

Features

Watch out, ticks about!

Lyme disease - what you need to know

Stella Huyshe-Shires explains the risks, and describes the precautions you can take to protect yourself and others from Lyme disease.

Trees, particularly in the form of deciduous woodland, help to provide an environment within which ticks can thrive: relatively high humidity, abundant small mammals on which to feed, leaf litter in which to remain safely dormant and the odd forester, woodland walker or deer on which to hitch a lift.

Why worry? Many reading this journal have been removing ticks from themselves for years without apparent ill effect. UK ticks can transmit several diseases and both the diseases and the ticks are on the increase (Tijssen-Klasen et al., 2010; Scharleman et al., 2008). Knowledge of how ticks live and feed and how diseases are transmitted can help reduce the risk. Awareness is a far better policy than complacency.

Ticks in the UK

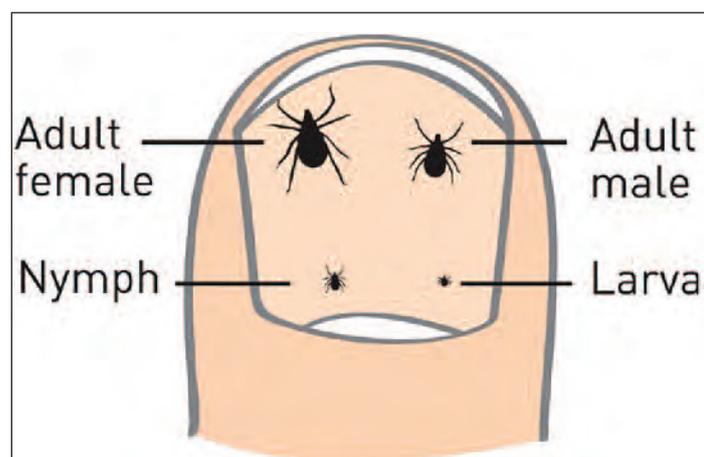
Ticks are small, blood-sucking arachnids related to mites and spiders. There are many different species of tick living in the UK, some of them preferring to feed on the blood of specific animal hosts (Jameson and Medlock, 2011). The

one most likely to bite humans is the sheep or castor bean tick, *Ixodes ricinus*. Despite its name, the sheep tick will feed on a wide variety of mammals and birds. Bites from other ticks are possible, including from the hedgehog tick, *Ixodes hexagonus*, and the fox or badger tick, *Ixodes canisuga*. These are all 'hard ticks' with a strong scutum very resistant to crushing.

There are four stages to an Ixodid tick's life-cycle: egg, larva, nymph, and adult. The eggs produced by the adult female hatch into six-legged larvae, which to the naked eye look like glistening specks of soot. They will attach to a small host such as a mouse or bird, feed for a few days until replete and then drop to the ground where they moult into the nymph stage. Nymphs have eight legs and are the size of a pinhead. The typical hosts for nymphs are squirrels, hedgehogs and birds including pheasants. After a feeding period of perhaps seven days, the nymph detaches and moults into an adult, the male being slightly smaller than the female. The adult female stays attached to a host, typically a deer, sheep or dog etc. feeding for up to ten days. As the body fills with blood it becomes lighter in colour swelling to the size of a small pea. The complete life cycle takes about two years.

With their eight legs, nymphs and adult ticks resemble small spiders. The adult is the stage often seen on dogs and cats, but it is the smaller nymph that is the stage most often seen on humans.

Ticks require a microclimate with a relative humidity above 80% for most of the time (Gray, 1998). They are therefore ground-based and complete each moult in the protection of decaying vegetation. The tick will then climb a nearby piece of vegetation, extending its hooked front legs which will be caught on the fur or clothing of a moving animal. This behaviour is known as questing and potentially exposes the tick to desiccation. Ticks are much less likely to be questing in very dry conditions or in rain. A suitable habitat for ticks is



The relative sizes of larva, nymph and adult compared with a fingernail.

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therefore vegetation that provides shade, humidity and a layer of leaf litter, abundant small animals on which the larvae and nymphs can feed and sufficient large animals to maintain a high enough adult population for reproduction. Deciduous woodland with good understory vegetation is ideal, but ticks can also abound in coniferous forest, rough pasture and managed gardens, particularly those bordering woodland with a strong wildlife population (Jameson and Medlock, 2011). Large town parks with wilder areas, such as Bradgate Park in Leicester and Richmond Park, also harbour a tick population.

