Alien species in Belgium: a fact sheet for

Rhipicephalus sanguineus

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This fact sheet was created as part of the project *Alien Alert*, which aims at developing an integrated quick-screening tool for emerging pests and invasive species in Belgium. This BELSPO-funded project involves eight scientific institutions. Coordination is provided through the Belgian Biodiversity Platform.

The objective of this fact sheet is to support the identification of potentially invasive non-native species for Belgium and neighbouring areas. Organisms that qualify for this fact sheet are species that are not present in Belgium but likely to become so in the near future, or that are present but not widely distributed, and are likely to cause environmental and/or socio-economic harm.

The scheme of this risk assessment is based upon the International Standards for Phytosanitary Measures, which are endorsed by the Food and Agriculture Organization of the United Nations (FAO 2004). It consecutively assesses the stages of entry, establishment, spread & ecological and/or economic impacts.

(Reference: FAO (2004) International Standard for Phytosanitary Measures No. 11: *Pest risk analysis for quarantine pests including analysis of environmental risks and living modified organisms.*)

(Cover picture taken from http://commons.wikimedia.org.)

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1 ABSTRACT

The brown dog tick (*Rhipicephalus sanguineus*) is the most widespread tick in the world and a well-recognized vector of many pathogens affecting dogs and occasionally humans. This tick can be found on dogs living in both urban and rural areas, being highly adapted to live within human dwellings and being active throughout the year not only in tropical and subtropical regions, but also in some temperate areas. Depending on factors such as climate and host availability, *R. sanguineus* can complete up to four generations per year. Recent studies have demonstrated that ticks exposed to high temperatures attach and feed on humans and rabbits more rapidly. This observation suggests that the risk of human parasitism by *R. sanguineus* could increase in areas experiencing warmer and/or longer summers, consequently increasing the risk of transmission of zoonotic agents (e.g., *Rickettsia conorii* and *Rickettsia rickettsii*) (Dantas-Torres 2010).

R. sanguineus is an endophilic (adapted to indoor living), monotropic (all developmental stages feed on the same host species), and three-host (each life stage requires a new host to feed on) tick species. However, although highly endophilic, *R. sanguineus* is also able to survive in outdoor environments, mainly if refuges such as limestone walls are available. Moreover, although monotropic, this tick can occasionally feed on other hosts (e.g. humans), which do not belong to its 'natural trophic chain'. These facts indicate that *R. sanguineus* is a catholic tick, being able to adopt different strategies for survival, as needed. When seeking a host, the brown dog tick is a hunter (host-seeking behaviour), although it can also adopt the ambush strategy (questing behaviour) (Dantas-Torres 2010).

R. sanguineus sensu strictu is a very host-specific species, infesting mostly dogs and occasionally some wild carnivores. However, the *R. sanguineus* spp. are three(2)-host-ticks, mostly found on African mammals including domestic ruminants. The different spp. are easily misidentified (Jongejan and Uilenberg 1994). Current concepts of tick phylogeny, taxonomy, and nomenclature are based on molecular analyses (Merck 2011).

2 ORGANISM IDENTITY AND DISTRIBUTION

2.1 ORGANISM IDENTITY

Scientific name:	*Rhipicephalus sanguineus* (Latreille 1806)
Synonyms:	(none known)
Common names:	Brown dog tick, kennel tick
Taxonomic position:	Arthropoda > Arachnida > Ixodida > Ixodidae

2.2 ORGANISM DISTRIBUTION

A/ Native range

The brown dog tick *Rhipicephalus sanguineus* is the most widespread tick in the world, even considering that many ticks currently identified as *R. sanguineus* might actually represent other closely related species (e.g., *Rhipicephalus turanicus*; Dantas-Torres 2010).

In tropical and subtropical areas, *R. sanguineus* ticks are prevalent throughout the year, whereas in temperate regions they are most active from the late spring to early autumn. *Rhipicephalus sanguineus* ticks can overwinter in the environment and even infest dogs during winter in some regions of temperate climate (e.g., south-eastern Oklahoma and north-western Arkansas, United States; Dantas-Torres 2010).

