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Spatial relationship between *Mycobacterium bovis* strains in cattle and badgers in four areas in Ireland

F.J. Olea-Popelka [a,*], O. Flynn [b], E. Costello [b], G. McGrath [c], J.D. Collins [c], J. O'Keeffe [c], D.F. Kelton [a], O. Berke [a,d], S.W. Martin [a]

[a] *Department of Population Medicine, Ontario Veterinary College, University of Guelph, Clinical Research Building, Guelph, Ont., Canada N1G 2W1*
[b] *Department of Agriculture and Food, Central Veterinary Research Laboratory, Abbotstown, Dublin 15, Ireland*
[c] *Centre of Veterinary Epidemiology and Risk Assessment, University College Dublin, Belfield, Ireland*
[d] *School of Veterinary Medicine, Hannover, Germany*

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Abstract

We investigated whether strains (restriction fragment length polymorphism, RFLP-types) of *Mycobacterium bovis* isolated from badgers and from cattle clustered among and within four areas in Ireland. The spatial scan test and nearest-neighbor analysis were used as the spatial cluster-detection techniques. In addition, for each of the major strains, associations between the distance to badger setts and the ''centroid'' of the cattle farm were assessed in a logistic model.

Overall, between September 1997 and May 2000, 316 and 287 *M. bovis* samples, from badgers and cattle, respectively, were strain-typed. The distribution of strains in badgers, and separately in cattle, differed among areas. Within each of the four large areas, badgers and cattle tended to have similar strains; this is consistent with the sharing of *M. bovis* strains within an area. In more detailed within-area analyses, some spatial clusters of *M. bovis* strains were detected, separately, in both cattle and badgers. Almost half of the infected badger setts with a specific strain were located outside of the ''detected'' clusters. There was no association between the number of infected badgers with a specific *M. bovis* strain within 2 or 5 km distances to cattle herds, and the risk of the same strain in cattle.

* Corresponding author. Tel.: +1 519 824 4120x54076; fax: +1 519 763 8621.
E-mail address: olea@uoguelph.ca (F.J. Olea-Popelka).

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We speculate about the dynamic nature of badger movements, as an explanation for the absence of more clusters of most of the strains of *M. bovis* isolated from badgers, and its impact on trying to study transmission of *M. bovis* between cattle and badger.

Keywords: Spatial; Distribution; *M. bovis*; Strain; Badgers; Ireland; Cluster

1. Introduction

Bovine tuberculosis (BTB) is a continuing problem in cattle in several countries, but it is only in Great Britain and the Republic of Ireland that badgers (*Meles meles*) are recognized as the principal wildlife reservoir. Tuberculosis in badgers in Ireland was identified first in 1973 (Noonan et al., 1975). Currently, *Mycobacterium bovis* (*M. bovis*) infection is endemic in the badger populations in Great Britain (Cheeseman et al., 1989; Clifton-Hadley et al., 1993) and in Ireland. Other authors provide evidence that tuberculous badgers are associated with *M. bovis* infection in cattle in Ireland (O'Connor and O'Malley, 1989; Dolan, 1993; Martin et al., 1997). In addition, identical strains (RFLP-types) of *M. bovis* have been found in local cattle and badger populations in Ireland (Costello et al., 1999).

The availability of data from a formal badger-removal project in four different areas of Ireland (Cork, 307 km^2; Donegal, 226 km^2; Kilkenny, 313 km^2; Monaghan, 368 km^2) for the period September 1997 until August 2002, provided the opportunity for us to study the among- and within-area distribution of badger and cattle-derived strains of *M. bovis*. Skuce and Neill (2003) stated that in a population of micro-organisms with sufficient genetic diversity, finding a group with the same strain (cluster) suggests that individuals are either infected from each other or from a common source. Thus our objectives were to compare the distribution of specific strains (RFLP-types) of *M. bovis* among and within-areas in badgers and, separately, in cattle. In addition, associations between the distance to badgers with specific strains of *M. bovis* and the risk of cattle having the same strain were assessed.

2. Material and methods

The data were obtained from the Four Area Badger-removal Project, Fig. 1 (FAP; Griffin et al., 1997, 2003, 2005). Exhaustive surveying for badger setts and capture activities to remove all badgers were introduced in the removal area beginning in September 1997 and continued to August 2002. We analysed the data arising from the first 2 years of removal activities (September 1997–August 1999). Each sett was examined for activity three times per year (twice in January–May, and once in September–December) each year. The tuberculosis status of badgers was based on a gross post mortem examination, histopathological examination of affected tissue and the culture of a pool of tissue (retropharyngeal, bronchial, mediastinal and mesenteric lymph nodes along with 1–2 g of kidney and lung tissue) as described by Costello et al. (1997). The geographical position of the sett at which infected badgers were caught was annotated on geographically