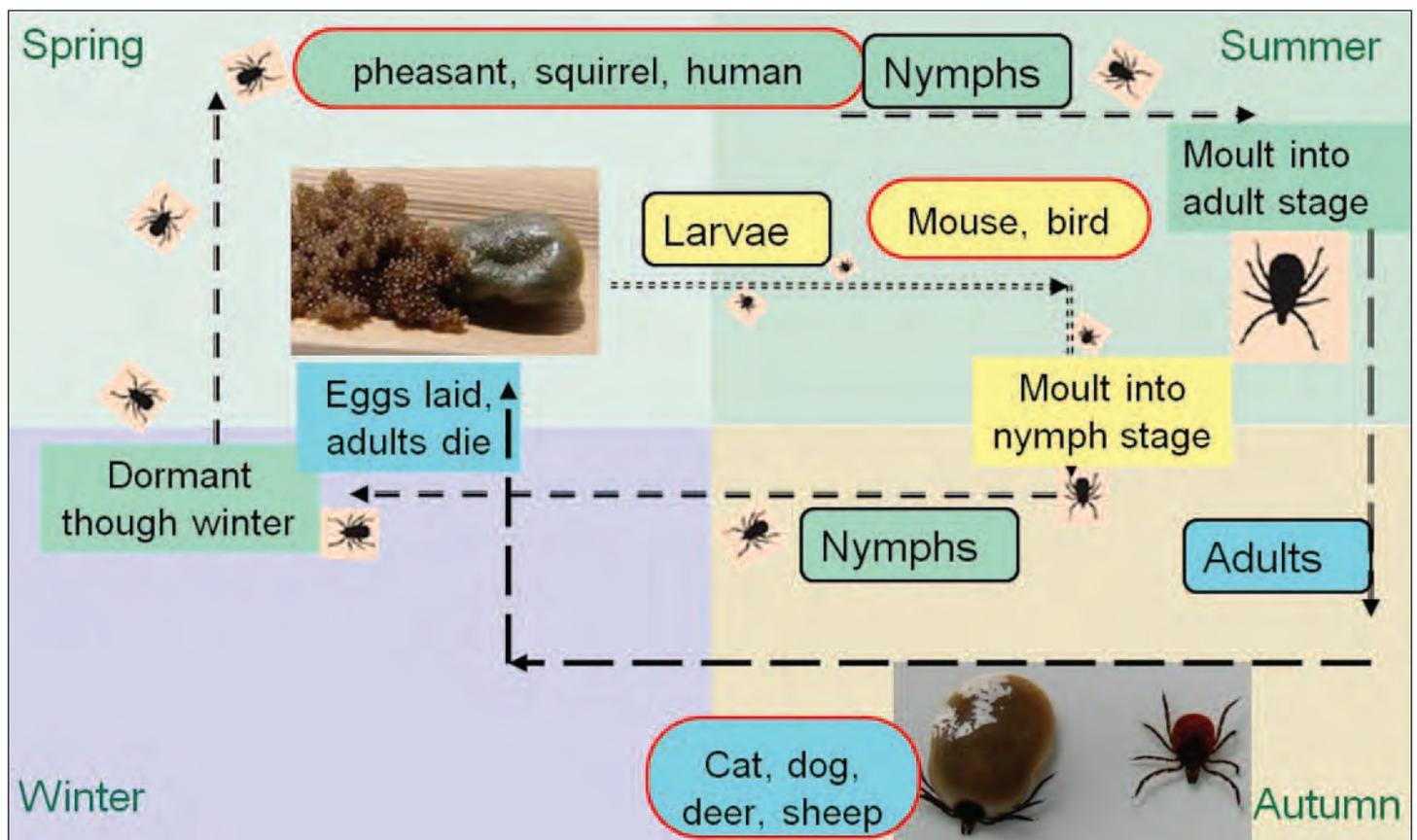
Because colder temperatures and dry conditions reduce tick activity, ticks are most active between March and October, with a lull during a dry summer period. The spring rise tends to occur earlier in woodland than open countryside and although ticks tend to remain dormant through a cold winter, they will be active in temperatures exceeding 7°C so mild winter days can cause a spike in tick activity (Dobson, Taylor and Randolph, 2011). Warmer winters mean that in many areas of the UK ticks can be active throughout the year; anyone working in, or managing, woodland should be aware of this.