Rhipicephalus sanguineus is an endophilous tick, being usually found indoors crawling on carpets, walls, and furniture. However, it can also be abundant in peridomestic areas, as reported in eastern Arizona. They can be found walking on outside walls of houses, on the ground (between rocks), and inside cracks and crevices. Indeed, high levels of environmental infestation might increase the risk of human exposure to *R. sanguineus* and thus the risk of acquiring certain tick-borne pathogens, such as *R. rickettsia* (Dantas-Torres 2010).

The Brown dog tick or kennel tick is one of the most widely distributed ticks in the world. *Rhipicephalus sanguineus* is found in practically all countries between 50 degrees N and 35 degrees S latitude. Brown dog ticks can be found outdoors in the southern regions during any time of the year, and can be found outdoors during the warm months in the some northern regions. It is generally believed that this species of tick cannot overwinter in the more northern regions except within buildings with centralised heating (CVBD 2012).

Figure – From CDC (2012)

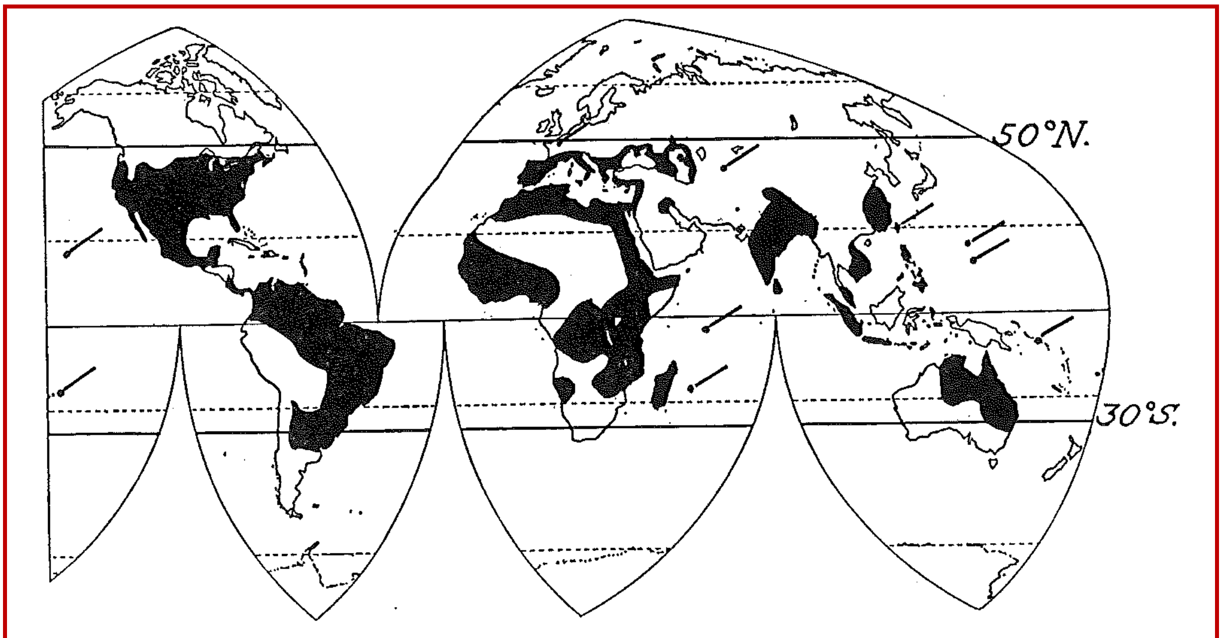

Fig. 1.—Recorded distribution of *Rhipicephalus sanguineus* to January, 1949.

Figure - Leeson 1951

B/ Introduced range

The best known African rhipicephalid, *R. sanguineus*, the kennel tick or brown dog tick, has spread worldwide with domestic dogs. It is now established in buildings as far north as Canada and Scandinavia and as far south as Australia (Merck 2011).

