A PROSPECTIVE STUDY OF A BADGER POPULATION WITH ENDEMIC TUBERCULOSIS

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In 1974 badgers (*Meles meles*) in the UK were described with *Mycobacterium bovis* infection (Muirhead et al, 1974) and evidence has since accrued indicating a causal association between tuberculosis in badgers and cattle (MAFF, 1976-1990). In 1975 a badger control policy for England and Wales was started by the Ministry of Agriculture, Fisheries and Food, and in the same year a prospective study of a badger population infected with *M.bovis* was established, which has continued to the present day.

This paper briefly describes the methodology of the study, problems associated with the study species and some of the principal findings.

MATERIALS AND METHODS

Experimental study site

The study site, covering approximately 8km^2, is centered on a valley in the Cotswold escarpment in south-west England. Farming is mixed, with beef and milk production predominating. Badger setts are found mainly in Cotteswold sand outcrops along the sides of the principal valley.

Social group boundaries

The social groupings of the badger population have been determined annually by bait marking. Apart from two statutory badger removal operations, in 1978 and 1979, on the eastern side of the study area, the site has remained undisturbed.

Capture-mark-release programme

Badger movements and the spread of *M.bovis* infection within the population have been followed by a capture-mark-release programme. At first capture, badgers are tattooed and have both ears tagged. A date of birth is given which is taken as 1st January of the year of birth. If a badger is not caught as a cub or yearling ('known-age' badgers), it is classed as an adult (>2yrs old) and ascribed a year of birth two years prior to that of first capture.

Bacteriological examination

At each capture, faeces and urine samples, tracheal aspirates, swabs from bite wounds, abscesses and other external, suppurating

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injuries, and aspirates from unruptured abscesses are taken and cultured for *M.bovis* isolation. Badgers found dead or killed *in extremis* for humane reasons are examined at post mortem. A cause of death is ascribed where possible. Tissues with gross lesions are examined histologically. Bacterial culture is performed on lymph node and viscera samples.

Analyses

Prevalence: The yearly period prevalences of *M.bovis* infection have been estimated from 1981-1990 for known-age cubs, yearlings and adults. The numerator includes each infected badger from the year of detection until death. The denominator comprises all badgers from the year of first capture until that of last capture.

Incidence rates: Incidence rates for *M.bovis* infection by age group have been calculated for known-age badgers where clinical samples have been taken and/or a post mortem performed. The date of entry is 1st January 1981 or the date of birth, if later. For infected badgers, the date of exit is halfway between the first positive result and either the previous negative sampling or, if there is no previous sampling, the date of birth. For *M.bovis*-negative badgers, the exit date is the last sampling date.

Survival analysis: Kaplan-Meier survival rates have been calculated for known-age badgers. The entry date is the date of birth. The exit date is either the date of death (ie when the carcase was found), one year after the last sample date or 31st December 1990 whichever is the sooner.

RESULTS AND DISCUSSION

Bait marking showed that in 1990 the badger population in the study area was divided into 32 social groups, with boundaries similar to those of previous years. Two hundred and seventy four badgers (157 adults, 36 yearlings and 81 cubs) were caught or found dead during the year. The population structure indicates that as birth cohorts age female survival is significantly better than that in males, perhaps reflecting the aggressive, territorial behaviour of the male.

The unadjusted yearly prevalences of *M.bovis* infection from 1981-1990 suggest that the epidemic curve declined during the middle of the decade but has since recrudesced. However, the prevalences for 1990 may be adjusted downwards once the 1991 captures are completed and may indicate that a plateau has been reached.

Incidence rates of *M.bovis* infection were generally greater in males than females. Although this difference has been commented on before (Cheeseman et al, 1988), the infected female may be more important in transmitting infection to cubs. Estimates of pre-capture mortality rates in cubs increase as the prevalence of tuberculosis infection at the site rises.

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Comparison of survival between *M.bovis*-positive and -negative badgers suggests no overall difference. However, when age group is considered, mortality rates in cubs and yearlings perhaps point to an advantage, or at least no disadvantage, for the *M.bovis*-positive animals, whereas the opposite may be true in 3-5 year old badgers. This aspect of infection dynamics is being investigated further.

This prospective study has presented various problems for the epidemiologist, principally related to the study species and its lifestyle. Trapping is not comprehensive at each sampling. Capture efficiency can be disrupted, eg by the weather, or by behaviour towards trapping. Furthermore, although badgers live within social groups, movements do occur across territorial boundaries and in and out of the study area, amounting to migration. Various causes of death apart from tuberculosis, eg road traffic accidents, and trap-shyness, are major causes of loss to follow-up, and each is a potential source of bias.

Since no valid means of ageing live badgers has been established, there is an unresolvable source of error should yearlings be wrongly classified as adults. Also, animals first caught as adults cannot be attributed a known age. Therefore, data especially from earlier years will be lost in age specific analyses.

Finally, the study is concerned with a high density population and the results may not be generalizable to populations of lower density, particularly with respect to movement ranges and the rigidity of the social group territories. Such differences may have a bearing on the dynamics of infection (Wilesmith et al, 1986).

Further analysis is required to assess the effects and dynamics of tuberculosis within and between social groups. The effects of badger removals on adjacent social groups, recolonization and reintroduction of tuberculosis after removal operations can now be studied after the accrual of more than ten years' results.

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