Tick-borne diseases

Ticks can transmit more than one disease at a time although Lyme disease, or Lyme borreliosis, is currently by far the most common tick-borne infection in the UK. Other tick-borne diseases include Q fever, rickettsia spotted fevers, anaplasmosis and babesiosis. The reported incidence of Lyme disease in the UK has been rising steadily since records were started, but although these other diseases are known to be present in UK ticks, their incidence is unknown as they are rarely tested for in humans.

The island status of Britain confers some protection from pathogens but, as with chalara, inevitably at some point other tick borne disease will cross from mainland Europe. Pets can now travel freely throughout Europe and there is no mandatory requirement for tick treatment on imported dogs. Any tick from Europe may carry other diseases. Tick borne encephalitis virus (TBE), which is endemic in mainland Europe, and tularaemia are two examples yet to be recorded in the UK.

If a larval tick picks up an infection from a small animal such as a vole, when it next feeds as a nymph it can pass the infection to the animal or human to which it attaches. So what



The 2 year life cycle of *Ixodes ricinus*, the commonest UK tick to attach to humans.

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a tick transmits in any given area is dependent upon the reservoir of disease in the local wildlife population.

Some diseases are carried principally by birds, some by rodents. It used to be thought that deer were the principal reservoir of the Lyme disease bacteria, but it is now clear that this role is filled by small rodents and birds (Franke, Hildebrandt and Dorn, 2013). Deer, and other ruminants, seem to be incompetent hosts and eliminate most Lyme disease bacteria in the feeding tick (Richter and Matuschka, 2010). However the deer, as large mammals, provide support to a large number of adult ticks thus increasing the tick population in the area. It seems likely that although deer amplify the tick population they may have a diluting effect on pathogen transmission. There are complications when considering whether deer fencing might be a way of decreasing the risk of infection to humans. Red deer tend to feed adult ticks, but roe deer feed all stages of tick, so the two species may have differing effects (James et al., 2013). In addition deer are incompetent hosts for some pathogens, but competent hosts for others. Ticks and their pathogens are integrated in an ecology that is complex to model (Bolzoni et al., 2012).

Not every tick carries an infection. Surveys in different

parts of the UK have shown that the percentage of ticks carrying disease ranges from zero to about 20%. This varies from place to place, seasonally and also from year to year (Bettridge et al., 2013).

Lyme borreliosis

The disease was known in Europe, under different names, in the late 19th and early 20th century but it was following an outbreak in the town of Old Lyme, Connecticut, that the bacterium *Borrelia burgdorferi* was discovered and linked to the European disease. There are now known to be at least five genospecies, which causes Lyme borreliosis (LB) in Europe but only one in the USA. Although there are differences between them, both in terms of their wildlife hosts and how they affect humans, they all give rise to a broadly similar disease presentation.

Symptoms of LB appear on average 14 days after the tick bite. The most common symptoms in adults are flu like symptoms of aching, fever, headache, fatigue, sweating, joint and muscle pain, light and sound sensitivity, abnormal skin sensations (tingling, numbness, itching); stiff neck; a spreading rash called erythema migrans. Not everyone displays all these symptoms and although the rash is



The erythema migrans rash is not necessarily a 'bull's eye'. It can be large or small, single or multiple, solid or clear in the middle.

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diagnostic, UK studies show about 1 in 3 people do not see a rash. (Lovett et al., 2008)

As the bacteria disseminate through the body they can affect many parts, including the heart, eyes and brain. Later symptoms can overlap with those of many other conditions, which may make clinical diagnosis difficult particularly if a tick or rash has not been noticed. There is a blood test, but it relies on the development of antibodies which may take several weeks to reach detectable levels. If the disease affects the peripheral or central nervous system it is known as Lyme neuroborreliosis (LNB).