Belgium

Fain (1990) considers *R. sanguineus* not to be belong to the native fauna of Belgium. Yet, it is stated to frequently appear in countries north of its native Mediterranean range, including Belgium. See below for details.

Rest of Europe

Fain (1990) also lists the UK, Germany, Switzerland and the Netherlands as countries where *R. sanguineus* is sometimes encountered on dogs that have previously been in southern Europe.

Other continents

Given its cryptic nature, it is not always easy to disentangle native from alien regions, especially in the tropics?

3 RISK ASSESSMENT

3.1 PROBABILITY OF ESTABLISHMENT AND SPREAD

3.1.1 Present status in Belgium

Fain (1990) reviewed the ticks recorded within Belgium up to that date. The Belgian fauna comprises 16 species, four of which are considered alien (including *R. sanguineus*). Their collections represent about 10 cases of vectors carrying the tick (about 40 inviduals in total), mostly dogs but also one human, distributed over the country.

A recent map of Belgian observations has been provided by Obsomer et al. (2013). Compared to the figure below, very few observations are added.

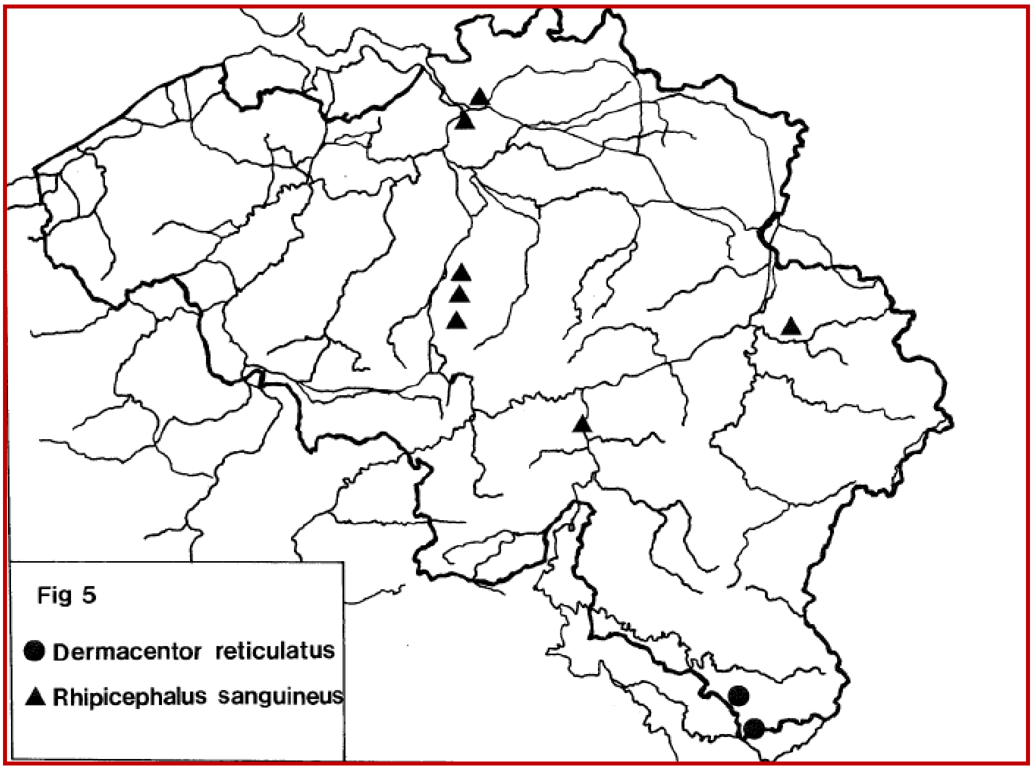

Figure – Distribution of *R. sanguineus* in Belgium, from Fain (1990).

3.1.2 Present status in neighbouring countries

UK - Featherstone et al (2012) reported the identification of a *R. sanguineus* brown dog tick, on a cross-bred, previously stray dog that had been imported from Greece in May 2012. However, there is no evidence to suggest that *R. sanguineus* is currently an endemic tick in the UK.

