The Deer Initiative

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Tick-borne diseases – wild deer and the future

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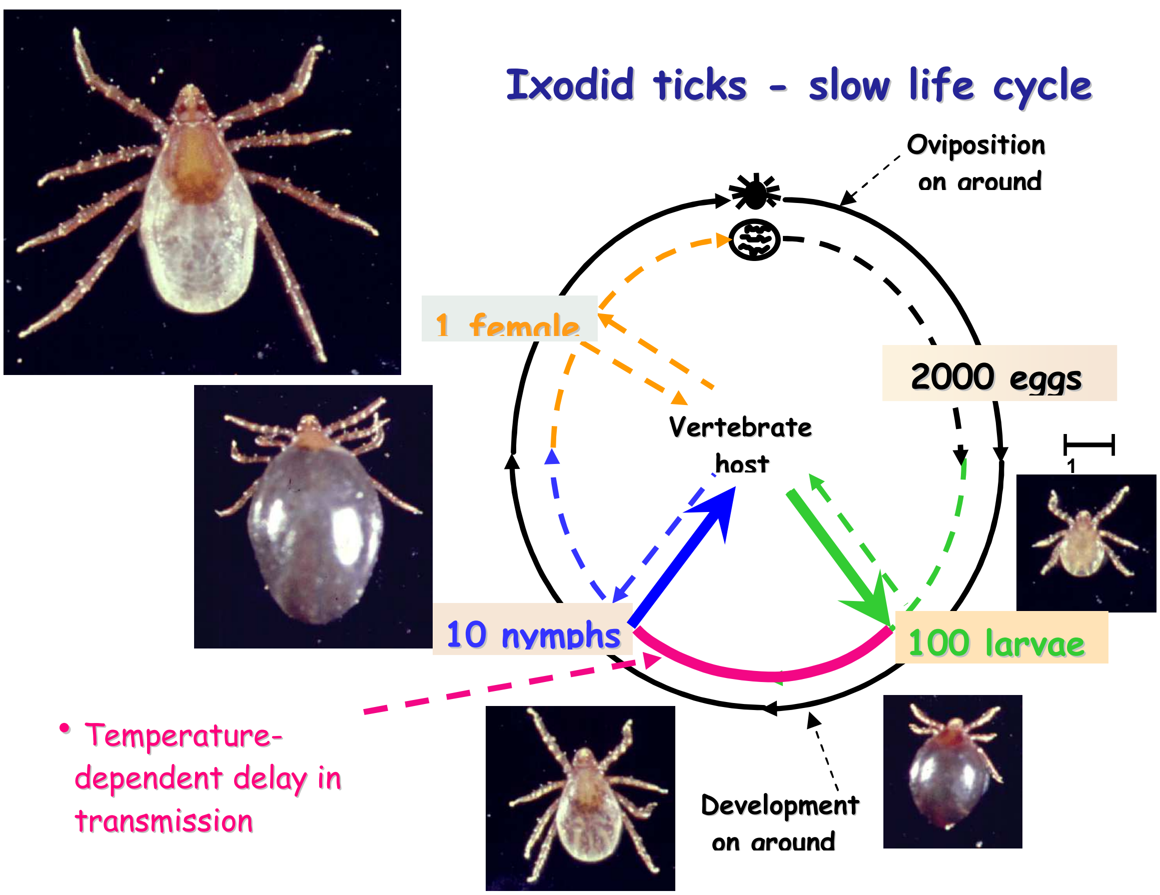
TICKS AS VECTORS OF PATHOGENS THAT CAUSE DISEASE