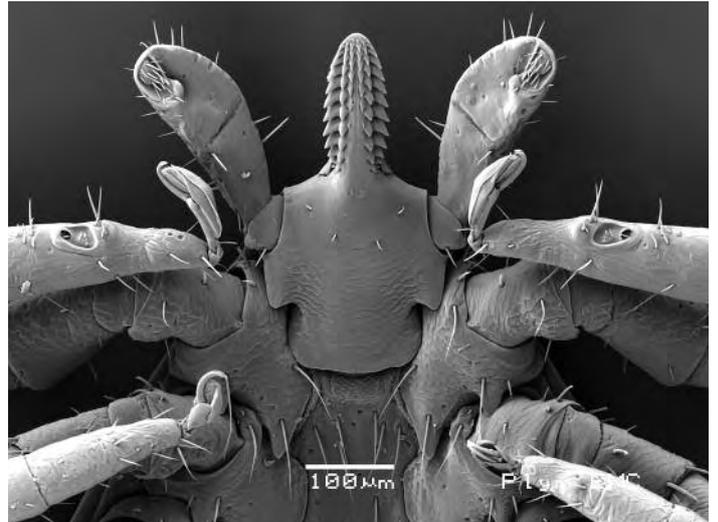
Treatment is with antibiotics, and the sooner they are started, the better. This makes recognition of the rash very important as if that is seen, then treatment can be started straight away without waiting for a blood test, which may be negative at that early stage. Anyone experiencing illness in the weeks following a tick bite should consult their GP who can seek advice from Public Health England (PHE) as to appropriate tests and diagnosis.

Prophylaxis, taking a single dose or a short course of antibiotics immediately after a tick bite, is not currently recommended. Short courses are not always effective at preventing disease but can stop an antibody response developing. As it is the antibody response on which the current blood tests rely, development of apparent Lyme disease some weeks later may not be supported by a positive blood test. This can mislead a doctor who has not met LB before into refusing to prescribe necessary treatment: "Your test is negative: it can't be Lyme". Better to wait for the first symptoms as there is a relatively low probability that any tick is infected, and a full course of early treatment following the first appearance of symptoms is very effective. The main exceptions where prophylaxis may be indicated are pregnant women and anyone with a degree of immune suppression, either through illness or prescribed medication.

Occupationally acquired LB should be reported to the Health and Safety Executive under RIDDOR regulations; this applies to employed and self-employed individuals. The wildlife hosts seem to be unaffected by disease, but LB can affect cats, dogs and horses.

Disease Transmission

The tick will not necessarily bite immediately, but will often spend some time finding a suitable site on the skin. The hooks on its legs enable it cling to fabric even if a person is still active. It will walk up socks, detecting the CO₂ given off from skin, and ascend the leg to find a suitable, moist place



Electron micrograph showing the barbed mouthparts of a nymph *Ixodes ricinus*. (Image courtesy of Keith Ryan)

with a good blood supply. Behind the knee and the groin are typical sites, but if someone has been working with their hands near the ground or in vegetation, the tick might start on the wrist and move up the arm.

When the tick finds a suitable place on the skin it inserts barbed mouthparts to fix itself securely and starts to feed. Tick saliva contains both immunosuppressant and anaesthetic so tick bites are painless and rarely itchy. Some bacteria may be transmitted to the bloodstream fairly quickly, but some need to be drawn from the mid gut of the tick up to the salivary glands and this process can take a few hours. Although any one tick may not be infected it should be removed as quickly as possible to reduce the chance of disease transmission. The risk of Lyme disease transmission increases with the length of time the tick is attached, but it is a fallacy that 24 hours must elapse before infection is passed.

Personal protection

Avoiding tick-borne disease requires a three pronged approach: trying to deter ticks from attaching, checking regularly and removing promptly any that do. Conventional wisdom is to wear long trousers and tuck them into socks so the protective clothing worn by chainsaw users, for example, might therefore seem ideal. However, ticks might be carried back to a vehicle on clothing and find an opportune opening to skin during rest breaks. The ease with which a tick can latch onto clothing versus bare skin has not been put to the test but if skin is exposed, the tick is more likely to detect CO₂ and other body odours and this will be especially relevant if someone is fairly stationary: habitat or botanical surveyors for

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Nymph attached to leg; note the small size.

example or wildlife photographers. Perhaps also those standing in the long grass listening to an interesting talk at a divisional meeting!