3.1.3 Introduction in Belgium

Global warming might prompt the establishment of tick populations in previously free areas. For instance, it has been speculated that an increase of about 2-3°C in the mean temperature from April to September could result in the establishment of populations of *R. sanguineus* in regions of northern temperate Europe. However, the actual impact of global warming on *R. sanguineus* ticks is uncertain (Dantas-Torres 2010).

Imported companion animals provide a route via which exotic ticks and their associated pathogens can be introduced (Featherstone et al. 2012; Jameson et al. 2010).

3.1.4 Establishment capacity and endangered area

A/ Life-cycle and reproduction

In Africa, the Near East, and parts of southern Europe, adult *R. sanguineus* parasitize wild and domestic carnivores, sheep, goats, camels, other livestock, and various wild mammals, especially hares and hedgehogs. Immatures in nature in this area feed on small mammals. However, in urban situations everywhere, dogs are virtually the only hosts of immatures and adults. Humans are attacked infrequently, more often in situations when children play and sleep in close contact with heavily infested dogs. Strains of adult *R. sanguineus* that feed on cattle are recorded in parts of Mexico and in Tahiti. This tick is active throughout the year in the tropics and subtropics but only from spring to fall in temperate zones. Newly active adults and nymphs are frequently seen climbing walls from floor-level cracks (Merck 2011).

Adult male ticks do not enlarge upon feeding as do females. Before feeding, adult female ticks resemble the males in size, shape and color. As they feed, females become engorged and swell. The legs, mouthparts and shield area behind the head remain red-brown, but the enlarged portion of the body becomes gray-blue to olive. The red-brown color is distinctive and no other tick normally encountered will be uniformly red-brown (CVBD 2012).

Egg-laying begins about three days after the engorged adult female drops from the dog. The female tick may deposit as many as 5,000 eggs in places such as between boards, under plaster or carpeting, or in other cracks and crevices. The eggs usually hatch in about three weeks, although up to several months may be required under particularly cool or dry conditions (CVBD 2012).

After hatching, the larvae wait months while waiting for a host. Once on the host, the larvae feed for about three days and then drop off. Molting occurs about one week after the blood meal, and nymphs emerge to climb vegetation or vertical surfaces to again wait for a host (CVBD 2012).

The feeding of the nymphs will last about four days, after which they again to drop off and molt into the adult stage. Adults can live up to 1 1/2 years, without feeding, but must feed before mating. After mating, the female completely engorges herself with blood and then drops off the host to lay eggs (CVBD 2012).

The adults commonly attach to the ears and between the toes and the larvae and nymphs are often found in hair along the back. While these developmental stages are often found on the indicated host body regions, they are not restricted to these regions and may be found on practically any part of the dog's body (CVBD 2012).

Each female produces about 1500-4000 eggs during several weeks. Egg incubation ranges from 6 days to some weeks, hatched larvae start searching for a host after 7 days, the pre-moulting period lasts some days to weeks (depending on T°) while moulting takes place in hours (Dantas-Torres 2010).

More details and tables on life cycle and reproduction for R. sanguineus can be found in Beugnet et al. (2009) and in Jacobs et al. (2004).

B/ Climatic requirements

It has been shown that *R. sanguineus* can develop well under different conditions in terms of temperature (e.g., 20-35°C) and relative humidity (e.g., 35-95%). In ideal, tropical, climatic conditions, 3 to 4 tick generations can be observed in 1 year. In tropical climates, the ticks are active all year round, whereas in temperate regions only from late Spring to early Autumn (Dantas-Torres 2010).

Brazil and Mexico are examples where 2,5(-3) generations per year can complete their lifecycle, due to tropical, typically warm and semi-humid weather and alternate, rainy vs. dry seasons. There is a positive correlation between tick prevalence and rainfall in these areas (during spring, summer and autumn) and with temperature (in winter; Silveira et al. 2009).