Class: Arachnida
Sub-class: Acarina
Order: Ixodidae

Predicting the future by understanding the past

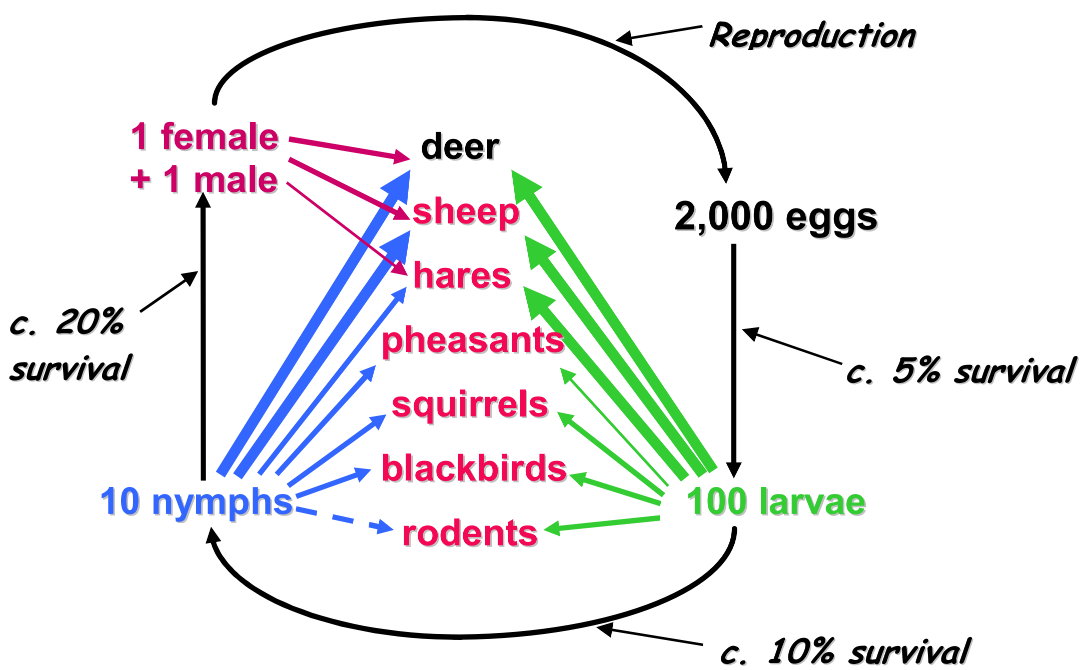


Examples of tick-borne parasites from various continents

PARASITE	DISEASE	REGION	HOSTS
Viruses (arboviruses – very many)	Tick-borne Encephalitis Louping ill Crimean-Congo Haemorrhagic Fever	Europe/Russia UK Africa, Central Asia, Turkey	humans† rodents sheep, grouse, hares humans†† livestock
Bacteria	Lyme disease spirochaetes (*Borrelia burgdorferi*)	N. hemisphere	humans, rodents, birds
Rickettsia	Spotted fevers Rocky Mountain Mediterranean Ehrlichiosis (Anaplasma spp)	 USA S Europe World-wide	humans†† livestock
Protozoans	Piroplasms: *Babesia* spp (redwater) *Theileria parva* (East Coast fever)	 World-wide East Africa	 cattle cattle

The most significant vector-borne zoonoses in Europe are Tick-borne encephalitis and RNA flavivirus carried by Sheep tick, Deer tick, Wood tick, Castor bean tick.

Ixodes ricinus **life cycle with typical reproductive and mortality rates and host relationships**



Biotic variability in Lyme disease systems

- Host diversity
- Genetic diversity of the *Borrelia burgdorferi* complex
- *B. burgdorferi s.s* - arthritis } mammals
- *B. afzelii* - dermatological disorders
- *B. garinii* - neurological symptoms
- *B. valaisiana* } birds and lizards
- *B. lusitaniae*

Deer are apparently non-competent for all *Borrelia*

Risk of Lyme disease depends on:

- Density of infected nymphs – small and abundant
- More on density of nymphs
- Less on infection prevalence in nymphs

What is the full distribution in the UK?

GIS mapping used to try to predict this. However, a distribution map based on abiotic environmental variables had several false positives, predicting ticks in areas where no ticks have been recorded. What does this tell us?

- Errors in model underlying the predictive map
- Ticks are present but not yet recorded
- Climatically suitable, but area not yet colonised:
    - Absence of hosts (deer) for ticks
    - Land cover important, especially woodlands
    - Deer populations require woods of certain size
    - What size woodland is needed to support deer/tick populations?

Comparing woodland cover with tick presence show ticks tend to be closer to woodlands, and occur in larger woodlands. We can use this information to derive risk maps to be used as:

- Blueprints to direct control
- Spotlights on processes underlying epidemiological patterns
- Integrating biological and statistical approaches
    - Explain the <u>increasing incidence of Lyme borreliosis</u>??

Recorded Lyme disease cases reflect public health as much as biology.

From 1980-2005, there were an estimated 1,000-2,000 additional cases diagnosed on clinical symptoms without lab-confirmation.

Roe deer abundance and cases of lyme disease are positively correlated (Spearman's rank rho = 0.754, P < 0.001).

The key is to understand not only distribution but also the abundance, or hosts available to ticks. Muntjac, for example, have spread rapidly since escaping from Woburn park in the 1950s and are free roaming in and around woodlands and also in gardens.

- Higher host density can result in lower seasonal questing tick densities. Seasonal abundance increases while rates of recruitment exceed death and attachment - turnover before end of recruitment if host density high.
- Lower host density - more questing ticks accumulate on vegetation. No hosts, no attachment - ticks stay on vegetation till they die.

Impact of deer removal on abundance of ticks, infection prevalence with *Borrelia*, and density of infected ticks via experimental removal of all deer on an island off Maine coast;

Abundance of questing ticks first increases over 2 years - product of LL and NN feeding on other hosts. Then crashes as no adults are fed.
% infection prevalence increases as more immature ticks feed on competent rodent hosts, then decreases in few remaining ticks – very, very few ticks.
So abundance of infected ticks crashes to zero - no ticks, no infected ticks!

Recent UK survey suggests an increase in ticks:

- ❑ 173 replies
- ❑ 153 reported ticks present
    - 13 sites: present now/absent in past
    - 3 sites: absent now/present in past
    - 132 sites: deer and ticks present
    - 16 sites: ticks but no deer
    - 5 sites: deer but no ticks

- ❑ 122 reports on tick abundance
    - 90 reports of increase, mostly over past 5 years
    - 8 reports of decrease, mostly over past 10 years

Mean daily temperature determines the time at which ticks start to become active (April time) but very hot temperatures can desiccate them – climate change implications?

Speaker's biography

After graduating from Oxford, Sarah Randolph started studying ticks for her PhD at King's College, London in 1970. As a departmental lecturer in Oxford from

1974, she married David Rogers, which precipitated a 15-year period of studying the field ecology of tsetse flies in Africa, before returning to tick-borne disease systems. Having explained the focal distribution of tick-borne encephalitis (TBE) in Europe, she is now trying to explain the dramatic up-surge in incidence of TBE. She has supported herself at Oxford on a series of external research fellowships from the Leverhulme Trust, the Royal Society, the Wellcome Trust and NERC.