Insect repellents containing the active ingredients DEET and Picaridine are effective against ticks. DEET products are widely available and thought to be safe for most people, but DEET has been associated with adverse reactions in sensitive individuals and can damage synthetic clothing, including the plastic round ear defenders. Picaridine has a slightly lower toxicity and does not damage synthetic fabrics but some studies have shown it to be less effective against ticks (Goodyer et al., 2010). Repellents should generally be applied sparingly directly to the skin, but manufacturers' instructions should be followed. Clothing can be treated with the insecticide Permethrin. This is safe for humans in normal doses, but is dangerous to cats and to aquatic creatures, so should be used with care.

The use of repellents should not lull anyone into a false sense of security: ticks will find you and their tiny size means it is difficult for you to find them. Brush off clothes at intervals, particularly before going indoors. Do the same for dogs, as ticks can be walking on their coat and then drop off inside the car or house. The best time for checking for ticks is in the shower or bath. Run your hands over your skin and any small 'scab' that can be rocked back and forth should alert you to the possibility of a tick. Use a tick removal tool or entomological tweezers. Do not use household eyebrow tweezers as these run the risk of squashing the body of the tick and increasing the chance of transmission of body fluids, as does the use of fingernails. For the same reason, do not put the tick under stress by applying Vaseline, alcohol or a cigarette. If no tool is available, a loop of thread wound as close to the skin as possible and pulled steadily upwards, will pull the tick off. The barbed mouthparts face backwards, and

you will meet considerable resistance with any method, but don't let this deter you! Detached ticks can be sent to the Tick Recording Scheme of PHE to assist in research (see Further Resources).

Public protection

Visits to the countryside, and woodlands particularly, are important to both physical and mental health (Pretty et al., 2011). Giving woodland visitors straightforward and palatable information is the key to their protection. Studies have found people are often reluctant to take precautionary measures (Quine et al., 2011; O'Brien et al., 2012); who wants to 'cover up' during a warm sunny, recreational visit? Perhaps it would be more effective to make visitors aware of ticks and the health risk they pose and advise brushing clothes off before getting into their cars and checking skin when they get home.

Vegetation management strategies, in particular strimming or mowing broad areas around the edges of paths and car parks, can reduce public contact with ticks, although will not eliminate it. The widespread use of acaricides, although sometimes recommended in the USA particularly around school playgrounds in endemic areas, is not a practice used or recommended in the UK because of the environmental impact.

Selling insect repellents and tick removal tools in on-site shops, reception or information areas can be a good way of raising awareness.

Further resources

Public Health England:

<https://www.gov.uk/government/collections/lyme-disease-guidance-data-and-analysis>

Lyme Borreliosis service with information on testing for tick-borne pathogens:

<https://www.gov.uk/lyme-borreliosis-service>

Tick Recording Scheme for information on ticks:<https://www.gov.uk/tick-recording-scheme>

Lyme Disease Action for information, patient and doctor support service and posters and leaflets aimed at the general public:

<http://www.lymediseaseaction.org.uk/>

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Summary of ways to minimise the risk of tick-borne disease

	Woodland workers	Woodland Visitors
Most at risk:	Anyone spending a lot of time stationary especially if kneeling, sitting or lying on the ground: surveyors, photographers.	People sitting or lying on the ground: picnickers, campers, photographers, small children. Children exploring wilder areas off the paths. Dogs off the lead.
Avoidance of ticks: staying away from tick habitats	Limited possibilities, but when having a break, be aware of where you sit.	Keeping to paths; sitting on benches or a picnic rug, not the grass.
Prevention: stopping ticks reaching the skin	Reduce amount of exposed skin. Use repellents on clothing and/or skin. Remove ticks before they attach - brush clothing down.	Use of repellents on clothing and/or skin. Remove ticks before they attach - brush clothing down.
Checking and removal:	Check skin immediately after work. Carry a tick removal tool and remove attached ticks properly.	Visitors should have information about ticks so they know to check. Tick removal tools should be present in first aid kits and could be offered in on-site shops.
Bottom line:	Carry a tick remover, check regularly, remove promptly and correctly.	Provide information so that visitors are informed.

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Stella Huyshe-Shires grows Christmas trees and manages a large garden in Devon, from whence she contracted Lyme disease. She is the current chairman of Lyme Disease Action, a UK charity.

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