Several phases of the lifecycle are temperature or humidity dependent: e.g. egg hatching is not possible at 8°C, laying eggs is possible between 15-40°C, low temperatures show a positive correlation with pre-oviposition period length and a negative correlation with hatch rate, longevity and reproductive fitness index (Dantas-Torres & Otranto 2011).

When T° drops below 18°C and/or when relative humidity drops below 50%, the lifecycle is severely limited or stopped (Silveira et al. 2009). Diapause sets in when temperatures drop to 10°C or below (Dantas-Torres 2010).

In tropical climates, the ticks are active all year round, whereas in temperate regions only from late spring to early autumn (Dantas-Torres 2010).

While global warming might affect the survival of some tick species that are adapted to live in humid environments (e.g., Atlantic rainforest), it will probably have only a minor (if any) negative impact on ticks like *R. sanguineus* that are less dependent upon a moisture-rich habitat for survival and more resistant to desiccating conditions (Dantas-Torres 2010).

On the contrary, the global warming might prompt the establishment of tick populations in previously free areas. For instance, it has been speculated that an increase of about 2-3°C in the mean temperature from April to September could result in the establishment of populations of *R. sanguineus* in regions of northern temperate Europe. Though the actual impact of global warming on *R. sanguineus* ticks is uncertain, further spread would expose more human hosts to this tick (Dantas-Torres 2010).

More details and tables on climatic requirements and influences on *R. sanguineus* can be found in Beugnet et al. (2009,) in Jacobs et al. (2004) and in Dantas-Torres & Otranto (2011).

C/ Habitat preferences

Most of the ticks are not found on the dog but in the environment. As a typical three-host-tick, *R. sanguineus* spends most of its lifetime in the environment, where it is under direct influence of several biotic (e.g., predators) and abiotic (e.g., weather condition) factors (Dantas-Torres 2010).

Rhipicephalus sanguineus is an endophilous tick, being usually found indoors crawling on carpets, walls, and furniture. However, it can also be abundant in peridomestic areas, as reported in eastern Arizona. They can be found walking on outside walls of houses, on the ground (between rocks), and inside cracks and crevices (Dantas-Torres 2010).

The Brown dog tick is almost exclusively a parasite of dogs. When individuals of each feeding stage become fully engorged, they drop from the host and seek some protected situation in the immediate surroundings. For this reason, all tick life stages may be found behind baseboards, under window and door moldings, in window pulley openings or in furniture. A home can become heavily infested with ticks are encountered crawling on carpeting, walls and sometimes furniture (CVBD 2012).

Dogs do not become infested with Brown Dog ticks by direct contact with other dogs. Ticks feeding on a dog drop off and molt before they will resume host-seeking behaviour and attach to another dog. By far the most common host is the domestic dog – especially those housed in kennels. In the United States *R. sanguineus* seems virtually to be restricted to the domestic dog, while in other parts of the world this tick seems to have a somewhat wider range of hosts (CVBD 2012).

D/ Feeding habits

The feeding period ranges from 2 days (larvae) to several weeks (females). Nymphs also feed longer than larvae. Males tend to move to other hosts for multiple feeds or can also remain on dog for a long time. Females require the presence of a male for full engorgement and drop off. Drop-off is diurnal for larvae diurnal, while nocturnal for nymphs and females (preferably into dog's bed) (Dantas-Torres 2010).

E/ Natural control agents

Natural *R. sanguineus* predators include spiders, birds and wasps (Dantas-Torres 2010).

The hymenopteran (chalcid) parasite of ticks, *Hunterellus hookeri*, frequently infests nymphal *R. sanguineus* in East Africa. Engorged ticks may also become parasitized by the larvae of some wasps (Hymenoptera), but these have not significantly reduced tick populations (Merck 2011).

Destruction of the required microhabitats reduces the abundance of ticks. Predators, including birds, rodents, shrews, ants, and spiders, play a role in some areas in reducing the numbers of free-living ticks (Merck 2011).

F/ Establishment capacity in Belgium

This tick is capable of establishing in domestic settings in Western Europe (Featherstone et al. 2012).

Temperature is a major limiting factor for the establishment or *R. sanguineus* populations in colder temperate regions (Dantas-Torres & Otranto 2011).

