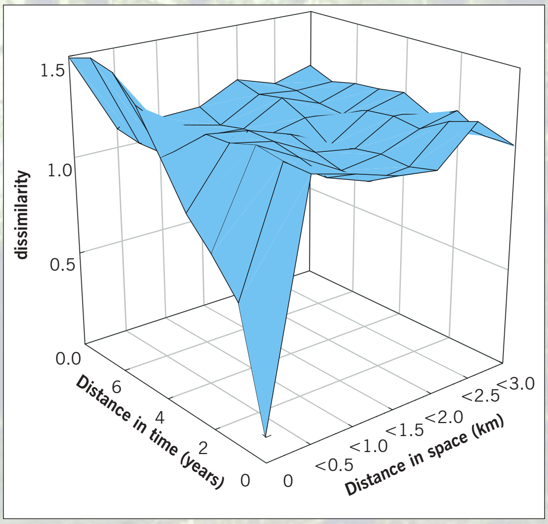

Figure 3. Three dimensional surface plot (variogram) showing variations in the 'dissimilarity' in TB index scores of badger social groups separated in space and time.

There was significant serial correlation in disease status within groups over time (Pearson's r=-0.393, n=15 years, $P<0.01$ by randomisation test), suggesting that infection persists for many years in some. The presence of infectious adult females in groups was associated with new infections (Logistic regression, χ^2=15.62, n=313, $P<0.001$), and provides further evidence for their importance in the maintenance of infection. No statistically significant correlations were detected between the demographic characteristics of social groups and group infection status.

Conclusions

The distribution of *M. bovis* in the Woodchester Park badger population reflects stable persistent foci of infection , with limited evidence of transfer between social groups. The accurate identification of such foci would allow the efficient targeting of a range of potential management strategies for the control of bovine TB in badgers. However, the extent to which this pattern of infection is representative of lower density and disturbed badger populations elsewhere in the UK is unknown.