Age-dependent patterns of bovine tuberculosis in cattle

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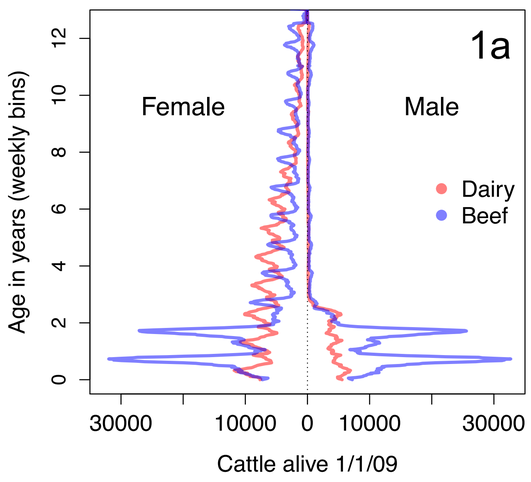
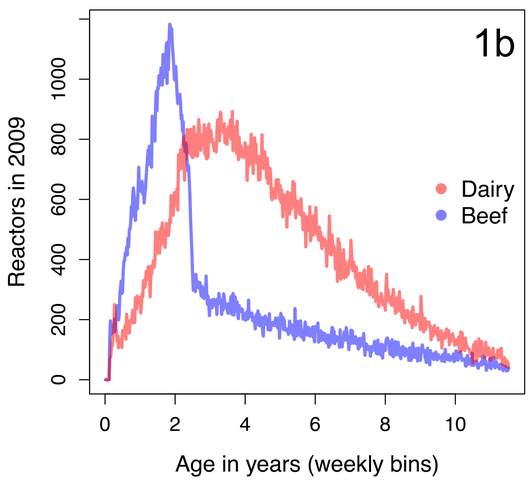
Premise

Bovine tuberculosis (BTB) is an infectious disease of cattle caused by *Mycobacterium bovis.* Knowledge of age-specific risks is crucial for accurately interpreting epidemiological data and for optimal control. The demography of many cattle populations is highly structured (fig. 1a), potentially amplifying age-specific patterns.



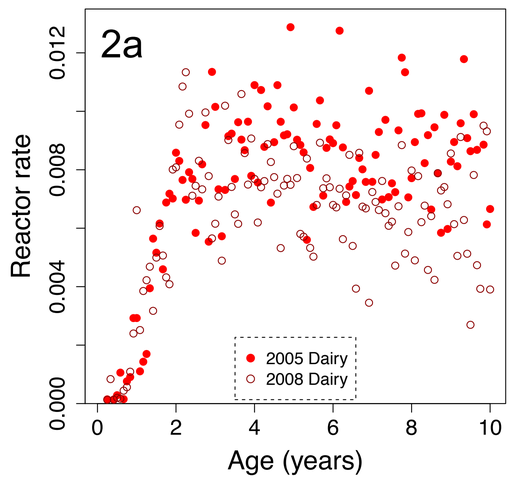


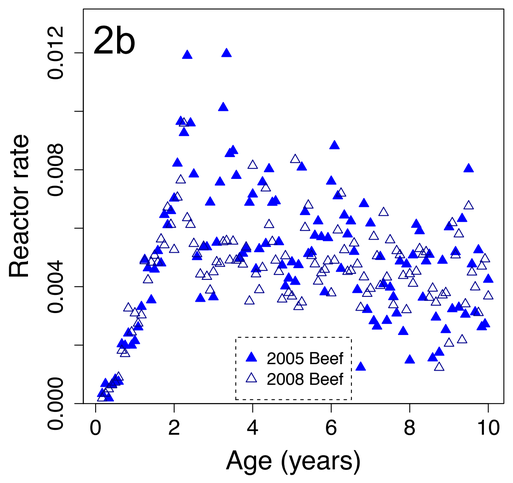
Methods and data

We used data on reactor cattle from Great Britain between 2004 and 2009 (fig 1b). We had to infer background testing patterns from cattle movement data as negative tests were not recorded.

Age and reactor rates

There is a clear association between age and reactor rates (figs 2a & 2b). Reactor rates increased with age for the first 2-3 years of life, after which rates in older animals remained constant or decreased.



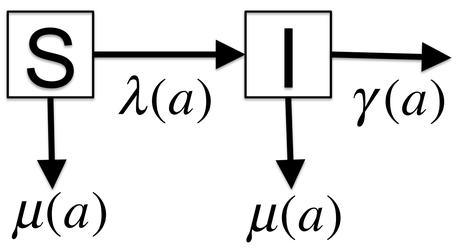


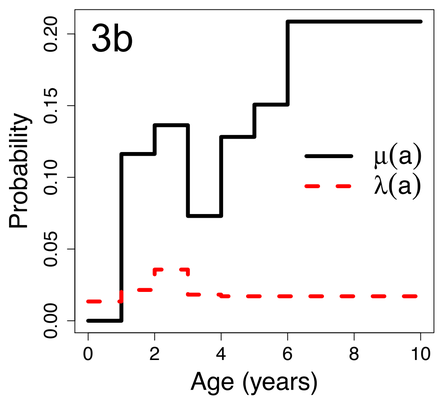
- **Reactor rates in young** beef and dairy calves under 1 year were approximately equal.
- **Reactor rates in dairy cattle over 2 years** were 40% higher than rates in beef cattle of similar age.