It is generally believed that this species of tick cannot overwinter in the more northern regions except within buildings with centralised heating (CVBD 2012).

G/ Endangered areas in Belgium

In an epidemiological study carried out in Marseille (France) it was observed that dense centres of housing were much less favourable for *R. sanguineus* ticks than scattered ones. Furthermore, it was observed that houses with gardens were more a suitable biotope for *R. sanguineus* than the environment of large buildings. Similar results have been obtained in Japan, where dogs that had contact with a garden (two weeks prior to examination) had a higher chance of being infested by *R. sanguineus*. Furthermore, in the same Japanese study, this tick was most frequently associated with dogs from urban and suburban areas (Dantas-Torres 2010).

3.1.5 Dispersal capacity

A/ Natural spread

N/A

B/ Human assistance

Travelling companion animals provide a route via which exotic ticks and their associated pathogens can be introduced into non-endemic areas (e.g. UK). There is little information on the importation of exotic disease vectors via companion animals. The possible effects of climate change on the survival of exotic tick species in the UK, and existing evidence for the geographical expansion of previously exotic pathogens within Europe, further suggest an increased risk to veterinary and public health should such importations occur frequently (Jameson et al. 2010).

In the UK, between 1976 and 2009, a total of 64 *R. sanguineus* ticks were collected from imported dogs in several quarantine stations across the country. These ticks were introduced from various locations around the globe, such as: Abu Dhabi, Ghana, Libya, Mozambique, Malawi, Nigeria, Sierra Leone, Zambia, Australia, Canada, Iran, Malta, Philippines, Saudi Arabia, Singapore, South Africa, Spain, St Lucia, Tunisia, USA, West Indies, and Cyprus (Jameson et al. 2010).

3.2 EFFECTS OF ESTABLISHMENT

3.2.1 Environmental impacts

The Brown dog tick is a putative vector of *Ehrlichia canis*, a gram-negative, intracellulear bacterium that causes canine ehrlichiosis. Other pathogens are *Babesia vogeli*, a protozoan parasite that causes canine babesiosis, *Rickettsia rickettsii*, the causative agent of Rocky Mountain spotted fever (RMSF), and other *Rickettsia* species such as *R. belli*, *R. rhipicephali* and *R. montana* (CVBD 2012).

R. sanguineus is a vector of *Babesia canis*, *Ehrlichia canis*, *Rickettsia rickettsii*, *R. rhipicephali*, *R. conorii*, Crimean-Congo hemorrhagic fever virus, and Thogoto virus. In southcentral USA, R sanguineus is associated with scattered foci of *Leishmania mexicana* (Merck 2011).

3.2.2 Animal health impacts

This tick is a parasite of dogs that can occasionally parasitize other hosts, including humans. Moreover, *R. sanguineus* is a vector of many disease agents, some of them (e.g., *Coxiella burnetii*, *Ehrlichia canis*, *Rickettsia conorii*, and *Rickettsia rickettsii*) being of zoonotic concern. Due to its veterinary and public health relevance, *R. sanguineus* is one of the most studied ticks (Dantas-Torres 2010).

In tropical endemic areas, the prevalence in free-ranging dogs can be as high as 80%. Urban dogs, young dogs and males are more infested than rural dogs, older dogs and females respectively. In dogs, the mean infestation rate can range from 3,8-39,4, being higher during the dry season (Dantas-Torres 2010).

R. sanguineus is a vector of canine babesiosis (Featherstone et al. 2012).

R. sanguineus sensu stricto is a vector of *Babesia canis* in dogs and also of *Ehrlichia canis*, the cause of tropical pancytopaenia in dogs, a severe rickettsial disease which occurs worldwide (Jongejan & Uilenberg 1994).