Age and infection rates

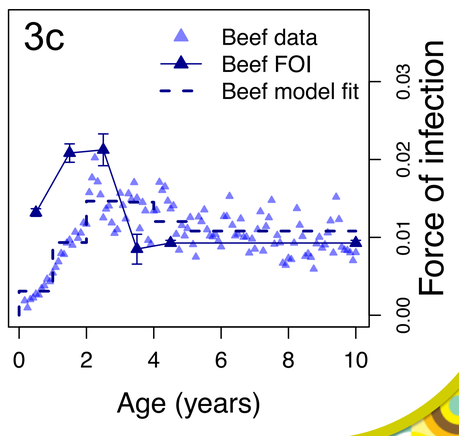
We used a two-state catalytic model to capture the dynamics of cattle becoming infected and detected with BTB with age (fig 3a). We calculated the mortality rate by age ($\mu(a)$) from the data. We assumed that cattle started life age 0 uninfected and susceptible to infection (state **S**) and used reactor rates to estimate the force-of-infection with age ($\lambda(a)$, state **I**) and the testing rate by age ($\gamma(a)$).

3a



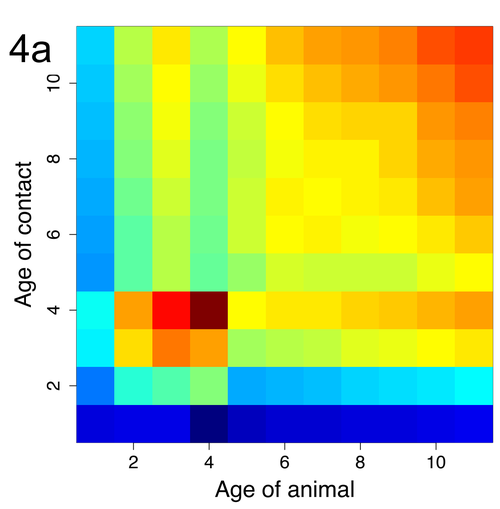


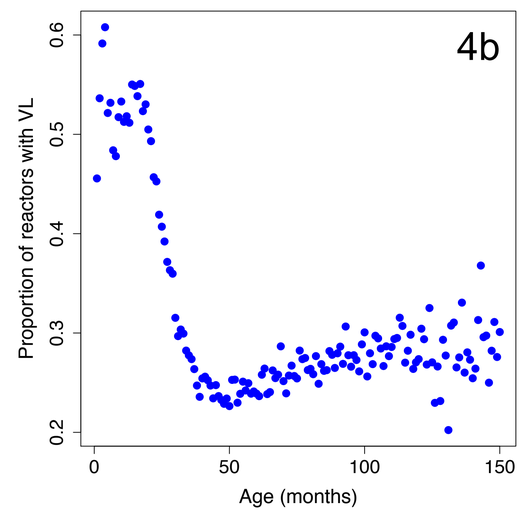
- **Infection rates in young cattle** were greater than reactor rates due to imperfect test sensitivity
- **Cattle aged 2-4 years** experienced the highest rates of infection (fig 3c)
- In **older cattle** the removal rate exceeded the infection rate



Age and contact patterns

What factors contribute to differences in reactor rates and force-of-infection with age? Using cattle movement records, we found marked differences in farm sizes by both age and breed purpose. Figure 4a shows the age-specific mixing matrix. Beef cattle aged 2-4 years formed a core group with the greatest number of within-farm contacts.





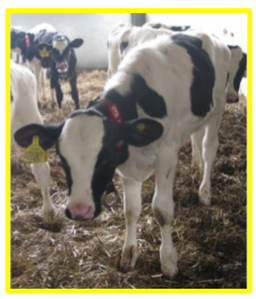
Age and visible lesions

Age-specific immunity is also important. Analysis of test data indicates that 50-60% of reactors under 2 years were found with visible lesions (VL) at slaughter compared to around 30% of older reactors, suggesting a different rate of disease progression with age (fig 4b).

Summary

The substantial variation of BTB rates with age has implications for both the understanding of BTB infection and the design and implementation of control programmes. Further work is needed to quantify:

- Skin test sensitivity with age
- Age groups most susceptible to infection
- Age groups at greatest risk of onward transmission
- Differences in dairy and beef herds
- Variation between countries and settings



Acknowledgements

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