3.2.3 Plant health impacts

N/A

3.2.4 Human health impacts

This tick is a parasite of dogs that can occasionally parasitize other hosts, including humans. Moreover, *R. sanguineus* is a vector of many disease agents, some of them (e.g., *Coxiella burnetii*, *Ehrlichia canis*, *Rickettsia conorii*, and *Rickettsia rickettsii*) being of zoonotic concern. Due to its veterinary and public health relevance, *R. sanguineus* is one of the most studied ticks (Dantas-Torres 2010).

R. sanguineus is a vector of Mediterranean spotted fever in people, caused by *Rickettsia conorii* (Featherstone et al. 2012).

The brown dog tick is an ectoparasite of public health significance, being involved in the transmission of major human pathogens, as it is the case of *R. rickettsia*. High levels of environmental infestation might increase the risk of human exposure to *R. sanguineus* and thus the risk of acquiring certain tick-borne pathogens, such as *R. rickettsii* (Dantas-Torres 2010).

This species is also a vector of classical tick-bite fever in humans (due to *Rickettsia conorïi*) (Jongejan & Uilenberg 1994).

Though the actual impact of global warming on *R. sanguineus* ticks is uncertain, further spread would expose more human hosts to this tick (Dantas-Torres 2010).

4 CONTROL

The main reasons for tick control are to protect hosts from irritation and production losses, formation of lesions that can become secondarily infested, damage to hides and udders, toxicosis, paralysis, and of greatest importance, infection with a wide variety of disease agents. Control also prevents the spread of tick species and the diseases they transmit to unaffected areas, regions, or continents. One can distinguish "Cultural and Biologic Control", "Chemical Control", "Vaccines" for the control strategies (Merck 2011).

Prospects of developing vaccines against ixodid tick vectors of diseases of major veterinary importance are not clear. When wild hosts of the vector ticks serve as reservoirs of these disease agents, vaccines against vector ticks may be unable either to eradicate the ticks or to eliminate important sources of the disease agents they transmit (Merck 2011).

Control of ticks with acaricides may be directed against the free-living stages in the environment or against the parasitic stages on hosts. Dog kennels, barns, and human dwellings may also require periodic treatment with acaricides to control the free-living stages of ixodid ticks such as the kennel tick, *R. sanguineus*. Treatment of hosts with acaricides to kill attached larvae, nymphs, and adults of ixodid has been the most widely used control method. In the first half of the 20th century, the main acaricide was arsenic trioxide. Subsequently, organochlorines, organophosphates, carbamates, amidines, pyrethroids, and avermectins have been used in different parts of the world. The introduction of new compounds, such as the phenylpyrazoles, has been necessary because of the development of resistance in tick populations (Merck 2011).

Correctly administered acaricide treatments are intended to minimise rather than eradicate the risk of imported exotic ticks. Tick controls could not be expected to completely eliminate the risk due to a degree of acaricide resistance in some tick populations. However, preventive treatment provides an important contribution to limiting exotic tick importations, and as UK data show, relaxation of tick control is likely to lead to an increased occurrence of importations of exotic species, most notably R. sanguineus (Jameson et al. 2010).

Treatment of companion animals for ticks is still recommended as best practice for pet owners when returning from abroad (Featherstone et al. 2012).

Initially the main uses of acaricides were tick eradication, prevention of spread of ticks and tickborne diseases (quarantine), and eradication and control of tickborne diseases. Eradication programs may be successful in some ecologically marginal areas, but less/unsuccessful in the ecologically more favorable areas. In the areas where eradication is not achieved, the costs of maintaining intensive tick control programs often become prohibitive and integrated biologic and chemical control strategies are being adopted. Strict quarantine measures to prevent reintroductions are enforced in countries from which ticks and tickborne diseases have been eradicated (Merck 2011).

The UK runs a tick surveillance scheme and encourages veterinary colleagues to submit ticks retrieved from both native and imported animals for identification either to the AHVLA or via the UK Tick Recording Scheme, run by the Health Protection Agency (HPA). This service is offered free of charge (Featherstone et al. 2012).

Climate-matching models, geographic information systems, and expert systems (models based on expert knowledge and artificial intelligence) are being used to identify unaffected areas in which tick pests could become established if introduced (Merck 2011).

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